UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

Laboratory Services and Applied Science Division
Quality Assurance and Support Branch
980 College Station Road
Athens, Georgia 30605-2720

June 16, 2022

Mr. Patrick Butler
North Carolina Department of Environmental Quality
Division of Air Quality (DAQ)
Green Square Office Complex
217 West Jones Street
Raleigh, NC 27699-1641

Project Number: 22-0214

Mr. Butler:

We have reviewed the following document submitted for approval:

Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality Particulate Matter (PM) Monitoring Program, Revision 3, May 26, 2022.

The quality assurance and technical elements within this QAPP were compared to EPA regulations and current guidance. EPA acknowledges that, per Section 16 of the referenced QAPP, NC DAQ is currently working with its contract laboratory, RTI International, to complete a revision of the RTI Microgravimetric Weighing of Particulate Matter QAPP, which is included in the NC PM QAPP as Appendix A. EPA further notes that, per Section 16, RTI has agreed to perform all gravimetric analyses in conformance with EPA protocols, including Quality Assurance Guidance Document 2.12, *Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods* (EPA-454/B-16-001, January 2016). Therefore, EPA approval of the NC PM QAPP is granted. EPA requests to receive an updated version of the QAPP once the RTI QAPP revision has been completed.

Please be aware that approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring that the particulate monitoring program (including the contract laboratory) adheres to all the applicable requirements detailed in 40 CFR Parts 50, 53, and 58, and that the data generated is of sufficient quality to be used for regulatory decision-making purposes. This QAPP, including the laboratory appendices, should be reviewed internally by NC DAQ on an annual basis and revised when procedures change. At a minimum, the QAPP must be revised within five years.

If you have any questions, please contact Tony Bedel at 706-355-8552 or via email at bedel.anthony@epa.gov.

Sincerely,

KEITH HARRIS

Digitally signed by KEITH HARRIS
Date: 2022.06.16 15:13:58 -04'00'

Keith Harris, Chief
Quality Assurance Section

Enclosure

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
MICHAEL ABRACZINSKAS
Director

NORTH CAROLINA
Environmental Quality

DAQ-01-005
Quality Assurance Project Plan for the North Carolina Division of Air Quality Particulate Matter Monitoring Program

Prepared for:

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Submitted by:

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1641 Mail Service Center
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NORTH CAROLINA
Department of Environmental Quality

DISCLAIMER

This Quality Assurance Project Plan (QAPP) covers the particulate matter (PM) monitoring network for the North Carolina Department of Environmental Quality Division of Air Quality (DAQ) and the Asheville-Buncombe Air Quality Agency (ABAQA). Throughout this document, the term “DAQ” includes this local program by reference.

Quality Assurance Project Plan Acronym Glossary

ABAQA – Asheville-Buncombe Air Quality Agency
ABS - acrylonitrile-butadiene-styrene
ADQ - Audit of data quality
AMS – Ambient Monitoring Section
AMTIC – Ambient Monitoring Technology Information Center
AQI – Air Quality Index
AQS - Air Quality System (EPA's Air database)
ARM – Air Resources Manager
ASC – Aerosols Sample Conditioner
BAM – Beta attenuation monitor
CAA – Clean Air Act
CAPA - corrective action preventative action
CFR – Code of Federal Regulations
Chief – Ambient Monitoring Section chief
COC – Chain of custody
CV – Coefficient of variation
DAQ - North Carolina Division of Air Quality
DAS – Data acquisition system
°C – degrees Celsius
DEHNR – North Carolina Department of Environment, Health and Natural Resources (1989-1997)
DENR – North Carolina Department of Environment and Natural Resources (1997-2015)
DEQ – North Carolina Department of Environmental Quality (2015 to present)
DFU – Disposable Filter Unit
Director – DAQ director
DIT – North Carolina Department of Information Technology
DNER – North Carolina Department of Natural and Economic Resources (1971-1977)
DNRCD – North Carolina Department of Natural Resources and Community Development (1977-1989)
DQA - Data quality assessment
DQI - Data quality indicators
DQO - Data quality objectives
DV – Design value
EBCI – Eastern Band of Cherokee Indians
ECB – Electronics and Calibration Branch
e-log – electronic logbook
email – electronic mail
EPA – United States Environmental Protection Agency
FEM – Federal equivalent method
FRM – Federal reference method
FTP – file transfer protocol
FTS - Flow Transfer Standard
HTML – Hypertext Markup Language
IBEAM – Internet-Based Enterprise Application Management
ID - identity
IDL – Instrument Detection Limit
JSP – Java Server Page
km – Kilometers
LAB – Laboratory Analysis Branch
LC – Local conditions
LED – light emitting diode
LMS – North Carolina Learning Management System
LPM -Liters per minute
LSASD – Laboratory Services and Applied Science Division
m – Meters
MDL – Method Detection Limit mg – Milligrams
µg - micrograms
µg/m^3 – micrograms per cubic meter
µm - micrometers
MQO – Measurement quality objective
NAAQS - National ambient air quality standards
NCore- National Ambient Air Monitoring Strategy - National Core Monitoring
NIST - National Institute of Standards and

Technology
OAQPS – EPA's Office of Air Quality Planning and Standards
OSHA – Occupational Safety and Health Administration
pdf = portable document format
PEP – Performance evaluation program
PM – Particulate matter
$PM_{2.5}$ – Particles with an average aerodynamic diameter of 2.5 microns or less, also known as fine particles
PM_{10} – Particles with an average aerodynamic diameter of 10 microns or less
PM_{10c} or $PM_{10-2.5}$ – Coarse particles defined as particles with an average aerodynamic diameter of 10 microns or less (PM_{10}) but greater than 2.5 microns ($PM_{2.5}$) generally measured by subtracting $PM_{2.5}$ measured at local conditions from PM_{10} measured at local conditions.
PPB – Projects and Procedures Branch
PQAO – Primary quality assurance organization
QA – Quality assurance
QA Handbook – EPA Quality Assurance Handbook for Air Pollution Measurements Systems, Volume II
QAM – Quality assurance manager
QA/QC - Quality assurance/quality control
QAO –Quality Assurance Officer
QAPP - Quality assurance project plan
QC – Quality control
QMP – Quality management plan
RCO – Raleigh central office
RDBMS – Relational Database Management System
RH – relative Humidity
RMC – Regional Monitoring Coordinator
RTI – RTI, International
SD – standard deviation
SLAMS - state and local air monitoring station
SOP - standard operating procedure
SQL – Structured Query Language
Statistician – Raleigh central office statistician
STP – standard temperature and pressure, which is 25 degrees Celsius and 760 millimeters mercury
TSA - technical systems audit
TSP – total suspended particles
USB – universal serial bus
VIP – valuing individual performance
VSCC – very sharp cut cyclone

1.0 Quality Assurance Project Plan Identification and Approval

Title: *DAQ-01-005 Quality Assurance Project Plan for the North Carolina Division of Air Quality PM Monitoring Program, Revision 3*

The Division of Air Quality hereby recommends the attached *DAQ-01-005 Quality Assurance Project Plan for the North Carolina Division of Air Quality PM Monitoring Program, Revision 3* for approval and commits the State of North Carolina, Department of Environmental Quality, Division of Air Quality to follow the elements described within.

Department of Environmental Quality:

1. **Signature:** DocuSigned by: Michael Abraczinskas D5013FED0218423... **Date** 5/25/2022
   Air Quality Division Director

2. **Signature:** DocuSigned by: Patrick Butler 4290A7E2D2A0429... **Date** 5/25/2022
   Quality Assurance Manager
   (Ambient Monitoring Section Chief)

3. **Signature:** DocuSigned by: Jim Bowyer C96894826C9B41D... **Date** 5/25/2022
   Laboratory Analysis Branch Supervisor

4. **Signature:** DocuSigned by: B278F8186CEC4DC... **Date** 5/25/2022
   Projects and Procedures Branch Supervisor

5. **Signature:** DocuSigned by: Travis Funderburk BDD86579E9314CD... **Date** 5/25/2022
   Primary QAPP Author, Environmental Chemist

Asheville-Buncombe Air Quality Agency:

1. **Signature:** DocuSigned by: Ashley Featherstone 136FFC59677948E... **Date** 5/25/2022
   Asheville-Buncombe Air Quality Agency Director

United States Environmental Protection Agency:

7. **Signature:** KEITH HARRIS Digitally signed by KEITH HARRIS Date: 2022.06.16 15:14:50 -04'00' **Date** _____
   EPA Region 4 Designated Approving Official

2.0 Table of Contents

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3.0 Distribution

Table 1 lists the primary recipients of this QAPP. In accordance with the organizational chart presented in Figure 1, the people on this distribution list ensure and document that the ABAQA monitoring staff, regional monitoring technicians and coordinators, Electronics and Calibration Branch, or ECB, electronics technicians, Laboratory Analysis Branch, or LAB, chemists and technicians, Raleigh Central Office, or RCO, chemists and statistician and any other personnel involved with this project have read and understood this QAPP. The Ambient Monitoring Section (AMS) chief, or chief, will post the official QAPP after it receives United States Environmental Protection Agency (EPA) approval on the Department of Environmental Quality, or DEQ, website and send a link to it via electronic mail (i.e., email) to everyone on this distribution list.

Table 1. DAQ Ambient Air Quality Monitoring Program QAPP Distribution List

Name/Position	Address	Phone and email
Michael Abraczinskas, Director	Division of Air Quality 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8447 michael.abraczinskas@ncdenr.gov
Patrick Butler, Ambient Monitoring Section Chief and Quality Assurance Manager	Division of Air Quality Ambient Monitoring Section 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8719 patrick.butler@ncdenr.gov
Heather Carter, Fayetteville Regional Office Air Quality Supervisor	Fayetteville Regional Office 225 Green Street, Suite 714 Fayetteville, NC 28301	(910) 433-3363 Heather.Carter@ncdenr.gov
Brendan Davey, Asheville Regional Office Air Quality Supervisor	Asheville Regional Office 2090 U.S. Highway 70 Swannanoa, NC 28778	(828) 296-4500 brendan.davey@ncdenr.gov
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Betsy Huddleston, Washington Regional Office Air Quality Supervisor	Washington Regional Office 943 Washington Square Mall Washington, NC 27889	(252) 948-3836 betsy.huddleston@ncdenr.gov
Brad Newland, Wilmington Regional Office Air Quality Supervisor	Wilmington Regional Office 127 Cardinal Drive Extension Wilmington, NC 28405	(910) 796-7215 brad.newland@ncdenr.gov
Ray Stewart, Winston- Salem Regional Office Air Quality Supervisor	Winston-Salem Regional Office 450 West Hanes Mill Rd, Suite 300 Winston-Salem, NC 27105	(336) 776-9800 Ray.Stewart@ncdenr.gov
Melinda Wolanin, Mooresville Regional Office Air Quality Supervisor	Mooresville Regional Office 610 East Center Avenue, Suite 301 Mooresville, NC 28115	(704) 663-1699 Melinda.Wolanin@ncdenr.gov
James Bowyer, Laboratory Analysis Branch Supervisor	Division of Air Quality Lab Analysis Branch 1622 Mail Service Center Raleigh, NC 27699-1622	(919) 715-7484 jim.bowyer@ncdenr.gov

Table 1. DAQ Ambient Air Quality Monitoring Program QAPP Distribution List

Name/Position	Address	Phone and email
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Joette Steger, Projects and Procedures Branch Supervisor	Division of Air Quality Projects and Procedures Branch 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8449 joette.steger@ncdenr.gov
Steven Rice, Database Manager	Division of Air Quality 1641 Mail Service Center Raleigh, NC 27699	(919) 715-7220 steven.rice@ncdenr.gov
Ryan Brown, EPA Region 4 State Contact	U.S. Environmental Protection Agency, Region 4 Air and Radiation Division 61 Forsyth Street, S.W. Atlanta, GA 30303-8960	(404) 562-9147 Brown.ryan@Epa.gov
Ashley Featherstone, Asheville-Buncombe Air Quality Agency Director	Asheville Buncombe Air Quality Agency P.O. Box 2749 Asheville, NC 28802	(828) 250-6777 ashley.featherstone@buncombecounty.org
Caroline Freeman, EPA Region 4 Director, Air and Radiation Division	U.S. Environmental Protection Agency, Region 4 Air and Radiation Division 61 Forsyth Street, S.W. Atlanta, GA 30303-8960	(404) 562-8975 Freeman.Caroline@epa.gov
Kevin Simmons, Acting Quality Assurance Section Chief	U.S. Environmental Protection Agency, Region 4 Laboratory Services and Applied Science Division 980 College Station Road Athens, GA 30605-2720	706-338-2872 simmons.kevin@epa.gov

4.0 Project/Task Organization

The EPA is responsible for developing the national ambient air quality standards or NAAQS defining the quality of data necessary to make comparisons to the NAAQS and identifying a minimum set of quality control (QC) samples from which to judge the data quality. The state and local air monitoring organizations are responsible for taking this information and using it to develop and implement a quality assurance, or QA, program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate.

The State of North Carolina Division of Air Quality, or DAQ, ambient air monitoring program is an independent primary QA organization, or PQAO, as defined in 40 Code of Federal Regulations (CFR) Part 58, Appendix A, Section 1.2. The DAQ operates the PM monitoring program as part of the DAQ PQAO.

The DAQ director, or director, has organized the AMS into three main branches: the Projects and Procedures Branch (PPB), the LAB and the ECB. The chief has responsibility for managing these branches per stated policy. The chief delegates the responsibility and authority to develop, organize, maintain and implement quality programs to the supervisors of each branch, in accordance with the EPA-approved quality management plan (QMP). These supervisors have direct responsibility for assuring data quality. The AMS shares the monitoring responsibilities with regional monitoring staff in the seven regional offices (Asheville, Mooresville, Winston-Salem, Fayetteville, Raleigh, Washington and Wilmington) shown in Figure 1, as well as with the Asheville-Buncombe Air Quality Agency, or ABAQA, shown in Figure 2, which is under the DAQ PQAO.

Figure 1. Division of Air Quality Regions

Figure 2. Asheville-Buncombe Air Quality Agency
(jurisdiction shown in gray)

The AMS also provides gravimetric laboratory analysis (through contract lab RTI, International or RTI) and technical assistance (upon request) to the Forsyth (shown in Figure 3) and Mecklenburg (shown in Figure 4) County local programs. The DAQ provides the Air Quality Program of the Eastern Band of Cherokee Indians (EBCI) shown in Figure 5 the same support and data as the local county programs, with the addition of performing quarterly audits for their network.

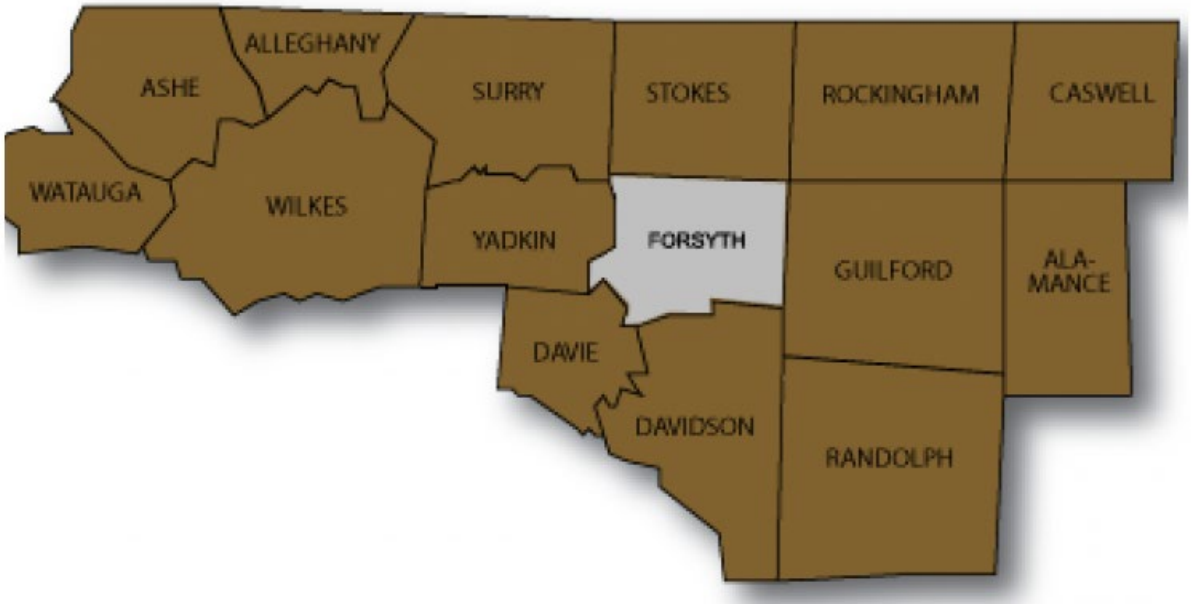


Figure 3. Forsyth County Local Program
(jurisdiction shown in gray)

Figure 4. Mecklenburg County Local Program
(jurisdiction shown in gray)

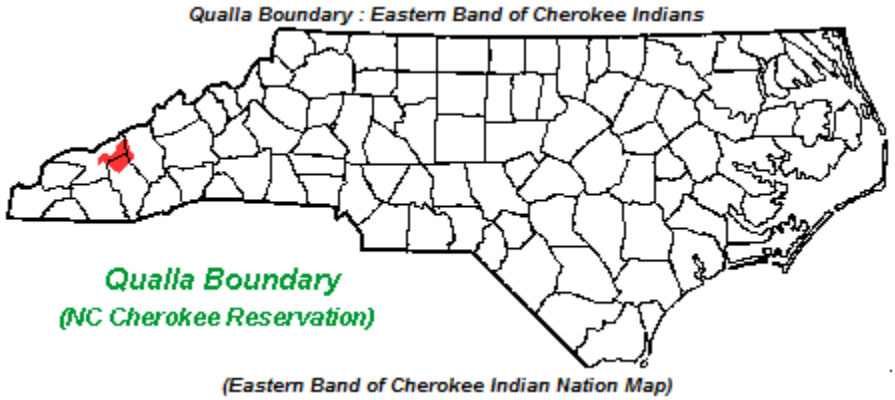
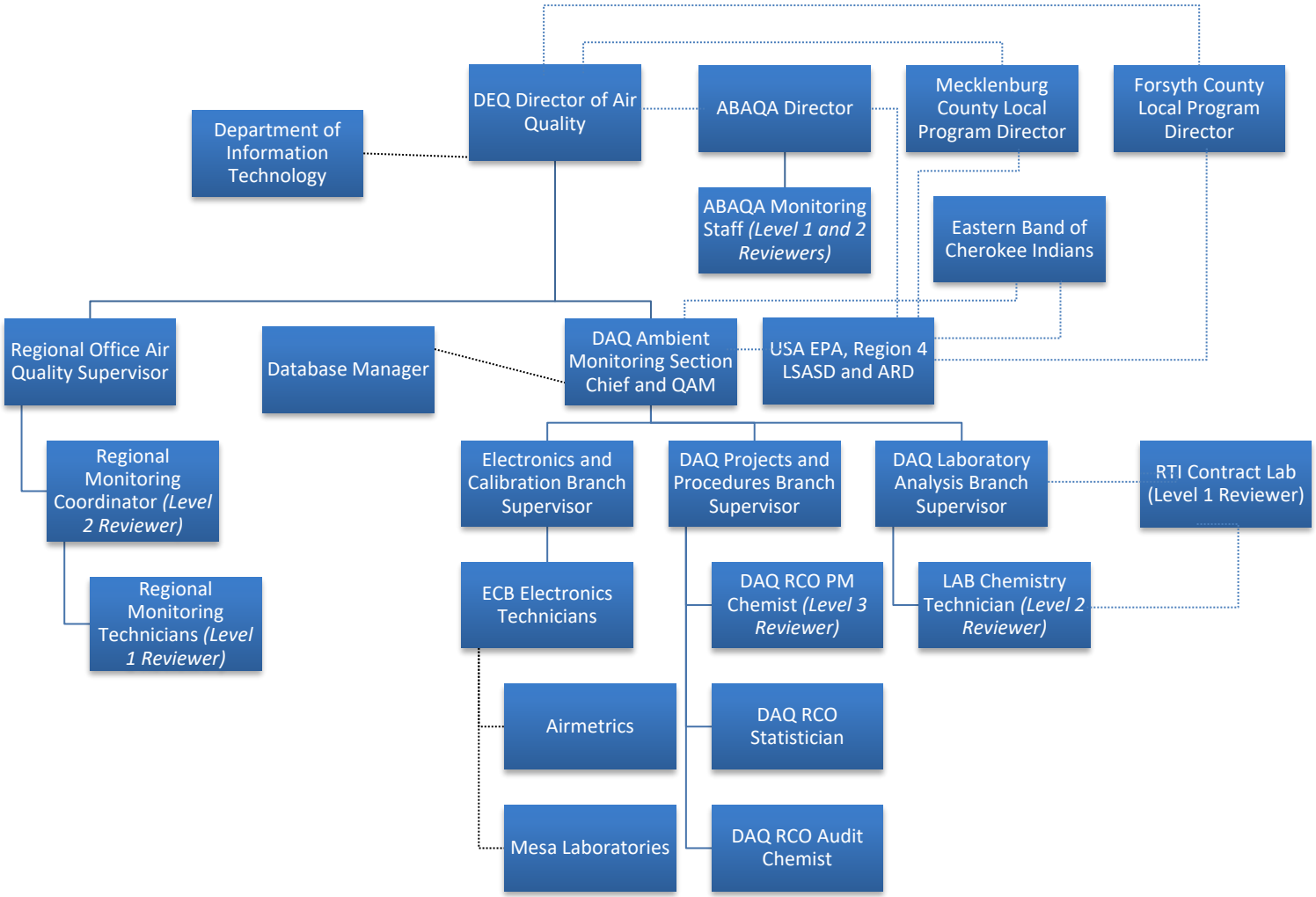


Figure 5. Eastern Band of Cherokee Indian Tribal Program
(jurisdiction shown in red)

Figure 6 displays the organizational structure for the implementation of the monitoring program. The following information lists the specific responsibilities of each significant position within the DAQ AMS and the regional offices and local programs.

Figure 6. Project Organizational Chart



4.1 DAQ Director, also known as Director

The director supervises the chief and regional office air quality supervisors. The director is responsible for ensuring adequate human and financial resources are available to support DAQ's PM monitoring program. The director has ultimate responsibility and final authority on all aspects of the PM monitoring program. The director has the authority to stop or resume work. In the event of an emergency or inclement weather, the director implements the Continuity of Operations Plan, including the hurricane readiness procedures. The director also serves as a liaison with other divisions in DEQ, with the North Carolina General Assembly, the North Carolina Department of Information Technology (DIT), and with other regional air-monitoring organizations.

4.2 Ambient Monitoring Section

The AMS contains the PPB, the LAB and the ECB and is responsible for coordinating the QA, data collection, sample collection and analysis, and data processing aspects of DAQ's PM monitoring program.

Ambient Monitoring Section Chief, or Chief: The chief serves as the QA manager (QAM) and reports to and has direct access to the director on all matters relating to DAQ's PM ambient monitoring program. The chief has ultimate authority for the program's data quality. The chief's duties include, but are not limited to the following:

- Serving as the QAM and maintaining oversight of all QA activities;
- Supervising the AMS staff and delegating responsibilities as appropriate;
- Serving as the liaison to EPA Region 4 air quality monitoring staff;
- Maintaining overall responsibility for the monitoring network design and review, subject to the director's approval, including oversight and approval of the annual network plan and five-year assessment;
- Authorizing the installation and discontinuation of monitors within the network;
- Approving and distributing division standard operating procedures, or SOPs, and QAPPs to the personnel listed in Table 1;
- Serving as the tie-breaker in the event of an impasse on how to handle corrective actions or make a final judgment call on data validity;
- Collaborating with DEQ staff in developing, administering and maintaining the QMP;
- Overseeing training for the ambient monitoring staff;
- Certifying the data every year in accordance with 40 CFR Section 58.15;
- Reviewing the quarterly QA reports and the QC summaries to ensure the bias and precision limits are attained;
- In the role of QAM, the Chief is responsible for ensuring that the agency's documents and records are properly stored and maintained in accordance with Section 9 of this document;
- Tracking corrective actions and determining their success;
- Participating in systems audits;

- Assuring that QAPPs are established and effectively implemented for each project as applicable; and
- Reviewing budgets, contracts, grants and proposals.

If the chief is unavailable to perform these duties, the chief will assign someone to fulfill these duties, or if the chief is unable to make that assignment, the director will assign someone to fulfill these duties.

Database Manager: Although the database manager does not report directly to the chief, he has direct access to the chief on all matters relating to the management of DAQ's PM ambient-air monitoring database. The database manager's duties include, but are not limited, to the following:

- Maintaining the RCO data polling station (i.e., Envista Air Resources Manager, or ARM), ensuring it polls hourly data for each hour of every day;
- Ensuring correct data are transferred to the DAQ Internet-Based Enterprise Application Management, or IBEAM, database and DAQ real-time air quality data webpage;
- Acting as the data-acquisition system manager for the continuous PM monitoring program;
- Participating in systems audits;
- Uploading environmental data to the EPA's Air Quality System (AQS) and AirNow-Tech databases;
- Serving as the AQS administrator for DAQ;
- Maintaining and updating the RCO data polling software and AQS database when sites and monitors are established or shut down; and
- Accomplishing other duties as assigned.

4.2.1 Projects and Procedures Branch

Project and Procedures Branch Supervisor: The PPB Supervisor reports to the chief. This supervisor's duties include the following:

- Directing and supervising the activities of the branch staff;
- Assisting the chief with preparing the annual network plan each year, and the 5-year network assessment;
- Supporting and assisting the QAM in providing oversight of all PM QA activities;
- Communicating with the QAM to bring to the attention of the QAM QA matters needing attention;
- Verifying implementation of all AMS QAPPs and procedures;
- Participating in systems audits;
- Responding to public records requests and statistical consulting requests;
- Ensuring training availability and utilization;
- Approving and implementing procedures; and
- Performing other duties as assigned.

Raleigh Central Office PM Chemist (level three reviewer): The RCO PM chemist reports to the PPB Supervisor and is responsible for coordinating the activities of the PM monitoring program. The RCO PM chemist's duties include the following:

- Organizing the collection, validation and reporting of air monitoring PM data through the use of DAQ's electronic logbooks, or e-logs, and correspondence with the ABAQA monitoring staff and regional monitoring technicians and coordinators;
- Assessing the effectiveness of the network quality assurance and quality control (QA/QC) system to ensure it is appropriate and effective;
- Assisting the regional offices and the ECB in data quality problems and prescribing corrective actions;
- Coordinating with the regional and ECB staff the writing, revising and maintaining of SOP updates, including documenting annual SOP and QAPP reviews;
- Validating data by serving as the level 3 reviewer;
- Verifying that all required QA/QC activities are performed and that measurement quality standards are met;
- As the level 3 data reviewer, maintaining QA/QC records, flagging suspect data, and assessing and reporting on data quality;
- Participating in systems audits;
- Identifying data quality problems and initiating corrective actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Performing other duties as assigned.

Raleigh Central Office Audit Chemist (data quality auditor): The RCO audit chemist reports to the PPB supervisor and is responsible for assessing, auditing and evaluating the DAQ PM monitoring program. The RCO audit chemist's duties include the following:

- Assessing the effectiveness of the network system;
- Tracking and ensuring RCO chemists document SOP and QAPP annual reviews and updates;
- Verifying that all required QA/QC activities are performed, that measurement quality standards are met, and decisions are documented;
- Maintaining QA/QC records and assessing and reporting on data quality;
- Conducting quarterly completeness evaluations and audits of data quality (ADQs);
- Planning and conducting data quality assessments, or DQAs, based on interpretation of data;
- Participating in systems audits;
- Conducting internal systems audits, as needed;
- Identifying data quality problems and initiating corrective actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Performing other duties as assigned.

Raleigh Central Office Statistician: The RCO statistician, or statistician, reports to the PPB supervisor. The statistician provides statistical programming support to the PPB supervisor, and other staff of the RCO and regional offices. The statistician's duties include the following:

- Assisting the branch supervisor with responding to consulting and data requests;
- Participating in training and certification programs to keep current on technology;
- Interpreting data;
- Developing each business day and maintaining statistical reports that include tabulations of the previous day's hourly raw data;
- Preparing statistical analysis and summaries of the data, including graphs, for QA and reporting;
- Participating in systems audits;
- Preparing and delivering data and statistical interpretation of the data to the regional offices and RCO;
- Responding to public records requests and statistical consulting requests;
- Uploading data to AQS;
- Serving as the backup to the database manager, as needed, and
- Accomplishing other duties as assigned.

4.2.2 Laboratory Analysis Branch

Laboratory Analysis Branch Supervisor: The Laboratory Analysis Branch (LAB) Supervisor reports to the chief. This supervisor supervises the PM LAB Chemistry Technician doing the second level review of the PM lab data verification. The LAB Supervisor's duties include the following:

- Supervising the LAB staff, including the PM LAB Chemistry Technician, and delegating responsibilities as appropriate;
- Maintaining oversight of all RTI laboratory contract activities, including corrective actions and their effectiveness;
- Approving all SOPs for the PM lab data verification and implementation;
- Preparing budgets, contracts, and proposals;
- Ordering supplies and consumables when needed;
- Participating in systems audits;
- Ensuring training availability and utilization for the DAQ LAB staff; and
- Accomplishing other duties as assigned.

LAB Chemistry Technician: The LAB chemistry technician reports to the LAB Supervisor. The chemistry technician's duties include the following:

- Acting as the PM raw data package liaison to RTI lab;
- Receiving raw data packages from the RTI Lab and performing Level 2 data verification procedures per the instructions and checklist found in Appendix E of this QAPP;
- Verifying that all required QA/QC activities are performed and measurement quality standards are met;
- Maintaining QA/QC records and reviewing flags for suspect data;

- Preparing data to be imported into IBEAM for final validation and data storage;
- Participating in systems audits;
- Identifying data quality problems and initiating actions that result in solutions; and
- Performing other duties as assigned.

RTI International: RTI is the contract gravimetric lab for the intermittent filter-based $PM_{2.5}$ sampling. The RTI lab duties include the following:

- Providing PM filter media to the regions and local programs, gravimetric analysis, PM raw data packages, and data and filter archiving for the DAQ PM monitoring program;
- Serving as the Level 1 PM data reviewers for the raw gravimetric data;
- Preparing QAPPs and SOPs for the RTI laboratory, reviewing the QA documents annually, updating them at least every 5-years, and getting them approved by DAQ; and
- Implementing effective corrective action when the need arises and reporting that action and any data impacts to RTI management and DAQ.

4.2.3 Electronics and Calibration Branch

Electronics and Calibration Branch Supervisor: The ECB supervisor reports to and has direct access to the chief. The ECB supervisor has the responsibility and authority to:

- Identify quality problems and initiate corrective action which results in solutions;
- Review and approve QAPPs and SOPs;
- Supervise the ECB electronics technicians;
- Participate in systems audits;
- Act as the liaison to Airmetrics and Mesa Laboratories for calibrating and certifying all PM flow transfer standards (FTS).
- Prepare budgets, contracts, proposals and purchase orders for field equipment;
- Provide and document training and certification of ECB electronics technicians on PM monitoring; and
- Accomplish other duties, as assigned.

ECB Electronics Technicians: The ECB electronics technicians report to the ECB supervisor and have the following responsibilities:

- Installing all PM field equipment and monitoring sites;
- Purchasing, maintaining and tracking an inventory of monitoring/sampling spare parts, spare equipment and consumable supplies to prevent unnecessary downtime of PM samplers and monitors;
- Certifying all transfer standards through outside vendors and periodically checking calibration of primary standards to ensure quality calibrations;
- Assisting in prescribing corrective actions;
- Recommending changes, when needed, in the QA/QC program;
- Participating in systems audits;

- Performing and documenting all major repairs and maintenance of PM monitoring field equipment as described by SOPs 2.24.1 and 2.37.1 (see Table 16 for SOP titles); and
- Performing other duties as assigned.

Airmetrics: Airmetrics, or an equivalent vendor, provides the calibration and verification services for all of the FTS orifices used in the PM monitoring program. When used, Airmetrics communicates with the ECB supervisor.

Mesa Laboratories: Mesa Laboratories, or an equivalent vendor, provides the calibration and verification services for all of the FTS Tetra-Cals used in the PM monitoring program. When used, Mesa Laboratories communicates with the ECB supervisor.

4.3 Regional Offices

The DAQ has seven regional offices. Each regional office has an air quality supervisor, a regional monitoring coordinator, and one or more regional monitoring technicians.

Regional Office Air Quality Supervisors: The regional office air-quality supervisors report to the director and have direct access to the director and chief on all matters relating to DAQ's PM monitoring program. The regional office air-quality supervisor's duties include:

- Assuring that division policies are maintained at the regional office level;
- Acquiring needed regional monitoring resources;
- Verifying that staff are implementing the SOPs and QAPPs;
- Recommending changes when needed in the QA/QC program;
- Providing regional input for the design of the PM monitoring network;
- Reviewing and approving the network monitoring plan and the 5-year network assessment as far as it affects the region;
- Supervising and delineating duties for the regional monitoring coordinator and regional monitoring technicians and
- Accomplishing other duties as assigned.

Regional Monitoring Coordinators (RMC): The RMCs, also referred to as monitoring coordinator or coordinator in this QAPP, report directly to their respective DAQ regional office air quality supervisor. Coordinators have the overall responsibility of ensuring the implementation of the QA/QC program at the regional level. The coordinator coordinates the activities of the regional monitoring technicians. The coordinator's responsibilities include:

- Coordinating and reviewing the collection of environmental data;
- Implementing the DAQ QA/QC program within the region;
- Acting as conduits for information to the regional monitoring technicians;
- Training other regional monitoring coordinators and regional monitoring technicians in the requirements of the QAPP and SOPs;
- Providing a backup to the regional monitoring technicians;
- Participating in systems audits;

- Recommending changes, when needed, in the QA program;
- Providing regional input on the design and documentation of the monitoring network;
- Performing level 2 data verification activities and flagging suspect data;
- Reviewing e-logs, other documentation and the work of the monitoring technicians to ensure they follow the QAPP and associated SOPs;
- Ensuring that regional technicians return for recertification all equipment before expiration and that all certification documents are appropriately filed and archived;
- Documenting and assessing corrective actions to ensure they are appropriate and effective;
- Participating in systems audits; and
- Accomplishing other tasks as assigned.

Regional Monitoring Technicians: The regional monitoring technicians also referred to as site operators or operators in this QAPP, report directly to the regional office air-quality supervisors. They work under the direction of the RMCs to ensure DAQ meets all monitoring requirements. The regional monitoring technician's duties include:

- Performing all required QC activities and ensuring that measurement quality objectives (MQOs) are met as prescribed in the QAPP and SOPs;
- Performing corrective actions to address any activities that do not meet the acceptance criteria as prescribed in the QAPP and SOPs;
- Participating in and providing hands-on training as needed of new RCO chemists, regional monitoring coordinators and technicians in the requirements of the SOPs;
- Calibrating, verifying and auditing of PM monitoring equipment;
- Operating and completing preventative maintenance on all monitoring equipment;
- Performing preventative maintenance and small repairs on PM monitoring equipment;
- Sending all PM FTSs to ECB for calibration and certification, and checking the calibration of primary standards to ensure quality calibrations;
- Ensuring all transfer standards used are within their expiration dates;
- Maintaining a supply of expendable monitoring items;
- Documenting deviations from established procedures and methods;
- Reporting nonconforming conditions and corrective actions to the RMC and the DAQ regional office air quality supervisor;
- Performing level 1 data verification activities and flagging suspect data;
- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Preparing corrective action reports, when needed, for the AMS; and
- Accomplishing other tasks as assigned.

4.4 Asheville-Buncombe Air Quality Agency

The ABAQA local program is under the PQAO of the DAQ AMS.

ABAQA Local Program Director: The ABAQA local program director reports to the Buncombe County board and primarily interacts with DAQ through the DAQ director. The ABAQA local program director also has access to the chief when needed. The ABAQA local program director's duties include:

- Communicating with the ABAQA monitoring staff about proper policies and processes with regards to PM monitoring;
- Supervising the ABAQA monitoring staff;
- Acting as the liaison to EPA, Region 4;
- Acting as the liaison to the DAQ director;
- Acquiring needed monitoring resources for the ABAQA program;
- Recommending changes when needed in the QA/QC program;
- Verifying implementation of quality programs; and
- Providing and approving input for the PM monitoring network plan and the 5-year network assessment.

ABAQA Monitoring Staff: The ABAQA monitoring staff report directly to the ABAQA director and have access to the chief when needed. The ABAQA monitoring staff perform the same roles as the regional monitoring technicians and this QAPP includes them by reference when it uses the term regional monitoring technician, site operator or operator:

- Performing all required QC activities and ensuring that MQOs are met as prescribed in the QAPP and SOPs;
- Performing corrective actions to address any activities that do not meet the acceptance criteria as prescribed in the QAPP and SOPs;
- Purchasing, maintaining and tracking an inventory of monitoring/sampling spare parts, spare equipment and consumable supplies to prevent unnecessary downtime of ABAQA PM samplers and monitors;
- Calibrating, verifying and auditing of PM monitoring equipment;
- Operating and completing preventative maintenance on all monitoring equipment;
- Performing preventative maintenance and small repairs on PM monitoring equipment;
- Sending all PM FTSs to ECB for calibration and certification, and checking the calibration of primary standards to ensure quality calibrations;
- Ensuring all transfer standards used are within their expiration dates;
- Installing PM field equipment at ABAQA monitoring sites;
- Participating in training and certification activities;
- Documenting deviations from established procedures and methods;
- Reporting nonconforming conditions and corrective actions to the RCO PM chemist and the ABAQA local program director;
- Performing level 1 and 2 data verification activities and flagging suspect data;

- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Preparing corrective action reports, when needed, for the AMS; and
- Performing other tasks as assigned.

4.5 Other North Carolina Local and Tribal Programs

EBCI, Forsyth and Mecklenburg County Local Programs: These local and tribal programs receive intermittent filter-based $PM_{2.5}$ filters, as well as gravimetric analysis and reporting, from the DAQ through the RTI contract lab. The official point of contact for these programs will be the chief.

4.6 Department of Information Technology

The DIT provides security for the ambient monitoring computers. They manage, in cooperation with the regional monitoring and ECB electronics technicians and database manager, the computers located at the monitoring sites as well as the primary server that houses the Envista ARM database. Their responsibilities include ensuring the security of the computers and network, updating of the operating system and other standard software on the computer and ensuring that the technicians maintain adequate access to the computers to perform all necessary monitoring functions.

4.7 United States Environmental Protection Agency, Region 4

The EPA is responsible for developing NAAQS, defining the quality of the data necessary to make comparisons to the NAAQS, and identifying a minimum set of quality control samples from which to judge data quality. State and local ambient air quality monitoring organizations are responsible for taking this information and developing and implementing a quality assurance program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate. The DAQ's PQAO operates within the jurisdiction of EPA Region 4 and collaborates with EPA Region 4, as necessary, to ensure the PQAO's PM monitoring network meets or exceeds regulatory requirements.

The DAQ will operate the PM monitors following the procedures in 40 CFR Part 58. As a result, the chief will include information on these monitors in the annual network-monitoring plan and the five-year network assessment and the EPA Region 4 Air and Radiation Division director or his or her designee will review, comment on and respond to the network plan each year. Likewise, the chief will include the data from these monitors in the annual certification request. The EPA Region 4 Air and Radiation Division director or his or her designee will review and apply concurrence codes in AQS in response to DAQ's data certification request. The chief will also submit a QAPP to the EPA Region 4 Laboratory Services and Applied Science Division, or LSASD, for EPA approval. The EPA Region 4 LSASD will include the PM monitors in the Performance Evaluation Program (PEP).

5.0 Problem Definition and Background

In 1970, the president signed the Clean Air Act (CAA) into law. Sections 108 and 109 of the CAA govern the establishment of and revision of the NAAQS for air pollutants (i.e., PM) that are determined to contribute to air pollution that is harmful to public health and welfare. Primary NAAQS are set at a level adequate to protect public health within an acceptable margin of safety, while secondary standards are set at a level that is requisite to protect public welfare. The CAA and its amendments provide the framework for the monitoring of PM by state, local, and tribal air monitoring organizations. Under the area designations process, the EPA uses data from PM ambient air monitors to characterize air concentrations for identification of areas that are either meeting or violating the PM pollutant standard. EPA and the state and local agencies typically designate monitors and samplers used for comparisons against a NAAQS as State and Local Air Monitoring Stations (SLAMS) monitors, which must meet the requirements stipulated in 40 CFR Parts 50, 53, and 58. For PM, DAQ must collect three years of valid, quality-assured data for comparison against the NAAQS.

The North Carolina Department of Natural and Economic Resources (DNER) initiated air quality PM monitoring in 1971 as part of an integrated, statewide survey effort. At that time, total suspended particulate (TSP) sampling was the driver in the PM NAAQS. The standards consisted of a 24-hour and annual mean of 260 micrograms per cubic meter ($\mu g/m^3$), and 75 $\mu g/m^3$, respectively, and a particle size limit of 50 micrometers (µm). For 15 years, this was the basis for compliance with the PM NAAQS.

In 1985, the North Carolina Department of Natural Resources and Community Development (DNRCD), which replaced the DNER in 1977, added sampling for PM with aerodynamic diameters of 10 µm or smaller (PM_{10}) to the monitoring network. Two years later, EPA adopted PM_{10} standards over TSP for compliance with the NAAQS. In 1988, the DNRCD adopted those same standards and began the transition from TSP sampling to PM_{10} sampling; the North Carolina Department of Environmental, Health and Natural Resources (DEHNR), which replaced the DNRCD in 1989, completed that process in 1991.

EPA updated its PM NAAQS in 1998 by commissioning sampling for $PM_{2.5}$ µm or smaller ($PM_{2.5}$). The North Carolina Department of Environment and Natural Resources (DENR), which replaced the DEHNR in 1997, added $PM_{2.5}$ sampling to the monitoring network, and in later years, decommissioned additional PM_{10} sites and added the ability to measure and report PM data in real time. Currently, DAQ measures continuous PM_{10}, continuous and filter-based $PM_{2.5}$ and coarse PM (PM_C) using continuous methods.

The EPA defines PM with aerodynamic diameters between 2.5 and 10 µm as PM_c. Because of its impacts on respiratory and cardiac health, the EPA looked on PM_c with renewed interest in 2006. On October 17, 2006, the EPA published in the Federal Register final rule revisions to ambient monitoring regulations as contained in 40 CFR, Parts 53 and 58. Included in these revised rules were requirements for establishing National Ambient Air Monitoring Strategy - National Core Monitoring, or NCore, sites. NCore is a multipollutant network, integrating several advanced measurement systems for particles, pollutant gases and meteorology. Each state was required to operate at least one NCore site starting January 1, 2011. The NCore sites must measure, at a minimum, mass of coarse particles with an average aerodynamic diameter between 2.5 and 10 microns or $PM_{10-2.5}$ particle mass.

The ABAQA came under DAQ's PQAO in 2007, along with the Forsyth and Mecklenburg County local programs. At the time, EPA Region 4 made each state one PQAO to conserve both state and EPA resources. In 2014/2015, EPA Region 4 held that the DAQ AMS was not meeting the needed PQAO requirements, and the Forsyth and Mecklenburg County programs chose to become their own PQAOs.

Table 2 shows the current NAAQS for $PM_{2.5}$ microns and smaller, and 10 microns and smaller. Primary standards are set at a level adequate to protect public health within an acceptable margin of safety, while secondary standards are set at a level that is requisite to protect public welfare.

Table 2. National Ambient Air Quality Particulate Matter Standards

Particulate Matter ($PM_{2.5}$) Particulate matter with aerodynamic diameters of 2.5 micrometers or less		
Averaging Time	**Standard Value**	**Standard Type**
Annual Arithmetic Mean	12 µg/m^3	Primary
	15 µg/m^3	Secondary
24-hour Average	35 µg/m^3	Primary and Secondary
Particulate Matter (PM_{10}) Particulate matter with aerodynamic diameters of 10 micrometers or less		
Averaging Time	**Standard Value**	**Standard Type**
24-hour Average	150 µg/m^3	Primary and Secondary

The objective of the DAQ AMS is to protect the health and sustainability of the State of North Carolina by identifying any violations of the PM NAAQS, locating the highest ambient particle pollution concentrations across the area and determining the general PM background concentration. The PM monitoring data collected supports the local, state, regional and federal air monitoring programs and the general population. Region 4 agencies may only shut down PM monitors following guidance in 40 CFR Part 58.14, after providing the public a 30-day public comment period to make comments on the decision and after obtaining permission from the EPA Region 4 administrator.

Health scientists have linked the size of particles directly to their potential for causing health problems. Small particles less than 10 µm in aerodynamic diameter pose the greatest problems, because they can get deep into the lungs, and some may even get into the bloodstream (coarse particles, i.e., $PM_{10\text{-}2.5}$, are of less concern, although they can irritate a person's eyes, nose, and throat). Exposure to such particles can affect both the lungs and the heart. People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- Premature death in people with heart or lung disease;
- Nonfatal heart attacks;
- Irregular heartbeat;
- Aggravated asthma;
- Decreased lung function; and
- Increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

Fine particles ($PM_{2.5}$) are also the main cause of reduced visibility (haze) in parts of the United States, including many of our treasured national parks and wilderness areas. The wind can carry fine particles

over long distances and these transported particles can then settle on the ground or water. Depending on their chemical composition, the effects of this settling may include:

- making lakes and streams acidic;
- changing the nutrient balance in coastal waters and large river basins;
- depleting the nutrients in soil;
- damaging sensitive forests and farm crops;
- affecting the diversity of ecosystems;
- contributing to acid rain effects; and
- staining and damaging stone and other materials, including culturally important objects such as statues and monuments.

In light of these problems, the DAQ AMS's goals are to encourage the wise and beneficial use of the natural environment of the State of North Carolina, to minimize the adverse impact of PM contaminants on human health and welfare, and to foster public awareness.

The EPA regulations require that agencies plan, document and prepare an approved QAPP for all projects involving the generation, acquisition and use of environmental data. This version of the QAPP is the third revision to the document; the second revision was conditionally approved by EPA in August 2019. A copy of the August 2019 QAPP is retained in IBEAM.

The QAPP is a compilation of QA/QC requirements, procedures and guidelines designed to achieve a high percentage of valid data and samples, while maintaining integrity and accuracy. Adherence to the requirements set forth in this QAPP will ensure consistent, repeatable results and improve the reliability and comparability of all data and samples collected. All ABAQA monitoring staff, regional monitoring technicians and coordinators, ECB electronics technicians, LAB technicians and chemist, RCO PM, LAB QA and audit chemists, statistician and supervisors will use this QAPP as a reference document, providing the framework for the monitoring network's QA program.

Additional details and technical specifications are set forth in individual PM SOPs used by the people involved in this program for each aspect of the PM monitoring program, such as instrument operations and data handling (see Table 16). This QAPP will reference these SOPs in later sections of this QAPP. It is the responsibility of all people involved with this program to ensure that they properly implement all procedures and guidelines in this QAPP.

The DAQ will review this PM QAPP annually and revise it if procedures have changed or when it needs updating; at a minimum, the DAQ will revise and update the PM QAPP every 5 years. Grant commitments also require that annual QAPP reviews be recorded in email correspondence to EPA Region 4. QAPP changes are subject to the approval of EPA's Region 4 QA staff. The DAQ AMS will adhere to the principles and procedures herein, unless a special project requires more stringent requirements. If any special project requires more stringent requirements, the QAPP will be revised or, depending on the purpose and scope of the project, a separate QAPP will be developed to address the requirements of the special project.

6.0 Project/Task Description

The chief with the help of the RCO chemists developed this PM QAPP to ensure that ABAQA and DAQ's PM monitoring network collects ambient data that meet or exceed EPA QA requirements. The EPA and DAQ use the PM data collected by the DAQ AMS for regulatory decision-making purposes (i.e., determination of compliance with the NAAQS). The DAQ will submit the data to EPA via EPA's national database, AQS. Other purposes of the data include determining trends over time, determining effects on air quality from adjustments to source emissions, verifying air quality modeling programs, and providing real-time monitoring data to the public.

In accordance with 40 CFR Part 58, Appendix D, Section 1.1, SLAMS monitoring networks must be designed to meet three basic monitoring objectives: provide air pollution data to the general public in a timely manner; support compliance with ambient air quality standards and emissions strategy development; and provide support for air pollution research studies. Section 10.1 of this QAPP provides additional objectives for the PM network. The chief and director designed the DAQ's PM monitoring network to support these objectives. Additional specific goals of the DAQ's PM monitoring program include:

- Determining the highest concentrations expected to occur in the area covered by the network;
- Determining representative concentrations in areas with high population density and\or heavily congested areas;
- Determining the general background concentration levels;
- Providing data to the State of North Carolina, ABAQA and EPA to assist these agencies in determining regional transport of specific pollutants and in support of secondary standards and visibility impairment issues;
- Determining the extent of regional pollutant transport among populated areas and in support of secondary standards; and
- Determining the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

DAQ will report data to AQS in accordance with the requirements stated in 40 CFR Section 58.16. The DAQ's PM monitoring network will operate and collect samples in accordance with the schedules codified in 40 CFR Section 58.12. Monitors and samplers designated as federal reference method, or FRM, or federal equivalent method, or FEM, in accordance with Section 2.1 of 40 CFR Part 58, Appendix C, will collect the ambient PM monitoring concentration data. The DAQ will collocate monitors in accordance with 40 CFR Part 58, Appendix A requirements. In some instances, the DAQ obtains waivers from the EPA so the DAQ may collect PM data that the EPA does not use to compare to the NAAQS, but DAQ can use for such purposes as calculating the air quality index (AQI). The types of data collected by the PM monitoring network, overall, includes:

- Continuous (near real-time) 24-hour and hourly-averaged PM concentration data collected by FEMs, including $PM_{2.5}$, PM_{10} (at standard and local conditions), and PM_C (see Section 11 of this QAPP);

- 24-hour $PM_{2.5}$ samples collected by FRM intermittent filter-based $PM_{2.5}$ samplers, and subsequently analyzed at the RTI gravimetric lab using the appropriate analytical method;
- Continuous (near real-time) hourly-averaged $PM_{2.5}$ concentration data collected by non-FEMs to report data for the AQI;
- Meteorological data (average 24-hour temperature and pressure readings) from the FRM sampling runs;
- 5-minute average readings of temperature and relative humidity (RH) for the RTI gravimetric lab;
- Bias measurements; and,
- Geographic measurements (e.g., locational, demographic, topographical).

The work required to collect, document, and report these data includes, but is not limited to, the following:

- Establishing a monitoring network that has:
  - Appropriate density, location, and sampling frequency;
  - Accurate and reliable monitors, data recording equipment, procedures and software;
- Developing encompassing documentation for:
  - Data and report format, content, and schedules;
  - Quality objectives and criteria;
- Establishing SOPs, which provide activities and schedules for:
  - Equipment operation and preventative maintenance;
  - Instrument calibrations, precision checks, and accuracy evaluations;
- Establishing assessment criteria and schedules;
- Verifying and validating the data produced by network monitors in accordance with the criteria and schedules established herein; and
- Certifying data.

6.1 Field Activities

The DAQ regional monitoring staff and ABAQA monitoring staff will perform those activities that support continued successful operation of the statewide PM monitoring network. The DAQ Regional and ABAQA Monitoring Staff will perform field activities that include, but are not necessarily limited to, the following:

- Conducting calibrations, verifications and audits on PM monitors;
- Conducting periodic maintenance and servicing of PM monitoring equipment;
- Performing routine site operations and servicing activities that include, but are not limited to:
  - Verifying the sampler or monitor status and diagnostics to ensure PM data collection;
  - Recording pertinent field data and measurements in e-logs and on required DAQ forms;
  - Restocking consumables, such as filter tape and cleaning supplies;

- Locating suitable monitoring sites for relocation of existing monitoring equipment or the location of new PM monitoring stations, when needed; and,
- Collecting sequential PM samples, shipping them to the RTI lab for subsequent analysis, while following correct chain-of-custody (COC) procedures.

6.2 ECB and ABAQA Activities

The ECB electronics technicians and ABAQA monitoring staff will perform those activities necessary to support the successful operation of the PM monitoring network. They will perform electronic laboratory activities consistent with certifying, calibrating and testing all equipment before installing it in the field. In addition, ECB electronics technicians and ABAQA monitoring staff will perform any functions necessary to support the deployed field equipment. Section 4.2.3 Electronics and Calibration Branch provides a more complete description of the activities the ECB electronics technicians may perform. Section 0 4.4 Asheville-Buncombe Air Quality Agency provides a more complete description of the activities the ABAQA monitoring staff may perform.

6.3 Laboratory Activities

The DAQ LAB chemistry technician, in conjunction with the RTI Lab, will perform those activities that support a successful operation of the intermittent filter-based $PM_{2.5}$ monitoring network. Additionally, where analysis of samples is required, the RTI lab staff shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. The RTI lab staff shall be responsible for preparing sequential filters for field use. This may include, but not be limited to:

- Scheduling, preparing, weighing, shipping and receiving, and archiving filters for PM sampling;
- Preparing and analyzing control samples (e.g., trip filter blanks and exposure lot blanks);
- Maintaining consumable inventories;
- Maintaining COC records;
- Conducting microbalance daily weight checks, quarterly weight checks and semi-annual weight checks; and
- Maintaining temperature and humidity data records necessary to determine weigh room conditioning compliance per EPA Method 2.12, Section 4.3.8.

The DAQ LAB chemistry technician will work as the liaison to the RTI lab staff, perform level 2 data review for the RTI gravimetric data package and participate in systems audits.

6.4 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, “assessment” is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance. Section 20 discusses the details of assessments. Table 3 provides information on the parties implementing assessments and their frequency.

Table 3. Assessment Schedule

Assessment Type	Assessment Agency	Frequency
Network Review	EPA Region 4 and DAQ	Every 3 years and annually
Network Assessment	EPA Region 4 DAQ	Every 5 Years
Quality Assurance Project Plan Review and Updates	DAQ RTI	Review annually Update at least every 5 years
Standard Operating Procedures Review	DAQ RTI	Annually
Data Quality Review	DAQ	Monthly
Quarterly Completeness and Audit of Data Quality	DAQ	Quarterly
Annual Data Certification	DAQ	Annually
Data Quality Assessment	DAQ	Quarterly
Instrument Performance Audits	DAQ RTI	At least every 6 months, preferably quarterly
Internal Systems Audits	DAQ	Every 3 years, minimum
Technical Systems Audits of RTI	DAQ	Annually
Technical Systems Audit	EPA Region 4	Every 3 years – DAQ Every 6 years - ABAQA
$PM_{2.5}$ Performance Evaluation Program	EPA designated contractor	8 valid audits per year/each monitor audited every 6 years

6.5 Project Records

The DAQ AMS will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision and maintenance of documents and records. Table 4 presents the categories and types of records and documents applicable to document control for ambient air quality information. Section 9.0 Documentation and Records explains information on key documents in each category in more detail.

Table 4. Critical Documents and Records

Categories	Record/Document Type
Site Information	Network Descriptions Site Files Site Maps Site Pictures

Table 4. Critical Documents and Records

Categories	Record/Document Type
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field Notebooks and e-logs Chain of Custody Records Inspection/Maintenance Records Lab Records and Data Packages
Raw Data	Original Continuous PM Data (Manual Downloads) Sequential PM Field Data Downloads Polled Continuous PM Data RTI PM Laboratory Raw Weigh and Environmental Data
Data Reporting	Annual Data Certification Package Air Quality Index Reports Annual AQS Reports Data/Summary Reports
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems
Quality Assurance	Data Quality Assessments Quality Assurance Reports Technical Systems Audits Response/Corrective Action Documentation Emails related to QA activities and assessments Annual Site Evaluations/Network Review Certification Documentation

6.6 Site Locations

At the time of this QAPP revision, Table 5 provides the location and information on the type of monitors located at each PM monitoring station maintained and operated by DAQ and ABAQA. Figure 7 through Figure 22 provide aerial views of each site.

Table 5. North Carolina PM Site Locations

Site Name	City/County	AQS ID	Types of Monitors	Operator
Board of Education	Asheville/ Buncombe	37-021-0034	Collocated $PM_{2.5}$ FRM and BAM 1022	ABAQA
Hickory Water Tower	Hickory/ Catawba	37-025-0004	Collocated $PM_{2.5}$ BAM 1022s	DAQ Mooresville Regional Office
William Owen School	Fayetteville/ Cumberland	37-051-0009	$PM_{2.5}$ BAM 1022 and PM_{10} BAM 1020	DAQ Fayetteville Regional Office
Lexington Water Tower	Lexington/ Davidson	37-057-0002	Collocated $PM_{2.5}$ FRM and $PM_{2.5}$ BAM 1020	DAQ Winston-Salem Regional Office

Table 5. North Carolina PM Site Locations

Site Name	City/County	AQS ID	Types of Monitors	Operator
Durham Armory	Durham/Durham	37-063-0015	BAM 1020 coarse	DAQ Raleigh Regional Office
Leggett	Tarboro/Edgecombe	37-065-0099	$PM_{2.5}$ BAM 1022 with sharp cut cyclone	DAQ Raleigh Regional Office
Mendenhall	Greensboro/ Guilford	37-081-0013	$PM_{2.5}$ BAM 1022 and PM_{10} BAM 1020	DAQ Winston-Salem Regional Office
West Johnston	Clayton/Johnston	37-101-0002	$PM_{2.5}$ BAM 1022	DAQ Raleigh Regional Office
Spruce Pine	Spruce Pine/Mitchell	37-121-0004	$PM_{2.5}$ BAM 1022	DAQ Asheville Regional Office
Candor	Candor/ Montgomery	37-123-0001	$PM_{2.5}$ BAM 1020	DAQ Fayetteville Regional Office
Castle Hayne	Castle Hayne/ New Hanover	37-129-0002	$PM_{2.5}$ BAM 1020 and T640X	DAQ Wilmington Regional Office
Pitt County Ag Center	Greenville/ Pitt	37-147-0006	$PM_{2.5}$ BAM 1022	DAQ Washington Regional Office
Rockwell	Rockwell/ Rowan	37-159-0021	$PM_{2.5}$ BAM 1022	DAQ Mooresville Regional Office
Bryson City	Bryson City/Swain	37-173-0002	$PM_{2.5}$ BAM 1020	DAQ Asheville Regional Office
Millbrook	Raleigh/Wake	37-183-0014	Collocated PM2.5 FRM and T640X	DAQ Raleigh Regional Office
Triple Oak	Raleigh/Wake	37-183-0021	$PM_{2.5}$ BAM 1022	DAQ Raleigh Regional Office

BAM – Beta Attenuation Monitor; FRM = Federal Reference Method
Note: These are the locations at the time of this QAPP revision. For current locations please see the network plan at https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan.

Figure 7. Aerial View of Board of Education Site

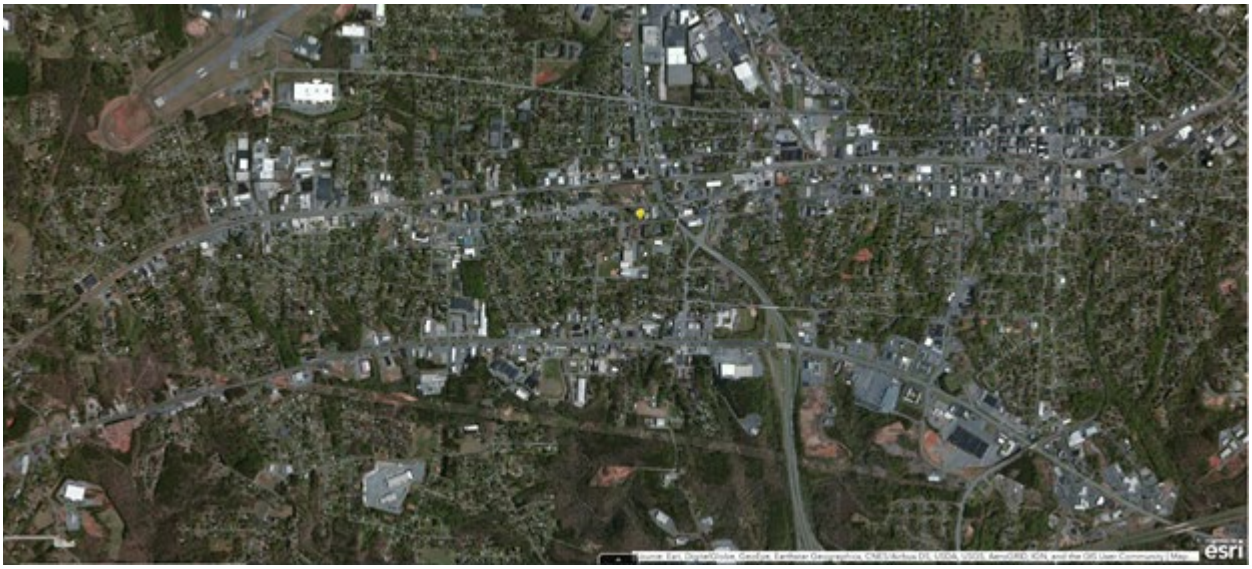


Figure 8. Aerial View of Hickory Site

Figure 9. Aerial View of William Owen Site

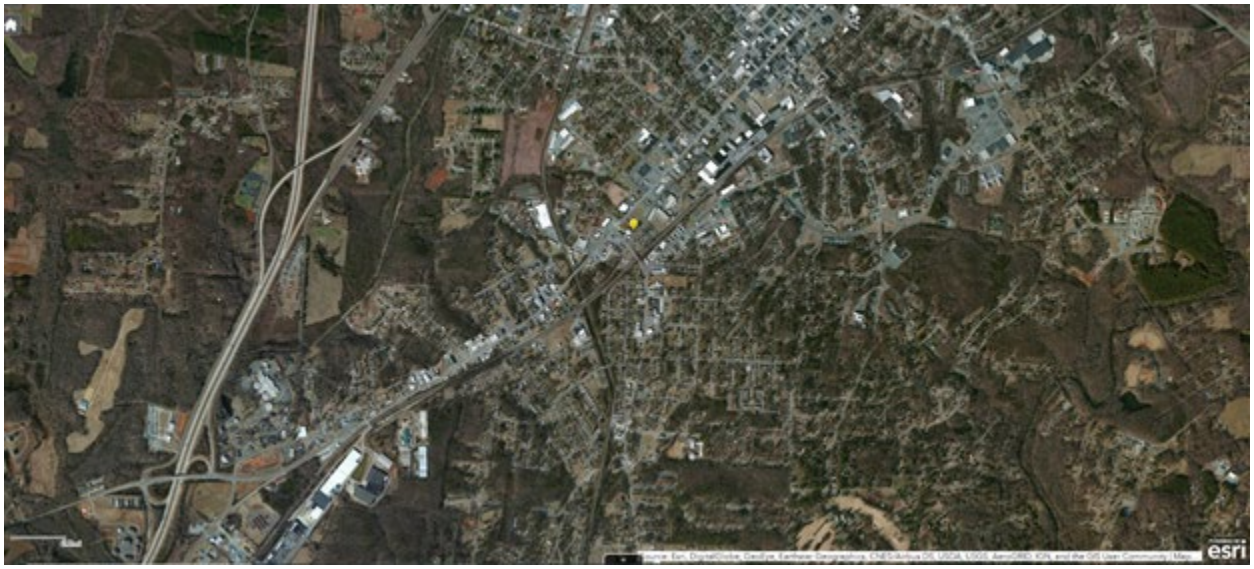


Figure 10. Aerial View of Lexington Site

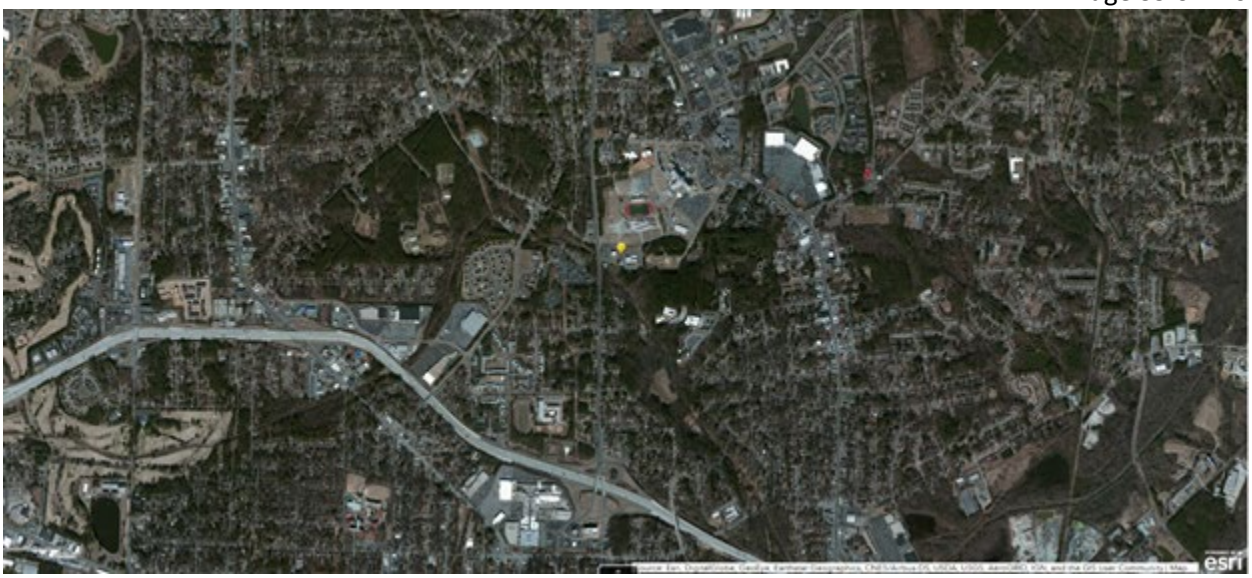


Figure 11. Aerial View of Durham Armory Site

Figure 12. Aerial View of Leggett Site

Figure 13. Aerial View of Mendenhall Site

Figure 14. Aerial View of West Johnston Site

Figure 15. Aerial View of Spruce Pine Site

Figure 16. Aerial View of Candor Site

Figure 17. Aerial View of Castle Hayne Site

Figure 18. Aerial View of Pitt Agricultural Center Site

Figure 19. Aerial View of Rockwell Site

Figure 20. Aerial View of Bryson City Site

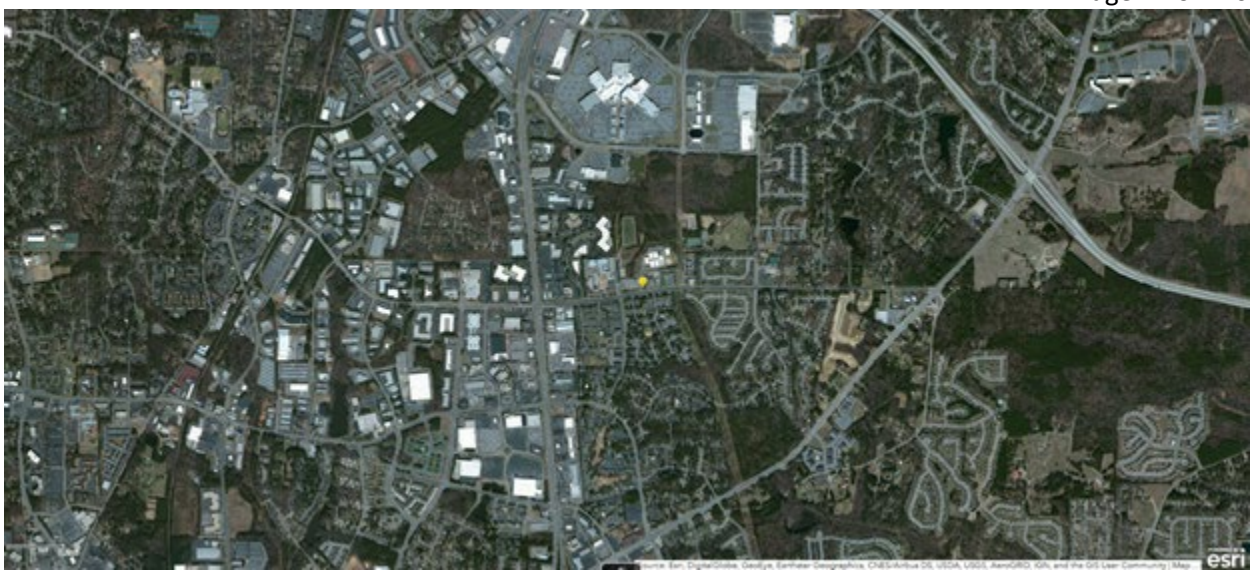


Figure 21. Aerial View of Millbrook site

Figure 22. Aerial View of Triple Oak site

7.0 Quality Objectives and Criteria for Measurement Data

The DAQ and ABAQA operate under an EPA-approved QMP that describes the agencies' system for communicating and implementing quality within the PQAO.

A quality system is a structured and documented set of management activities in which an organization applies sufficient QC practices to ensure the data produced by an operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that the agency obtains and maintains acceptability in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. The policies of the DAQ and ABAQA are to implement QA programs to assure that DAQ and ABAQA collect data of known and acceptable precision, bias, sensitivity, completeness, comparability and representativeness within their ambient air quality monitoring programs.

The EPA, DAQ and ABAQA use precision, bias, completeness, comparability, sensitivity and representativeness as the principal data-quality indicators (DQI) that provide qualitative and quantitative descriptions in interpreting the degree of acceptability of data. Section 7.5 Measurement Quality Objectives defines these DQIs. Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the measurement process. Of the six principal DQIs, precision, sensitivity and bias are the quantitative measures, representativeness and comparability are qualitative measures and completeness is a combination of both qualitative and quantitative measures. The DAQ establishes the specific requirements of these six DQIs before data collection starts. The goal is to locate and eliminate (or minimize) bias, so the data collected show the true conditions of the area being sampled. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configurations and the duration of the study.

All individuals must adhere to the written procedures and methodologies in the QAPP and associated SOPs (see Table 16) for operating air monitoring instruments and handling data to assure quality data for purposes of DAQ and ABAQA's air quality designations concerning attainment of the NAAQS. EPA-approved FRMs are the designated methodologies and basis for operating pollutant-monitoring equipment, although agencies may use FEMs as well.

7.1 Data Quality Objectives

This section provides a description of the data quality objectives (DQOs) for the PM monitoring program for DAQ and ABAQA. Data quality objectives are qualitative and quantitative statements that:

- Clarify the intended use of the data,
- Define the type of data needed, and
- Specify the tolerable limits on the probability of making an erroneous decision due to uncertainty in the data.

7.2 Intended Use of Data

The EPA, DAQ and ABAQA will use the data collected in this PM monitoring network to:

- Evaluate compliance with the NAAQS,
- Establish an historical baseline concentration of natural and anthropogenic PM pollution;
- Monitor the current dynamic concentrations of PM air pollutants;
- Monitor progress made toward meeting ambient air quality standards for PM;
- Activate emergency control procedures that prevent or alleviate PM pollution episodes;
- Provide data upon which long term PM control strategies can be reliably developed;
- Support daily AQI forecasting efforts, including the activation of burn bans when high PM levels are observed (i.e., AQI color orange or higher), in accordance with North Carolina law;
- Observe pollution trends throughout the region; and
- Provide a database for researching and evaluating effects.

7.3 Type of Data Needed

The DAQ determines the type of data needed by its intended use. Because the primary use of the DAQ and ABAQA PM monitoring program data is for comparison to the NAAQS, data must be collected in accordance with 40 CFR Parts 50, 53, and 58 requirements, and be of such quality that decision makers can make comparisons to the NAAQS with confidence and certainty. The monitoring data compiled by the DAQ PM monitoring program includes the following: $PM_{2.5}$, PM_{10} and $PM_{10\text{-}2.5}$ (otherwise known as PM_c). 40 CFR Section 58.16 specifies the data reporting requirements that the DAQ PM monitoring program will follow, and the appendices to 40 CFR Part 50 explain the data handling conventions and computations necessary for determining whether the NAAQS are met for PM. The DAQ PM monitoring network will operate and collect data in accordance with the schedules codified in 40 CFR 58.12. The ambient PM concentration data for comparison to the NAAQS will be collected by monitors that have been designated as FRM or FEM, in accordance with 40 CFR Part 58, Appendix C, Section 2.1.

The DAQ will collect PM data for comparison to the NAAQS using 24-hour PM concentration data from continuous FEM monitoring and 24-hour filter samples from FRM monitoring. For each of these methods, quarterly data capture will need to be ≥75 percent completeness, as shown in the following subsections. The collection of precision and bias data is also required. In addition to these requirements, the data needed for the DAQ PM monitoring program will meet the following principal quality objectives:

- All data should be traceable to a National Institute of Standards and Technology (NIST) primary standard.
- All data shall be of a known and documented quality. As noted above, two key quantitative indicators for assessing data quality are precision and bias. This QAPP establishes the precision and bias requirements.
- All data shall be comparable. This means DAQ shall produce all data in a similar and scientific manner. The use of the standard methodologies for sampling, calibration,

auditing, etc. found in the QAPP and its associated SOPs (see Table 16) should achieve this goal.

- All data shall be representative of the parameters DAQ measures with respect to time, location and the conditions from which DAQ obtained the data. The use of the standard methodologies contained in the QAPP and its associated SOPs (see Table 16) should ensure that the data generated are representative. Support in achieving representativeness is also provided through adhering to the requirements prescribed in 40 CFR Part 58, Appendices D and E.
- The QAPP and its associated SOPs must be dynamic to continue to achieve its stated goals as techniques, systems, concepts and technology change.

Title 40 CFR Part 50, Appendix K provides specific information on PM_{10} NAAQS calculations. The CFR appendix explains the computations necessary for analyzing PM_{10} data to determine attainment of the 24-hour standard specified in 40 CFR Section 50.6, using the reference method based on 40 CFR Part 50, Appendix J, or a designated equivalent method per 40 CFR Part 53. In accordance with Appendix K, a PM_{10} exceedance means a daily value that is above the level of the 24-hour standard after rounding to the nearest 10 $\mu g/m^3$ (i.e., values ending in 5 or greater are to be rounded up).

The EPA based the information in Appendix K on high-volume sampling. In the DAQ network, the PM_{10} samplers are FEMs which collect low-volume, continuous (hourly) PM_{10} data. Therefore, DAQ will use the protocols of the low-volume $PM_{2.5}$ method found in 40 CFR Part 50, Appendix N, for general guidance, which follows:

- Keep each hourly data point with at least one decimal place in units of $\mu g/m^3$.
- Calculate a 24-hour period in a day from midnight(00:00) to midnight (23:59) for the daily average.
- The EPA shall consider a 24-hour average concentration valid if at least 75 percent of the hourly averages (i.e., 18 hourly values) for the 24-hour period are available.
- The EPA shall also consider twenty-four-hour periods with seven or more missing hours valid if, after substituting zero for all missing hourly concentrations, the resulting 24-hour average daily value is greater than the level of the 24-hour $PM_{2.5}$ NAAQS.
- Twenty-four-hour average $PM_{2.5}$ mass concentrations that are averaged in AQS from hourly values will be truncated to one decimal place, consistent with the data handling procedure for the reported hourly (and also 24-hour filter-based) data.
- For 24-hour filter-based samples, the sampler must have operated for 23-25 hours or the day will not be valid (unless a sample with less than 23 hours run time has a concentration that exceeds the NAAQS).
- The EPA refers to the 3-year average of $PM_{2.5}$ annual mean mass concentrations for each eligible monitoring site as the "*annual PM2.5 NAAQS Design Value(DV)*" and compares it to the annual standard.

- The 3-year average of annual 98th percentile 24-hour average $PM_{2.5}$ mass concentration values recorded at each eligible monitoring site is referred to as the "*24-hour (or daily) $PM_{2.5}$ NAAQS DV*" and compared to the daily standard.

Title 40 CFR Part 50, Appendix N provides specific information on $PM_{2.5}$ NAAQS calculations.

7.4 Tolerable Error Limits

The DQO process defines tolerable limits as the probability of making a decision error due to uncertainty in the data. That is, limits on the probability of measuring a false positive or false negative error. Concerning air quality data, a false positive error occurs when data indicates a NAAQS violation when in fact, due to random deviations in the data, a violation has not occurred. Alternatively, a false negative error occurs when data indicate that no NAAQS violation has occurred when in fact, due to random deviations in the data, a violation has occurred.

Utilizing the formal DQO process, EPA established the tolerable error limits for ambient air monitoring precision and bias data in order to reduce the probability of decision errors. Title 40 CFR Part 58 Appendix A, Section 2.3.1 sets the DQOs for the PM measured within the ABAQA and North Carolina network and defines the goal for acceptable measurement uncertainty for precision as an upper 90 percent confidence limit for the coefficient of variation, or CV, of 10 percent and ±10 percent for total bias. The EPA has not completed a formal DQO process for PM_{10}; however, the EPA has provided DQOs for these parameters in the *EPA Quality Assurance Handbook for Air Pollution Measurements Systems, Volume II* (i.e., QA Handbook). The PM monitoring program has established the acceptable precision, as measured by CV, and acceptable bias for each pollutant as listed in Table 6. The DAQ has chosen to adopt the DQOs provided by the EPA.

Table 6. Acceptable Precision as Measured by Coefficient of Variation (CV) and Bias

Pollutant	Acceptable Precision	Acceptable Bias
$PM_{2.5}$	upper 90 percent confidence limit for the CV of ≤10 percent	Within ±10 percent
$PM_{10-2.5}$	upper 90 percent confidence limit for the CV of ≤10 percent	upper 95 percent confidence limit for the absolute bias of ≤10 percent
PM_{10}	upper 90 percent confidence limit for the CV of ≤10 percent	Within ±10 percent

7.5 Measurement Quality Objectives

The DQO process functions to identify the allowable measurement uncertainty for a given objective. Once DAQ establishes a DQO, DAQ must evaluate and control the quality of the data to ensure that DAQ maintains the DQO within the established acceptance criteria. The EPA designed the MQOs to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. The EPA derived the MQOs from the DQOs, and established them to evaluate overall measurement uncertainty, as well as uncertainty for individual phases of the measurement process. The EPA

defines the MQOs for the DAQ PM monitoring program in terms of the following DQIs: **precision**, **bias**, **comparability**, **sensitivity, representativeness**, and **completeness**.

- Precision - "Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. This agreement is calculated as either the range or as the standard deviation" (US EPA QA/G-5, Appendix B). This is the random component of error. For the DAQ, standard deviation (SD) and percent difference serve as methods of determining precision.
- Bias - "Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction" (US EPA QA/G-5, Appendix B). Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- Comparability - "Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability must be carefully evaluated to establish whether two data sets can be considered equivalent in regard to the measurement of a specific variable or groups of variables." (US EPA QA/G-5, Appendix B)
- Sensitivity – "The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest" (US EPA QA/G-5, Appendix B). The minimum concentration or attribute that can be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit).
- Representativeness - "Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether in situ or other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied." (US EPA QA/G-5, Appendix B).
- Completeness - Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the amount that were expected to be obtained under correct, normal conditions. The DAQ expresses completeness as a percentage. Data completeness requirements are included in 40 CFR Part 50, Appendix N and K.

The EPA developed acceptance criteria for these DQIs using various parts of 40 CFR Parts 50, 53, and 58 and EPA guidance documents. Specifically, the EPA has compiled the MQOs for the criteria pollutants into "validation templates" found in the QA Handbook. The DAQ has reproduced the validation templates here in Table 7 through Table 11. The DAQ PM monitoring program adopts these tables and establishes them as the MQOs for the PM monitoring program. DAQ has made modifications to some

operational criteria in the tables, where permissible, to reflect more accurately the procedures followed by the DAQ PM monitoring program or to clarify intent.

As described in the QA Handbook and implemented here, the tables that follow list three validation criteria for each criteria pollutant: **critical**, **operational**, and **systematic**. The tables discriminate between:

- Criteria that DAQ must meet to ensure the quality of the data (i.e., critical criteria),
- Criteria that indicate issues may exist with the quality of the data and further investigation is warranted before making a determination about the validity of the sample or samples (i.e., operational criteria), and
- Criteria indicating a potentially systematic problem with the environmental data collection activity that may affect the ability to make decisions with the data (i.e., systematic criteria).

For each criterion, the tables include: (1) the requirement, (2) the frequency with which compliance is to be evaluated, (3) the acceptance criteria, and (4) information where the requirement can be found or additional guidance on the requirement.

The DAQ defines control limits as the level of allowable imprecision before data are invalidated. The DAQ cannot set control limits higher than the MQOs. The DAQ uses these limits when validating ambient air measurements. The use of control limits strengthens the precision of these measurements and improves the data validation practices to better meet regulatory requirements.

The DAQ has also implemented warning limits for PM monitoring. The DAQ defines warning limits as the level of allowable imprecision before regional monitoring staff must calibrate an analyzer or take other corrective action. The DAQ set the warning limits lower than the control limits to reduce imprecision and bias and enhance data completeness. Other elements, as well as the SOPs associated with this QAPP that are specific to each monitor type, provide more detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty.

7.6 Network Scale

The EPA defines representativeness as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system. The DAQ achieves representativeness through adhering to the requirements provided in:

- 40 CFR Part 58, Appendix D (Network Design Criteria for Ambient Air Quality Monitoring); and
- 40 CFR Part 58, Appendix E (Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring).

The chief with the assistance of the regional monitoring coordinators and PPB supervisor assigns each monitor operated a scale of representativeness based on the definitions in 40 CFR Part 58, Appendix D.

- **Micro Scale -** describes air volumes associated with area dimensions ranging from several meters up to about 100 meters (m).
- **Middle Scale -** describes air volumes associated with area dimensions up to several city blocks in size with dimensions ranging from about 100 m to 500 m (0.5 kilometer [km]).
- **Neighborhood Scale -** describes air volumes associated with an area of a city that has relatively uniform land use with dimensions in the 500 to 4,000 m (0.5 to 4.0 km) range.
- **Urban Scale -** describes air volumes within cities with dimensions about 4,000 m to 50,000 m (4.0 km to 50 km). This scale would usually require more than one site for definition.
- **Regional Scale -** describes air volumes associated with rural areas of reasonably homogeneous geography that extends for tens to hundreds of kilometers.

Of these, the primary scales used in the DAQ PM monitoring program are either neighborhood or urban, with sporadic use of the micro scale for special studies such as near road PM monitoring and the regional scale for general background or transport monitors. Please see the annual network plan (https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan) for each DAQ or ABAQA PM monitor's spatial scale of representativeness.

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - $PM_{2.5}$ Filter-Based, Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	all filters	≤ 30 days before sampling	1,2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.5
Sample Recovery	all filters	≤7 days 9 hours from sample end date	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 10.10
Sampling Period (including multiple power failures)	all filters	1380-1500 minutes, or value if < 1380 and exceedance of NAAQS*, midnight to midnight local standard time	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 3.3 and 40 CFR Part 50, Appendix N, Section 1.0 *See CFR details if less than 1380 minutes sampled
Sampling Instrument			
Sampler/ Monitor	not applicable	Meets requirements listed in FRM/FEM designation	1) 40 CFR Part 58 Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Average Flow Rate	every 24 hours of operation	average within 5 percent of 16.67 liters per minute (LPM)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
One-point Flow Rate Verification	Every 30 days each separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	<± 4.1 percent of transfer standard <± 5.1 percent of flow rate design value (DAQ warning limit <±3 percent of transfer standard and <±4 percent of flow design value)	1) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A, Section 3.2.1 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1, 40 CFR Part 58, Appendix A, Section 3.2.1 and *DAQ 2025i SOP* Section 7.0
Design Flow rate Adjustment	***after multi-point verification or calibration***	<± 2.1 percent of design flow rate	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
Individual Flow Rates	every 24 hours of operation	no flow rate excursions > ± 5 percent for > 5 minutes	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Filter temp Sensor	every 24 hours of operation	no excursions of > 5° C lasting longer than 30 minutes	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.11.4
External Leak Check	before each flow rate verification or calibration, before and after PM2.5 separator maintenance	<80.1 mL/min (DAQ goal is ≤ 25mmHg/minute)	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) 40 CFR Part 50, Appendix L, Section 9.2.3 and Method 2.12 , Section 7.4.3 *3)* 40 CFR Part 50, Appendix L, Section 7.4.6.1, *DAQ QAPP, $PM_{2.5}$, 2.24 Fine Particles, Section 2, Operator Responsibilities for DAQ limits*
Internal Leak Check	If failure of external leak check	<80.1 mL/min ≤ 140 mmHg/minute	1) 40 CFR Part 50, Appendix L, Section 7.4.6.2 2) Method 2.12, Section 7.4.4 *3)* 40 CFR Part 50, Appendix L, Section 7.4.6.2, *DAQ QAPP, $PM_{2.5}$, 2.24 Fine Particles, Section 2, Operator Responsibilities for DAQ limits*
Laboratory Activities			
Filter Visual Defect Check (unexposed)	all filters	Correct type and size and for pinholes, particles or imperfections	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 10.2
Determine Deadline for Post-Sampling Weighing	all filters	Protected from temperatures above 25°C from sample retrieval to conditioning. ≤10 days from sample end date if shipped at ambient temperature, or ≤30 days if shipped < average ambient (or 4°C or below for average sampling temperature < 4° C) from sample end date. >25°C receiving temperature = void	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.6 and 10.13. See technical note on holding time requirements at: https://www3.epa.gov/ttn/amtic/pmpolgud.html Check the *DAQ QAPP, $PM_{2.5}$, 2.24 Fine Particles, Section 3, Laboratory Responsibilities* for laboratory activities
Filter Conditioning Environment			
Equilibration	all filters	24-hour minimum	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.5

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Temperature Range	all filters	24-hour mean 20.0-23.0° C	1 and 2) 40 CFR Part 50, Appendix L, Section 8.2.1 3) 40 CFR Part 50, Appendix L, Section 8.2.1 and RTI SOP for PM Gravimetric Analysis Rev. 15
Temp. Control	all filters	< 2.1° C SD** over 24 hours	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.2
Humidity Range	all filters	24-hour mean 30.0 – 40.0 percent RH‡ or ≤ 5.0 percent sampling RH but ≥ 20.0 percent RH	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.3 3) 40 CFR Part 50, Appendix L, Section 8.2.3 and RTI SOP for PM Gravimetric Analysis Rev. 15
Humidity Control	all filters	<5.1 percent SD** over 24 hours.	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.4 SD use is a recommendation
Pre/post Sampling RH	all filters	difference in 24-hour means < ± 5.1 percent RH	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.3
Balance	all filters	located in filter conditioning environment	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.2
Microbalance Auto-Calibration	Prior to each weighing session	Manufacturer's specification	1) 40 CFR Part 50, Appendix L, Section 8.1 2) 40 CFR Part 50, Appendix L, Section 8.1 and Method 2.12 Section 10.6 3) NA
OPERATIONAL EVALUATIONS TABLE - $PM_{2.5}$ Filter-Based, Local Conditions			
Field Activities			
One-Point Temperature Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12, 7.4.5 3) Recommendation
Pressure Verification	1/30 days	<± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12, 7.4.6 3) Recommendation
Annual Multi-Point Calibrations			

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Temperature multi-point Verification/Calibration	on installation, then every 365 days and once a calendar year	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12, section 6.4.4
Pressure Verification/Calibration	on installation, and on one-point verification failure	< ± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12 Section 6.5 Sampler barometric pressure verified against an independent standard verified against a laboratory primary standard that is certified as NIST-traceable 1/365 days
Flow Rate Multi-Point Verification or Calibration	Electro-mechanical maintenance or transport or every 365 days and once a calendar year	< ± 2.1 percent of transfer standard	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Section 6. 3) Recommendation
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	1, 2 and 3) Recommendation
Precision			
Collocated Samples	every 12 days for 15 percent of sites by method designation	CV < 10.1 percent of samples ≥ 3.0 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.1
Accuracy			
Temperature Audit	1/180 days	<± 2.1°C	1, 2 and 3) Method 2.12, Section 11.2.2 and Table 11-1
Pressure Audit	1/180 days	<±10.1 millimeters mercury	1, 2 and 3) Method 2.12, Section 11.2.3 and Table 11-1

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Semi-Annual Flow Rate Audit	Twice a calendar year and between 5-7 months apart (DAQ's goal is 1/90 days)	<± 4.1 percent of audit standard (DAQ's warning limit is ≤±3 percent) <± 5.1 percent of design flow rate (DAQ's warning limit is ≤±4 percent)	1) 40 CFR Part 58, Appendix A, Section 3.2.2 *2)* 40 CFR Part 58, Appendix A, Section 3.2.2 and *DAQ 2025i SOP* Section 7.0 *3)* Method 2.12 Section 11.2.1 and Table 11-1 and *DAQ 2025i SOP* Section 7.0
Monitor Maintenance			
Very Sharp Cut Cyclone	every 30 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.3.3
Inlet Cleaning	1/30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Downtube Cleaning	1/90 days	cleaned	1,2 and 3) Method 2.12, Section 8.4
Filter Housing Assembly Cleaning	1/30 days	cleaned	1, 2 and 3) Method 2.12, Section 8.3
Fan Filter Cleaning	1/90 days	cleaned/changed	1, 2 and 3) Method 2.12, Section 8.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	< ±15.1 µg change between each weighing	1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12 Section 10.5
Exposure Lot Blanks	3 filters per lot	< ±15.1 µg change between each weighing	1, 2 and 3) Method 2.12 Section 10.5 Used for preparing a subset of filters for equilibration
Filter Integrity (exposed)	each filter	no visual defects	1, 2 and 3) Method 2.12 Section 10.7 and 10.3
Lab QC Checks			
Field Filter Blank	10 percent or 1 per weighing session	<± 30.1 µg change between each weighing	1) 40 CFR Part 50, Appendix L, Section 8.3.7.1 2 and 3) Method 2.12 Section 10.5

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Lab Filter Blank	10 percent or 1 per weighing session	<± 15.1 µg change between each weighing	1) 40 CFR Part 50, Appendix L, Section 8.3.7.2 2 and 3) Method 2.12 Section 10.5
Balance Check (working standards)	beginning, every 10th sample, end	< ± 3.1 µg from certified value	1, 2 and 3) Method 2.12 Section 10.6 Standards used should meet specifications in Method 2.12, Section 4.3.7
Routine Filter re-weighing	1 per weighing session	<± 15.1 µg change between each weighing	1, 2 and 3) Method 2.12 Section 10.8
Microbalance Audit	every 365 days and once a calendar year	<± 0.003 mg or manufacturers specs, whichever is tighter	1, 2 and 3) Method 2.12 Section 11.2.7
Lab Temp Check	1/90 days	< ± 2.1°C	1, 2 and 3) Method 2.12 Section 4.3.8 and 9.4
Lab Humidity Check	1/90 days	< ± 2.1 percent	1, 2 and 3) Method 2.12 Section 4.3.8 and 9.4
Verification/Calibration			
Microbalance Calibration	At installation every 365 days and once a calendar year	Manufacturer's specification	1) 40 CFR Part 50, Appendix L, Section 8.1 2) 40 CFR Part 50, Appendix L, Section 8.1 and Method 2.12, Section 10.11 3) Not applicable
Lab Temperature Certification	every 365 days and once a year	< ± 2.1°C	1, 2 and 3) Method 2.12 Section 4.3.8 and 9.4
Lab Humidity Certification	every 365 days and once a year	< ± 2.1°C	1, 2 and 3) Method 2.12 Section 4.3.8 and 9.4
Calibration & Check Standards			
Working Mass Standards Verification Compared to Primary Standards	1/90 days	< ±2.1 micrograms (µg)	1, 2 and 3) Method 2.12, Section 9.7
Primary standards certification	every 365 days and once a calendar year	0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12, Section 4.3.7

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
SYSTEMATIC CRITERIA - $PM_{2.5}$ Filter-Based, Local Conditions			
Siting	1/365 days and 1/calendar year	Meets siting criteria or waiver documented	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	Annual Standard	≥ 75 percent scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24- Hour Standard	≥ 75 percent scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
Reporting Units	all filters	µg/m^3 at ambient temperature and pressure	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Rounding convention for design value calculation	all filters	to one decimal place, with additional digits being truncated	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual values.
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding convention for data reported to AQS is a recommendation
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding rule for AQS data is a recommendation
Detection Limit			
Lower Detection Limit	all filters	≤ 2 µg/m^3	1,2 and 3) 40 CFR Part 50, Appendix L, Section 3.1
Upper Concentration Limit	all filters	≥ 200 µg/m^3	1,2 and 3) 40 CFR Part 50, Appendix L, Section 3.2
Precision			
Single analyzer (collocated monitors)	1/90 days.	CV*** < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3-year estimates	90 percent confidence limit of CV*** < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias			

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Performance Evaluation Program (PEP)	5 audits for PQAOs with < 5 sites 8 valid audits for PQAOs with > 5 sites and each PQAO primary monitor audited every 6 years	< ± 10.1 percent for values ≥ 3.0 $\mu g/m^3$	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1
Field Activities			
Verification/Calibration Standards Recertification – All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	1/365 days and 1/calendar year	<± 2.1 percent of NIST-Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2-12 Section 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	1/365 days and 1/calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12, Section 4.2.2 and Table 4-1
Field Barometer	1/365 days and 1/calendar year	± 1 millimeter mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12, Section 4.2.2 and Table 4-1
Field Manometer	1/365 days and 1/calendar year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12, Section 4.2.2 and Table 4-1
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12, Table 8-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Laboratory Activities			
Microbalance Readability	at purchase	± 1 µg	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.1
Microbalance Repeatability	at purchase	1 µg	1) Method 2.12, Section 4.3.6 2) Recommendation 3) Method 2.12, Section 4.3.6

Table 7. Measurement Quality Objectives. PM2.5 (Gravimetric, Filter-Based, Local Conditions

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Primary Mass/Working Mass Verification and Calibration Standards	At purchase	0.025 mg (Tolerance for the weight, Class 2 or better)	1, 2 and 3) Method 2.12, Section 4.3.7 and Table 4-2
Comment: The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			
***DAQ must flag the value. **SD= Standard Deviation. CV= Coefficient of Variation ǂ RH = Relative Humidity**			

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ Continuous, BAM 1020, Local Conditions			
Sampler/Monitor	Not applicable	Meets requirements listed in FRM/FEM designation Confirm method designation on front panel or just inside instrument	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Firmware of monitor	At setup	1. Must be the firmware (or later version) as identified in the published method designation summary. 2. Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).	40 CFR Part 50, Appendix N, section 1 (c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50 App N. Sec 3 (c)
Sampling Instrument			
PM_{10} Inlet	At setup	Must be a Louvered PM_{10} size selective inlet as specified in 40 CFR Part 50, appendix L, Figures L-2 through L-19	1, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
$PM_{2.5}$ second stage separator	At setup	Must be a BGI Incorporated Very Sharp Cut Cyclone (VSCC^{TM}) or Tisch TE-PM2.5C particle size separator.	1, 2 and 3) FRM/FEM method list
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within ± 5 percent of 16.67 LPM at local conditions	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV* ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))			
1) Criteria (PM 1020 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
One-point Flow Rate Verification	1/30 days, separated by 14 days (DAQ's goal is 2/month separated by 14 to 18 days)	< ± 4.1 percent of transfer standard; < ± 5.1 < percent of flow rate design value (DAQ's warning limit for percent of transfer standard and flow design value is 3 and 4 percent respectively)	1) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A, Section 3.2.1 and 3.3.1 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1, 40 CFR Part 58, Appendix A, Section 3.2.1 and 3.3.1, and *DAQ BAM SOP*, Section 7.0
Design Flow Rate Adjustment	After multi-point calibration or verification	< ± 2.1 percent of design flow rate	1,2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
External Leak Check	Before each flow rate verification or calibration and before and after $PM_{2.5}$ separator maintenance	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) 40 CFR Part 50, Appendix L, Section 9.2.3 and Method 2-12 Section 7.4.3 3) 40 CFR Part 50, Appendix, L, Section 7.4.6.1
Internal Leak Check	If failure of external leak check	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.2 2) Method 2-12 Section 7.4.4 3) 40 CFR Part 50, Appendix L, Section 7.4.6.2
OPERATIONAL CRITERIA - $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ Continuous, BAM 1020, Local Conditions			
Annual Multi-point Verifications/Calibrations			
Leak Check	Every 30 days	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) Recommendation 3) DAQ BAM SOP Section 7.0
Temperature multi-point Verification or Calibration	on installation, then Every 365 days and 1/calendar year	< ± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
			2.12 Section 6.4.4
One-point Temperature Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12 Section 7.4.5 and Table 6-1 3) DAQ BAM SOP Section 7.0
Pressure Verification/Calibration	on installation, then every 365 days and 1/calendar year	± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) DAQ BAM SOP Section 7.0
Flow Rate Multi-point Verification/Calibration	Electromechanical maintenance or transport or every 365 days and 1/calendar year	≤+ 2.1 percent of transfer standard	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Table 6-1 and 6-3 3) Recommendation
Other Monitor Calibrations/checks	per manufacturers' operating manual	Annual zero test on Met One BAM 1020	1, 2 and 3) Per manufacturers' operating manual. Note: more frequent zero tests may be appropriate in areas with seasonal changes in dew points.
Precision			
Collocated Samples	every 12 days for 15 percent of sites by method designation	CV < 10.1 percent of samples ≥ 3 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit (DAQ goal is 1/90 days)	< ± 2.1°C	1, 2 and 3) Method 2.12 Section 11.2.2

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
Pressure Audit	every 180 days and at time of flow rate audit (DAQ goal is 1/90 days)	< ± 10.1 millimeters mercury	1, 2 and 3) Method 2.12 Section 11.2.3
Semi-Annual Flow Rate Audit	Twice a calendar year and 5-7 months apart (DAQ goal is 1/90 days)	< ± 4.1 percent of audit standard (DAQ's warning limit is ≤±3 percent) < ± 5.1 percent of design flow rate (DAQ's warning limit is ≤±4 percent)	1) 40 CFR Part 58, Appendix A, Section 3.2.2 and 3.3.3 2) 40 CFR Part 58, Appendix A, Section 3.2.2 and 3.3.3 and DAQ BAM SOP Section 5.0 3) Method 2.12 Section 11.2.1 and DAQ BAM SOP Section 5.0
Shelter Temperature			
Temperature Range	At set-up	20 to 30 ° C	
Temperature Control	Daily (hourly values)	< 2.1° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Temperature Device Check	Every 180 calendar days and twice a calendar year	< ± 2.1° C	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Monitor Maintenance			
PM2.5 Separator (VSCC)	every 30 days	cleaned/changed	1,2 and 3) Method 2.12 Section 8.3.3
Inlet Cleaning	every 30 days	cleaned/changed	1,2 and 3) Method 2.12 Section 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12 Section 8.4
Filter Housing Assembly Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Section 8.3
Circulating Fan Filter Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Section 8.3

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	1, 2, and 3) Per operator manual
Met One 1020 BAM Specific Operational Criteria			
BAM check of membrane span foil	Daily	Average < + 5.1 percent of ABS	1, 2 and 3) Applies on the BAM 1020
BAM electrical grounding	At setup	1. Ground the chassis of the BAM 2. Ground the downtube to the chassis at the collar (i.e., with setscrews)	1, 2, and 3) Per operator manual
Nozzle cleaning	Every 30 days, or more often as needed	cleaned	Per operator manual
Zero test	Yearly	Standard deviation of the data from a 72-hour zero test < 2.4 µg/m^3	1,2 and 3) Per operator manual
SYSTEMATIC CRITERIA- $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ Continuous Met One BAM 1020, Local Conditions			
Siting	1/365 days and 1/calendar year	meets siting criteria or waiver documented	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	Annual standard	≥ 75 percent	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24-hour standard	≥ 75 percent	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
Reporting Units	all hourly and 24-hour values	µg/m^3 at ambient temperature and pressure	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
Rounding convention for design value calculation	all hourly averages	to one decimal place, with additional digits to the right being truncated	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) The rounding convention is for averaging values for comparison to the NAAQS not for reporting individual values.
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding rule for AQS data is a recommendation
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding rule for AQS data is a recommendation
Recertification of Standard Verifications and Calibrations - All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	Every 365 days and once a year	<± 2.1 percent of NIST- Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2.12 Section 4.2.3 and 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	Every 365 days and once a year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Barometer	Every 365 days and once a year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	Every 365 days and once a year	± 0.1 inches water resolution, ± 1.0 inches water accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12 Table 8-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12

Table 8. Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One Beta Attenuation Monitor (BAM) 1020, Local Conditions (LC))

1) Criteria (PM 1020 LC)	2) Frequency	3) Acceptable Range	Information /Action
Precision			
Single analyzer (collocated monitors)	1/91 days.	CV ≤ 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias			
Performance Evaluation Program (PEP)	5 audits for PQAOs with < 5 sites 8 valid audits for PQAOs with > 5 sites and each PQAO primary monitor audited every 6 years	<±10.1 percent for values ≥ 3.0 µg/m^3	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - PM_{10} Continuous, BAM 1020, STP			
Sampler/Monitor	Not applicable	***meets requirements listed in FRM/FEM designation*** Confirm method designation on front panel or just inside instrument	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Firmware of monitor	At setup	1. Must be the firmware (or later version) as identified in the published method designation summary. ***2. Firmware settings must be set for flowrate to operate and report at STP.***	1, 2 and 3) 40 CFR Part 50, Appendix J, Section 2.2
Data Reporting Period	Report every hour	1. The BAM 1020 bases the calculation of a valid hour of data on the collection of 42 valid minutes of data per hour. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day	1) and 2) 40 CFR Part 50, Appendix N, Section 3 (c) 3) See BAM 1020 operator's manual and 40 CFR Part 50, Appendix N, Section 3 (c) Hourly data are always reported as the start of the hour on local standard time
Sampling Instrument			
PM_{10} Inlet	At setup	Must be a Louvered PM_{10} size selective inlet as specified in 40 CFR Part 50, appendix L, Figures L-2 through L-19	1, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within ± 5 percent of 16.67 LPM at local conditions	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
Verification/Calibration			

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
One-point Flow Rate Verification	Every 30 days, each separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	< ± 4.1 percent of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1 percent of flow rate design value (DAQ's warning limit is ≤± 4 percent of flow rate design value)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.3.1 and *DAQ BAM SOP*, Section 7.0 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and *DAQ BAM SOP*, Section 7.0
Design Flow Rate Adjustment	***After multi-point calibration or verification***	***< ± 2.1 percent of design flow rate***	1,2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
OPERATIONAL CRITERIA - PM_{10} Continuous, BAM 1020, STP			
Annual Multi-point Verifications/Calibrations			
External Leak Check	Before each flow rate Verification or calibration	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) 40 CFR Part 50, Appendix L, Section 9.2.3 and Method 2-12 Section 7.4.3 40 CFR Part 50, Appendix L, Section 7.4.6.1 and DAQ BAM SOP Section 6 and 7
Internal Leak Check	If failure of external leak check	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.2 2) Method 2-12 7.4.4 3) 40 CFR Part 50, Appendix L, Section 7.4.6.2 and DAQ BAM SOP 2.37.2 Appendix A: Internal Leak Check Procedures
Temperature multi-point Verification or Calibration	On installation, electromechanical maintenance, transport or every 365 days and 1/calendar year	< ± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12 Section 6.4.4

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
One-Point Ambient Pressure Verification or Calibration	On installation, electromechanical maintenance, transport or every 365 days and 1/calendar year	< ± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12, Section 6.5 Barometric pressure verified against an independent standard verified against a laboratory primary standard that is certified NIST-traceable 1/365 days
Flow Rate Multi-point Verification or Calibration	On installation, electromechanical maintenance, transport or every 365 days and 1/calendar year	< ± 2.1 percent of transfer standard	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Table 6-1 and 6-3 3) Recommendation
Routine One-point Verifications			
Leak Check	1/30 days	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) DAQ BAM SOP Section 7.1 3) DAQ BAM SOP Section 7.1
One-point Temperature Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12 Section 7.4.5 and Table 6-1 3) DAQ BAM SOP Section 7.1
One-point Pressure Verification	1/30 days	< ± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) DAQ BAM SOP Section 7.1 3) DAQ BAM SOP Section 7.1
Other Monitor Calibrations/checks	per manufacturers' op manual	Annual zero test on Met One BAM 1020	1, 2 and 3) Per manufacturers' operating manual. Note: more frequent zero tests may be appropriate in areas with seasonal changes in dew points.
Precision			

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
Collocated Samples	every 12 days for 15 percent of sites by method designation	CV < 10.1 percent of samples $\geq$ 3 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit (DAQ goal is 91 days)	< $\pm$ 2.1°C	1) Method 2.12 Section 11.2.2 2) Method 2.12 Section 11.2.2 (and DAQ BAM SOP Section 5.0) 3) Method 2.12 Section 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit (DAQ goal is 91 days)	< $\pm$ 10.1 millimeters mercury	1) Method 2.12 Section 11.2.3 2) Method 2.12 Section 11.2.3 (and DAQ BAM SOP Section 5.0) 3) Method 2.12 Section 11.2.3
Semi-Annual Flow Rate Audit	Twice a calendar year and 5-7 months apart (DAQ goal is 91 days)	< $\pm$ 4.1 percent of audit standard; < $\pm$ 5.1 percent of design flow rate (DAQ's warning limit for percent of transfer standard and flow design value is ≤±3.0 and ≤±4.0 percent respectively)	1) 40 CFR Part 58, Appendix A, Section 3.3.3 2) 40 CFR Part 58, Appendix A, Section 3.3.3 (and DAQ BAM SOP Section 5.0) 3) Method 2.12 Section 11.2.1 (and DAQ BAM SOP Section 5.0)
Shelter Temperature			
Temperature Range	At set-up	0 to 50 ° C (DAQ goal is 20 to 30 ° C)	1, 2 and 3) BAM 1020 Operation Manual
Temperature Control	Hourly values	Within ± 2 ° C	1, 2 and 3) BAM 1020 Operation Manual
Temperature Device Check	Every 180 calendar days and twice a calendar year	< $\pm$ 2.1° C	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Monitor Maintenance			
Inlet Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Section 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12 Section 8.4

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
Filter Housing Assembly Cleaning	every 30 days	cleaned	1, 2 and 3) Method 2.12 Section 8.3
Circulating Fan Filter Cleaning	every 30 days	Cleaned or changed	1, 2 and 3) Method 2.12 Section 8.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	1, 2 and 3) BAM 1020 Operations Manual
MetOne 1020 BAM Specific Operational Criteria			
Check of membrane span foil	Daily	Average < + 5.1 percent of ABS	1, 2 and 3) BAM 1020 Operations Manual
BAM electrical grounding	At Installation, 1/year	1. Ground the chassis of the BAM 2. Ground the downtube to the chassis at the collar (i.e., with setscrews)	1, 2 and 3) BAM 1020 Operations Manual
Nozzle and vane cleaning	Every 30 days, or more often as needed	cleaned	1, 2 and 3) DAQ BAM SOP Section 8.0
Zero test	Yearly	Standard deviation of the data from a 72-hour zero test < 2.4 µg/m^3	1, 2 and 3) DAQ BAM SOP Section 7.0
SYSTEMATIC CRITERIA – PM_{10} Continuous, BAM 1020, STP			
Siting	1/365 days and 1/calendar year	***meets siting criteria or waiver documented***	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	24-hour quarterly	≥ 75 percent of hours per day and scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50, Appendix K, Section 2.3 (a)
Reporting Units	all hourly and 24-hour values	µg/m^3 at STP	1, 2 and 3) 40 CFR Part 50, Appendix K

Table 9. Measurement Quality Objectives: PM10 (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
Rounding convention for design value calculation	***All 24-hour averages from midnight to midnight***	***Nearest 10 µg/m³ at STP (≥ 5 round up***)	1, 2 and 3) 40 CFR Part 50, Appendix K Section 1 The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual values
Rounding convention for data reported to AQS	all hourly averages	to one decimal place, with additional digits to the right being truncated	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Re-certifications of Verification and Calibration Standards - All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	1/365 days and once per calendar year	<± 2.1 percent of NIST-Traceable Standard	1) 40 CFR Part 50, Appendix J, Section 7.3 2) Method 2.11, Section 1.1.3 3) 40 CFR Part 50, Appendix J, Section 7.3
Field Thermometer	1/365 days and once per calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Barometer	1/365 days and once per calendar year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.10, Section 1.1.2
Field Manometer	1/365 days and once per calendar year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Clock/timer Verification	1/30 days	***± 1 minute/month***	1and 2) Method 2.12 Table 8-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Precision (using flow rate verifications – no collocation is required for continuous PM_{10})			
Primary Quality Assurance Organization	Annual and 3-year estimates	Upper 90 percent confidence limit for the CV <10.1 percent	1, 2 and 3) 40 CFR Part 58, Appendix A, Sections 2.3.1.1, 4.2.2 and 3.3.1
Bias (using flow rate verifications – no NPAP or PEP is available for PM_{10})			
Primary quality assurance organization	Annual and 3-year estimates	≤ ±10.0 percent for total bias	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 2.3.1.1, 4.2.2 and 3.3.1

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA - $PM_{2.5}$ Continuous, BAM 1022, Local Conditions			
Sampler/Monitor	Not applicable	meets requirements listed in FRM/FEM designation Confirm method designation on front panel or just inside instrument	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Firmware of monitor	At setup	1. Must be the firmware (or later version) as identified in the published method designation summary. 2. Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).	40 CFR Part 50 Appendix N, section 1 (c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50 Appendix N, Section 3 (c)
Sampling Instrument			
PM_{10} Inlet (if applicable to method designated)	At setup	Must be a Louvered PM_{10} size selective inlet as specified in 40 CFR Part 50, Appendix L, Figures L-2 through L-19	1, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
$PM_{2.5}$ second stage separator (if applicable to method designated)	At setup	Must be a BGI Inc. Very Sharp Cut Cyclone (VSCC™) or equivalent second stage separator approved for the method.	The other approved second stage separator option for select FEMs is the Dichot. +

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within 5 percent of 16.67 LPM at local conditions	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
One-point Flow Rate Verification	1/30 days, separated by 14 days	< ± 4.1 percent of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1 percent of flow rate design value (DAQ's warning limit is ≤± 4 percent of flow rate design value)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A, Section 3.2.3 and 3.3.2 3) DAQ's warning limit for percent of transfer standard and flow design value is 3 and 4 percent respectively, *DAQ BAM SOP*, Section 7.0
Design Flow Rate Adjustment	After multi-point calibration or verification	< ± 2.1 percent of design flow rate	1,2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
External Leak Check	Before each flow rate verification or calibration and before and after PM2.5 separator maintenance	Method specific. See operator's manual.	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) 40 CFR Part 50, Appendix L Section 9.2.3 and Method 2-12 Section 7.4.3 3) 40 CFR Part 50, Appendix L, Section 7.4.6.1
Internal Leak Check	If failure of external leak check	Method specific. See operator's manual.	1) 40 CFR Part 50, Appendix L, Section 7.4.6.2 2) Method 2-12 7.4.4 3) 40 CFR Part 50, Appendix L, Section 7.4.6.2
OPERATIONAL CRITERIA - PM BAM 1022, Local Conditions			
Annual Multi-point Verifications/Calibrations			
Leak Check	1/30 days	< 1.5 LPM	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) Recommendation 3) DAQ BAM SOP Section 7.0.

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)

1) Criteria (PM 1022 LC)	2) Frequency	3) Acceptable Range	Information /Action
Temperature multi-point Verification/Calibration	on installation, then Every 365 days and 1/calendar year	< ± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12 Section 6.4.4
One-point Temperature Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12 Section 7.4.5 and Table 6-1 3) Recommendation
Pressure Verification/Calibration	on installation, then every 365 days and 1/calendar year	± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) DAQ BAM SOP Section 7.0
Flow Rate Multi-point Verification/Calibration	Electromechanical maintenance or transport or every 365 days and 1/calendar year	≤+ 2.1 percent of transfer standard	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Table 6-1 and 6-3 3) Recommendation
Other Monitor Calibrations/checks	Per manufacturers' operation manual	Annual zero test on Met One BAM 1022	1, 2, 3) Per manufacturers' operating manual. Note: more frequent zero tests may be appropriate in areas with seasonal changes in dew points.
Precision			
Collocated Samples	every 12 days for 15 percent of sites by method designation	CV < 10.1 percent of samples ≥ 3 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	< ± 2.1°C	1, 2 and 3) Method 2.12 Section 11.2.2

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)

1) Criteria (PM 1022 LC)	2) Frequency	3) Acceptable Range	Information /Action
Pressure Audit	every 180 days and at time of flow rate audit	< ± 10.1 millimeters mercury	1, 2 and 3) Method 2.12 Section 11.2.3
Semi-Annual Flow Rate Audit	Twice a calendar year and 5-7 months apart	< ± 4.1 percent of audit standard; < ± 5.1 percent of design flow rate (DAQ's warning limit for percent of transfer standard and flow design value is ≤±3.0 and ≤±4.0 percent respectively)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.3.3 3) Method 2.12 Section 11.2.1, DAQ BAM SOP Section 5.0
Monitor Maintenance			
PM2.5 Separator (VSCC)	every 30 days	cleaned/changed	1,2 and 3) Method 2.12 Section 8.3.3
Inlet Cleaning	every 30 days	cleaned/changed	1,2 and 3) Method 2.12 Section 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12 Section 8.4
Filter Housing Assembly Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Section 8.3
Circulating Fan Filter Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12 Section 8.3
Manufacturer-Recommended Maintenance	Per manufacturers' SOP	per manufacturers' SOP	
Design Flow Rate Adjustment	at multi-point calibration	± 2 percent of design flow rate	1,2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
MetOne 1022 BAM Specific Operational Criteria			
BAM check of membrane span foil	Quarterly	Average < + 5.1 percent of ABS	1, 2 and 3) Applies on the BAM 1022
BAM electrical grounding	At Installation, 1/year	1. Ground the chassis of the BAM. 2. Ground the downtube to the chassis at the collar (i.e., with setscrews)	1, 2, 3) Per operator manual

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Nozzle cleaning	Every 30 days, or more often as needed	cleaned	1, 2, 3) Per operator manual
Zero test	Yearly	Standard deviation of the data from a 72-hour zero test < 2.4 µg/m^3	1, 2, 3) Per operator manual
SYSTEMATIC CRITERIA- PM2.5 Continuous, Local Conditions			
Siting	1/365 days and 1/calendar year	meets siting criteria or waiver documented	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	Annual standard	≥ 75 percent	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24-hour standard	≥ 75 percent	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
Reporting Units	all hourly and 24-hour values	µg/m^3 at ambient temperature/pressure ($PM_{2.5}$)	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Rounding convention for data reported to AQS	all hourly averages	to one decimal place, with additional digits to the right being truncated	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) Rounding rule for AQS data is a recommendation
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4
Recertification of Standard Verifications and Calibrations - All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	Every 365 days and once a year	<± 2.1 percent of NIST-Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2.12 Section 4.2.3 and 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2

Table 10. Measurement Quality Objectives: $PM_{2.5}$ (Continuous Met One BAM 1022, Local Conditions)

1) Criteria (PM 1022 LC)	2) Frequency	3) Acceptable Range	Information /Action
Field Thermometer	Every 365 days and once a year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Barometer	Every 365 days and once a year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	Every 365 days and once a year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12 Table 8-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Precision			
Single analyzer (collocated monitors)	1/91 days.	CV ≤ 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3-year estimates	90 percent confidence limit of CV < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias			
Performance Evaluation Program (PEP)	5 audits for PQAOs with < 5 sites 8 valid audits for PQAOs with > 5 sites, each PQAO primary monitor audited every 6 years	<±10.1 percent for values > 3.0 µg/m^3	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
1) Criteria (T640X)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA – T640x Continuous $PM_{2.5}$, and PM_{10} and $PM_{10-2.5}$ Continuous T640X, Local Conditions and STP (PM_{10})			
Sampler/Monitor	Not applicable	Meets requirements listed in FEM designation Confirm method designation on front panel or just inside instrument.	40 CFR Part 58, Appendix C, Section 2.1 Not applicable 40 CFR Part 53 and FRM/FEM method list
Firmware of monitor	At setup and as updated	1. Must be the firmware (or later version) as identified in the published method designation summary. 2. Firmware settings must be set for flowrate to operate and report at (1) "local conditions" for PM2.5 and (2) STP for PM10.	1) FEM: EQPM-0516-238/239 2) EPA T640x SOP 3) 1. FEM: EQPM-0516-238/239 2. 40 CFR Part 50 App N. sec. 1 (c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day.	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50 App N. Sec 3 (c)
Sampling Instrument			
PM10 Inlet	At Setup	Must be a Louvered PM10 size selective inlet as specified in 40 CFR 50 appendix L, Figures L-2 through L-19	1) FEM: EQPM-0516-238/239 2) EPA T640x SOP 3) FEM: EQPM-0516-238/239
Average Flow Rate	every 24 hours of operation; alternatively, each hour can be checked	average within ±5% of 16.67 liters/minute at local conditions	1, 2 and 3) 40 CFR Part 50 App L Sec. 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV* ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
1) Criteria (T640X)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
One-point Flow Rate Verification (Total Flow)	1/30 days, separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	< ± 4.1 percent of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1 percent of flow rate design value (DAQ's warning limit is ≤± 4 percent of flow rate design value)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 40 CFR Part 58, Appendix A, Section 3.2.1 3) *DAQ T640X SOP*, Section 7.0
One-point Flow Rate Verification (Sample Flow)	1/30 days, separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	< + 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard)	1, 2 and 3) 40 CFR Part 50, App.L, Sec. 9.2.5, 40 CFR Part 58, Appendix A, Sec. 3.2.1, 3) *DAQ T640X SOP*, Section 7.0
PMT verification	every 90 days	≤ ± 1.5 of SpanDust™ value stated on bottle	1) Teledyne T640 manual 2) EPA T640x SOP 3) To meet DQO set forth in 40 CFR Part 58, Appendix A, Sec. 2.3.1.1 and *DAQ T640X SOP*, Section 7.0
OPERATIONAL CRITERIA - Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
Routine Verifications			
Mid-Month Flow Rate Verification	1/30 days	Total Flow < ± 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1% of flow rate design value (DAQ's warning limit is ≤± 4 percent of flowrate design value) Sample Flow < + 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard);	1) 40 CFR Part 50, Appendix L, Section 9.2.5 and 40 CFR Part 58, Appendix A, Section 3.2.1 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
One–point Temperature Verification	1/30 days	<± 2.1°C	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual and *DAQ T640X SOP*, Section 7.0
Pressure Verification	1/30 days	<± 10 millimeters mercury	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual and *DAQ T640X SOP*, Section 7.0
Leak Check (Zero Test)	1/30 days	≤ 0.2 µg/m^3	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual and DAQ T640X SOP, Section 7.0
Span Deviation Tracker	Daily	If flagged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric as a leading indicator of potential instrument malfunction.
Signal Length	Daily	Logged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric because it is useful when diagnosing instrument malfunction.
Annual Multi-Point Calibrations			
Pressure Verification/ Calibration	On installation, electromechanical maintenance or transport or 1/365 days and 1/calendar year	<± 10.1 millimeters mercury	1) Teledyne T640 manual 2) Method 2.12 Sec. 6.5 3) Teledyne T640 manual

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
Flow Rate Multi-Point Calibration	Electromechanical maintenance or transport or 1/365 days and 1/calendar year	<± 2.1 percent of transfer standard for all flows	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Sect. 6.3 and Table 6-1 3) Recommendation
Precision			
Collocated Samples	every 12 days for 15% of sites by method designation	CV < 10.1% of samples > 3 µg/m^3	1) and 2) 40 CFR Part 58 App A Sec. 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	± 2°C	1, 2 and 3) Method 2.12, Section 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit	<±10 millimeters mercury	1, 2 and 3) Method 2.12, Section 11.2.3
Semi-Annual Flow Rate Audit (Total Flow)	Twice a calendar year and 5-7 months apart	< ± 4.1 percent of audit standard; < ± 5.1 percent of design flow rate (DAQ's warning limit for percent of transfer standard and flow design value is ≤±3.0 and ≤±4.0 percent, respectively)	1 and 2) 40 CFR Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1
Semi Annual Flow Rate Audit (Sample Flow)	Twice a calendar year and 5-7 months apart	< ± 4.1% of audit standard (DAQ's warning limit is ≤±3.0 percent)	1 and 2) 40 CFR Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1
Shelter Temperature			
Temperature range	During operation	0 - 50°C	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Temperature Control	Daily (hourly values)	< 2.1° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
Temperature Device Check	every 180 days and twice a calendar year	< + 2.1° C	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Monitor Maintenance			
Clean inlet (PM_{10} Head)	Every 30 days	cleaned	1,2 and 3) Teledyne T640 manual
Downtube Cleaning	every 90 days	cleaned	1) Teledyne T640 manual 2) and 3) Method 2.12 Sec. 8.4
Inspect and clean optical chamber and relative humidity/temperature (RH/T) sensors	every 180 days and twice a calendar year. More frequently with high loading	cleaned	1) Teledyne T640 manual 2) EPA T640x SOP 3) EPA T640x SOP
Change Disposable Filter Unit	Annually or when Pump PWM value approaches 80%.	cleaned/changed	1) Teledyne T640 manual 2) EPA T640x SOP 3) EPA T640x SOP
Inspect Downtube and ASC to ensure vertically plumbed	every 90 days	Plumb (90° from instrument horizontal axis)	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Check Pump Performance (Pump)	every 30 days	PWM value 30 < 80%	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Check Pump Performance (Valve)	every 30 days	PWM value 50 < 85%	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Inspect inner and outer sample tubes	every 30 days	Inspected and cleaned as needed	1,2 and 3) Teledyne T640 manual
Empty Water Collection Bottle	Every 30 days	cleaned	1 and 3) DAQ T640X SOP Section 8.0 2) DAQ practice
Inspect O-rings	Every 30 days	Visual inspection	1 and 3) DAQ T640X SOP Section 8.0 2) DAQ practice

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
Internal/External Data Logger Data	Every month highest value on three randomly selected days	agree exactly (digital) and ± 1 µg/m^3 (analog)	1 and 3) DAQ T640X SOP Section 9.0 2) DAQ practice
Manufacturer-Recommended Maintenance	per manufacturers' manual	per manufacturers' manual	Manufacturer-Recommended Maintenance
SYSTEMATIC CRITERIA - $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Continuous T640X, Local Conditions			
Siting	1/365 days and 1/calendar year	meets siting criteria or waiver documented	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	Annual Standard	≥ 75% scheduled sampling days in each quarter	40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24-hour averages	≥ 75% scheduled sampling days in each quarter PM_{10}	40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
Reporting Units	all data	µg/m^3 at ambient temperature and pressure ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$) µg/m^3 at STP (PM_{10})	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b), 40 CFR Part 50 App K
Rounding convention for data reported to AQS	all concentrations	to one decimal place or as reported by instrument	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) Rounding rule for AQS data is a recommendation
Rounding convention for PM_{10} design value calculation	***All 24-hour averages from midnight to midnight***	***Nearest 10 µg/m^3 at STP (≥ 5 round up)***	1, 2 and 3) 40 CFR Part 50, Appendix K Section 1 The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual values

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
Rounding convention for annual 3-yr average for $PM_{2.5}$	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4, the rounding convention for comparison to NAAQS not for reporting individual values.
Rounding convention for 24-hour, 3-year average for $PM_{2.5}$	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up) ($PM_{2.5}$)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4, the rounding convention for comparison to NAAQS not for reporting individual values.
Verification/Calibration Standards Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Standard	Every 365 days and once a year	< ± 2.1 percent of NIST- Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 **2)** Method 2-12 Section 4.2.3 and 6.3.3 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	Every 365 days and once a year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Barometer	Every 365 days and once a year	± 1 millimeter mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	Every 365 days and once a year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Precision ($PM_{2.5}$) – no collocation is required for continuous PM10			
Single analyzer (collocated monitors)	1/90 days	CV < 10.1% for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.

Table 11. Measurement Quality Objectives: Teledyne T640x Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (T640X)	2) Frequency	3) Acceptable Range	Information /Action
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV* < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias ($PM_{2.5}$) – no NPAP or PEP is available for PM_{10}			
Performance Evaluation Program (PEP)	5 audits for PQAOs with < 5 sites 8 audits for PQAOs with > 5 sites	<±10.1 percent for values ≥ 3.0 µg/m^3	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1

8.0 Training Requirements

Adequate education and training are integral to any PM monitoring program that strives for reliable and comparable data. The DAQ and ABAQA personnel will meet the educational requirements, accountability standards and training requirements for their positions. Section 4 of the QMP describes the DEQ training program. The DAQ requires all staff to take specific, mandatory governmental training courses, such as safety training, defensive driving and harassment awareness courses, among others. The DAQ and ABAQA maintain records on personnel qualifications and training in several locations, dependent upon the applicability of the information. For example, staff may maintain copies of certificates received from classes or workshops, whereas human resources will keep records of personnel qualifications. The DAQ uses the North Carolina Learning Management System, or LMS, to track training by DIT and the Office of State Human Resources.

The DAQ PM monitoring program pursues training that increases the effectiveness of employees as well as the efficacy of DAQ as a whole. In general, training for the PM monitoring program consists of a combination of required reading, participation in ambient monitoring monthly meetings, active cross-training amongst staff, completion of EPA-led training classes and attendance at DAQ and EPA workshops and conferences. Currently, no recurring annual training is required for PM monitoring staff other than attendance at the annual ambient monitoring workshop. Observations made during internal systems audits or EPA technical systems audits (TSAs) may result in the need for specific refresher training to be provided by the DAQ staff. In addition, DAQ management encourages all ambient air monitoring staff to complete additional training – such as self-instructional air monitoring courses and EPA-provided webinars.

Specific PM monitoring personnel training consists of required reading before implementing the requirements of this QAPP. Documents that PM monitoring personnel must read shall include this QAPP, its associated SOPs (see Table 16), EPA's Quality Assurance Guidance Document 2.12, and instrument-specific manuals for the equipment personnel will be working with or servicing. Employee supervisors or trainers typically document required reading on a form available in IBEAM indicating the employee has read and understood the PM QAPP and its associated SOPs. These forms are archived in IBEAM. Specific training requirements are provided in SOP DAQ-15-003 (in draft and under review at this time). The DAQ continually revises the training program and updates the training forms used to document training as needed.

All positions have a training guide that provides suggested training for employees to complete to achieve competency in that position. The DAQ makes efforts to ensure all employees receive timely training and periodic refreshers in accordance with the established training guide. Experienced staff members provide on-the-job training. As the RRO has the largest ambient monitoring staff and operates the most diversified monitoring equipment, the chief and supervisors often call upon the RRO to provide hands-on training when needed. The chief or one of the supervisors typically arranges this training. In some cases, the chief or one of the supervisors calls upon other regional offices, the ECB electronics technicians and RCO chemists to provide hands-on training. The employee documents this training on

the provided training forms (obtained from IBEAM), which are archived in IBEAM as well as in the employee's valuing individual performance (VIP). Before 2021, DAQ employees may also have archived training records in the LMS. The DAQ and ABAQA supervisors actively encourage all employees to pursue training opportunities whenever possible and as needed because the chief continually evaluates DAQ's PM monitoring network to ensure it continues to meet its objectives. Because of these evaluations, the chief could add new equipment, procedures or new personnel to the program. The DAQ provides vendor-based training for its personnel when DAQ obtains new equipment. The employees document this training on the provided training form and archive it in IBEAM. The employees may also archive the training records in the LMS, if they choose to do so.

Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses and seminars. The DAQ may provide these courses and seminars in a variety of formats, including web based real-time interaction, video recordings, closed circuit transmissions and/or live instruction.

Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Mid Atlantic Regional Air Management Association and EPA. The employees document this training on the appropriate training form and archive it in IBEAM. The air quality supervisors ensure the air monitoring personnel reporting to them have sufficient training to currently perform necessary functions at an acceptable level.

The DAQ supervisors also evaluate employee proficiency, based on performance and feedback from peers and other coworkers. During the VIP review, the supervisors recommend any refresher training the employee may need and develop a plan for the employee to receive the needed training. The LMS provides and archives certificates of completion for any course work taken through LMS.

The DAQ PM monitoring staff, along with the DAQ PM LAB Staff, provide new personnel the necessary on the job training for their individual monitoring responsibilities. On the job training primarily consists of mentoring or apprentice style training for new or reassigned employees. All new PM staff will work closely with a mentor or trainer for an extended period prior to being allowed to perform the tasks, including data review, verification and validation, on their own. The employee documents all on the job training on the appropriate forms and archives the forms in IBEAM. Ongoing proficiency is reviewed on an as needed basis. No certificates are provided to the trainee and trainee proficiency is documented as part of the on-the-job training process and documentation.

The chief invites the regional monitoring technicians and coordinators and ABAQA monitoring staff to the DAQ ambient monitoring workshop held each year. This workshop provides an opportunity to discuss any necessary changes to the PM program and to observe new procedures and train on PM equipment. Additionally, the workshop may provide additional training or discussions to assist staff to better understand QC and QA processes and the role they play in the collection of valid data. Vendors are used to provide training when new PM equipment is purchased. DAQ and sometimes EPA staff provide additional training during the ambient monitoring workshop. The agenda is attached to the attendance record and is stored in IBEAM. No formal training evaluation forms are collected during or after the workshop.

Training guides are provided for each position in DAQ, listing the required minimum and the suggested training necessary to demonstrate competency for that position. The DAQ's goal is to ensure that all employees receive timely training and periodic refreshers in accordance with the established training guide. Hands-on training is documented on forms that are archived in IBEAM.

Each ABAQA employee records his training annually as part of the annual performance evaluation ABAQA submits for the air planning agreement. The agency keeps this training record for each employee and stores it on the ABAQA server.

DEQ - DAQ Training Links

Air Monitoring:	http://www.epa.gov/ttn/amtic/training.html
Professional Skills:	http://oshr.nc.gov/state-employee-resources/training

9.0 Documentation and Records

The following information describes DAQ's management of documents and records, including this QAPP, for the DAQ and ABAQA PM monitoring program. The DAQ does not have a single designated staff person responsible for policing documents and/or records for the entire AMS. A dedicated document and records custodian would be a tremendous asset; however, funding for such a position has not been made available within the existing budget for the department. Currently, the responsibility for records custodianship is shared within the already overburdened monitoring staff. The AMS has established that the individual staff member who generated the original document and/or record is responsible for the placement, maintenance and archiving of the respective documents and records.

DIT maintains a shared group drive for use by Ambient Monitoring personnel in the RCO and regional offices. Access to this drive is restricted to DAQ personnel and assigned DIT personnel. Although it is commonly referred to as the "P" drive, the group drive may have different letter designations in the regional offices. To reduce confusion, the group drive will be referred to as the "Raleigh Central Office (RCO) group drive" in this QAPP.

Microsoft SharePoint is utilized as an access-restricted document and records storage repository by the seven regional offices. Each regional office has its own specific SharePoint site. The regional ambient monitoring coordinator is responsible for ensuring that all ambient monitoring documents and/or records are stored on their specific SharePoint site. Access to each SharePoint page is restricted to its respective regional office personnel. Regional records and/or documents are stored on the regional SharePoint sites and the regions retain their records and/or documents according to the state's retention schedule. RCO chemists do not have access to the regional SharePoint sites. Therefore, any document and/or record requiring RCO review is placed on the RCO group drive for the RCO chemist to review and approve. The RCO chemists are assigned specific program areas for which they are responsible. For instance, each chemist is responsible for a specific criteria pollutant, such as ozone, particulate matter (PM), sulfur dioxide, nitrous oxides, and carbon monoxide. Also, a specific RCO chemist is assigned to meteorology data and a specific RCO Chemist is assigned to air toxics data. These chemists are responsible for the final approved records that are stored on the RCO group drive.

Documents and records are also archived in the internal access-restricted IBEAM. The RCO staff also utilize SharePoint to share information such as reference materials, meeting notes, draft copies of documents, news articles, workshop materials, presentations, and other miscellaneous information. The RCO SharePoint page is for internal division usage by the AMS and access is restricted to specific North Carolina air quality and DAQ staff but it is not the official location of the approved DEQ QMP, QAPPs and SOPs. The approved DEQ QMP, QAPPs and SOPs are posted to the DEQ/DAQ website for the ease of access for all State, Local and Tribal staff at any location where internet access can be utilized, such as the monitoring sites. All approved documents are posted to the website under strict approval processes and protocols. DAQ stores copies of the RTI QAPP and associated SOPs on the SharePoint page.

DIT routinely creates backups of all data stored on the RCO group drive and IBEAM. Files stored in the "General Documents" module of IBEAM are protected from deletion; any file a user attempts to delete remains in the database but is hidden from view. A supervisor can restore that file to its previous location via a request to the IBEAM administration staff. As a cloud-based file storage location, SharePoint file backups are facilitated by Microsoft, Inc.; all files are backed up twice daily and Microsoft provides a 90-day window for recovery of documents from inadvertent editing or deletion.

The DAQ secures all electronic documents by utilizing encrypted laptops or password protected computers and by storing paper documents in limited access areas. Additionally, SOPs must not conflict with any part of this QAPP or with any other relevant local, state, or federal regulation.

Table 12 lists the documents and records pertaining to all data the EPA requires DAQ to collect and all other data deemed important by DAQ's policies and records management procedures, including documents and records required to support the concentration data reported to EPA.

Table 12. Documentation and Records Information

Categories	Record / Document Type	File Location
Management and Organization	State Implementation Plan Reporting agency information EPA directives Grant allocations Support contracts	Raleigh, North Carolina – Raleigh Central Office
	Quality Management Plan	DEQ Website
	Organizational structure	Ambient Monitoring Administration Page on SharePoint
	Personnel qualifications and training	DEQ HR and DAQ Training page on SharePoint
	Training records and certification	Learning Management System, IBEAM General Documents Module and Valuing Individual Performance
Site Information	Network descriptions Site files Site maps Site pictures	Raleigh Central Office group drive, Regional Office SharePoint page, IBEAM General Documents Module
Environmental Data Operations	Quality Assurance Project Plans	DAQ: DEQ Website for official repository. Other file locations may include IBEAM General Documents Module for archived versions, North Carolina Ambient Monitoring Section QAPP page on SharePoint or Raleigh Central Office group drive (see 9.1)
		RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; IBEAM General Documents Module for archived versions

Table 12. Documentation and Records Information

Categories	Record / Document Type	File Location
	Standard Operating Procedures	DAQ: DEQ Website, IBEAM General Documents Module (see Section 9.1)
		RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; IBEAM General Documents Module for archived versions
	QA Bulletins	DEQ Website, IBEAM General Documents Module (see Section 9.1)
	Field and site notebooks	Raleigh Central Office group drive, Regional Office SharePoint page, monitoring site
	Inspection, Equipment and Maintenance Records	Raleigh Central Office group drive, Regional Office SharePoint page, ECB
Raw Data	Any original data including routine, QC, RTI data packages(see section 9.2.1), etc. Including data entry forms	Raleigh, North Carolina – Raleigh Central Office, Regional Offices, ECB and RTI lab
Data Reporting	Air Quality Index Reports	DAQ Website, IBEAM General Documents Module
	Annual Certification Report	IBEAM General Documents Module
	Data Summary Reports	DAQ Website, IBEAM General Documents Module
	Journals/ articles/ papers/ presentations	Raleigh Central Office group drive, IBEAM General Documents Module
Data Management	Data Algorithms Data Management Plans/ Flow Charts Data Management Systems	Raleigh, NC – Raleigh Central Office
	Pollutant Data Minute Data	Envista ARM database
	Meteorological Data (from State Climate Office)	Raleigh Central Office group drive
Quality Assurance	Network Reviews Control Charts Certification Documentation Data Quality Assessments Quality Assurance Reports Response/ Corrective Action reports Site Audits Internal Technical Systems Audits RTI Technical Systems Audits Emails relating to QA activities and assessments	Raleigh, NC – Raleigh Central Office, Regional Offices, and ECB IBEAM General Documents Module

Table 12. Documentation and Records Information

Categories	Record / Document Type	File Location
	RTI Corrective Action reports	RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; IBEAM General Documents Module for archived versions

The state of North Carolina considers all e-mails official records and the state of North Carolina retains all email correspondence for a minimum of 10 years. In addition, DAQ archives e-mails that are critical in documenting official decisions regarding network decisions and data quality decisions in IBEAM.

Most documentation and records produced by DAQ's PM monitoring program consist of data and information gathered to support the data collection activities. Documentation and records include:

- QAPPs;
- SOPs;
- Logbooks and data collection records in electronic and written format;
- Instrument and equipment calibration information;
- QA documentation in electronic and written format; and
- Documentation that supports data review, validation and certification activities.

Upon assuming a new role working with DAQ documents and/or records, personnel are trained on the appropriate specific locations for each of the document and record types listed in Table 12, how to access the various locations, and proper procedures for maintaining those documents and/or records for which they are responsible. If DAQ personnel require access to documents or records outside of their sphere of responsibility, they may contact the appropriate RCO branch supervisor or regional monitoring coordinator for more information.

Section 19.0 Data Management contains detailed information regarding how DAQ will manage data from the PM monitoring program, including information on data recording, transmittal, storage and retrieval.

9.1 Statewide Policy and Procedure Documentation

DAQ maintains records of program policy and procedure documentation. Documents in this category include:

- QAPPs,
- SOPs,
- Electronic QA/QC data forms that technicians must use to document their work, and
- QA and technical notes, which provide air monitoring policy interpretations or best practices.

The DAQ ensures that document numbers and revision numbers and dates are clearly discernible, generally in the header and on the cover page. The DAQ generates document numbers for these documents using the DAQ Document Identity (ID) Builder, which can be found on the RCO SharePoint

page. Detailed instructions for drafting SOPs can be found in DAQ-14-001 - Standard Operating Procedure (SOP) for Preparing SOPs for the North Carolina Division of Air Quality (NCDAQ).

As of this QAPP revision, DAQ is in the process of purchasing and implementing a new document and record storage database (pending funding), which may result in changes to these procedures and locations. When these changes are made, this QAPP and relevant SOPs will be revised to reflect new procedures and document and record locations.

The DAQ currently uses IBEAM for a controlled internal locale for archiving all QA/QC forms, SOPs and QAPPs. PPB chemists are responsible for the blank QA/QC forms and final records concerning their assigned pollutant(s). Intermediate records are the responsibility of the regional ambient monitoring coordinator. In IBEAM, documents that are archived are marked as *OBSOLETE* in the title so that staff know not to use them for current procedures. The QAM or his designee is responsible for changing the title to *OBSOLETE* when a new version is approved. QA/Tech Notes are also stored in IBEAM. The DEQ website is the official DAQ repository for controlled QMPs, QAPPs and SOPs, i.e., current approved versions. All other QMPs, QAPPs and SOPs not on the website or in IBEAM are uncontrolled and therefore not considered official. Personnel are responsible for obtaining and utilizing current versions of documents.

Also, at the time of this QAPP revision, RCO uses the RCO group drive and SharePoint as repositories for working documents. Regional offices use SharePoint as a repository for working documents, and transfer completed documents to the RCO group drive. Draft documents will be watermarked as *DRAFT* so that no confusion arises as to the finality of the document. The QAM or designee receives final versions for review and approval. Once all approvers sign the QAPPs and SOPs, the QAM or designee will upload or assign someone to upload the document to the website and IBEAM. The QAM will notify staff of the issuance of the new document via email and on the next ambient monitoring work group call. The chief and RCO chemists may change these procedures when the new document and record storage database is implemented and will revise the QAPP if changes are made at that time.

9.2 Data Collection Records and Logbooks

Table 12 lists the documents and records DAQ must retain. The appropriate sections of this QAPP will discuss the details of these various documents and records. The DAQ will collect all raw data required for calculations, the submissions to the AQS database and QA/QC data electronically, in e-logs, spreadsheets or on data forms recorded in the field; see Section 11.0 Sampling Methods Requirements for additional information.

All regional and ABAQA monitoring technicians, coordinators, ECB electronics technicians, RCO chemists and other DAQ personnel shall fill out information in the site visit logbook in indelible ink. In addition, the ECB electronics technicians will fill out instrument maintenance logs and Air Quality Section Maintenance Order or AQ-109 forms and Continuous Monitor Performance Audit Report or AQ-121 forms in indelible ink. They shall make corrections by inserting one line through the incorrect entry, initialing and dating this correction and placing the correct entry alongside the incorrect entry, if

they can accomplish this legibly, or by providing the information on a new line if the above is not possible.

9.2.1 Logbooks

Each regional and ABAQA monitoring technician will be responsible for obtaining, maintaining and documenting the appropriate logbooks or associated QA/QC data forms. Each variety of PM monitor type has an e-log created for that specific monitor type. The e-log contains all data entry forms required by regional and ABAQA monitoring technicians to document all routine operations. After each use, the regional and ABAQA monitoring technician uniquely numbers these e-logs by giving them a specific file name before saving them to a storage device such as a laptop computer. From the laptop computer, the regional monitoring technician will transfer the e-log to the regional SharePoint page for the regional monitoring coordinator to review. The regional and ABAQA monitoring technician will use these e-logs to record information about the site operations, as well as document routine operations. The e-logs are editable but the original e-logs remain on the access-restricted regional SharePoint page, which tracks changes and edits and are recoverable in the event of inadvertent deletion. Once the regional monitoring coordinator has reviewed and approved an e-log, they upload it to the RCO group drive, which is the official repository of these records. ABAQA will email the e-logs to the RCO PM Chemist, who uploads them to the RCO group drive. The ECB electronics technicians will fill out instrument maintenance logs, Air Quality Section Maintenance Order or AQ-109 forms, and Continuous Monitor Performance Audit Report or AQ-121 forms. The original AQ-109 forms are retained at the ECB facility. The AQ-121 forms are scanned and stored in IBEAM; hard-copies are stored in a filing cabinet at RCO.

The monitoring and ECB electronics technicians must complete e-logs, instrument maintenance logbooks and Air Quality Section Maintenance Order or AQ-109 forms associated with all routine environmental data operations, even when the site logbooks contain all appropriate and associated information required for the routine operation performed.

Field Logbooks – The DAQ and ABAQA use a combination of bound paper logbooks and e-logs for recordkeeping for each sampling site, sampling instrument, specific program or individual. Each paper logbook should be hardbound and paginated. The ABAQA monitoring staff, regional monitoring and ECB electronics technicians use the paper site logbooks to document site visits and other activities, including who is at a site, when and why. Every visitor must sign the site logbook. The logbooks generated and maintained by ABAQA and regional office staff are filed and archived at the ABAQA or appropriate regional office once completed. Logbooks generated and maintained by ECB staff are filed and archived at the ECB once completed. The e-logs capture monitor maintenance and QA/QC activities, including calibrations.

RTI Lab Logbooks – A combination of bound paper logbooks and electronic databases exist in which the RTI laboratory retains all records pertaining to PM gravimetric analysis. Copies of all pertinent records are sent electronically to DAQ in the form of a “data package” on a routine basis. All other records kept at RTI labs that may be needed for audit purposes that are not

included in the data package are available upon request and are reviewed during DAQ TSAs on the RTI lab.

9.2.2 Chain of Custody

As part of the pre-weighing process, the RTI lab prepares a COC form with the batch of filters that are sent to the designated field location in the PM network. After the sample run, the operators of the PM network collect exposed filters from the sequential samplers and return them to the RTI lab accompanied by COC forms, packing material and synthetic ice packs. RTI retains COC records on site, while the DAQ retains copies of COC records at the regional and ABAQA offices and the RCO. For more about COC see Section 12.0 Sample Handling and Custody.

9.2.3 Electronic Data Collection

All instrument types currently used in the DAQ PM monitoring program can provide an automated means for collecting information that DAQ would otherwise record on data entry forms. Section 19.0 Data Management provides detailed information on these systems. To reduce the potential for data entry errors, the DAQ will use automated systems where appropriate that will record the same information the regional and ABAQA monitoring technician would record on data entry forms. To provide a backup, the PPB staff will store electronic copies of the automated data collection information (daily poll) for an appropriate period on the RCO group drive. Electronic backup copies of automated data collection information will also be stored on the site computers.

9.3 QA/ QC Records

The DAQ achieves QA/QC through the performance of periodic activities such as:

- Internal systems audits,
- Verification/calibration procedures,
- Maintenance activities,
- Performance evaluations,
- EPA performance audits such as the PEP,
- Traceability certifications and calibrations and
- Corrective actions.

The DAQ documents internal systems audits in the form of a written report. The DAQ typically documents and maintains most of the other QA/QC activities using a variety of activities, including Excel spreadsheets, fillable portable document format (PDF) data forms, worksheets and data management systems such as Envidas Ultimate and Envista ARM, both developed by the software developer, Envitech. The associated SOPs describe the use of these methods to create air monitoring QA/QC records. The DAQ retains and archives these records according to the procedures identified in Section 9.5 Data Archiving and Retrieval.

However, for some of the QA/QC activities described above – such as the traceability certifications – the ECB retains many of those records at the ECB, which they store in a file in the office. If DAQ personnel require information related to these documents, they may contact the ECB for assistance. The regional

monitoring coordinators store certifications for PM equipment provided by the vendors in secured file cabinets at the appropriate regional office and in IBEAM. The electronic records are stored on the RCO group drive and additionally on local computer hard drives in the certification rooms. Records of certification from the RTI lab (e.g. infrared temperature guns, RH monitors, weight standards) are retained at the RTI lab and are made available upon request. Data packages from RTI, which include QA/QC records and certificates, are saved on the RCO group drive. The division is in the process of evaluating and purchasing a database for generating and archiving these types of records. When the database is obtained, the chief and RCO chemists will review the new record generating and retention processes and will revise the QAPP.

9.4 Reference Materials

Because of the technical nature of ambient air monitoring, DAQ requires numerous reference materials to administer the PM monitoring program effectively. This category includes publications such as instrument operation manuals, troubleshooting guides, EPA guidance documentation, EPA technical memoranda and various other reports. DAQ maintains access to applicable reference materials if DAQ has an administrative need for them. DAQ retains these documents at the RCO, in the IBEAM general documents module, or on the RCO group drive.

9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability and regulatory requirement for retention. DAQ follows the state of North Carolina's functional schedules for files. Files used and created by DAQ will be kept for a minimum amount of time set by these functional schedules. To meet DAQ's contractual obligation to the EPA, DAQ will retain all the information listed in Table 12 for a minimum of four complete calendar years from the date of collection in accordance with 2 CFR Part 200.334. However, if any litigation, claim, negotiation, audit or other action involving the records has been started before the expiration of the four-year period, DAQ will retain the records until completion of the action and resolution of all issues that arise from it, until the end of the regular four-year period, or until the minimum time required by the state of North Carolina functional schedules, whichever is later. The records custodians are responsible for ensuring these retention times are met and disposing of records after their retention period has elapsed.

DAQ stores electronic records within the data management systems located at PM monitoring sites, or Envidas Ultimate, the RCO, or Envista ARM, and on network servers in the DAQ regional offices, ABAQA office and RCO. The database manager regularly backs up the Envista ARM database following the procedures in Section 5.7 of DAQ-05-001.5 Ambient Monitoring Section Database Manager Standard Operating Procedure.

10.0 Network Description

The primary function of the PM monitoring program is to verify compliance with the NAAQS in highly populated areas throughout the state. Other purposes for the program possibly include (1) determining trends over time, (2) determining effects on air quality from adjustments to source emissions, (3) verifying air quality modeling programs, (4) providing real-time pollutant data to the public and (5) correlating health effects to air quality levels.

Sampling network design and monitoring site selection comply with the following appendices of 40 CFR Part 58:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix G – Uniform Air Quality Index (AQI) and Daily Reporting

10.1 Network Objectives

In addition to the three basic monitoring objectives and specific goals listed in Section 6.0 of this QAPP, the PM ambient air quality monitoring network is designed to meet the following monitoring objectives:

- The highest concentrations expected to occur in the area covered by the network,
- Representative concentrations in areas of high population density,
- The impact of significant sources or source categories on ambient pollution levels,
- General background concentration levels,
- The extent of regional pollutant transport among populated areas and in support of secondary standards, and
- The welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

The PM network may be comprised of one or more of the basic site types. A variety of factors, such as pollutant of interest, monitoring objective, geographic location, and meteorology, may determine the site type requirements for the PM network. The annual network-monitoring plan, available at this link, covers this specifically and in detail.

Data collected within the PM monitoring network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring objective of the station. For a discussion of the representative measurement scale for the PM sites, see Section 7.6 Network Scale. PM monitoring sites may include SLAMS monitors intended to address specific air quality management interests, as well as SPM monitors (e.g., short-term PM study). The annual network plan includes monitoring objective, spatial scale of representativeness, operating schedule (see Section 10.4), and site

type information for each DAQ and ABAQA PM monitor. The annual network plan may be accessed on the DEQ website at the following link: (https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan/annual-monitoring-network-plan-for-north-carolina-air-quality).

10.2 Site Selection

The DAQ and ABAQA adhere to the site selection criteria specified in 40 CFR Part 58, Appendix D. The selection of a specific monitoring site includes the following activities:

- Developing and understanding the monitoring objective and appropriate DQOs;
- Identifying the spatial scale most appropriate for the monitoring objective of the site;
- Identifying potential locations where the monitoring site could be placed; and
- Identifying the specific monitoring site.

The DAQ evaluates each monitoring site to assure it adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

10.2.1 Site Location

The ABAQA monitoring staff, regional monitoring technicians and coordinators, ECB electronics technicians and RCO chemists consider four criteria when evaluating potential sites. Monitoring sites should be oriented to measure the following (singly or in combination as appropriate for the sampling objective):

- Impacts of known pollutant emission categories on air quality;
- Population density relative to receptor-dose levels, both short- and long-term;
- Impacts of known pollutant emission sources (area and point) on air quality; and
- Representative air quality.

Selection per these criteria requires detailed information concerning the location of sources, geographic variability of ambient pollutant concentrations, meteorological conditions, and population density.

Selection of the number, geographic locations, and types of sampling stations is, therefore, a complex process. The sampling site selection process also involves consideration of the following factors:

- **Economics -** The quantity of resources required to accomplish all data collection activities, including instrumentation, installation, maintenance, data retrieval, data analysis, QA, and data interpretation, must be established.
- **Security -** In some cases, a preferred location may have associated problems that compromise the security of monitoring equipment (i.e., high risk of theft, vandalism, etc.). If such problems cannot be remedied using standard measures such as additional lighting, fencing, etc., then an attempt to locate the site as near to the preferred location as possible shall be made.
- **Logistics -** This process includes procurement, maintenance, and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications, and inventory management.

- **Atmospheric Considerations -** These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain, and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. The DAQ considers meteorology in determining the geographic location of a site as well as the height, direction, and extension of monitoring and sampling inlets. Evaluation of a local wind rose is essential to locate properly many monitoring sites (e.g., siting to either detect or avoid emissions from specific sources).
- **Topography –** The DAQ must complete evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps, and other available resources. The DAQ must also identify and evaluate minor and major topological features that affect both the transport and diffusion of air pollutants. Minor features may include an adjacent tree lined stream or tall structures upwind or downwind of a point source, each of which may exert small influences on pollutant dispersion patterns. Major features include river canyons or deep valleys, mountain ranges, and large lakes. Major features significantly affect the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- **Pollutant Considerations** – The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. To determine the applicability of each site for a specific pollutant, the DAQ must evaluate the changes pollutants undergo temporally and spatially.

An interdependence exists between all the factors listed above. Consequently, the DAQ and ABAQA must employ an iterative procedure to select appropriate sites successfully that can provide the data necessary to accomplish the stated objectives of the project. In situations where the sites do not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the site priorities may be necessary before the final monitoring site selection. Experience in the operation of air quality measurement systems; estimates of air quality, field, and theoretical studies of air diffusion; and considerations of atmospheric chemistry and air pollution effects make up the expertise required to select the optimum sampling site for obtaining data necessary to fulfill the monitoring objectives. The AMS shares these responsibilities amongst the AMS staff as well as with other DAQ staff.

10.2.2. Inlet Siting Criteria

General inlet siting criteria for PM monitors at the DAQ and ABAQA sites shall adhere to the requirements in 40 CFR Part 58, Appendix E. The inlet is to be located from 2 to 15 m above the ground; 2 to 7 m above the ground for micro and middle scale, and near road monitoring. The inlet is to be more than 2 m horizontally or vertically away from any supporting structures, and greater than 1 m from other monitoring inlets. Because of their ability to alter normal wind flow patterns and provide surfaces for PM adsorption or discharge, a monitor inlet must be located greater than 10 m away from trees and shrubs. Also, the distance between the inlet and any obstacle must be at least twice the height that the obstacle extends above the probe. The ABAQA monitoring staff and ECB electronics technicians measure the tree to inlet distance from the drip-line, or outside edge of the crown, of any tree, not the trunk. For monitors operated at the same site for several years, it is best to allow some additional space for

vegetation growth. PM sites should not be located in an unpaved area unless there is vegetative ground cover year round, so that the impact of wind-blown dusts will be kept to a minimum.

The monitor must have unrestricted airflow in at least a 270 degree arc around the monitor. The arc must include the predominant wind direction for the season of maximum concentration. 40 CFR Part 58, Appendix E gives the required separation distance from the nearest traffic lane.

The defined monitoring objective generally determines the placement of each monitor (continuous instrument) and sampler (intermittent or manual instrument). Thus, the ABAQA monitoring staff and ECB electronics technicians usually place monitors and samplers according to potential exposure to pollution. Due to the various factors discussed above, tradeoffs are often necessary to locate a site for collection of optimally representative data. Final placement of a monitor or sampler at a selected site is dependent on physical obstructions and activities in the immediate area. The ABAQA monitoring staff and ECB electronics technicians must place both the monitors and the samplers away from obstructions such as trees and fences to avoid their effects on airflow. To prevent sampling bias, airflow around monitor and sampler inlets must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and cellular telephone services) is critical.

10.3. Sampling Frequency

The EPA establishes minimum sampling frequencies in 40 CFR 58.12, which the DAQ and ABAQA follow. In instances requiring every third, sixth or twelfth-day sampling, the EPA requires specific sampling days so that the entire nation samples on the same day. Thus, the DAQ and ABAQA accomplish this intermittent sampling by following a national sampling schedule published annually by the EPA.

The DAQ and ABAQA should take the minimum number of samples required for appropriate summary statistics as prescribed by 40 CFR Part 50. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear in Table 13. For filter-based $PM_{2.5}$ monitoring, DAQ and ABAQA follow EPA guidance for collecting makeup samples. Makeup samples can be collected either before the next scheduled sample or one week from the missed sample date. (See Section 12.2 Post-Sample Custody of this QAPP for more details on collecting makeup samples.) Table 14 provides the sampling schedule and frequency for each PM method.

Table 13. Requirements for Calculating Summary Statistics

Pollutant	Completeness Requirement	Time Frame
PM_{10}	75 Percent	Per quarter
$PM_{2.5}$	75 Percent	Hours per day for continuous monitors; days per quarter
	4	Complete quarters per year

Table 14. PM Sampling Schedule and Frequency

Pollutant	Time Frame (Local Standard Time)	Frequency	Monitor Type
PM_{10}	Midnight to Midnight	24 hours a day / 7 days a week	Continuous
PM_{10}	Midnight to Midnight	1 day in 6 days	Filter-Based
$PM_{2.5}$	Midnight to Midnight	24 hours a day / 7 days a week	Continuous
$PM_{2.5}$	Midnight to Midnight	1 day in 3 days or 1 day in 6 days	Filter-Based
$PM_{10-2.5}$	Midnight to Midnight	24 hours a day / 7 days a week	Continuous

11.0 Sampling Methods Requirements

11.1 Sample Methodology

In accordance with 40 CFR Part 58, Appendix C, Section 2.1, a criteria pollutant monitoring method used for making NAAQS decisions at a SLAMS site must be a FRM or FEM. Towards that end, the ABAQA and DAQ PM monitoring program uses only EPA-approved FRM or FEM instrumentation for determining pollutant concentrations for NAAQS compliance determinations. An instrument that has received FRM or FEM status has been rigorously tested, in accordance with 40 CFR Part 53 requirements and found to meet (or be comparable to) the EPA FRMs codified in 40 CFR Part 50. The Ambient Monitoring Technology Information Center (AMTIC) website (https://www3.epa.gov/ttn/amtic/criteria.html) provides the List of Designated Reference and Equivalent Methods, issued by the EPA Office of Research and Development, which provides the detailed specifications upon which a specific monitoring method has received its FRM or FEM status. The ABAQA and DAQ will operate each analyzer in accordance with these designation specifications. To ensure the monitors meet these specifications DAQ uses the criteria in the validation templates in Section 7.0 and follows the procedures in the SOPs in Table 16.

Table 15 lists the analyzers used in the DAQ PM monitoring network. The method for filter-based $PM_{2.5}$ data collection is dual designated as a FRM and FEM method. The DAQ may use alternative non-FEM or non-FRM methods for AQI reporting. Otherwise, the methods DAQ uses for measuring PM are FEMs.

Table 15. DAQ Particulate Matter Monitoring Network Analyzers

Pollutant	Analyzer	AQS Method Codes	EPA Reference/ Equivalence
$PM_{2.5}$ local conditions, filter-based	Thermo Model 2025 i Sequential Air Sampler (with PM_{10} head and Very Sharp Cut Cyclone, or VSCC)	145	RFPS-1006-145
$PM_{2.5}$ local conditions, continuous	Met One BAM 1020 (with PM_{10} head and VSCC) Met One BAM 1022 (with PM_{10} head and VSCC) Teledyne T640x (with PM_{10} head)	170 209 236	EQPM-0308-170 EQPM-1013-209 EQPM-0516-236
PM_{10} local conditions, continuous	Met One Instruments BAM 1020 (with PM_{10} head alone) Teledyne T640x (with PM_{10} head)	122 238	EQPM-0798-122 EQPM-0516-238
PM_{10} STP, continuous	Met One Instruments BAM 1020 (with PM_{10} head and downtube) Teledyne T640x (with PM_{10} head)	122 239	EQPM-0798-122 EQPM-0516-239
Acceptable $PM_{2.5}$ AQI	Met One BAM 1020 (with PM_{10} head and VSCC) Met One BAM 1022 (with PM_{10} head and VSCC) Met One BAM 1022 (with PM_{10} head and SCC)	733 733 171	Not a reference method
$PM_{10-2.5}$, local conditions continuous	Met One BAM 1020 (one unit with PM_{10} head and VSCC paired with a unit with PM_{10} head alone) Teledyne T640x (with PM_{10} head)	185 238	EQPM-0709-185 EQPM-0516-238

This subsection describes the sampling methods used in the DAQ PM monitoring network. The DAQ categorizes sampling methods for PM into two general categories:

- Intermittent sample collection (non-continuous or static) – A physical sample is collected using a monitoring device that passes ambient air through a filter, collects a sample in a container, or exposes a sample collection media to a sample stream. The sample containing media (i.e., filter) is then removed and analyzed via laboratory methods to identify and/or quantify the pollutant of interest.
- Real-time or near real-time sample analysis (continuous) – Physical samples are not collected. Instead, the analyzer itself performs "In situ" analysis of the composition of the sample using a specific methodology.

Additionally, the annual monitoring network plan at this link lists the instrument methods located at each monitoring station within the ABAQA/DAQ network.

This section provides a brief overview of the theories of operation of the various sampling methods used. The instrument manuals provide detailed descriptions of these principles for the specific analyzers, including theories of operation. The vendor provides copies of these manuals online. DAQ also maintains copies in IBEAM, on the RCO group drives, SharePoint, regional office SharePoint sites and ABAQA Office group drive.

11.1.1. Particulate Matter (Intermittent Filter-Based Operation)

The sequential air sampler provides a convenient means of collecting high quality samples of ambient PM. The EPA designed the sampler so agencies could install it at outdoor sampling locations without needing to install a shelter to protect it from the elements. It draws a PM-laden ambient air stream at a flow of 16.67 liters per minute (LPM) through a sample inlet (that is size-selective for PM_{10}), a secondary size-selective device (that is size-selective for $PM_{2.5}$) and then through a pre-weighed 47 millimeter diameter filter with a pore size of 2 µm (volumetric flow is dependent on temperature and pressure). These pre-weighed weighed filters are in the air stream for a specified period of time. The combination of flow and duration identify a controlled volume of air that passes through the filter. After sampling, the sampled filter is precisely weighed again, at the same humidity level as at the initial weighing in the gravimetric lab. The resulting difference yields the mass trapped during sampling. Determining the amount of mass added and dividing by the volume of air filtered, yields a $PM_{2.5}$ concentration averaged over the time the flow occurred.

11.1.2. Particulate Matter (Continuous Operation, BAM)

A beta attenuation monitor (BAM) is composed of sensing and control units. The carbon 14 beta radiation source and glass-fiber filter tape, which form the heart of the sensing unit, combine in a measurement technique for making near-real-time direct measurement of particle mass collected on the filter tape. This measuring equipment can determine the fine changes in mass that accumulate on the filter tape as a constant stream of air passes through it. The ECB electronics technicians configure the Met One BAM 1020 to operate on 1-hour cycles. During this one-hour cycle, the unit makes two 8-

minute beta measurements (one for the background or blank and one for the sample) and collects one 42-minute sample for a combined total of 58 minutes. The monitor uses the remaining 2-minutes of each hour for filter tape and nozzle movements. The combination of the difference between blank and sample radiation counts, coupled with the air's known volumetric flow rate, yields an accurate method of determining the concentration of PM in the air. The equipment can calculate the 1-hour, 8-hour and 24-hour averages. The control unit employs a microprocessor system, flow control hardware, temperature and humidity sensors, transformers, power supplies and a software algorithm to determine when to advance the filter tape.

Initially, an inertial separator filters the air stream. The EPA designed the inertial separator specifically to eliminate particles with aerodynamic diameters either greater than 10 µm, or greater than 2.5 µm, depending upon the data EPA and North Carolina desires to collect. This equipment draws in 16.7 LPM (1.0 cubic meters per hour) of air. After the air stream exits the inertial separator, the stream passes through a defined spot on the filter tape. The mass transducer is a radiation scintillation counter. The system measures the accumulated mass every hour. Information required for installing and maintaining the BAM PM monitor is available in SOP 2.37.1 and the Met One BAM 1020 Continuous PM Monitor manual.

The Met One Instruments Model BAM 1022 Continuous PM Monitoring System uses the principal of beta ray attenuation, just the same as the Met One Instruments Model BAM 1020. However, the Model 1022 continuously monitors the particle mass load throughout the measurement cycle. The monitor uses the degree of beta ray attenuation to determine the mass of PM deposited on the filter tape.

During sampling, the flow rate is precisely controlled. Having determined both mass and sample volume, the BAM 1022 calculates and reports the ambient $PM_{2.5}$ concentration, expressed as $\mu g/m^3$.

11.1.3. Particulate Matter (Continuous Operation, T640X)

The Model T640X PM Mass Monitor is an optical aerosol spectrometer that converts optical measurements to mass measurements by determining sampled particle size via scattered light at the single particle level according to Lorenz-Mie Theory. Briefly, the sampling head draws in ambient air, which is dried (i.e., brought below 35 percent RH) with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The particles move separately into the T-aperture through an optically differentiated measurement volume homogeneously illuminated with polychromatic light. The polychromatic light source, a light emitting diode (LED), combined with a 90 degree scattered light detection, achieves a precise and unambiguous calibration curve in the Mie range, resulting in a large size resolution.

Each particle generates a scattered light impulse detected at an 85 degree to 95-degree angle where amplitude (height) and signal length are measured; the amplitude of the scattered light impulse directly relates to the particle size diameter. The T-aperture and simultaneous signal length measurements eliminate border zone error, characterized by the partial illumination of particles at the border of the measurement range.

The T640x operates at 16.7 LPM and uses an EPA-approved PM_{10} inlet. The EPA approved this configuration as an FEM for PM_{10}, $PM_{2.5}$ and $PM_{10-2.5}$ (North Carolina uses the T640X for all three). The T640 operates at 5.0 LPM with a TSP inlet. The EPA approved this configuration as an FEM for PM2.5; however, it also provides data (not approved as an FEM) for PM_{10} and $PM_{10-2.5}$. The monitor reports sample volume in actual conditions by using the instrument's ambient temperature and barometric sensor data.

11.2 Sample Collection Methodology

Table 16 lists the specific SOP titles used in the PM monitoring network.

Table 16. List of SOPs Associated with this Quality Assurance Project Plan

General Standard Operating Procedures	
Section 2.39.4	SOP for Quarterly Completeness Data Review, Revision 1.0, June 12, 2020
Section 2.43.2	SOP for Completing the Annual Network Review for the DAQ, Revision 2, September 29, 2017
DAQ-05-001.5	Envista Database Management Procedures, Revision 0, March 5, 2021
DAQ-14-001.5	SOP for Preparing SOPs for the DAQ, Revision 2.0 May 21, 2021
DAQ-14-002.5	SOP and QAPP Tracking Database Procedures, RCO Responsibilities, Revision 0, Dec. 1, 2020
DAQ-14-003	Document Retention Procedure (currently under revision)
DAQ-15-002	Corrective Action Process Revision 0, Dec. 1, 2021
Calibration and Maintenance Procedures for PM Monitoring Support Equipment	
Section 2.3.3	Certification and Accuracy Check of Field Barometers and Thermometers (Performed by the Electronics and Calibration Branch)
Section 2.49.2	BGI TetraCal SOP for Operators, Revision 2020, Dec. 16, 2019
SOP R2020	Dwyer and SPER Manometer Calibration SOP Revision 2020 February 18, 2020
DAQ-13-001.1	Standard Operating Procedure (SOP) for the BGI TetraCal Flow Transfer Standards ECB RESPONSIBILITIES, Revision 0.0, May 7, 2021
DAQ-13-002.1	SOP for the DryWell 3101 Temperature Generator ECB RESPONSIBILITIES Revision 0 May 5, 2021
DAQ-15-001.1	Standard Operating Procedure DAQ-15-001.1Verification of Ambient Monitoring Thermometers Version 0.0 Nov. 13, 2020
Standard Operating Procedures for Collecting and Validating PM Monitoring Data	
Section 2.24.1	Particulate Matter 2.5 SOP for the Electronics and Calibration Branch, Revision 2011, Jan. 1, 2011
Section 2.37.1	Installation, Calibration and Maintenance Responsibilities of the Electronics and Calibration Branch for the Met One Instruments Beta Attenuation Monitor, Revision 0, Oct. 8, 2008
Section 2.37.2	Met One BAM 1020 Standard Procedures for Operators (Touch Screen and Touch Key Versions), Revision 2020, Dec. 4, 2019
Section 2.46.2	SOP for Met One BAM 1022 SOP, Revision 2020, Dec. 3, 2020
Section 2.24.2	Thermo Scientific 2025i Standard Procedures for Operators, Revision 2020, Dec. 5, 2019

Table 16. List of SOPs Associated with this Quality Assurance Project Plan

Section 2.47.2	Teledyne Model 640X Standard Procedures for Operators, Revision 2020, Dec. 16, 2019
DAQ-16-020.5	FRM Validation Template
Section 2.63.4	SOP for Validation of Particulate Matter, Revision 0.0, Aug. 15, 2020
RTI Laboratory QAPP and SOPs and DAQ Laboratory Review Checklist	
Appendix A	RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14)
Appendix B	RTI SOP for PM Sample Receipt & Log-in Revision 9 Date: March 29, 2022
Appendix C	RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022
Appendix D	RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022
Appendix E	NCDAQ Checklists (DAQ-16-018.4 R0) for review of RTI PM Data Packages
Appendix F	Sample RTI Data Package

11.2.1. Physical Collection

The physical collection of intermittent (i.e., filter-based) samples, sample transport and preservation techniques adhere to the requirements of 40 CFR Part 50, Appendix L. PM data that are collected via continuous monitoring do not produce a physical sample, therefore no handling requirements are necessary.

11.2.2. Electronic Data Collection

Electronic data collection is possible for the continuous PM monitors through the network's DAS, which is currently Envidas Ultimate and wireless modems. This equipment is in shelters where the DAS records the data history and the modems provide a path to download the data for analysis. The database manager configures the computer in the RCO, managed by DIT, to connect automatically to the stations periodically to retrieve these data for analysis. Monitoring personnel can contact the stations manually to retrieve data or determine the status of the systems.

For sites where the ABAQA monitoring staff and regional monitoring technicians operate sequential PM samplers, the ABAQA monitoring staff and regional monitoring technicians download data on a weekly basis. The regional coordinator uploads it to IBEAM or the RCO group drive. In the case of ABAQA, the ABAQA monitoring staff send the downloaded data to the RCO PM Chemist, who uploads it to IBEAM or the RCO group drive.

With both monitors and samplers, DAQ and ABAQA monitoring personnel can contact the stations manually to retrieve data or determine the status of the systems, if needed. Section 19.0 Data Management of this QAPP discusses this in more detail.

The Envista ARM data software automatically sends all data to AirNow-Tech and the IBEAM database for real time reporting of ambient concentrations and the AQI to the public via EPA's AirNow website and the DEQ real-time web page.

11.3 Support Facilities

This subsection describes the monitoring shelters used in the DAQ PM monitoring network.

11.3.1 Monitoring Station Design

The monitoring station design must 1) encompass the operational needs of the equipment, 2) provide an environment that supports sample integrity, and 3) allow the operator to service, and maintain the equipment safely and easily. The chief considers winter weather conditions during site selection to meet the station safety and serviceability requirements.

11.3.2 Shelter Criteria

The ECB electronics technicians should house the BAM 1020 in a cabinet shelter capable of fulfilling these requirements:

- As is recommended by DAQ, the optimal shelter temperature or set points should be maintained between 20 and 30 degrees Celsius (°C) and stable to within ±2°C per hour;
- The power supply should not vary more than ±10 percent from 117 alternating current voltage. It is best to provide some type of voltage regulation to accomplish this;
- The shelter should protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes, meet federal Occupational Safety and Health Administration (OSHA) regulations, and be cleaned regularly to prevent a buildup of dust; and
- The shelter should protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

The ECB electronics technicians should house the T640X in a cabinet shelter capable of fulfilling these requirements:

- The shelter temperature should be maintained between 0-50 °C, with a SD of <2.1°C, over 24 hours.
- The power supply should not vary more than ±10 percent from 117 alternating current voltage. It is best to provide some type of voltage regulation to accomplish this;
- The shelter should protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes, meet federal OSHA regulations, and be cleaned regularly to prevent a buildup of dust; and
- The shelter should protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

Intermittent Filter-based samplers and the BAM 1022 monitors do not require a shelter capable of fulfilling these requirements.

12.0 Sample Handling and Custody

The goal of the sample handling and custody process is to preserve and maintain the integrity of the PM sample from initial equilibration of the new filter through the archiving and storing of the exposed filter. Sample handling and custody processes practiced by the RTI Lab are described fully in Appendix A through D of this document. Procedures followed by DAQ for the collection of particulate filter data are described fully in the documents listed in Table 16 of this document. Throughout the process a COC form (see RTI Chain of Custody.pdf) is used to track each sample through the various stages of its life. The sample custody process is designed to do the following:

- Ensure the PM samples are not altered either intentionally or inadvertently at any time prior, during or after use at the location where the sample was taken;
- Identify a person or agency responsible for that filter for specific stages of the filter; and
- Assign specific responsibility to help ensure that problems do not arise from improper handling or storage and helps to trace the cause of a problem when it does occur.

12.1 Pre-Sample Custody

The sample custody is initiated when the bulk shipment of EPA approved filter media is received at RTI for gravimetric analyses. The filters are visually inspected, identified, prepared for field use, labeled and recorded at the RTI lab during the pre-weighing (tare) procedure. The pertinent information regarding the filter batch inspection and conditioning are recorded at the lab. The RTI lab staff ships the filters with COC to the designated field locations on a specified schedule. An example of the COC form is included in the RTI Raw Data Package (Appendix F) The ABAQA monitoring staff and regional monitoring technicians receive filters from RTI and document on the COC that they received the filters. They inspect the filters upon receipt and document compromised or damaged filters on a photocopy of the COC and return them unused to RTI.

12.2 Post-Sample Custody

Site operators collect $PM_{2.5}$ samples using procedures outlined in the DAQ 2025i $PM_{2.5}$ SOPs. In general, site operators collect exposed $PM_{2.5}$ samples from the FRM samplers in the field within 177 hours of sample collection. The site operators remove samples from the samplers in the protective magazines and then transfer the protective magazines into a cooler containing frozen blue ice packs (or equivalent). From there, the site operators take the samples to the regional or ABAQA office. Site operators observe the exposed filters for possible instrument processing or sample handling damage. They note compromised or damaged filters on the COC and in the e-logs (sample log). If it is determined that damage to the filter is significant, such as a breach in the filter substrate, the sample is invalid.

The site operators complete and sign the COC for the filters going back to the laboratory. If the site operators do not ship the filters back immediately, then they store the filters in a designated refrigerator in the regional or ABAQA office, along with the COCs, until they do ship them. Table 7 of this QAPP provides filter-holding requirements for the samples.

When preparing the exposed samples for shipment, the site operator places the sample magazines (in their metal transport boxes), surrounded by frozen ice packs. The signed COC is included in the cooler. The site operator then seals the cooler with tape and addresses it to the RTI gravimetric lab. The site operators or coordinators ship the coolers (overnight delivery service) to the RTI gravimetric lab.

Upon receipt, the lab staff documents the shipment details, date he or she received the samples and records the cooler shipment temperature using an infrared thermometer to measure it. The lab staff will determine the analytical holding time based upon the shipment temperature. Filters are subsequently conditioned and prepared for weighing. Filter conditioning data (e.g. weigh date, final temperature mean, temperature control (SD), final RH mean, RH control (SD), etc.) are documented during the final weigh session.

During this process, the lab staff also inspects samples for damage. He or she notes compromised or damaged filters and documents the findings in the data package and on the COC. Based on RTI's schedule, the exposed filters will be weighed immediately or stored in a controlled environment until a weighing session is scheduled. The original COC form is filed in a binder at RTI and retained in accordance with Section 12.3. Copies of all COCs are included in the RTI Raw Data Package. The RTI lab staff also notifies DAQ when the PM laboratory relative humidity and temperature data loggers record out-of-specification conditions in the gravimetric laboratory. The RTI lab provides filter conditioning information, and other weigh session data, to the DAQ in the form of a data package.

Site operators may miss scheduled samples due to a variety of situations including sampler malfunction; power outage; and filter problems, among others. Adequate numbers of $PM_{2.5}$ measurements are important to maintain high data capture, in accordance with 40 CFR Part 50, Appendix N. Specifically, the EPA requires a minimum of 75 percent of scheduled samples per quarter to show that a site meets the standard. The EPA allows agencies to use replacement samples (i.e., makeups) to help monitoring organizations achieve desirable data capture goals.

DAQ collects PM2.5 samples in accordance with the scheduled specified in 40 CFR Section 58.12. The national sampling scheduled is set each year by EPA. A "make-up" sample becomes a replacement for a scheduled day. The number of make-up samples permitted by EPA in any calendar quarter should be limited to no more than 5 samples.

When make-up samples are necessary, site operators will document the reason why the original sample was invalidated. The following is the approach DAQ site operators will take when selecting the make-up sampling day. In all cases, the make-up sampling day must be no later than 1 week from the missed sampling day.

Preferred choice for make-up sampling day: Sample before the next scheduled sampling day.

- For monitoring sites sampling every sixth day, the preferred replacement day is the next scheduled every third-day sample. This provides the benefit of additional spatial resolution of network measurements and is likely to be most convenient for site operators. Otherwise, the EPA suggests a day closest to the missed sampling day.

- For monitoring sites sampling every third day, the EPA suggests the earliest possible day before the next scheduled sample at the monitoring site. Although there are only two possible make-up days with 1-in-3-day sampling, selection of a replacement day as close as possible to the missing day increases the chances of a replacement day with similar meteorological conditions.

Alternative approach: Sample one week later, on the same calendar day. This provides a replacement day on the same day of the week, thereby helping with temporal balance for the quarterly data set to reduce any potential day of the week effect of emissions.

12.3 Sample Custody: Archive

After the exposed filters are weighed, they will be archived at RTI for the period of the contract with DAQ and for one additional year thereafter. At that time, RTI will return the filters to DAQ for storage or disposal. DAQ may also, at its discretion, take possession of the filters at an earlier date. Regardless of the term of the contract with RTI, DAQ will continue to store any exposed filters or other records, in compliance with its own record retention rules, discussed in other sections of this QAPP, in the DAQ QMP, and in SOP DAQ-14-003 (currently under revision). All exposed filters will be properly stored in a cold-room facility or refrigerator whose temperature is maintained at 4 ˚C or less for at least one year. After the first year, the filters may be stored at room temperature in a secured indoor location. All filters will be archived for a minimum of five years before disposal.

13.0 Analytical Methods

The DAQ has chosen to utilize RTI as the contract lab for analysis of the $PM_{2.5}$ FRM samplers. All analysis performed by RTI will satisfy the requirements set forth in 40 CFR Part 50, Appendix L, and the recommendations in the QA Guidance Document 2.12 and in the QA Handbook Volume II. The analytical methods and descriptions in the following section are included to provide an understanding of the methods used. Copies of the most current versions of the RTI QAPP and laboratory SOPs are included in Appendix A through D of this document. Note: Continuous PM monitors are not included in this section because there is no external analytical method used in producing data from those monitors.

13.1 Purpose/Background

This section identifies the method requirements to complete analyses of the samples collected by sequential PM samplers. The DAQ uses one analytical method for analyzing filters collected by sequential samplers: Appendix L to 40 CFR Part 50—Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere. The RTI laboratory will conduct these gravimetric analyses, where the net mass of the sample is identified. The net mass is calculated by subtracting the initial filter weight from the final filter weight of the exposed filter. Once the data package from RTI is received and reviewed by DAQ, the field data providing the total filter exposure air volume, recorded during the exposure of the filter, will be used to determine the PM concentration for each filter. The net mass of the exposed filter is divided by the total filter exposure volume to calculate the PM concentration for that filter. The concentration data will be used for comparison to the daily and annual NAAQS. Since the method is non-destructive, and due to possible interest in sample composition (e.g., subsequent chemical analyses), the DAQ has contracted RTI to archive the filters as described in Section 12.3.

13.2 Preparation of Samples

Detailed procedures for receiving, inspecting and conditioning the filters and preparing the samples are described in the RTI SOP for PM Gravimetric Analysis Sections 1.13.1 through 1.13.3 and 1.13.4 (see Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022). These procedures are summarized here. The bulk shipment of EPA approved Teflon™ filters designated for DAQ are received at the RTI lab. Filters are put into the conditioning room by laboratory staff and laid out sequentially to detect any missing or duplicate filter numbers. Laboratory staff inspect the filters at this time to ensure that they are suitable for use. Once the filters have been conditioned, they are weighed and their id numbers and weights are recorded into the laboratory database. The laboratory staff records the number for each filter, loads the filter into a cassette and prints the COC form. The cassettes are put into magazines around which is wrapped the COC form. The wrapped magazine is then sealed individually in a plastic bag for shipment. Lab staff ship the magazines by next day air carrier on previously specified dates to tribal, local and regional field offices. Site operators keep the unexposed filters at their field locations until they are installed in the samplers.

13.3 Analysis Methods: Gravimetric $PM_{2.5}$

The gravimetric analysis for the Teflon filters used in the $PM_{2.5}$ monitoring program includes conditioning and pre-sample weighing, and conditioning and post-sample weighing. The components of the methods are described below:

Filter Conditioning: Detailed procedures for conditioning the filters are described in the RTI SOP for PM Gravimetric Analysis Section 1.13.3 (see Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022)The lab staff expose new for pre-sample and used for post-sample filters on open petri slides for a minimum of 24 hours in the weighing room. The conditions in the weighing room during the 24-hour conditioning period must be stable, monitored and available for use in data verification. The temperature and humidity for the 24-hour period must be reported in 5 minute averages or less. Mean 5-minute average temperature for the entire equilibration and weigh session must be no less than 20 °C and no more than 23 °C, with a variation of no more than ± 2 °C. Humidity measured during this period must be no less than 30 percent and no more than 40 percent with a variation of no more than ± 5 percent. For QA/QC purposes, various filters are weighed and used as blanks to ensure that filter conditioning is adequate. A brief explanation of the designated purpose of each type of blank follows. A more complete description of these processes and the intended purpose and name for each different type of blank used is contained in Section A8 and Table 5 of the RTI QAPP attached as Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14). In short, exposure lot blanks (also known as lab blanks) and lot blanks are checked periodically to ensure that the filter conditioning is adequate. The lab filter and field filter blanks must meet the pre and post weight change stability requirements of 15 and 30 micrograms (µg), respectively. Exposure lot blanks should be initially weighed and then re-weighed weekly as soon as batches of filters are received to determine that the conditioning period is adequate for each batch of filters.

Pre-weigh Procedure: Laboratory staff weigh each conditioned $PM_{2.5}$ filter without the cassette installed within the 30 days prior to the filter being used in the field. The lab staff record the following information in a database table when each filter is weighed: Filter Number, Cassette Number, Batch, Weight, Weigh Date, Use by Date, and Lab Blank weight, as well as other pertinent data listed in the attached Appendix D RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022. (See Appendix F Sample RTI Data Package for an example of information that is recorded.) The filter is loaded into a cassette and put into the sequential sampler magazine. Magazines are loaded with filters and field and trip filter blanks as required. A filter information sticker is attached to each magazine with the batch number, use by dates, and magazine ID. The COC documentation (filter ID numbers, cassette numbers, filter expiration date) are included in the shipment from RTI. (See Appendix F)

Post-weigh Procedure: The RTI lab receives filters from the field in plastic insulated coolers. The cooler contains: the metal shipping container with the sequential sampler magazines, the COC, and ice substitutes (above and below the magazines in the shipping container). The ice substitute is designed to freeze at minus 1˚C and maintains the temperature of the filters during transport below 4˚C. The lab staff inspect the shipping container upon arrival, open the shipping box and record the temperature of the sampling magazines. The temperature recorded by the infrared thermometer is considered to be

the highest temperature experienced by the filters throughout the entire trip from the shipping locations to the laboratory. The lab staff log in the filters and take them to the conditioning room where they are taken out of the cassettes. After equilibration for at least 24 hours or the minimum amount of time as determined by the lot blank procedure, the lab staff then weigh the filters and update the database tables with the following information: shipment temperature, filter and cassette number, conditioning room temperature and humidity during weighing, analysts name, weight and the five-minute mean temperature and humidity in the conditioning room for the 24 hours prior to weighing.

13.4 Internal QC and Corrective Action for Measurement System

The internal QC at the RTI lab is designed to meet or exceed the requirements in 40 CFR Part 50, Appendix L, and recommendations in the QA Guidance Document 2.12. The RTI quality assurance officer (QAO) is responsible for ensuring that the quality system is implemented and followed. The RTI QAO will notify management of deficiencies in the quality system and monitor corrective action. The RTI Lab internal QC standards and processes, including data review responsibilities, is discussed in detail in Appendix A of this document and includes but is not limited to: the use of lot and lot exposure (i.e., lab) blanks, instrument calibration/verifications (balance, thermometer, RH), accuracy audits (balance audits, balance checks), use of certified calibration standards (working mass standards and primary standards) and precision checks (duplicate filter weighing). The failure of any internal QC check to meet the criteria previously established for that measurement triggers a corrective action on the part of RTI which will include the following as necessary:

1. Immediate retest of the result found to be at variance with established criteria.
2. Examination of the instrumentation involved, including visual inspection, cleaning, system internal and external diagnostic checks (performed by RTI staff).
3. Equipment service/ repair (performed by external vendor).
4. Determination of impact of the nonconformance on data quality.
5. Preparation and dissemination of the Corrective Action report to RTI management and DAQ outlining the nonconformance, the reason it occurred, the steps taken to correct the problem and prevent it from reoccurring and an assessment of the impact of the nonconformance on DAQ data.

14.0 Quality Control Requirements and Procedures

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item or service against defined standards to verify they meet the stated requirements established by the end user. For the PM monitoring network, DAQ uses QC activities to ensure DAQ maintains measurement uncertainty, as discussed in Section 7.0 Quality Objectives and Criteria for Measurement Data, within acceptance criteria for the attainment of the DQOs. The SOPs (see Table 16), the specific instruments' operation manuals, and RTI's QAPP (see Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14)) provide lists of pertinent QC checks. This section contains QA/QC information regarding the specifications and performance criteria for the field and laboratory operations used by DAQ and its contractors.

To assure the quality of data from air monitoring measurements, RTI, the ABAQA and DAQ perform two distinct and important interrelated functions. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific QC procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

The PM monitoring program consists of two primary networks. The first is comprised of the continuous monitors which are operated and served exclusively by ABAQA and DAQ personnel. The second is the gravimetric program where ABAQA and DAQ personnel are responsible for all activities necessary to collect gravimetric data, while an independent contractor, RTI is responsible for all activities related to filter weighing and storage. DAQ and ABAQA use QC activities to ensure that both networks maintain measurement uncertainty within acceptance criteria for the attainment of the DQOs. The DQOs are discussed in Section 7.0 Quality Objectives and Criteria for Measurement Data. Applicable SOPs are listed in Table 16 and instrument manuals provide lists of pertinent QC checks.

The DAQ and ABAQA achieve QC for these two networks through annual, or as needed, multipoint calibrations, daily review of instrument measurements, periodic maintenance, flow rate audits, accuracy, bias, and precision checks, collocated instruments, e-log control charts, acceptance test procedures and other verification techniques. In addition, for the contractor provided portion of the gravimetric program, DAQ requires RTI to provide QC data demonstrating that all filter weigh data meets or exceeds the minimum requirements for inclusion in the NAAQS. Table 7 through Table 11 provide the specific QC measures, with frequencies and acceptance criteria that DAQ requires of itself and its contractors. To reduce the potential for error, DAQ, where possible, has embedded all calculations used for QC purposes in e-log books and spread sheets. RTI utilizes the same protections to preserve the integrity of the weigh data it provides. In all cases, any formulas used are derived from relevant sections of 40 CFR Part 58 and the appendices to 40 CFR Part 50.

14.1 Adjusted Calibrations

An adjusted calibration, which DAQ calls a calibration, is the process used to change an instrument's measurements to minimize deviation from a standard. This multiphase process begins with certifying a

calibration or transfer standard against an authoritative standard such as a NIST-traceable standard. The operator compares the PM instrument's measurements to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, the operator implements corrective action (i.e., adjustments) to rectify the instrument's measurements.

The SOPs in Table 16 and in the specific instruments' operations manuals provide calibration procedures for the critical field and laboratory equipment. For the PM monitors, the operator adjusts flow rate when performing a calibration. The design (desired) flowrate of low-volume PM samplers and monitors is 16.67 LPM. After the operator has adjusted the flow rate, the operator verifies the flow rate to ensure the calibration is successful. Using a certified FTS, flow rate is measured and a comparison between the known (transfer standard) and the measured (sampler or monitor) is calculated using percent difference. For the ABAQA monitoring staff and regional monitoring technician to consider the calibration successful, the calibration verification value must be within 2 percent.

DAQ requests RTI to provide specific documentation demonstrating calibration of the analytical microbalance used to weigh all filters when the devices are recalibrated. RTI must provide to DAQ, upon request, documentation demonstrating that all calibrations meet listed requirements for frequency and accuracy and that all standards used to establish instrument performance are in certification and meet listed requirements for NIST traceability.

14.2 Precision Checks

Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. To meet the DQOs for precision, DAQ will ensure the entire measurement process is within statistical control. To do this, DAQ will employ various tools in evaluating and monitoring precision measurements. Employing collocated monitoring, and monitoring data integrity with e-log flow control charts, will provide evidence of deviations from the required precision measurement. Since an atmosphere of a known PM concentration cannot be made (such as in gaseous ozone monitoring), collocated monitors are the best way to test field precision comparing one monitor against another. The DAQ places collocated monitors at 15 percent of all primary intermittent $PM_{2.5}$ monitoring sites as well as at 15 percent of each primary continuous monitoring sites to support precision evaluations. The DQOs, contained in Table 6 of this QAPP, for the PM network are based on the precision estimates of the collocated monitors.

14.2.1 Flow Rate Verifications

In accordance with 40 CFR Part 58, Appendix A, Sections 3.2 and 3.3, the ABAQA monitoring staff and regional monitoring technician must perform a one-point flow rate verification check at least once every month on each sampler used to measure $PM_{2.5}$ and low-volume PM_{10}. In the DAQ network, the goal is to complete these verifications every 14 to 18 days, except during audit months. The ABAQA monitoring staff and regional monitoring technicians complete the verification by checking the operational flow rate of the sampler. If the ABAQA monitoring staff and regional monitoring technicians complete the verification in conjunction with a flow rate adjustment (calibration), they must complete it before

making the adjustment. They compare the flow rate measured by the transfer standard to the flow rate reported by the sampler. The ABAQA monitoring staff and regional monitoring technicians calculate the percent difference and compare the results to the acceptance criteria. They also calculate percent difference between the design flow rate of the sampler (i.e., 16.67 LPM) and the flow rate measured by the transfer standard during the check. These QC checks verify (confirm) the PM sampler is in good working order and, therefore, support the defensibility of the data.

14.2.2 Duplicate Filter Weights

For the gravimetric network, DAQ requires RTI to complete duplicate filter weighing for at least one filter per batch, or 10% of the total filters per batch, whichever is more. Successive filter weights may vary no more than 15 µg to meet acceptance requirements. RTI randomly selects one or more filters to reweigh from each batch. The frequency of filter duplicate weighing is in accordance with Quality Assurance Guidance Document 2.12.

14.3 Quality Control Samples

Collecting blanks are required under 40 CFR Part 50, Appendix L Section 8.3.7.1. DAQ currently requires field personnel and RTI to collect field filter, trip filter, exposure lot (i.e., lab), and lot blank samples for use as QC checks. RTI pre-weighs field blank filters with routine sample filters; the ABAQA monitoring staff and regional monitoring technician then installs this pre-weighed filter in the field sampler without any flow passing over the filter; RTI re-weighs the field blank filters with routine exposed sample filters; and calculates the change in weight. Results are included in the data package. Final weights for field blanks must differ from initial recorded weights by less than 30 µg to meet acceptance criteria. All other blanks may vary by no more than 15 µg between final and initial weights. The purpose of blanks is to provide an estimate of total measurement system contamination, such as for transport or field activities. Through a comparison of exposure lot blanks against field filter blanks, DAQ can assess contamination from field activities. The DAQ network collects field filter blanks within its network at a frequency of approximately 10 percent of the sampling runs scheduled per site. For example, for a sampler operating on a 1-in-6-day operating schedule, DAQ would collect six field filter blanks over the course of a year. The DAQ takes field filter blanks throughout the duration of the sampling schedule (spaced evenly across the year) and not concentrated in a short period.

As an additional QC check, DAQ will also collect trip filter blank filters. Collecting trip filter blanks is not a requirement under 40 CFR Part 50, Appendix L; however, collecting trip filter blanks is a best practice. The site operator treats a trip filter blank exactly as a field filter blank, but the operator never places the filter into the sampler or exposes it to the ambient environment. The purpose of the trip filter blank is to assess possible contamination to filters during packing and transport to and from the laboratory to the sampling location. Trip filter blanks may vary by no more than 15 µg between the initial and final weighing. If the weight change exceeds 15 µg, contamination in the laboratory or during shipping may be occurring and further assessment of the exposure lot (i.e., lab) blank data will be necessary to identify the contaminant source. As with field filter blanks, the DAQ collects trip filter blanks in the PM network at a frequency of approximately 10 percent of the sampling runs.

RTI includes field filter and trip filter blanks in the shipments of filters to DAQ regional offices, and customers. DAQ customers include ABAQA, EBCI, Mecklenburg and Forsyth Counties. All filter blanks are accounted for using the same processes as regular filters and utilize the same COC.

Lot blanks are conditioned, unsampled filters used to determine filter weight stability for each new supply of filters. RTI will randomly select nine filters from the manufacturer's lot received through the EPA. These filters will be used to determine the minimum conditioning time required for all the filters in the new lot. The procedure followed includes weighing the nine filters several times over the course of several days until the change in mass is no more than 15 µg. The number of hours needed to achieve this stability becomes the conditioning time of the whole lot. At a minimum, filters must be conditioned for at least 24 hours.

RTI will select and weigh exposure lot (i.e., laboratory) blanks with each batch of filters. Laboratory blanks may vary by no more than 15 µg compared to the original mass measurement made when the blank filter was first pre-conditioned. If the exposure lot blanks are not within the specifications after weighing, RTI will implement corrective action to locate and correct the problem.

14.4 Accuracy or Bias Checks

The EPA defines accuracy as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). Although the DAQ primarily uses collocated monitors for evaluating and controlling precision, the DAQ can use the data from the collocated monitors to determine accuracy or bias. With that in mind, by employing percent difference calculations and monitoring patterns of collocated $PM_{2.5}$ samplers, the DAQ can observe trends that indicate bias occurring within the measurements. Percent difference measurements, using flow rates in lieu of concentrations, obtained during flow rate verifications are used to assess the bias as described in 40 CFR Part 58, Appendix A, Section 4.2.2.

14.4.1 Field Flow Rate Audits

For instruments that measure flow, a member of the ABAQA monitoring or regional office staff who is not the regular operator will perform a flow rate audit at least every 6 months and preferably every quarter. The auditor does the audit measuring the analyzer's normal operating flow rate using a certified flow-rate transfer standard.

The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the monitor or sampler. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. The applicable instruments' operations manuals and the appropriate SOPs in Table 16 provide details for implementing flow rate audits.

14.4.2 External Agency Audits

The DAQ participates in the EPA Performance Evaluation Program (PEP). For $PM_{2.5}$, the PEP is a QA activity, which the DAQ uses to evaluate measurement system bias of the PM monitoring network. The EPA defines a performance evaluation as a type of audit in which an independent party obtains the quantitative data generated in a measurement system and compares it with routinely obtained data to

evaluate the proficiency of the analyst or laboratory. In the case of the PM PEP, the goal is to evaluate total measurement system bias, which includes measurement uncertainties from the field and the laboratory activities. The strategy is to collocate a portable $PM_{2.5}$ air-sampling instrument within 2 to 4 m of an air-monitoring instrument, operate both monitors in exactly the same manner, and then compare the results. Further information on the PEP is available at https://www.epa.gov/amtic/national-pm25-performance-evaluation-program.

14.5 Reference Membrane Span Foil Verification

For the BAM 1022 instruments, the operator must perform a reference-membrane span foil verification once every 90 days. The reference-membrane span foil verification monitors the stability and performance of the beta counter. If the verification fails, the operator will call the ECB to have the BAM 1022 replaced.

For the BAM 1020 instruments, the monitor must undergo an automated reference-membrane span foil verification once every 24 hours. The reference-membrane span foil verification monitors the stability and performance of the beta counter. If the verification fails, the operator will call the ECB to have the BAM 1020 replaced.

14.6 BAM Background Tests

Operators must perform a zero background test on the BAM (1020 or 1022), after the initial installation and calibration, as soon as the weather conditions meet the minimum weather requirements: 72 hours of clear weather with no precipitation forecasted. The ECB electronics technicians may also perform a zero-background test indoors before they install the monitor: they do not have to follow the weather requirements in this circumstance, yet they must still use the smart heater. This test corrects the background value to compensate for minor variations caused by local conditions such as grounding and shelter characteristics. The ABAQA monitoring staff and regional monitoring technicians will perform subsequent background tests on an annual basis in early spring (March/April/May) or fall (September/October/November) when dew points are generally very low. The test collects data for at least 72 consecutive hours having the PM_{10} and $PM_{2.5}$ inlets replaced with a HEPA filter (BX-302) on a flow audit adapter. At the end of a completed 72-hour period, the ABAQA monitoring staff or regional monitoring technician must download the data and statistically analyze it using an Excel spreadsheet template. After the ABAQA monitoring staff or regional monitoring technician has calculated a new background value and compared it with the factory zero, he or she should audit the new coefficient for 24 hours before resuming normal data collection, especially if the newly calculated background value is approaching the operating limits established for the monitor.

14.7 Filter Inspections

Initial filter inspections are performed by RTI technical staff prior to weighing. The RTI technician will inspect all filters before weighing to ensure that the filters are the correct type and size and do not have pinholes, particle contamination, or other imperfections. The technician will discard any filter that fails the initial visual defect check.

When the DAQ field operators receive the filters from RTI, they inspect the filters for damage and pin holes before installing the filters into the sampler. They document compromised or damaged filters on a photocopy of the COC and return them unused to RTI. The DAQ field operators also inspect the filters after sampling is complete before shipping the filters back to RTI. Any damage to the filter is recorded on the COC that accompanies the filter back to RTI.

When the DAQ field operators return the exposed filters to the lab, the technician will again inspect each filter and note any imperfections that are apparent. The RTI technician will carefully note any filters which are damaged and record his observations on the filter data page in the data package reported to DAQ. The DAQ PM chemist will void sampled filters which are found to be damaged or to have defects which might have affected sampling data.

14.8 Balance Verification and Audits

Balance checks are frequent checks of the balance working standards against the laboratory balance to ensure precision throughout weighing sessions in order to test the micro-balance repeatability. RTI will use American Society for Testing and Materials Class 1 weights for its primary and secondary (working) standards. The RTI technician will measure working standards at the beginning of each weighing session. Additionally, the analyst will weigh standards after every 10 filters and at the end of each weighing session. All balance verifications performed by RTI during the weighing of DAQ filters will be supplied to DAQ as part of the QC documentation for the weigh session. DAQ will conduct yearly audits of the RTI facility utilizing EPA supplied audit forms and procedures. DAQ audits will rely on RTI supplied third party validations to determine balance function and accuracy. These function and accuracy tests are discussed more fully in Appendix A of this document.

14.9 Quarterly Verification of Weights

RTI has the working standards re-certified annually against a NIST-traceable standard at an accredited metrology laboratory. RTI verifies the working standards' masses against the laboratory's in-house primary standards every 90 days to check for mass shifts associated with handling or contamination. RTI staff must record the verified values of the working standards as measured relative to the laboratory primary standards in a laboratory QC log and use them to check the integrity of the working standards.

The double substitution method is the method for conducting quarterly verifications of the working mass reference standards. This procedure is a version of SOP Number 4 in NIST Handbook Number 14521. Using this method, the RTI technician weighs a set of primary standards against a set of working standards to generate a reference point. The working and primary standards are each weighed twice.

Whenever the RTI technician computes the double substitution, he or she compares the new calculation to the previous calculation to determine if there has been a significant shift in mass. The technician does not use the double substitution method to generate a "new mass" for any weight standard; the double substitution method serves only as a verification (check) of the standards. The acceptance criterion is 2 µg from the certified weights.

14.10 Filter Holding Times

The RTI technicians must document, using COC documents, receiving logs, and temperature data to determine that all filters do not exceed acceptable holding times. DAQ field operators must only use filters to collect samples that are within 30 days of their initial weighing. If an operator collects a sample on a filter 31 days after its initial weighing, the PM chemist will void the sample. The operator must recover all sampled filters within 7 days and 9 hours from the sample end date. The PM chemist will void any samples recovered later than that. RTI must weigh all received filters within a specified time. The holding time on received filters vary depending on the temperature of the sample during collection and when received at the lab. In order to meet the requirements of EPA Method 2.12, filters received at ambient temperature must be weighed within 10 days of the sample date. Filters received at less than the average ambient temperature or at less than 4 °C, must be weighed within 30 days of the collection date to remain valid. RTI must note holding times for all filters and include this information on the filter data page of the data package supplied to DAQ. The PM chemist will void any data from filters which are received above 25 °C or which exceed their holding times.

14.11 Filter Conditioning Environment

RTI will equilibrate all filters in a temperature and humidity controlled environment for a minimum of 24 hours. The controlled environment must meet the following conditions:

- The 24-hour mean temperature must fall between 20 and 23 °C;
- The SD in the temperature over a 24-hour period must be less than ± 2.1 °C;
- The 24-hour mean RH must fall between 30 and 40 percent or less than or equal to 5 percent sample RH but great than 20 percent RH;
- The SD in the RH over a 24-hour period must be less than ± 5.0 percent; and
- The difference in the 24-hour mean RH must be less than 5.1 percent between when the analyst takes the initial and final weights.

14.12 Corrective Actions

All RTI laboratory personnel and DAQ and ABAQA ambient air monitoring personnel take corrective action measures as necessary to ensure the PQAO attains the MQOs. Given the number of monitors, the diversity of monitoring activities and the complexity of the instruments, a potential exists that issues may arise with sampling and measurement systems. In the PM monitoring network, the ABAQA and DAQ have anticipated many of the issues in advance and prepared and equipped the staff to address the issues as they arise.

However, the RTI, ABAQA and DAQ staff will encounter unexpected or unforeseen circumstances so they will also need to implement corrective actions on an "as-necessary" basis. The SOPs (see Table 16) contain examples of corrective actions that the staff may need to complete under certain circumstances. Regional monitoring technicians and ABAQA ambient air monitoring staff should consult the SOPs in Table 16 for technique-specific checks, required frequency of checks, acceptance criteria and additional corrective action guidance. Table 17 is an abridged list for typical problems that require corrective action

by the ABAQA or DAQ operator. It is the DAQ policy that ABAQA monitoring staff, regional monitoring and ECB electronics technicians and RCO chemists report the need for corrective actions to the appropriate ABAQA air monitoring staff, regional monitoring coordinator or supervisor within two business days and address the issue as soon as possible, ideally within five business days. The ABAQA monitoring staff, regional monitoring technicians, ECB electronics technicians and RCO chemists can resolve most problems within one or two business days, but occasionally it takes longer to identify what caused the problem and find a solution. When equipment is down, ABAQA and DAQ staff must work to repair the problem as quickly as possible to limit the amount of data loss.

Table 17. Possible ABAQA and DAQ Operator Corrective Actions

Activity	Problem	Likely Actions
QA/QC Check	Out of specification; flow rate check or failed flow rate audit exceeds acceptance criteria	1) Verify / reproduce performance check findings. Use an alternate transfer standard to confirm failures. 2) Perform alternate performance checks to determine cause (for example – leak tests to aid in flow rate issues). 3) Recalibrate monitor using SOPs. 4) Identify any required procedural changes to prevent the occurrence. 5) Document actions on an e-log as appropriate. 6) Notify the ABAQA monitoring staff or regional monitoring coordinator and RCO PM chemist, of performance audit failures as soon as practical.
Filter inspection (Pre- or Post-sample)	Pinhole(s) or torn	1) Void filter with pinhole or tear. 2) Substitute an undamaged filter. 3) Inspect sample stream and exchange mechanism to determine cause. 4) Document action taken on field COC form, data sheets, and logbook, as appropriate.
Run-time parameter check	Shortened sample run times	1) Verify proper monitor run-time programming. 2) Diagnose likely causes – low flow rates, low pressure, power disruption, others. 3) Document cause and any actions on field COC form, data sheets, and logbookas appropriate.
Power	Loss or interruptions	1) Verify power supply integrity. 2) Verify circuit breaker and fuse integrity. 3) Document cause and actions taken on field COC form, data sheets, and logbook as appropriate.
Data Review	Data missing from the DAS or from intermittent sampler	1) Verify DAS operation. 2) Ensure monitor polling is current. 3) Isolate telecommunications problem by connecting to the monitor using alternate processes. 4) Verify monitor operations remotely. 5) Notify the database manager, RCO PM chemist or ECB electronics technicians, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.

RTI's corrective action procedures are described in Section C1.1 of RTI's QAPP (see Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14)). RTI will notify DAQ if RTI's investigations of the corrective action show that the laboratory results may have been affected. In that case, RTI will communicate to DAQ the corrective actions taken by RTI. DAQ will also contact RTI during the review of the data packages when the DAQ level 2 reviewer notes data abnormalities or needs additional clarification of the data.

14.13 Documentation

The ABAQA monitoring staff, regional monitoring and ECB electronics technicians will document all events, including routine site visits, calibrations, maintenance, and calibration equipment maintenance, in field data records (ECB form 109), e-logs and site logbooks. The ECB electronics technicians will also record field maintenance activities associated with equipment used by the regional monitoring technicians in dedicated instrument logbooks as well, which are stored at the ECB. The ABAQA monitoring staff and regional monitoring technicians document data from $PM_{2.5}$ FRM sample runs on COC forms and in e-logs. The site logbooks and e-logs will normally be controlled by the regional monitoring coordinators, and ABAQA monitoring staff, and located in the field sites when in use or at regional or ABAQA offices when being reviewed or used for data validation. The regional monitoring coordinators transfer these records to the RCO group drive for the RCO PM and audit chemists to use to validate and audit the data.

The RTI lab QC documents are contained in the data package (see Appendix F) and updated as required in the RTI QAPP (see Appendix A)

15.0 Instrument and Equipment Testing, Inspection, and Maintenance Requirements

The instrumentation used in the PM monitoring program are tested and inspected by the RTI or ABAQA staff or ECB prior to use or deployment into the field. The ECB maintains a repair shop in the Maywood facility for off-site repair, maintenance, and field or lab readiness certification of equipment. This section discusses the procedures used to verify that the RTI lab staff, ABAQA monitoring staff and ECB electronics technicians maintain all instruments and equipment in sound operating condition so they can operate at acceptable performance levels. Refer to the instrument specific SOPs (listed in Table 16) for more details on the specific preventative maintenance and repair activities. All documentation associated with instrumentation, equipment testing, inspections and maintenance must be recorded and filed in the appropriate locations. See Section 9.0 Documentation and Records for document and record details.

15.1 Testing

The DAQ PM monitoring program uses established procedures to verify that the ABAQA monitoring staff, regional monitoring and ECB electronics technicians maintain all instruments and equipment in sound operating condition and capable of operating at acceptable performance levels. Refer to the instrument specific SOPs (listed in Table 16 of this QAPP) for more details on the specific preventative maintenance activities. In general, the ABAQA monitoring staff or ECB electronics technicians perform the acceptance and testing activities (see below) upon receipt of new monitors and samplers and after a monitor or sampler has undergone significant repair. If the equipment is new and fails to meet the field readiness certification described below, the ABAQA monitoring staff or ECB electronics technicians will contact the vendor.

- Verify that instrument contains its EPA equivalent or reference method decal and meets the specifications of the purchase request.
- Verify that all expected parts arrived with the instrument and that nothing is physically broken. Contact the vendor if there are issues.
- Perform field readiness “certification” testing, summarized as follows. Although the designation of the FRM/FEM status ensures the make/model of the instrument meets EPA requirements for use in the network, ABAQA and DAQ must still ensure individual instruments perform as expected before the ABAQA monitoring staff or ECB electronics technician deploy them in the field.
    - Check the diagnostics of the sampler, looking for any fault lights or warnings, and document the status.
    - Check, and if need be, calibrate, the temperature and pressure sensors.
    - Perform flow rate checks and make sure they fall within the acceptance criteria.
    - Run the intermittent sampler at the ABAQA office or ECB for a short period of time (e.g., a week) and track the sampler’s operational performance. For example, these tests confirm the functionality of the filter exchange mechanism in the

sampler and verify that the software is working appropriately. For continuous PM samplers, the ABAQA monitoring staff or ECB electronics technician runs the sampler in the lab and observes the ambient concentration values; these values should be low (as this is indoor air) and track steadily.

If an instrument has undergone significant repair and fails to meet the field readiness certification (testing), the ABAQA monitoring staff or ECB electronics technician will contact the vendor. If after working with the vendor, the instrument cannot be repaired such that it passes performance testing, then the instrument will be shelved (i.e., removed from service). At that point, the ABAQA monitoring staff or ECB electronics technician tags the instrument as inoperable, sets it on the shelf and uses it for spare parts. If the shelved and tagged instrument served as a back-up instrument, then the ABAQA or ECB will begin the process to purchase a new instrument to replace that backup, such that a spare is once again available for use.

15.2 Inspection

This subsection provides a discussion of the necessary inspections of various equipment and components. The two subsections below cover conditioning and weighing room issues and field activities.

15.2.1 Inspections in Conditioning/Weighing Room

Several items need routine inspection in the gravimetric laboratory, including the RH and temperature sensors, sticky mats and functioning of the antistatic devices. (See Section 1.13.3 of RTI SOP for PM Gravimetric Analysis.) The RTI lab provides laboratory RH and temperature data in the data package submitted to DAQ. Day-to-day laboratory inspections are documented at RTI and made available to DAQ upon request and during the DAQ RTI TSA. Any testing, inspection, and maintenance of lab equipment that is outside the scope of RTI's laboratory is performed by a contract vendor.

15.2.2 Inspections of Field Items

Several items periodically require field inspection. The applicable equipment SOPs are listed in Table 16 and operations manuals present details on these items and procedures. In general, the following inspection activities are used:

- The ABAQA monitoring staff and regional monitoring technicians inspect monitoring shelters, sample inlets, and other enclosures quarterly to ensure conditions do not adversely affect monitor operation or data integrity. The ECB electronics technicians inspect DAQ monitoring shelters, platforms, sample inlets and other enclosures during each site visit and at least once a year to ensure conditions do not adversely affect monitor operation or data integrity.
- The ABAQA monitoring staff and regional monitoring technicians and coordinators and RCO PM Chemist and statistician review data collection and data quality each business day, inspecting the data for trends and signs of problems with continuous PM monitors. Data trends that signal inspection would include such issues as frozen numbers for

multiple hours in a row, or erratic spikes or valleys in the concentrations obtained.

- Inspections on equipment also occur during site visits to verify the entire system is in good working order. The RCO PM chemist incorporated the site visit checklists into the e-logs.
- The ABAQA monitoring staff and regional monitoring technicians review the site and monitors annually to ensure continuing compliance with 40 CFR Part 58, Appendices A, D and E. They document their review on the DAQ site review form.

15.3 Routine Maintenance

With regard to routine maintenance, the following are general protocols:

- The regional monitoring technicians and ABAQA staff keep the site clean, free of rodents and overgrowth of vegetation around the site.
- The ECB electronics technicians maintain a limited supply of critical spare parts in the ECB to aid in rapid response to issues. For example, pump rebuild kits, spare pumps, sample media and expendable kits are routinely on hand.
- Preventive maintenance is scheduled ahead of time so all parts/tools can be easily available to complete the tasks and data loss is kept at a minimum.
- The ABAQA staff, regional monitoring and ECB electronics technicians typically perform preventive maintenance activities in the field, although the ECB electronics technicians complete some activities in the ECB.

The routine preventive activities and schedules are detailed in the specific equipment SOPs (see Table 16) and supplemented by the equipment user manuals. The ABAQA monitoring staff and regional monitoring technicians service all PM inlet heads monthly, very sharp cut cyclones, or VSCCs, monthly and down-tubes at least quarterly. Also, the regional monitoring technicians and ABAQA staff perform diagnostic checks before and after preventive maintenance. The diagnostic checks and routine maintenance are documented in the e-log. The RTI lab will perform or contract routine preventive maintenance of all laboratory systems as listed in Appendix A through D of this document. Maintenance outside the scope of RTI's laboratory is performed by a contract vendor. These records are made available upon request and during the DAQ RTI TSA.

16.0 Instrument Calibration and Frequency

The EPA defines “calibration” as the comparison of a measurement standard, instrument or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustment. Use of the term “calibration” indicates that an adjustment in either the instrument or the software occurred. The EPA recommends that agencies minimize adjustments to prevent introducing measurement uncertainty and that verifications, “i.e., checks without correction (adjustment),” be used to confirm whether an instrument is operating within its acceptance range. Thus, the purpose of calibration is to minimize bias. Section 14.0 Quality Control Requirements and Procedures discusses calibrations in more detail. The operator SOPs listed in Table 16 describe calibration procedures for each specific pollutant monitor or sampler.

Title 40 CFR Part 58, Appendix A, Section 2.6 requires that flow rate standards used in the ambient air monitoring network be traceable to NIST. The ECB electronics technicians procure and maintain dedicated traceable standards for the certification of the ambient air quality monitoring systems. These standards provide a direct link to established national standards, i.e., NIST, and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines.

Traceability is defined in 40 CFR Parts 50 and 58 as meaning that a local standard (i.e., one maintained by a monitoring organization) has been compared and certified, either directly or via not more than one intermediate standard, to a primary standard such as a NIST standard. Similarly, traceability is the property of a measurement result whereby the agency or an auditor can relate the result to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. Standard traceability, therefore, is the process of transferring the accuracy or authority of a primary standard to a field-usable standard, resulting in a documented unbroken chain of calibrations and certifications. The applicable SOPs (see Table 16), operation manuals and RTI QAPP provide specific calibration procedures and timeframes for certifications of field and laboratory equipment. DAQ is currently working with RTI to complete revision of the existing RTI QAPP. In the meantime, RTI has agreed to perform all gravimetric analysis in conformance with applicable EPA protocols and Method 2.12.

To achieve and ensure traceability, DAQ adheres to the following principles:

- DAQ and RTI recertify devices at least annually. These records are kept at RTI and the ECB and in the regional and ABAQA offices. All records, including RTI lab records, are available to the RCO chemists and auditors upon request.
- Where applicable, the ECB electronics technicians perform in-house certification procedures (i.e., certifying a transfer standard against a certified primary standard - i.e., one of higher authority) following the applicable SOPs in Table 16. The ECB electronics technicians maintain documentation of these procedures in the ECB shop on appropriate forms.
- The DAQ and RTI maintain records of all equipment calibrations, using the traceable standards (with equipment identification numbers clearly documented). DAQ stores all records,

including QC, COC and raw data files, received from RTI on the RCO group drive or DAQ Ambient Monitoring Team SharePoint page. DAQ stores all other records on the regional SharePoint page or RCO group drive.

In this manner, documentation exists that provides a documentation trail that links all DAQ and RTI calibrations back to NIST.

The following subsections summarize the standards used by DAQ in the PM network and their recertification process. The RTI QAPP provides details on the standards used by RTI and their recertification process. The regional monitoring and ECB electronics technicians monitor all certification periods to ensure operators and auditors do not use equipment beyond the documented certification expiration dates. The ABAQA monitoring staff and regional monitoring technicians are responsible for verifying the equipment they are using is within certification and contacting the ECB electronics technicians at least 30 days before the certification expires. Likewise, RTI Lab maintains records of service and calibration records ensuring all equipment used in the laboratory are within its certification period. Records at the RTI Lab which are not included in the RTI data packages, are available to DAQ upon request and during the DAQ RTI audits.

16.1 Certification of Local Primary Standards

A primary standard is a standard that is sufficiently accurate such that it is not calibrated by or subordinate to other standards. The vendors and ECB electronics technicians use primary standards to calibrate other standards referred to as working standards.

The DAQ uses “local primary standards” or standards certified against NIST-traceable standards and kept in the ECB shop for the sole purpose of certifying transfer standards used in the field to calibrate equipment and verify equipment calibrations. The DAQ owns two “local primary standards” for each type of device. The ECB sends each “local primary standard” to the vendor for recertification in alternate years, ensuring one local primary standard is always available for use and has been certified within 365 days. DAQ staggers the rotation of standards such that one device remains in certification at all times. An ECB electronics technician compares the “local primary standard” that did not return to the vendor to the one that did return to the vendor to certify it and uses it to certify equipment for the next year.

16.1.1. Local Primary Temperature Standard

The ECB electronics technicians use an Omega Digital Thermometer DP 41 (with resistance temperature detectors) RTD 805 Lab Standard (LS) as a local primary temperature standard to verify the accuracy of the field temperature transfer-standards. An ECB electronics technician sends one of the local primary standards to the vendor for recertification against a NIST primary standard every 365 days. DAQ-15-001.1 SOP provides information on and procedures for the certification and verification of the local primary temperature standards.

16.1.2. Local Primary Pressure Standard

The ECB uses a Mensor Model # 2500 as a local primary pressure standard used to verify the accuracy of the field barometer transfer-standards. An ECB electronics technician sends it to the vendor for

recertification every 365 days. SOP Section 2.3.3 provides information on and procedures for the certification and verification of the local primary barometer standards.

16.1.3. Local Primary Time Standard

The ABAQA monitoring staff, ECB and regional monitoring technicians use the WWV NIST atomic clock in Boulder, Colorado (telephone number: 1-303-499-7111) as a primary time standard. They can also obtain the correct time via the website http://nist.time.gov.

Regional monitoring technicians and ABAQA monitoring staff can also call the ECB electronics technicians to request the NIST Time. The DIT configures all state network resources and devices, including site computers at PM monitoring stations, to receive time settings from the web clock at nist.gov (primary) and the Internet Time Service at bldroc.gov (backup). The DIT also configures the site computers at PM monitoring stations to remain on Eastern Standard Time, which is the local standard time for all of North Carolina, throughout the year.

16.2 Calibration of Transfer Standards

Either the vendor or the ECB electronics technicians certify all transfer standards against either a primary standard or the "local primary standard." This establishes the traceability of the calibration.

16.2.1 Flow Transfer Standards

The field FTSs used for flow rate calibration and flow rate verification will have their own certifications and will be NIST-traceable to the factory primary flow rate standard. The ECB electronics technicians will supply either a TetraCal or streamline FTS for field calibrations and flow rate verifications of the flow rates of the network samplers. The ECB electronics technicians will also provide an additional set of field FTSs to conduct independent performance audits. Both devices have the advantage of providing volumetric flow rate values directly, without requiring conversion for mass flow measurements, temperature, pressure or water vapor content. The manufacturer establishes (and verifies as needed) a calibration relationship for the flow rate standard, such as an equation, curve or family of curves, as accurate to within 2 percent over the expected range of ambient temperatures and pressures at which the flow rate standard is used. The vendor shall recalibrate and recertify flow rate standards at least annually and provide a certificate of traceability to DAQ.

16.2.2 Temperature Transfer Standards

The ABAQA monitoring staff and regional monitoring technicians use either mineral thermometers or Tetra-Cals as field- temperature transfer standards. The Tetra-Cals have their own certification by the vendor. An ECB electronics technician will re-verify or recertify the mineral thermometers at least annually against the local primary temperature standard or auditor's transfer standard, to within 1°C, over the expected range of ambient temperatures at which the temperature standard is to be used. DAQ-15-001.1 SOP provides information on and procedures for the certification and verification of the field temperature transfer-standards. ECB will provide a certificate of traceability to DAQ field staff.

16.2.3 Pressure Transfer Standards

The field pressure transfer-standards will be handheld digital barometers or Tetra-Cals that will have their own certification by the vendor. An ECB electronics technician re-verifies or recertifies the handheld digital barometers at least annually against the local primary pressure standard. SOP Section 2.3.3 provides information on and procedures for the certification and verification of the field pressure transfer-standards. ECB will provide a certificate of traceability to DAQ field staff.

16.2.4 Pressure Differential Transfer Standards

The field manometers will have their own certification. The ECB re-verifies or recertifies them at least annually against the local primary pressure standard or auditor's transfer standard, to within 1 millimeter of mercury, over the expected range of pressures at which the standard is to be used. Standard Operating Procedure for the Calibration of the Dwyer and SPER Manometers provides information on and procedures for the certification and verification of the manometer transfer-standards. ECB will provide a certificate of traceability to DAQ field staff.

16.3 Weighing Lab Calibration and Check Standards

An external certified metrology lab recertifies the working and primary weights used at the RTI lab annually or on an as-needed basis. These calibration certifications are made available to DAQ upon request.

16.4 Analytical Balance

As described in Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14), an external certified metrology lab calibrates the analytical microbalance at the RTI lab annually and on an as-needed basis. The RTI lab staff verifies the calibration before each weighing session. These verifications are provided to DAQ in the monthly data package. RTI calibration certificates are available to DAQ upon request

16.5 Lab Temperature and Relative Humidity

Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14) provides the accuracy and resolution of the temperature and RH sensors (see Section A7). The temperature and RH sensors are calibrated annually against NIST traceable standards. The sensor that monitors lab temperature must be within ± 2 °C of the NIST transfer standard. The sensor that monitors lab RH must be within ± 2 percent of the NIST transfer standard. RTI lab staff maintains records of service and certifications of calibration. These documents are made available to DAQ upon request.

16.6 Documentation

See the appropriate SOP (Sections 2.46.2, 2.47.2, and 2.37.2, for example) for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of sampler flow rates, temperature, pressure, and time synchronization. The field sampler flow rate,

temperature, and pressure-sensor verification checks include one-point checks at least monthly and multipoint calibrations at least annually, as documented by tracking on control charts.

All these events, as well as sampler and calibration equipment maintenance, will be documented in field data records and logbooks. The technical staff will keep field activities associated with the equipment they use in record logbooks as well. The records will normally be controlled by the regional coordinator and located in the field site when in use or at the regional office when being reviewed or used for data validation.

Please reference Table 12 for the storage location of all documentation.

17.0 Inspection/Acceptance of Supplies and Consumables

DAQ SOPs (see Table 16) itemize the apparatus, equipment, materials, and supplies required for various monitoring equipment. In general, the ABAQA monitoring staff and ECB electronics technicians procure supplies and consumables directly from the vendor manufacturing the samplers and monitors used by DAQ. Most manufacturers' operating manuals itemize parts lists, including recommended replacement schedules, as well. The DAQ uses this information to determine the appropriate procurement schedule and volume of consumables required to support continuing operations.

The regional monitoring technicians and ECB electronics technician work together to track supplies and consumables, e.g., BAM filter tape. When the regional monitoring technicians need replacements, they notify the ECB electronics technicians, who supply the needed items out of the ECB inventory or purchase the needed supplies. The ECB electronics technicians maintain an inventory of supplies in the ECB shop for later distribution. They inspect received materials to ensure they received the proper part number as ordered. They also perform a general inspection to identify any damaged products. They do not retain supplies deemed unsuitable. They log and date the parts received so that they can easily determine storage duration. The ECB electronics technicians use a revolving inventory system (first in, first out) to ensure that storage times do not affect the material's integrity. If a manufacturer or EPA requirement indicates a specific expiration period for supplies, the ECB electronics technicians discard those supplies exceeding expiration dates if they have not used them within the acceptable period.

The ABAQA's Field Services Program Manager is responsible for tracking, ordering, and inspecting supplies and consumables for the Agency. When supplies are ordered and received, they are inspected for any damages before use. Any materials that have a specific expiration will be discarded if not used within the acceptable period.

The RTI lab technician must properly handle and condition the air sampling filters used to collect $PM_{2.5}$ samples and the integrity of the filter is of primary concern. The EPA provides vendor lot certification of filters used to support the ambient air quality monitoring programs before distributing the filters to monitoring organizations. The lab technician receives documents, and inspects and conditions air-sampling filters for use in the $PM_{2.5}$ sampling program. The lab technician removes filters that do not meet initial QC specifications from service.

18.0 Non-Direct Measurements

This section addresses data not obtained by direct measurement from the PM monitoring program. This includes data from outside sources and historical monitoring data. Possible databases and types of data and information that the DAQ might use include:

- Core-based statistical area boundaries
- Chemical and physical properties data
- Sampler manufacturers' operational literature
- Geographic location data (e.g., site metadata for AQS)
- Historical monitoring information
- External monitoring databases
- Lead and speciated PM data
- Census data (e.g., for determining minimum monitoring requirements in an MSA)
- Dispersion modeling
- National Weather Service and State Climate Office meteorological data and
- Annual average daily traffic count data from the North Carolina Department of Transportation (e.g., to assist in identifying minimum separation distances between DAQ PM monitor and sampler inlets and the nearest roadways)

Any use of outside data is quality controlled to the extent possible following QA procedures outlined in this document and in applicable EPA guidance documents.

19.0 Data Management

19.1 Purpose/Background

The primary work product of the DAQ PM monitoring program is data. Thus, DAQ established formalized procedures to ensure successful data management. Data management describes an inter-related set of standardized processes used to acquire, transmit, transform, reduce, analyze, store and retrieve data. When documented and followed, a data management system helps maintain the data integrity and validity throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life-cycle starts before data collection begins and ends with use of the data. The following subsections identify the processes and procedures the DAQ follows to acquire, transmit, transform, reduce, analyze, store and retrieve data. These processes and procedures maintain the data integrity and validity through application of the identified data custody protocols.

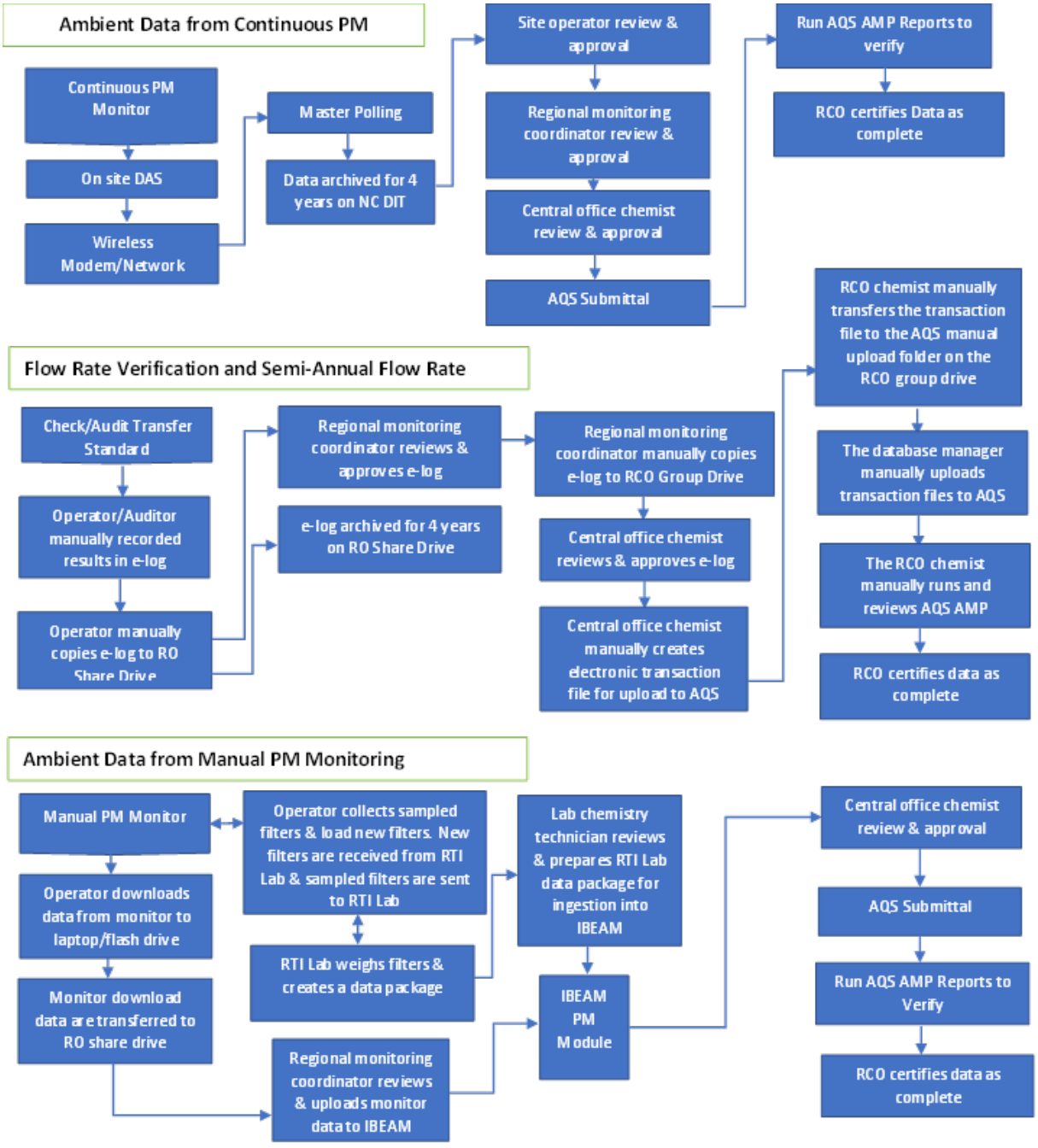
Figure 23 displays the generalized flow path of the DAQ ambient air monitoring data, including the QA/QC data collected within the PM monitoring program. The DAQ follows the procedures in the SOPs in Table 16 (SOP 2.63.4, etc.). The ABAQA monitoring staff, regional monitoring technicians and coordinators, ECB electronics technicians, RCO chemists, statistician and database manager acquire and process the ambient air monitoring data. Section 4.0 Project/Task Organization describes staff responsibilities.

19.2 Data Collection and Recording

The DAQ will only use ambient air monitoring samplers and monitors which the EPA has designated as FRMs or FEMs to collect data used for NAAQS compliance. The DAQ may use other continuous PM monitors that do not meet FRM or FEM requirements to provide real time and AQI data. Upon installation and at regular intervals as specified, the ABAQA monitoring staff and regional monitoring technicians calibrate the ambient air monitoring instrumentation following the specific pollutant SOPs identified in Table 16 of this QAPP. Note: When DAQ or ABAQA establishes a new site, the ABAQA monitoring staff or the coordinator and ECB electronics technicians manually collect metadata for the site (GPS coordinates, etc.). The database manager maintains the metadata and uploads it into AQS, as appropriate. The ABAQA monitoring staff and regional monitoring technicians and coordinators review the metadata annually during the network review and update it as needed.

For the PM monitoring network, DAQ records most data electronically. The site computer is equipped with a DAS, called Envidas Ultimate, and a wireless modem used to transmit data to the master polling system, i.e., the Envista ARM data storage database, which is a separate software package located on a state server. The DAS and site computer can record the output of the monitors at the site, perform any required data transformation and format the resulting data in preparation for downloading to the Envista ARM database. The Envidas Ultimate and Envista ARM databases do not allow the deletion of raw (i.e., original) data. The DAQ uses the Envista ARM database for data verification, validation and reporting; the database uses replicate versions of the raw data to avoid violating the integrity of the original dataset. The ABAQA monitoring staff and regional monitoring technicians and coordinators, RCO chemists and database manager can modify, flag or void data stored in the Envista ARM “edit”

Figure 23. PM Data Flow



database as needed; the DAS records and makes available an edit history to track changes made to the data.

The DAQ also collects data manually. ABAQA air quality staff and regional monitoring and ECB electronics technicians keep e-logs for most parameters, documenting QA/QC activities and preventive maintenance. For example, the operators document activities such as operational checks, leak check results, flow check results, audit results, filter changes and calibrations in these e-logs. The regional monitoring technicians upload the resulting e-logs to the regional office SharePoint drive. Then the regional monitoring coordinators transfer the e-logs to the RCO group drive for subsequent incorporation into the data validation process, discussed in Section 23 of this QAPP. The ABAQA staff email their e-logs directly to the RCO PM chemist, who transfers them to the RCO group drive for subsequent incorporation into the data validation process, discussed in Section 23.0 of this QAPP. Additionally, the regional monitoring technicians and RCO PM Chemist manually compile the results of the QA/QC checks from these e-logs for submission into the AQS database.

For the intermittent filter-based method, DAQ uses IBEAM to determine the 24-hour concentration values. This process combines the electronically provided data from the gravimetric laboratory with the electronically collected data from the field instrument during a 24-hour sampling event. The DAQ chemistry technician electronically receives the data package from the RTI lab and performs the Level 2 data verification as detailed in Appendix E DAQ Instructions and Checklists for review of RTI PM Data Packages. Upon completion of the Level 2 verification, the DAQ chemistry technician stores the entire data package on the RCO group drive. Then either the DAQ chemistry technician or the RCO PM chemist directly copies and pastes the pertinent information from the electronic RTI data package into the filter tracking, final weights, initial weights and lab blanks excel files, uploads the files to the File Transfer Protocol (FTP) folder and runs a macro that uploads the files into IBEAM. IBEAM is designed to recognize upload errors and rejects any data that does not meet its internal criteria, providing a report on which data were not accepted and why so the technician or chemist can make appropriate corrections. DAQ is developing a program which will automate the transfer process of the data from the RTI spreadsheets into the spreadsheets IBEAM uploads. The filter weigh data, once in IBEAM, is transferred into the PM module, which stores and archives it. The regional operator downloads the field data generated directly from the site sampler; these data represent the conditions of the 24-hour sampling event. The regional monitoring coordinators transfer these data electronically to IBEAM using FTP. The operator transfers sampler runtime data into the e-logs and completes the COC form. The exposed filters and COC form are returned to the RTI lab, as discussed in Section 12 of this QAPP. Once the DAQ LAB chemistry technician verifies the data package, IBEAM combines the verified lab data with the FTP-transferred field data to determine final concentration values for the filter-based $PM_{2.5}$ samples.

IBEAM is a Java-based web application system used by DAQ as a primary repository and tracking system for many of the division's business processes including facility tracking, permits, mobile sources, emission source inventories, ambient monitoring data, forecast data, compliance and enforcement actions, source tests, and facility and DAQ business documents. The DAQ modeled the design architecture of IBEAM after the standard n-tier architecture supported by Tomcat Application Server

running on a Windows Server. The system uses a thin client interface for presenting information, via hypertext markup language (HTML) and Java Server Pages, or JSP's, in Internet Explorer. The DAQ designed the system in a modular format with each module containing sub categories as appropriate. The DAQ defined security at the module level with a range of security options appropriate to staff requirements. Although IBEAM displays systems in a modular format, it stores the data in the background in an integrated data structure managed by the Oracle Relational Database Management System, or RDBMS. This means no duplication of data or data entry and a single point source for reporting and information dissemination.

19.3 Data Transmittal and Transformation

Data transmittal is accomplished using wireless communication to access a site modem. Downloading collected data does not delete data from the DAS. The Envidas Ultimate software removes data from the site computer by overwriting data on a first-in, first-out basis. This configuration requires the Envista ARM software to extract data from the site computer on a regular basis (hourly for hourly and minute data) to prevent any data loss. If communications problems arise, the Envista ARM software retrieves the data from the Envidas Ultimate system when it can once again communicate with the site. The ABAQA monitoring staff and regional monitoring technicians must make a site visit if the database manager or ECB electronics technician informs them that he or she cannot correct the communications problems in a timely fashion.

For the PM continuous monitor, the DAS reads hourly PM values from the monitor. The DAS stores each hour and this acts as the base unit for all measurements taken by the PM monitors within the DAQ monitoring network. The monitors, as well as the Envidas Ultimate system, average the stored hourly averages to form averaged 24-hour values. Envidas Ultimate transmits all these values to Envista ARM for retention. Every month the regional monitoring technician or coordinator or ABAQA staff compares the data in Envista ARM with the data downloaded from the monitors. The specific procedures are described in Section 10.0 Quality Assurance and Data Handling in the PM operator SOPs. The database manager submits only the 1-hour ambient PM concentrations to the EPA AQS database. The AQS database also averages the submitted hourly averages to form averaged 24-hour values and weighted annual averages. See Section 7.3 for how the data are aggregated into design values.

19.4 Data Verification and Validation

Data verification and validation is an important routine process that involves several steps to ensure the ABAQA monitoring staff and regional monitoring technicians and coordinators and RCO chemists have carried out the field and data processing operations correctly. The verification and validation process will identify data with errors, biases and physically unrealistic values before DAQ or the EPA uses them to identify NAAQS exceedances, for further analysis, or for modeling. Once the ABAQA, regional offices or RCO have identified these problems, the ABAQA monitoring staff, regional monitoring technicians and coordinators and RCO chemists can correct, flag or invalidate the data. If necessary, ABAQA monitoring staff, the regional monitoring and ECB electronics technicians can take corrective actions.

Section 23.0 Verification and Validation Methods contains additional information on data verification and validation.

Each of the network's instruments employed to measure the ambient concentrations of PM undergoes periodic audits, flow rate verifications and calibrations. SOPs 2.46.2, 2.47.2, and 2.37.2 (see Table 16 for SOP titles) outline these procedures. Audits and verification checks ascertain the accuracy, precision and repeatability of each instrument in performing its required function.

The continuous sampler-generated data are stored on site in the DAS. When Envista ARM accesses the data through the wireless modems, it downloads the data into its database where the data undergo verification, reduction and analysis (level 0). The ABAQA monitoring staff and regional monitoring technicians, using Envista ARM, perform data verification electronically by searching the data for status flags and comparing reported values to acceptable range criteria (Level 1). After the level 1 data reviewer flags data as questionable, level 2 (preliminary) and 3 (final) reviewers evaluate the flagged data to identify underlying causes and decide whether the data are valid. If the data are invalid, DAQ and the EPA do not use them to determine compliance with the NAAQS. If the data are valid, but flagged due to some extenuating circumstance, then DAQ and the EPA may use the data to determine compliance with the NAAQS, accompanied by a comment documenting the situation. For the filter-based sampling, the data review process contains a similar structure and procedure as the continuous data review. However, this process is done manually and via IBEAM and includes the RTI lab. Section 23 of this QAPP discusses the data review process in more detail.

19.5 Data Reduction and Analysis

As described in the subsections above, data reduction activities take place throughout the entire data management process. The on-site DAS gathers data from the monitors at each site each hour and transmits them to the Envista ARM database. The data are gathered and transmitted in response to a poll via the wireless modem. The Envista ARM system can aggregate hourly PM data into the 24-hour averages as appropriate; once validated, the database manager uploads the data into the AQS database. The EPA compares submitted results to the PM NAAQS.

The regulations, at 40 CFR Part 50, define the quantity of valid data points required within a data set. For most pollutants, the EPA requires a minimum data capture of 75 percent of the interval – hour, day, quarter – for the EPA to consider the interval valid for use in NAAQS comparisons. Table 7 through Table 11 summarize thesecompleteness requirements as well as provide specific references to the CFR.

The DAQ analyzes data periodically throughout the data collection and validation process. For example, the ABAQA air quality staff, regional monitoring and ECB electronics technicians, coordinators, RCO PM and audit chemists and statistician can download data from Envidas Ultimate directly into Microsoft Excel spreadsheets. The ABAQA air quality staff, regional monitoring and ECB electronics technicians, coordinators, RCO PM and audit chemists and statistician use Microsoft Excel spreadsheets solely for data analysis and in-depth study of the data. For example, each business day the statistician prepares a tabulation of the raw hourly data from the previous day, evaluating it for missing data, trends and data

higher or lower than Tukey's fences for that day to ensure it is within specifications. However, with filter-based sampling, daily reviews are not possible due to the methodology.

The RCO audit chemist and statistician also review all validated data looking for trends, data outside of three times the interquartile range, etc. to establish the reasonableness of the data sets. The RCO audit chemist and statistician accomplish these tasks by retrieving several reports, such as the AMP256, AMP430, AMP450 and AMP600, from the AQS database and analyzing the results.

19.6 Data Submission

After the ABAQA monitoring staff, regional monitoring technicians and coordinators and RCO PM chemist complete all three levels of verification and validation for a month of data, as described in Section 23.0 Verification and Validation Methods, the database manager or statistician uploads the data to the AQS. This submittal must occur no later than 90 days following the close of each calendar quarter, as specified in 40 CFR Section 58.16.

At the end of each quarter, an RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 (for regulatory monitors) reports in AQS and verifies that all hourly data, monthly flow rate verification and semi-annual flow rate audit data have been successfully entered. The DAQ will also notify the EPA if a monitor does not meet the completeness requirements summarized in Tables 7 through 11.

The RCO chemist assigned to this task shall certify to the chief that the data are complete to the best of his or her knowledge. The quarterly data submittal shall contain the following summary data:

- The AQS site code, monitoring method code, and parameter occurrence code;
- The results of all valid precision, bias and accuracy tests performed during the quarter for PM_{10} (including both local and standard conditions), $PM_{10-2.5}$, and $PM_{2.5}$; and
- The ambient air quality data obtained for PM_{10} (including both local and standard conditions), $PM_{10-2.5}$, and $PM_{2.5}$.

Every year before the annual data certification due date, the chief reviews the data from the EPA AQS summary reports, along with internal performance evaluation and audit reports to confirm the data meet the required criteria. The RCO chemists address any concerns with the data.

DAQ shall submit to the EPA an annual AMP600 summary report of all the PM monitoring data from any PM monitoring station designated as a SLAMS and from all FRM, FEM and special purpose monitors that meet criteria in Appendix A, in accordance with 40 CFR Section 58.15. DAQ will also submit a signed certification letter on DAQ agency letterhead signed by the chief. The chief will submit the report by May 1 of each year for the data collected from Jan. 1 through Dec. 31 of the previous year. The chief, or designee, must certify the report as accurate to the best of his or her knowledge. The chief will base this certification on the various assessments and reports performed by DAQ, including the AMP600 report, discussed in Section 21.3, that documents the quality of the ambient air quality data and the effectiveness of the quality system.

19.7 Data Storage and Retrieval

Once collected, data are stored in a variety of ways and for varying periods. Initially, data are stored in the monitor and/or the station-specific DAS. The monitors keep an unalterable record of instrument measurements for a period of days to weeks, depending on the amount of information stored. The on-site DAS also keeps an unalterable record of instrument measurements for a period of months to years depending on the number of monitors operated at the site. The RCO Envista ARM database system automatically accesses data stored in the on-site Envidas Ultimate system.

Because of the DAQ archiving system, the DAQ can store and retrieve the air quality monitoring data. Backup and recovery procedures exist to ensure the regional monitoring and ECB electronics technicians and database manager can recover data in the event of a catastrophic failure. The database manager manually executes a backup of the full database every Friday. Due to the lack of a second structured query language (SQL) database in which to import the backup files, the database manager has not routinely tested procedures for using the backup files; however, he has used backup files to import data into the virtual server's database. The use of backup files worked as expected. The DAQ has recently established a backup computer with SQL software installed to continue data polling operations in the event of a catastrophic failure of the server. When storage space limits the amount of data that DAQ can keep in the database, procedures exist for moving the data into an archive database. Presently, the database manager backs up data weekly using Zip File. The database manager keeps the most recent copy available on SharePoint. Envidas Ultimate polls data older than one week old directly from the site computer. DAQ keeps all data in real time.

Note: The ABAQA monitoring staff and regional monitoring technicians also download data directly from instruments to laptops or universal serial bus (USB) flash drives in the field for continuous PM twice a month; these data downloads serve as a back-up, as they are uploaded to the regional office SharePoint site for archival and transferred to the RCO group drive upon request of the RCO PM chemist.

The DAQ retains all supporting electronic and written information, such as logbooks, maintenance logs, certifications and diagnostic information worksheets for a minimum period of four calendar years, unless any litigation, claim, negotiation, audit or other action involving the records started before the expiration of the four-year period. When this type of situation occurs, the DAQ will retain the records until completion of the action and resolution of all issues that arise from it, or until the end of the regular four-year period, whichever occurs later. The DAQ shall store the data on electronic media or in hard copy, whichever format proves most advantageous. Envitech software updates have no impact on data accessibility. After the storage period has passed, the database manager may dispose of the storage media or recycle it. However, the database manager uploads the validated dataset to the EPA AQS for long-term storage.

20.0 Assessments and Response Actions

An assessment is the process used to measure the performance or effectiveness of the quality system, the PM monitoring network, its sites, the pertinent QAPP and various measurement phases of the data operation. The DAQ also uses assessments to determine whether the monitoring staff has implemented the ambient-air quality monitoring program in accordance with the approved QAPP. Although not all of these assessments are required, the DAQ follows 40 CFR Part 58, which calls for network plans as well as some of the other assessments listed here. DAQ also evaluates these monitors according to the requirements in Appendix A to 40 CFR Part 58. Thus, to ensure the adequate performance of the quality system, DAQ will perform the following assessments:

- Network reviews and assessments
- External performance evaluations
- Semi-annual flow rate audits
- Quarterly completeness assessments
- Annual data certification
- Data quality audits
- Data quality assessments
- EPA external TSAs
- DAQ internal TSAs
- DAQ-conducted RTI TSAs

Table 3 provides information on the parties implementing assessments and their frequency.

20.1 Network Reviews and Assessments

20.1.1 Annual Network Review

Conformance with network requirements of the PM monitoring network as set forth in 40 CFR Part 58, Appendices A, C, D and E are determined through annual network reviews of the ambient air quality monitoring systems, as required by 40 CFR Section 58.10(a). The chief uses the network review to determine if the PM air-monitoring network collects adequate, representative and useful data in pursuit of its air monitoring objectives. Additionally, the annual network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing an annual network review, the ABAQA monitoring staff and regional monitoring technicians compile and evaluate significant data and information pertaining to the PM sites and network. Such information might include:

- Network files (including metadata, updated site information and site photographs);
- AQS reports, especially AMP380 and AMP390 reports;
- Network monitors' five-year air quality summaries;
- Major metropolitan area emissions trend reports;
- Emissions information, such as a monitor's emission density maps and maps delineating an area's major emissions sources; and
- National Weather Service or State Climate Office meteorological data summaries for the monitoring network area.

Upon receiving the information, the ABAQA monitoring staff and regional monitoring technicians will check it to ensure it is current. They will note discrepancies and resolve them during the review. They will also

identify files and photographs that need updating during the review. The ABAQA monitoring staff and regional monitoring technicians will emphasize the following categories of information during network reviews: the monitor location, distance from roadways and amount of traffic on nearby roads, population density and changes in the area, changes in nearby land use and other pertinent information.

During the annual network review, the ABAQA monitoring staff and regional monitoring technicians will reconfirm the stated objective for the monitoring site and re-verify the location's spatial scale. If the site location does not support the stated objectives or the designated spatial scale, the ABAQA monitoring staff or regional monitoring technician will propose changes to rectify the discrepancy. The ABAQA monitoring staff or regional monitoring coordinator, PPB supervisor and database manager will then act to correct the information in AQS, relocate the monitors or site, or move the site to a more suitable location, if needed.

In addition to the items included in the checklists, other subjects for discussion as part of the network review and overall adequacy of the monitoring program will include:

- Installation of new monitors,
- Relocation of existing monitors,
- Siting criteria problems and suggested solutions,
- Problems with data submittals and data completeness,
- Maintenance and replacement of existing monitors and related equipment,
- Quality assurance problems,
- Air quality studies and special monitoring programs, and
- Other issues such as proposed regulations and funding.

State and Local Air Monitoring Stations. Adequacy of the network will be determined using the following information:

- Appendix D to 40 CFR Part 58;
- The most current design values,
- The most recent census or population estimates,
- Maps of historical monitoring data,
- Maps of emission densities,
- Dispersion modeling,
- Special studies/saturation sampling,
- Best professional judgment,
- State implementation plan requirements, and
- Revised monitoring strategies (e.g. reengineering of the air-monitoring network).

Monitor Locations. For SLAMS, the geographical location of monitors is not specified in the regulations, but is determined on a case-by-case basis to meet the monitoring objectives specified in 40 CFR Part 58, Appendix D. Suitable monitor locations can only be determined based on the stated objectives. Maps, graphical overlays and GIS-based information will be helpful in visualizing or assessing the adequacy of

monitor locations. The operator may also use plots of potential emissions, historical monitoring data and/or saturation study findings versus monitor locations.

During the network review, the ABAQA monitoring staff or monitoring technician will reconfirm the stated objective for each monitoring site and re-verify the location's spatial scale. If the site location does not support the stated objectives, or the designated spatial scale, the person doing the review will propose changes to rectify the discrepancy.

Once the annual network plan is updated based on the annual network review, latest census and traffic data and other pertinent information, the network plan is posted on the DAQ website for a 30-day public comment period. The plan is prepared by DAQ and submitted to EPA Region 4 by July 1 each year.

20.1.2 Five-Year Network Assessment

The five-year network assessment, as required by 40 CFR 58.10(d), is a more extensive evaluation of the air-monitoring network prepared by the chief with assistance from the PPB supervisor. The assessment determines at a minimum:

- If the PM network meets the monitoring objectives defined in 40 CFR Part 58 Appendix D,
- Whether DAQ must add additional PM sites,
- Whether any existing PM sites are no longer needed and can be terminated, and
- Whether new technologies are appropriate for incorporation into the PM ambient-air monitoring network.

During the five-year network assessment, the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, for example, children with asthma, as well as the potential impact any sites proposed for discontinuance may have on other data users is considered. As part of the 5-year network assessment, DAQ requests renewals and provides additional information related to applicable waivers for the DAQ PM monitoring network sites in the network plan submitted with the 5-year network assessment. The DAQ submits a copy of the five-year assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2010 for the PM network and are due to EPA every five years on July 1.

For more information about the PM monitoring locations, please see the annual network plan at this link: https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan.

20.2 External Performance Evaluations

DAQ addresses performance evaluation activities by participating in the EPA's PEP as described in 40 CFR Part 58, Appendix A, Section 2.4 and 3.2.4. In general, the PEP is a performance evaluation where quantitative data are collected independently to evaluate the accuracy of the monitoring equipment. In Region 4, a mobile laboratory arrives at a DAQ $PM_{2.5}$ monitoring site and sets up a collocated FRM monitor to collect a sample to compare to the concentrations measured by the onsite monitors. Only qualified and authorized personnel execute performance audits. The PEP program EPA contractor must

collect, and report eight valid performance evaluation audits each year for $PM_{2.5}$ and must evaluate each $PM_{2.5}$ method designation each year. EPA must evaluate all $PM_{2.5}$ monitors at least once every six years. Since DAQ has 16 $PM_{2.5}$ sites, and operates three method designations, the EPA may audit the $PM_{2.5}$ site more frequently than once every six years. Because the EPA reports the PEP results directly to AQS after the national laboratory completes the analysis, the ABAQA monitoring staff, regional monitoring technicians and coordinators and RCO chemists will initiate corrective actions, when needed, after the results become available in AQS.

20.3 Semi-annual Flow Rate Audits

As specified in 40 CFR Part 58, Appendix A, Section 3.2.2, an ABAQA monitoring staff member or regional monitoring technician, other than the person who routinely operates the $PM_{2.5}$ monitors, completes a flow rate audit on the monitors at least once every 182 days and preferably once every quarter or 91 days. The person doing the flow rate audit uses different equipment to conduct the audit than the equipment used to calibrate the monitors and do the monthly or semi- monthly flow verification checks. The person doing the flow rate audit follows the audit procedures in SOPs 2.46.2, 2.37.2 and 2.47.2. The person doing the flow rate audit documents the semi-annual flow rate audit in the e-log. Acceptance criteria applicable to semi-annual flow rate audits may be found in the data validation tables in Section 7. If a monitor does not pass the evaluation, the ABAQA and DAQ monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation.

20.4 Quarterly Completeness Assessment

After the database manager uploads to AQS all data for a quarter, the RCO audit chemist assesses the data to ensure all data made it through the upload process and into AQS. The RCO chemist accomplishes the quarterly completeness assessment by running the AMP430 Completeness Report, the AMP350 Raw Data Report and the AMP251 QA Data Report. The RCO chemist compares the data in AQS with the data that should be in AQS based on the monitoring schedule. When the RCO audit chemist identifies missing data or some other problem, he or she informs the Level 3 reviewer and database manager who act to resolve the issue. The RCO audit chemist archives the AMP251, AMP350 and AMP430 reports used for the quarterly completeness review in IBEAM. If the monitor does not meet completeness requirements, the chief contacts EPA Region 4 providing information on what occurred and what actions DAQ plans to take to keep the event from reoccurring.

20.5 Annual Data Certifications

In accordance with 40 CFR Section 58.15, the EPA requires an annual air monitoring data certification letter to certify that the regulatory data, collected by the FRM and FEM monitors at the PM sites from Jan. 1 to Dec. 31 of the previous year, meet criteria in 40 CFR Part 58, Appendix A. Along with the certification letter, the chief must submit to EPA an annual summary report of all the ambient air quality data collected by the monitors, as well as a summary of the precision and accuracy data, for the previous year.

Data certification is the final process of assessing the PM data for the previous calendar year. The DAQ verifies and validates continuous PM data monthly and intermittent PM data quarterly, as discussed in Section 23.0 Verification and Validation Methods. Additionally, the chief or a designee assesses data on a quarterly basis when the RCO audit chemist generates specific AQS reports to assess the DQOs as discussed in Section 20.7 Data Quality Assessments. With these assessments ongoing throughout the year, annual data certification, then, serves as the last assessment of the data – looking at it from an all-inclusive, annual perspective – to see if any unidentified anomalies or trends exist in the data that the data reviewers did not previously identify. The annual data certification process starts with running and reviewing AMP reports contained in AQS. The reports typically queried include the following:

- AMP350 Raw Data
- AMP251 QA Data
- AMP430 Data Completeness
- AMP600 Certification Evaluation
- AMP450NC Quicklook All Parameters
- AMP256 Data Quality Indicator
- AMP503 Extract Sample Blank Data
- AMP504 Extract QA Data
- AMP450 Quicklook Criteria Parameters

An RCO chemist and the PPB supervisor review these reports and confirm everything is complete and accurate. The RCO audit chemist and PPB supervisor also review the reports to ensure the statistical results indicate the monitoring data were in control over the course of the entire year and met the DQOs. If they identify problems, the RCO audit chemist investigates them in accordance with Section 24.0 Reconciliation with Data Quality Objectives. Ultimately, this process verifies that the PM monitoring data submitted to AQS is correct and complete. Once the RCO chemists, statistician and database manager complete any necessary corrections, additions or deletions in AQS and finalize the dataset, the chief officially recommends the data for certification to EPA Region 4. The data certification package provided to EPA includes a signed copy of the AMP600 report, along with a letter signed by the chief, certifying that the ambient concentration and QA data in AQS are complete and accurate, taking into consideration the QA findings, to the best of his or her knowledge.

The annual data certification package is due to EPA Region 4 by May 1 of each year.

20.6 Audit of Data Quality

An RCO audit chemist who does not validate the data conducts the ADQ, which reveals how the level 1 to 3 reviewers handled data, what judgments they made, and whether they made uncorrected mistakes and records exist to support the decisions made. An ADQ can often identify the means to correct systematic data reduction errors. Sufficient time and effort will be devoted to this activity so that the RCO audit chemist has a clear understanding and complete documentation of data flow. The RCO audit chemist shall perform this assessment quarterly in accordance with the quarterly data review described in SOP 2.39.4. The DAQ ensures the level 1 to 3 reviewers maintain data collection and handling integrity via the quarterly data review. If the RCO audit chemist finds a problem during the ADQ, the RCO audit chemist will work with the level 1 to 3 reviewers to correct the situation and modify the procedures to ensure the problem does not reoccur. See Section 23.0 Verification and Validation

Methods of this document for more information related to the data review process which occurs monthly and/or quarterly.

20.7 Data Quality Assessments

A DQA is the statistical analysis of environmental data to determine whether the data meet the assumptions under which the DQOs and data collection design were developed and whether the total error in the data are tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A. The regulations at 40 CFR Part 58, Appendix A provide terminology associated with measurement uncertainty.

An RCO audit chemist will evaluate the data quality on a quarterly basis using the AQS AMP256 and AMP600 reports. The RCO audit chemist reports the results to the PPB Supervisor via email. The PPB Supervisor, RCO audit chemist and RCO PM chemist work together to determine how to address any observed issues and present a proposal to the chief. The chief reports the individual results of these tests for each method or analyzer to the EPA annually as part of the AQS AMP600 report.

Level 1 data reviewers use the BAM flow rate control chart in the e-log semi-monthly to identify unusual variations in the flow rate. The Level 1 data reviewers must take corrective action when the control chart shows the flow rate reaching the action level.

20.8 External EPA Technical Systems Audits

An external EPA TSA is a thorough, independent and systematic on-site qualitative assessment, where an EPA auditor examines facilities, equipment, personnel, training procedures, protocols and record keeping for conformance with the regulatory requirements and this QAPP. The EPA Region 4 QA staff conducts a TSA of DAQ every 3 years, in accordance with 40 CFR Part 58, Appendix A, Section 2.5. The EPA reports its findings to the DAQ director and chief. The chief regularly monitors progress on corrective actions required by the TSA findings and communicates progress to the DAQ and ABAQA directors and EPA Region 4.

An EPA TSA team or an individual TSA auditor may segregate TSA activities into three or even more categories. The auditor may audit each category independently or may combine them. The possible TSA categories may include:

- Field activities – Monitor installation, calibration, and operation, sample handling and shipping.
- Laboratory activities - Pre-sampling filter weighing, filter shipping and receiving, post- sampling filter weighing, filter archiving and associated QA/QC activities.
- Data and document management activities – Collecting, flagging, editing, and uploading data, providing data security and storing documentation to support the decisions made.

During the audit, the auditors will interview key personnel with responsibilities for planning, field operations, laboratory operations, QA/QC, data and document management and reporting.

Upon completion of the audit, EPA verbally alerts the DAQ director and chief or the ABAQA director and air quality staff of any deficiencies or findings during an on-site TSA exit briefing. This briefing allows

DAQ or ABAQA staff to begin formulating or implementing corrective actions. The EPA typically distributes a draft TSA report within 30 days of the completion of the audit. EPA Region 4 allows a brief comment period of the draft report for factual accuracy. After EPA receives comments from DAQ or ABAQA, EPA finalizes the TSA report and resubmits the report to the DAQ director and chief or ABAQA director and air quality staff. The DAQ director and chief or ABAQA director and air quality staff must complete and submit to EPA Region 4 within 30 days a formal response to address the TSA findings. The chief or ABAQA air quality staff will communicate with EPA routinely after submitting the corrective action plan to provide progress updates on a periodic basis until DAQ or ABAQA has completed the corrective actions.

EPA shall conduct TSAs of DAQ once during every three-year period and ABAQA once during every six-year period that the PM monitoring program collects data verifying compliance with the NAAQS.

20.9 DAQ Internal Systems Audits

At the time of this QAPP revision, DAQ is in the process of implementing internal system audits. These audit procedures, complete with audit checklists, are detailed in SOP DAQ-15-004.5, currently under development. The RCO audit chemist or one or more RCO chemists not involved in the PM monitoring program will conduct the internal systems audits. These audits are separate from the annual audit of the RTI Lab.

20.10 RTI Lab Systems Audits

The RCO audit chemist, the PM RCO chemist or the Lab Technician will conduct a systems audit of the RTI Lab at least once per year, ideally before the data is certified each year. This audit will ensure that the RTI Laboratory staff are properly following all of the procedures in their QAPPs and SOPs allow DAQ to obtain or review any QA/QC documentation that RTI has not already provided as part of the data packages or upon request. The auditors or auditor will summarize the results of the audit in a report that will be distributed to DAQ management and to RTI. The auditors and RTI contract manager will follow up with RTI to ensure any deficiencies found during the audit are resolved as promptly as possible.

20.11 Reporting and Resolution of Issues

The communication process regarding necessary corrective actions within DAQ's PM monitoring program as a result of the previously mentioned assessments is detailed in SOP DAQ-15-002. The NC DAQ Ambient Monitoring Section - Hurricane Readiness Task List provides emergency/contingency plans that should be implemented when a hurricane or tropical storm is approaching North Carolina.

21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support PM network operations and the associated data acquisition, validation, assessment, and reporting. Besides the reports discussed in this section, staff meetings occur regularly on either a weekly, biweekly or a monthly schedule depending on the part of the organization involved. In addition, as needed, the DAQ supervisors hold meetings with the affected parties to address any additional issues that may arise. See Section 20.0 of this QAPP for additional information regarding the types of reports generated from AQS used to inform management of QA issues. Unless otherwise indicated, all reports will contain monitoring data for the list of pollutants provided in Table 2.

Various sections of 40 CFR Parts 50, 53 and 58 discuss the reports to management required for the PM program. The EPA's Air Quality Assessment Division within the Office of Air Quality Planning and Standards (OAQPS) provides guidance for management report format and content. The following subsections describe the reports to management used by DAQ.

21.1 Quarterly Data Report

The DAQ monitoring staff will edit, validate and upload air quality data submitted for each reporting period to AQS using the procedures described in the EPA's AQS User Guide, EPA's *AQS Data Coding Manual*[3], DAQ's PM data handling and validation SOP 2.63.4, and section 10.0 Quality assurance and data handling of the pertinent SOPs listed in table 16. The level 1 to 3 reviewers review, verify and validate the concentration data in the Envista ARM database. When data completeness, for a monitor, falls below 75 percent for the quarter, an RCO chemist prepares for the chief a memo explaining why and the corrective action taken. Otherwise, the PPB supervisor documents that the quarterly data submittal is complete and the data meets 75 percent completeness by sending an email to the chief. Table 18 provides the dates by which the DAQ uploads the previous quarter's data.

Table 18. Required AQS Data Reporting Periods

Reporting Period	Last Day to Upload Data to AQS
Jan. 1 to March 31	June 29
April 1 to June 30	Sept. 28
July 1 to Sept. 30	Dec. 29
Oct. 1 to Dec. 31	March 30 or 31 (of following year)

Each quarter, DAQ uploads to AQS the results of all valid precision, bias and accuracy tests it carried out during the previous quarter. The database manager submits data to AQS consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A. DAQ reports the required QA data on the same schedule as quarterly monitoring data submittals. The chief is responsible for ensuring that the level 1 to 3 reviewers use the results of QA data to validate concentration data.

In accordance with 40 CFR Section 58.16(b), DAQ submits data to the AQS database no later than 90 days following the end of the quarter in which DAQ collected the data. Table 18 provides the dates by

which the DAQ must upload the previous quarter's data. After the database manager uploads all quarterly data to AQS, an RCO audit chemist retrieves and reviews the following quarterly reports from AQS: the AMP251, AMP256, AMP350, AMP350MX, AMP430 and AMP600. After reviewing the reports, the RCO chemist archives the reports in the IBEAM general documents module and sends an email to the Level 3 reviewer summarizing the review and any corrective action needed.

21.2 Annual Network Review

By Oct. 31 of the year, the ABAQA monitoring staff and regional monitoring technicians conduct an annual site review documenting the information requested on the annual site review forms, which is part of the agency's overall annual network review. SOP 2.43.2 describes this process. The network review determines if the monitoring site and inlet locations meet the siting requirements and monitoring objectives defined in 40 CFR Part 58, Appendices A, D and E. The review identifies any needed modifications to the site and network including termination or relocation of unnecessary stations or monitors or establishment of new stations or monitors. The regional monitoring technicians submit the annual network review forms to the regional monitoring coordinators, who review the forms and submit them to the RCO by Dec. 31. The PPB supervisor, or a designee, archives the network review forms in the IBEAM general documents module and provides them to the public and the EPA as appendices to the annual network-monitoring plan.

21.3 Annual Data Certification

The chief, with assistance from the PPB supervisor, will prepare a data certification package for the chief's signature by May 1 of each year. The report will consist of a letter, for signature, along with AQS generated summaries of PM concentration data collected during the previous year and all applicable QA data. The OAQPS and EPA Region 4 specify the exact AQS reports for the chief to submit. Generally, the chief submits an AMP600 and AMP450NC report.

The EPA requires state and local programs to report periodic assessments of SLAMS data quality for the PM network to EPA (40 CFR Part 58, Appendix A, Section 1.4). The DAQ issues the annual data certification report to meet this requirement. This document describes the quality objectives for measurement data as well as how DAQ met those objectives.

21.4 Annual Network Monitoring Plan

Following the requirements in 40 CFR Section 58.10(a), DAQ prepares and submits to the regional administrator an annual monitoring network plan by July 1 of each year. This plan is reviewed and submitted by the chief. It is composed by the regional air quality supervisors and coordinators, ABAQA air quality staff, RCO PM chemist, the PPB supervisor, and the chief. The plan provides for the establishment and maintenance of an air-quality surveillance system consisting of a network of SLAMS and special purpose monitoring stations. The plan includes: (1) a statement of purpose for each monitor and (2) evidence that siting and operation of each monitor meets the requirements of appendices A, C, D and E of 40 CFR Part 58, where applicable. The DAQ makes the annual monitoring network plan available for public inspection for at least 30 days before submission to EPA.

As required by 40 CFR Part 58, Appendix A, Section 5.1, DAQ provides a list of all monitoring sites and their AQS site identification codes to EPA Region 4 each year in the network plan. DAQ keeps AQS up-to-date by creating site data records with the date DAQ established a site and other pertinent info. DAQ also sends any appropriate data to AIRNow-Tech. Whenever there is a change in this list of monitoring sites or in a reporting organization between network plans, the chief reports this change to EPA Region 4 via email and to AQS and AirNow-Tech by updating the appropriate site records.

21.5 Five-Year Network Assessment

The DAQ conducts and submits to the EPA regional administrator an assessment of the air-quality surveillance system every 5 years, which is due on July 1. At a minimum, this assessment determines if the network meets the monitoring objectives defined in 40 CFR Part 58, Appendix D, whether DAQ needs to add new sites, whether DAQ no longer needs existing sites and can terminate them, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. In the network assessment, DAQ considers the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma). For any sites that DAQ proposes for discontinuance, DAQ also considers the effect on users of the data, other than the agency itself, such as nearby states and tribes or health effects studies. For $PM_{2.5}$, the assessment also identifies needed changes to population-oriented sites. The chief submits a copy of this 5-year assessment, along with a revised annual network plan, to the regional administrator.

21.6 Internal System Audit Reports

SOP DAQ-15-004.5 is currently under development that describes DAQ's internal systems audit program. An RCO auditor or audit team will perform an internal systems audit to verify that the PM-monitoring program meets the data MQOs outlined in Section 7.2. When completed, the RCO auditor or audit team will distribute copies of the systems audit report to the ABAQA director and monitoring staff, DAQ regional office air quality supervisors, RCO PM chemist, ECB supervisor, PPB supervisor and chief.

21.7 RTI System Audit Reports

An RCO auditor or audit team will perform a technical systems audit on the RTI Laboratory at least once each year to verify that RTI is following the procedures in their QAPP and that the data they are collecting for DAQ meets the needs of the DAQ PM intermittent monitoring program (i.e., the data MQOs for the laboratory as outlined in Section 7.2). When completed, the RCO auditor or audit team will distribute copies of the systems audit report to RTI, the ABAQA director and monitoring staff, RCO PM chemist, LAB supervisor, PPB supervisor and chief.

21.8 Response/Corrective Action Report

Currently, ABAQA monitoring staff and regional monitoring technicians document any corrective action taken at the site in an e-log. The ABAQA monitoring staff and regional monitoring technicians do not send these e-logs to management but the regional monitoring coordinator and RCO PM and audit chemists review them. When the corrective action needed is beyond what the regional monitoring

technician can handle at the site, the regional monitoring technician contacts the regional monitoring coordinator and ECB electronics technicians. The ECB electronics technicians document all corrective actions taken on an Air Quality Section Maintenance Order or AQ-109 Form which the supervisors of the ECB and PPB review. When the level 1, 2 or 3 reviewers need to correct data reported to AQS, they document the changes on a data correction form. If the corrective action affects several days or a month or more of data, involves systemic issues, or endangers meeting completeness, an RCO chemist documents the corrective action in a memo to the chief and carbon copies the DAQ regional office air quality supervisor. SOP DAQ –15-002, describes when a need exists for a formal corrective action preventative action (CAPA) process that documents the root cause analysis, investigates solutions, and confirms that the solution was effective.

21.9 RTI Corrective Action Report

The RTI Lab corrective action process is discussed in detail in Appendix A. The failure of any internal QC check to meet the criteria previously established for that measurement triggers a corrective action on the part of RTI which will include the preparation and dissemination of a corrective action report to RTI management and DAQ outlining the nonconformance, the reason it occurred, the steps taken to correct the problem and prevent it from reoccurring and an assessment of the impact of the nonconformance on DAQ's data.

22.0 Data Validation and Usability

Data review is the in-house examination to ensure that all of the equipment and people involved have recorded, transmitted, and processed the data correctly. It includes completeness checks to determine if there are any deficiencies such as missing data or lost integrity. The data reviewers should compare the data under evaluation to actual events, as per guidance (*Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8)). In addition, DAQ expects that some of the QC checks will indicate that the data fail to meet the acceptance criteria. The data reviewers shall invalidate or flag data identified as suspect, or does not meet the acceptance criteria, with AQS codes prior to upload to AQS.

Data verification is the process for evaluating the completeness, correctness, and conformance or compliance of the data set against method, procedural and contractual specifications. The EPA and DAQ further define verification as confirmation, through provision of objective evidence, that the data collection process fulfilled all specified requirements. The verification process also involves the inspection and acceptance of the field samples.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. The EPA and DAQ further defined data validation as examination and provision of objective evidence that the data collection process fulfilled the particular requirements for a specific *intended use*. The primary intended use for the DAQ PM data set is NAAQS compliance.

Thus, DAQ must use a progressive, systematic approach to data validation to ensure and assess the data quality. Data validation includes the review of the DAQ PM data sets against the individual pollutant MQOs. Reviewing data long-term (over a monthly or quarterly period) provides information about the structure of the data and may identify patterns, relationships, or potential anomalies. If the RCO PM chemist finds a problem or discrepancy, he will conduct further investigations to find the source of the error and correct it. Deviations from operational procedures or QA requirements that do not result in data invalidation may require that data be qualified with QA qualifier flags before upload to AQS.

22.1 Sampling Design

Sampling network design and monitoring site selection must comply with the following:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix G – Uniform Air Quality Index (AQI) and Daily Reporting

The location of each DAQ PM monitoring site has received EPA approval; thus, data from each PM monitor will be considered spatially representative as long as the PM sites continue to meet the requirements set forth in 40 CFR Part 58, Appendix E and in this QAPP. *Guidance for Choosing a Sampling Design for Environmental Data Collection* (EPA QA/G-5S) provides additional guidance.

The ABAQA monitoring staff and regional monitoring technicians shall thoroughly document any deviations from the minimum siting criteria (e.g., shelter location, inlet placement and/or monitor sight path requirements) in the site's QC documentation. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower installed after establishment of the monitoring site). Data from monitors deviating from siting requirements should be flagged with an "SX" qualifier flag in AQS.

22.2 Data and Sample Collection Procedures

Section 11.0 Sampling Methods Requirements outlines data and sample collection procedures. The PM monitors used by DAQ are designated as FRM or FEM; thus, the methodologies and technologies are considered acceptable for regulatory use. For data collection, the Envidas Ultimate DAS routinely identifies potentially unacceptable data points in the database through electronic application of Envidas-Ultimate applied general status flags. The database manager has associated each instrument-specific flag with a unique error. The level 1 to 3 reviewers routinely review these Envidas Ultimate applied status flags as part of the data validation process. This activity assists in identifying suspect (potentially bad) data points that could invalidate the resulting averaging periods. A similar process, although manual, is performed with the filter-based samples, including the weigh lab. Table 19 presents a compilation of the AQS validation flags and null codes (see https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html). The ABAQA monitoring staff and regional monitoring technicians must document any deviation from the established data or sample collection plan in the appropriate logbook or data sheet. Accurate and complete documentation of any data or sample collection deviations will assist in any subsequent investigations or evaluations.

Table 19. Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	Informational Only	To provide information on events that influenced the measured values.
IB	Asian Dust	Informational Only	
IC	Chem. Spills and Industrial Accidents	Informational Only	
ID	Cleanup After a Major Disaster	Informational Only	
IE	Demolition	Informational Only	
IF	Fire - Canadian	Informational Only	
IG	Fire - Mexico/Central America	Informational Only	
IH	Fireworks	Informational Only	
II	High Pollen Count	Informational Only	
IJ	High Winds	Informational Only	
IK	Infrequent Large Gatherings	Informational Only	
IL	Other	Informational Only	
IM	Prescribed Fire	Informational Only	
IN	Seismic Activity	Informational Only	

Table 19. Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
IO	Stratospheric Ozone Intrusion	Informational Only	To provide information on events that influenced the measured values
IP	Structural Fire	Informational Only	
IQ	Terrorist Act	Informational Only	
IR	Unique Traffic Disruption	Informational Only	
IS	Volcanic Eruptions	Informational Only	
IT	Wildfire-U. S.	Informational Only	
J	Construction	Informational Only	
1C	A 1-Point QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data are valid	Missing QA/QC Audit	Codes to account for completeness of 1-Point QC checks where the results are not reportable
1F	No 1 Point QC but need to count for completeness	Missing QA/QC Audit	
AA	Sample Pressure out of Limits	Null Data Qualifier	Void the data and submit the code in its place.
AB	Technician Unavailable	Null Data Qualifier	
AC	Construction/Repairs in Area	Null Data Qualifier	
AD	Shelter Storm Damage	Null Data Qualifier	
AE	Shelter Temperature Outside Limits	Null Data Qualifier	
AF	Scheduled but not Collected	Null Data Qualifier	
AG	Sample Time out of Limits	Null Data Qualifier	
AH	Sample Flow Rate or CV out of Limits	Null Data Qualifier	
AI	Insufficient Data (cannot calculate)	Null Data Qualifier	
AJ	Filter Damage	Null Data Qualifier	
AK	Filter Leak	Null Data Qualifier	
AL	Voided by Operator	Null Data Qualifier	
AM	Miscellaneous Void	Null Data Qualifier	
AN	Machine Malfunction	Null Data Qualifier	
AO	Bad Weather	Null Data Qualifier	
AP	Vandalism	Null Data Qualifier	
AQ	Collection Error	Null Data Qualifier	
AR	Lab Error	Null Data Qualifier	
AS	Poor Quality Assurance Results	Null Data Qualifier	
AT	Calibration	Null Data Qualifier	
AU	Monitoring Waived	Null Data Qualifier	
AV	Power Failure	Null Data Qualifier	
AW	Wildlife Damage	Null Data Qualifier	
AX	Precision Check	Null Data Qualifier	
AY	QC Control Points (zero/span)	Null Data Qualifier	

Table 19. Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
AZ	QC Audit	Null Data Qualifier	Void the data and submit the code in its place.
BA	Maintenance/Routine Repairs	Null Data Qualifier	
BB	Unable to Reach Site	Null Data Qualifier	
BC	Multi-point Calibration	Null Data Qualifier	
BD	Auto Calibration	Null Data Qualifier	
BE	Building/Site Repair	Null Data Qualifier	
BF	Precision/Zero/Span	Null Data Qualifier	
BG	Missing ozone data not likely to exceed level of standard	Null Data Qualifier	
BH	Interference/co-elution/misidentification	Null Data Qualifier	
BI	Lost or damaged in transit	Null Data Qualifier	
BJ	Operator Error	Null Data Qualifier	
BK	Site computer/data logger down	Null Data Qualifier	
BL	QA Audit	Null Data Qualifier	
BM	Accuracy check	Null Data Qualifier	
BN	Sample Value Exceeds Media Limit	Null Data Qualifier	
BR	Sample Value Below Acceptable Range	Null Data Qualifier	
CS	Laboratory Calibration Standard	Null Data Qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)	Null Data Qualifier	
DL	Detection Limit Analyses	Null Data Qualifier	
EC	Exceeds Critical Criteria	Null Data Qualifier	
FI	Filter Inspection Flag	Null Data Qualifier	
MB	Method Blank (Analytical)	Null Data Qualifier	
MC	Module End Cap Missing	Null Data Qualifier	
QV	Quality Control Multi-point Verification	Null Data Qualifier	
SA	Storm Approaching	Null Data Qualifier	
SC	Sampler Contamination	Null Data Qualifier	
ST	Calibration Verification Standard	Null Data Qualifier	
SV	Sample Volume Out of Limits	Null Data Qualifier	
TC	Component Check and Retention Time Standard	Null Data Qualifier	
TS	Holding Time or Transport Temperature Is Out of Specs.	Null Data Qualifier	
XX	Experimental Data	Null Data Qualifier	
1	Deviation from a CFR/Critical Criteria Requirement	Quality Assurance Qualifier	Flag indicating the quality of the data

Table 19. Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
1V	Data reviewed and validated	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
2	Operational Deviation	Quality Assurance Qualifier	
3	Field Issue	Quality Assurance Qualifier	
4	Lab Issue	Quality Assurance Qualifier	
5	Outlier	Quality Assurance Qualifier	
6	QAPP Issue	Quality Assurance Qualifier	
7	Below Lowest Calibration Level	Quality Assurance Qualifier	
9	Negative value detected - zero reported	Quality Assurance Qualifier	
CB	Values have been Blank Corrected	Quality Assurance Qualifier	
CC	Clean Canister Residue	Quality Assurance Qualifier	
CF	Canister Bias: NATTS/UATMP Data for compounds that have failed certification for the canister	Quality Assurance Qualifier	
CL	Surrogate Recoveries Outside Control Limits	Quality Assurance Qualifier	
DI	Sample was diluted for analysis	Quality Assurance Qualifier	
DN	DNPH peak less than NATTS TAD requirement, reported value should be considered an estimate	Quality Assurance Qualifier	
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier	
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
FX	Filter Integrity Issue	Quality Assurance Qualifier	
HT	Sample pick-up hold time exceeded	Quality Assurance Qualifier	
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier	
LJ	Identification of Analyte is Acceptable; Reported Value Is an Estimate	Quality Assurance Qualifier	
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier	
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier	
MD	Value less than MDL	Quality Assurance Qualifier	
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	
MX	Matrix Effect	Quality Assurance Qualifier	
ND	No Value Detected, Zero Reported	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
QP	Pressure Sensor Questionable	Quality Assurance Qualifier	
QT	Temperature Sensor Questionable	Quality Assurance Qualifier	
QX	Does not meet QC criteria	Quality Assurance Qualifier	
SB	Sampler Bias: NATTS/UATMP Data for compounds that have failed certification for the sampler	Quality Assurance Qualifier	

Table 19. Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
SP	NATTS/UATMP data with Spike Recovery outside acceptance limits	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperature is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average out of Spec.	Quality Assurance Qualifier	
X	Filter Temperature Difference or Average out of Spec.	Quality Assurance Qualifier	
Y	Elapsed Sample Time out of Spec.	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Flags data influenced by an exceptional event for which the agency will request an exclusion.
RB	Asian Dust	Request Exclusion	
RC	Chemical Spills and Industry Accidents	Request Exclusion	
RD	Cleanup After a Major Disaster	Request Exclusion	
RE	Demolition	Request Exclusion	
RF	Fire - Canadian	Request Exclusion	
RG	Fire - Mexico/Central America	Request Exclusion	
RH	Fireworks	Request Exclusion	
RI	High Pollen Count	Request Exclusion	
RJ	High Winds	Request Exclusion	
RK	Infrequent Large Gatherings	Request Exclusion	
RL	Other	Request Exclusion	
RM	Prescribed Fire	Request Exclusion	
RN	Seismic Activity	Request Exclusion	
RO	Stratospheric Ozone Intrusion	Request Exclusion	
RP	Structural Fire	Request Exclusion	
RQ	Terrorist Act	Request Exclusion	
RR	Unique Traffic Disruption	Request Exclusion	
RS	Volcanic Eruptions	Request Exclusion	
RT	Wildfire-U. S.	Request Exclusion	

Data and sample collection procedures must adhere to those procedures documented in the SOPs listed in Table 16. Anytime the ABAQA monitoring staff, regional monitoring technicians or coordinators use a

code to void or flag data, they should document the reason for using the code in the appropriate logbook or datasheet. Accurate and complete documentation of any flagged or voided data will assist in any subsequent investigations or evaluations.

22.3 Sample Handling

The ABAQA and regional office monitoring staff record pertinent deviations from established sample-handling protocols for each sample physically retrieved from the monitoring site and equipment. They shall record these deviations on the filter COC for intermittent samples, e-logs for all PM data, and in the Envista electronic database for continuous PM monitors. The RTI lab technician, likewise, records deviations in samples and sample handling in the data package submitted to DAQ.

22.4 Analytical Procedures

Data reviewers shall ensure that the gravimetric analysis of filter-based samples has been performed in accordance with regulatory requirements found in 40 CFR Part 50, Appendix L, Section 8. To do this, data reviewers will review lab data manually and through electronic means to ensure all method specification were met as found in Table 7 of this QAPP. Lab data that does not meet these requirements will be voided or flagged as suspect.

22.5 Quality Control

Section 14.0 Quality Control Requirements and Procedures specifies the QC checks ABAQA and regional office monitoring staff must perform during monitoring, sample collection and analysis. These include the analysis of monthly or semi-monthly flow rate verifications, which provide indications of the quality of data produced by specified components of the measurement process. SOPS 2.46.2, 2.37.2, and 2.47.2 (See Table 16 for SOP titles) specify the procedure, acceptance criteria and corrective action (and changes) for each QC check. Data validation should document the corrective actions taken, affected PM sampling days or hours and the potential effect of the actions on the validity of the data. SOPS 2.46.2, 2.47.2, and 2.37.2 provide further information about monthly flow rate verifications. The RTI contract laboratory provides level 1 QC verification for all weigh data associated with the gravimetric PM2.5 program. DAQ personnel perform level 2 QC verification of the RTI data package and Level 3 QA validation for the DAQ gravimetric program once the laboratory and field data have been consolidated. Additional information on the procedures followed by RTI Lab personnel is detailed in Appendix A through D of this QAPP. DAQ personnel perform level 2 QC verification of the RTI data package (see RTI Data Package Checklist) and Level 3 QA validation for the DAQ gravimetric program once the laboratory and field data have been consolidated (see SOP 2.63.4).

22.6 Calibration

Section 14.0 Quality Control Requirements and Procedures addresses the calibration of the PM monitors along with the information the ABAQA monitoring staff and regional monitoring technicians should present to demonstrate they performed the calibrations correctly and the results are acceptable. When a level 1 to 3 reviewer identifies calibration problems, a level 1 to 3 data reviewer should flag or void any data produced between the suspect calibration event and any subsequent recalibration to alert data

users. SOPS 2.46.2, 2.47.2, and 2.37.2 (see Table 16 for SOP titles) provide further information about calibrations.

22.7 Data Reduction and Processing

As mentioned in the above sections, the EPA will perform external TSAs and the DAQ will perform internal TSAs to ensure the level 1 to 3 data reviewers follow the data reduction and processing activities mentioned in the QAPP. The level 1 to 3 data reviewers will review continuous PM data monthly to ensure that associated flags or any other data qualifiers have been appropriately associated with the data. The level 1 and 2 data reviewers will review intermittent PM data when each batch of data is received from RTI and the level 3 reviewer will review it quarterly to ensure that associated flags or any other data qualifiers have been appropriately associated with the data. An RCO audit chemist will review the data quarterly to ensure that regional monitoring and ECB electronics technicians, coordinators and the RCO PM chemist took appropriate corrective actions.

22.8 Exceptional Events

The regulations at 40 CFR Section 50.14 allow the EPA Administrator to exclude certain data from use for determinations of exceedances and violations of a NAAQS, so long as a state or local agency demonstrates to the Administrator's satisfaction that an “exceptional event” caused the exceedance or violation. The regulations at 40 CFR Section 50.1 define an "Exceptional Event" as an event or events, in which:

- The resulting emissions affect air quality in such a way that there exists a clear causal relationship between the specific event(s) and the monitored exceedance(s) or violation(s);
- The event(s) is not reasonably controllable or preventable; and
- The event(s) is caused by a human activity that is unlikely to recur at that location or is a natural event(s).

An exceptional event does not include:

- Air pollution relating to source noncompliance;
- Stagnation of air masses or meteorological inversions; and
- Meteorological events involving high temperatures or lack of precipitation.

Conditions involving high temperatures or a lack of precipitation may promote occurrences of some types of exceptional events, such as wildfires or high wind events, which do directly cause emissions.

The EPA does not consider data impacted by an exceptional event "representative" of air quality for NAAQS comparison purposes, or calculation of certain summary statistics. The RCO PM chemist should flag all concentration data affected by an exceptional event with an AQS information code and linked within AQS to an event description. Exceptional event codes and descriptions should be added to AQS during the monthly data review or as soon as possible, thereafter, but no later than the schedule established by Federal rulemaking.

It is the responsibility of the RCO PM Chemist to analyze the data for potential exceptional events, with

the assistance of the regional office staff and air quality forecasters, and to add the necessary flags and descriptions into AQS, with the assistance of the database manager, by the applicable regulatory due dates.

To obtain concurrence with an exceptional event the RCO must notify and cooperate with the EPA Regional Office to prepare a demonstration package for the Administrator. When the chief submits a demonstration package, the RCO PM Chemist and database manager will change the informational flags in AQS to request exclusion flags.

Exceptional event data in AQS must receive concurrence from the EPA administrator. Data that does not receive a concurrence is still eligible for NAAQS comparisons, regardless of the application of request exclusion flags.

23.0 Verification and Validation Methods

Data verification is the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural, or contractual requirements, as specified in both the SOPs and 40 CFR Part 58. Data validation is a routine process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to ensure that reported values meet the quality goals of the environmental data operations and that the data can be used for its intended purpose.

The DAQ uses the validation templates provided in Table 7 through Table 11 for the weight of evidence approach afforded to PQAOs within 40 CFR Part 58, Appendix A. The DAQ follows the guidance in the QA Handbook regarding the use of these templates and handles the criteria as follows:

- Critical criteria are criteria deemed critical to maintaining the integrity of an ambient air concentration value or group of values. The level 1 to 3 reviewers should invalidate observations that do not meet each criterion on the critical table unless there are compelling reasons and justification for not doing so. Basically, the concentration value or group of concentration values that do not meet one or more of these criteria is invalid until proven otherwise. In most cases, the CFR dictates the requirement, the implementation frequency of the criteria and the acceptance criteria so these criteria are therefore regulatory in nature.
- Operational criteria are situations in which violations of a criterion or criteria may be cause for invalidation of the data. The level 1 to 3 reviewers should consider other QC information that may or may not indicate the data are acceptable for the parameter they want to control. Therefore, the data, which do not meet one or more of these criteria, are suspect, unless other QC information demonstrates otherwise, and the reviewers have adequate documentation of that information. The level 1 to 3 reviewers should investigate, mitigate or justify the reason for not meeting the criteria.
- Systematic criteria include those criteria which are important for the correct interpretation of the data, but do not usually change the validity of a datum or data. An example criterion is that at least 75 percent of the scheduled samples for each quarter should be successfully collected and validated. The DQOs are also included in this table. If the data do not meet the DQOs, this does not invalidate any of the data, but it may reduce the confidence in the attainment or non-attainment decision.
- The designation of QC checks as operational or systematic does not imply that the ABAQA monitoring staff, regional monitoring and ECB electronics technicians do not need to perform these QC checks. Not performing an operational or systematic QC check required by regulation can be a basis for invalidation of all associated data. The DAQ applies the validation templates only to small datasets of single values or a few weeks of information and does not allow a criterion to be in non-conformance simply because it is operational or systematic.

The following levels of data review describe the overall DAQ data verification and validation process, including the individuals responsible for the stated activities.

23.1 Validating and Verifying Data

23.1.1 Continuous PM Data

The verification procedures that the ABAQA and DAQ level 1 and 2 reviewers will employ for continuous PM data shall conform to the BAM 1020 SOP 2.37.2 R2020, BAM 1022 SOP 2.46.2 R2020, and T640x SOP 2.47.2 R2020 listed in Table 16. The validation procedures that the DAQ level 3 reviewer will use for continuous PM data shall conform to the PM validation SOP 2.63.4. *Guidance on Environmental Data Verification and Data Validation,* (EPA QA/G-8) also discusses verification and validation issues at length. The ABAQA monitoring staff and regional monitoring technicians and coordinators shall perform all verification activities. The RCO chemists shall provide additional support through a final review of all data reconciling any anomalies through discussions with the regional offices. Following the final review, the RCO chemists will provide a final validation of all data. The RCO chemists will also provide other QA/QC support.

The level 1 to 3 data reviewers should compare data under evaluation to actual events as specified in the applicable SOPs. However, significant or unusual field events may occur, and field activities may negatively affect the integrity of the data. In addition, the DAQ expects some of the QC checks will indicate the data fail to meet the acceptance criteria listed in Table 8 through Table 11. The level 1 to 3 data reviewers shall void, or flag data identified as suspect, or which does not meet the acceptance criteria, using the codes in Table 19.

The DAQ verifies and validates routine continuous PM data and associated QC data monthly. Presently, these review periods are the most efficient period for PM verification and validation activities. The DAQ finds that if DAQ can control the measurement uncertainty for these periods noted above, then DAQ will maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQOs.

23.1.2 Intermittent PM Data

The validation and verification procedures that DAQ employs for the intermittently collected data conform to SOP 2.46.2 Thermo Scientific 2025i and PM validation SOP 2.63.4 listed in Table 16 of this QAPP and DAQ-16-018.4 RTI Data Package Checklist and DAQ-16-020.5 FRM data validation. Guidance on Environmental Verification and Validation, (EPA QA/G-8) also discusses verification and validation issues at length. The RTI lab staff and DAQ LAB chemistry technician shall perform all verification activities. The RCO PM chemist shall provide additional support through a final review of all data reconciling any anomalies through discussions with the ABAQA monitoring staff and regional monitoring technicians, coordinators and DAQ LAB chemistry technician. Following the final review, the RCO PM chemist will provide a final validation of all data. The RCO PM chemist will also provide QA/QC support.

The level 1 to 3 data reviewers should compare data under evaluation to actual events as specified in the applicable SOPs. However, significant or unusual field events may occur, and field activities may

negatively affect the integrity of the data. In addition, the DAQ expects some of the QC checks will indicate the data fail to meet the acceptance criteria listed in Table 7. The level 1 to 3 data reviewers shall void, or flag data identified as suspect, or which does not meet the acceptance criteria, using the null codes and data validation flags in Table 19.

The DAQ verifies the intermittently collected data and its associated QC data as each batch of data is received from the RTI lab and validates the data quarterly. Presently, for the data collected by the FRM, batchwise is the most efficient period for these verification activities and quarterly is the most efficient period for validation activities. The DAQ finds that if DAQ can control the measurement uncertainty for each batch and each quarter, then the DAQ will also maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQOs.

23.2 Verification

23.2.1Continuous PM Data Verification

After the previous month of data are available, the level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Once the database manager enters the data into the Envista ARM database, the ABAQA monitoring staff and regional monitoring technicians will review the data for routine data outliers and conformance to acceptance criteria. The ABAQA monitoring staff and regional monitoring technicians will void or flag appropriately unacceptable or questionable data. The coordinators will verify all flagged data again to ensure the regional monitoring technicians entered the flags and voids correctly and that the data are acceptable for use. The level 1 and 2 reviewers document their review in Envista ARM along with their data review decisions.

23.2.2 Intermittent PM Data Verification

Verification of intermittent PM data can be characterized into two parts, field data verification and lab data verification. The **field data verification** occurs, after each sample is collected and each batch of laboratory data becomes available. The level 1 and level 2 reviewers conduct a thorough review of the data for completeness and accuracy. The ABAQA monitoring staff and regional monitoring technicians will review the data for routine data outliers and conformance to acceptance criteria. They will void or flag appropriately unacceptable or questionable data. The coordinators will verify all flagged data again to ensure the regional monitoring technicians entered the flags and voids correctly and that the data are acceptable for use. The level 1 and 2 reviewers document their review in e-logs along with their data review decisions (SOP 2.46.2 R2020).

The lab data verification occurs, after the each batch of laboratory data becomes available. The level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Prior to submitting lab data to DAQ, the RTI lab will review the data for routine data outliers and conformance to acceptance criteria. The RTI labs submits the data package to DAQ, where the DAQ LAB chemistry technician verifies the lab data to ensure the flags and voids are correct and that the data are acceptable for use (See Checklist DAQ-16-018.4 R0). Afterwards, the DAQ LAB chemistry technician or RCO PM chemists copies and pastes the data into four separate spreadsheets, or uses a macro when one is available, to transform the excel data file from RTI so that the filter weight data will automatically be

uploaded into IBEAM. The PM data streams from the field and lab are merged, concentrations calculated and data are stored in IBEAM. The level 1 reviewer documents his or her review in the data package and the level 2 reviewer documents his or her review in the RTI Data Package Checklist DAQ-16-018.4.

23.3 Validation

Validation of continuously obtained measurement data are performed by DAQ using a three tiered approach. The Envista ARM database retains records of all invalid data. Information shall include a summary of why the level 1 to 3 reviewers invalidated the measurement along with the associated void codes or validation flags. Logbook notes and field data sheets shall have more detailed information regarding the reason a reviewer voided or flagged a measurement.

The DAQ brackets all PM data by flow verifications or a calibration before and after any invalidated period. This requirement ensures that the PM monitors were in proper operating condition before and after the incident. In cases where weight of evidence exists that the data are valid, the DAQ may choose to invalidate data back to the last passing flow verification or calibration, unless there is sufficient evidence to indicate otherwise.

Data validation occurs monthly for continuously collected data and quarterly for intermittently collected data. The subsections below outline the continuous and intermittent collected data review, verification and validation processes. The organizational chart in Figure 1 labels the specific roles for review level 1 through 3 within the organization.

23.2.1 Continuous Data Review, Verification and Validation Process

Level 0 Review - The Envidas Ultimate DAS does the level 0 review:

- Acquire hourly data; and
- Flag missing and irregular data with pre-programmed, user-defined status flags.

Level 1 Review - The ABAQA monitoring staff or regional monitoring technician does the level 1 review for DAQ:

- Review daily for anomalies and completeness and acquire missing data if available;
- Flag data collected during an hour where the shelter temperature was not within the acceptable range;
- Verify maximum daily values for validity and take appropriate action if necessary;
- Assess data for values or outliers outside of the acceptable ranges;
- Review the hourly values for any exceedances and take appropriate action if necessary;
- Flag data as necessary for further investigation; and
- Apply necessary AQS null codes from Table 19 for hours in which maintenance or calibrations were occurring.

Level 2 Review (Verification) - The ABAQA monitoring staff or regional monitoring coordinator does the level 2 review for DAQ:

- Review site records (operator logbook, site data sheets);
- Review operator checks (leak checks, filter changes, monthly flow verifications, VSCC cleaning, maintenance);
- Assess data for values or outliers outside of the acceptable ranges;
- Compare pollutant data with wind direction data;
- Determine if mobile or area source specific emissions caused any irregularities;
- Flag data as necessary for further investigation;
- Ensure level 1 reviewers used consistent reasons for data invalidation throughout the monitoring period to indicate calibrations, audits, etc.; and
- Resolve any inconsistencies, anomalies or systemic issues.

Level 3 Review (Validation) - The RCO chemist does the level 3 review for DAQ and ABAQA:

- Ensure the ABAQA monitoring staff and regional monitoring technicians and coordinators used the proper null codes;
- Ensure the ABAQA monitoring staff, regional monitoring technicians and coordinators bracketed all invalidated data with the appropriate void codes and the correct checks of analyzer accuracy;
- Ensure all data falls within the acceptable ranges as stated in the MQOs in Table 8 through Table 11;
- Ensure all data are acceptable and can be used for its intended purpose;
- Review downloaded monitor data as needed when completing the level 3 review procedures;
- Add informational AQS flags (from Table 19) to describe data that is out of the ordinary but may be considered “valid;” and
- Provide final validation signature.

23.3.2 Intermittent Data Review, Verification and Validation Process

Field Data

Level 0 Review - The 2025i FRM sampler does the level 0 review:

- Acquire 5-minute-data (interval data), 30-minute data (user data) and collection period or 24-hour data (filter data); and
- Data from the FRM sampler will provide status codes when pre-programed specifications have been exceeded.

Level 1 Review - The ABAQA monitoring staff or regional monitoring technician does the level 1 review for DAQ:

- Examine (filter data) start date, start time, end time, average flow, CV, volume, max temperature differential, filter damage, and status codes for each sample during each site visit;

- Ensure that the filter IDs match the appropriate sample run date; and
- Update the e-log with any pertinent information regarding each sample.
- Check the Level 0 review and investigate any flags or non-conformities.
- Download the interval, user and filter data and ensure the files downloaded properly.

Level 2 Review (Verification) - The ABAQA monitoring staff or regional monitoring coordinator does the level 2 review:

- Verify that the filter, interval and user files have been downloaded and properly archived;
- Verify that each filter record downloaded in the filter file meets the criteria listed in Table 7 of this QAPP;
- Verify the Site ID in the filter file matches that of the site;
- Verify filter ID in the filter file matches that of the e-log;
- Verify all sample or sampler issues in the filter file are clearly documented in the e-log;
- Verify all sample dates are accounted for per the EPA sampling calendar;
- Review the interval file as necessary to validate any questionable data in the filter file;
- Review all e-logs for completeness, verifications, audits, calibrations, and sampler problems; and
- Upload reviewed filter files to the IBEAM database.

Level 3 Review (Validation) - The RCO chemist does the level 3 review.

- Complete the DAQ-16-020.5 FRM data validation as described in Section 2.63.4.4 of SOP 2.63.4 Validation of Particulate Matter, which covers the following:
- Performing a completeness review.
- Reviewing the data for routine data outliers and conformance to acceptance criteria.
- Voiding unacceptable data and flagging questionable data.
- Ensuring all sample dates are accounted for per the EPA sampling calendar and a record for every run date, including field filter and trip filter blanks.
- Reconciling the filter data in the e-logs to the filter data in IBEAM.
- Reviewing lab data and field data in IBEAM.
- Reviewing all e-logs for completeness, verifications, audits, calibrations, and sampler problems.
- Ensuring all data falls within the acceptable ranges as stated in the MQOs in Table 7 of this QAPP.
- Ensuring all data are acceptable and can be used for its intended purpose.
- Reviewing downloaded monitor data as needed when completing the level 3 review procedures.
- Preparing data for AQS including qualifier codes, QA files, etc.
- Recording comment/notes on the FRM Site Validation Checklist(DAQ-16-020.5).
- Providing final validation signature.

Lab Data

Level 1 Review - The RTI lab does the level 1 review.

- RTI lab is responsible for supplying gravimetric PM data that has been approved by a Level 1 reviewer. **Note:** RTI has an internal verification and validation process they must undergo prior

to submitting each data package. The measures used by the Level 1 reviewer are equal to the measures listed in Table 7: Laboratory Activities of this QAPP. The data that have not passed the validation criteria in Table 7 must have an associated qualifier or null flag with an explanatory note included in the data package.

Level 2 Review (Verification) - The DAQ lab technician does the level 2 review.

- Complete the RTI Data Package Checklist (DAQ-16-018.4 Revision 0), which covers the following:
  - Checking the data package for completeness.
  - Verifying COC forms.
  - Verifying the PM receiving log.
  - Verifying laboratory activities requirements are met listed on Table 7 of this QAPP.
  - Reviewing the filter inventory inspection form.
  - Reviewing the shipping log.
  - Recording comment/notes on the RTI Data Package Checklist.
  - Providing final validation signature.

Level 3 Review (Validation) - The RCO chemist does the level 3 review.

- Complete the FRM validation checklist (DAQ-16-020.5) as described in Section 2.63.4.4 of SOP 2.63.4 Validation of Particulate Matter, which covers the following:
  - Performing a completeness review.
  - Reviewing the data for routine data outliers and conformance to acceptance criteria.
  - Voiding unacceptable data and flagging questionable data.
  - Ensuring all sample dates are accounted for per the EPA sampling calendar and a record for every run date, including field filter and trip filter blanks.
  - Reconciling the filter data in the e-logs to the filter data in IBEAM.
  - Reviewing lab data and field data in IBEAM.
  - Reviewing all e-logs for completeness, verifications, audits, calibrations, and sampler problems.
  - Ensuring all data falls within the acceptable ranges as stated in the MQOs in Tables 7 of this QAPP.
  - Ensuring all data are acceptable and can be used for its intended purpose.
  - Reviewing downloaded monitor data as needed when completing the level 3 review procedures.
  - Preparing data for AQS including qualifier codes, QA files, etc.
  - Recording comment/notes on the FRM Validation Checklist.
  - Providing final validation signature.

The DAQ uses a weight of evidence approach in validating data. After level 1 and 2 verifications, the independent level 3 reviewer determines the validity of the data by reviewing:

- The hourly and 24-hour values;
- Verifications and calibrations;

- e-logs and the information documented therein;
- Nearby concentrations;
- Collocated results of sample pairs;
- Correspondence with the ABAQA monitoring staff, regional monitoring technicians and coordinators and ECB electronics technicians; and
- The results of DAQ flow rate audits and EPA performance evaluations (PEP).

The level 3 reviewer must, at a minimum, review all data that has been flagged or voided during the Level 0-2 reviews and at least 10% of the other data that has not been flagged. Typically though, given the relatively small size of the FRM data set, the Level 3 reviewer will include all FRM data in the Level 3 review. The Level 3 reviewer compares all the available information to the specifications in Tables 7 through 11. The amount of weight the reviewer should give to the available evidence depends on factors such as the quality of the data, consistency of results, nature and severity of effects and relevance of the information. During the validation process, the Level 3 reviewer will generally follow the guidance provided in EPA-454/B-21-007. The weight of evidence approach requires use of scientific judgment and, therefore, it is essential for the ABAQA monitoring staff, regional monitoring technicians and coordinators to provide adequate and reliable documentation in a structured and organized manner.

As a general principle, the more information the ABAQA monitoring staff and regional monitoring technicians provide, the stronger the weight of evidence. The ABAQA monitoring staff, regional monitoring technicians and coordinators should present the information in a structured and organized way and the data validator should consider the robustness and reliability of the different data sources to support any justification for validating or invalidating data.

The PM samplers and monitors provide a level 0 review. The Envidas Ultimate software provides an additional level 0 review daily for the continuous PM monitors which are connected to it. The ABAQA monitoring staff, regional monitoring technicians and coordinators will complete the level 1 and 2 reviews within 20 calendar days from the end of the monitoring month for continuous data (example: the month ends on February 28th; the level 1 and 2 reviews must be complete by March 20). The RCO chemist will complete the level 3 review 20 calendar days after the level 2 review is completed. (Using the prior example, the level 3 review must be complete by April 9.)

An independent RCO chemist will complete a review of the validated data after the database manager uploads it to AQS and within 40 calendar days after completion of the level 3 review. A similar process for PM intermittent sampling is in place, but does not have the same time limitations as with continuous monitors.

As discussed earlier, the EPA and DAQ have developed certain criteria based upon federal requirements and ABAQA monitoring staff and regional monitoring technician judgment that the level 1 to 3 reviewers will use to invalidate a datum or measurement. The level 1 to 3 reviewers shall use the null data codes listed in Table 19 to indicate they have invalidated individual measurements, or groups of measurements from an instrument.

24.0 Reconciliation with Data Quality Objectives

Section 6.0 of this QAPP describes the objectives of the PM monitoring program. Section 7.0 Quality Objectives and Criteria for Measurement Data describes the DQO's for the PM monitoring program. The AQS AMP256 and AMP600 reports are automated reports based on data uploaded to AQS. These reports provide summary statistics for the PM monitoring program data collected. Because the DAQ uses warning limits that are more stringent than EPA's control limits for its data and implements EPA's critical criteria for all monitoring, DAQ should not have to directly calculate confidence intervals annually because all data should statistically meet the DQOs.

As described in Sections 20.5 and 20.7 of this QAPP, an RCO chemist will analyze the results of both the AQS AMP256 and AMP600 reports on a quarterly and annual basis to ensure that all monitoring stations meet the required DQO's. If the data from at least one of the monitors violates the DQO bias and/or precision limits, then the RCO audit and PM chemists will investigate to uncover the cause of the violation. If all the monitors in the network of a similar type or pollutant violate the DQO, the cause may be at the agency level (operator training) or higher (problems with method designation). If only one monitor or site violates the DQO, the cause is more likely specific to the site (site operator, problem with the site). Tools for determining the cause include reviewing:

- Data from a collocated network (local or tribal program, nearby reporting organizations);
- Data from performance audits (PEP); and
- QC trends.

Once RCO chemists have identified a cause, DAQ will implement an appropriate corrective action. Some courses of action include:

- Determining the level of aggregation at which DAQ violated the DQOs: The results of the DQAs tell which monitors are having problems, since the EPA developed the DQOs at the monitor level. To determine the level at which to take corrective action, DAQ must determine whether the violations of the DQOs are unique to one site, multiple sites, or a network of similar monitors, or caused by a broader problem. The AQS generates QA reports summarizing bias and precision statistics at the national and reporting organization levels by method designation. Examination of these reports may assist in determining the level at which the DQOs are being violated.
- Communicating with EPA Region 4: If the DAQ finds a violation of the bias and precision DQOs, the chief will remain in close contact with EPA for both assistance and for communication.
- Extensively reviewing quarterly data until the DAQ achieves the DQOs: The chief will continue to review extensively the quarterly QA reports and the QC summaries until the DAQ attains the bias and precision limits.
- Updating MQOs and quality assurance documents: If the cause indicates that the MQOs, SOPs associated with this QAPP, or this QAPP need to be updated, the RCO chemists will

inform the chief and PPB supervisor of the needed changes and either the chief or PPB supervisor will assign staff to make the necessary updates.

Ultimately specifying tolerable error limits reduces the probability of making an error in a decision due to uncertainty in the data. Decision makers, such as EPA and the director, need to determine if the data collected within the DAQ monitoring network are adequate for meeting the monitor objectives listed earlier in Section 6.0. The annual data certification process, and reports generated as part of the certification, provide a quantitative assessment of the measurement uncertainty within the DAQ PM data set. By controlling uncertainty in the data to the extent prescribed by the DQOs, decision makers can use DAQ's ambient air monitoring data with confidence.

Revision History

Page	Description
Revision 1 – From November 1998 to February 2018	
5	Changed George C. Murray, Thomas Manuszak and Louis Pat Bello to Patrick Butler, Joette Steger and Paul Chappin.
17-18	Updated Section 1.0 Project Description to Section 5.0 Problem Definition and Background.
11-16	Updated Section 2.0 Project Organization and Responsibilities to Section 4.0 Project/Task Organization.
23-66	Updated Section 3.0 Quality Assurance Objectives for Measurement Data to Section 7.0 Quality Objectives and Criteria for Measurement Data.
76-80	Updated Section 4.0 Sampling Methods Requirements to Section 11.0 Sampling Methods Requirements.
81-84	Updated Section 5.0 Sampling Custody to Section 12.0 Sample Handling and Custody.
87-91	Updated Section 6.0 Instrument Calibration and Frequency to Section 14.0 Quality Control Requirement and Procedures.
85-86	Updated Section 7.0 Analytical Procedures to Section 13.0 Analytical Methods.
112-118	Updated Section 8.0 Calculations, Validation, and Reporting of PM2.5 Monitoring Data to Section 22.0 Data Validation and Usability.
87-91	Updated Section 9.0 Analytical Procedures to Section 14.0 Quality Control Requirements and Procedures.
103-108	Updated Section 10.0 Performance Evaluation Procedures to Section 20.0 Assessment and Response Actions.
92-93	Updated Section 11.0 Maintenance Procedures to Section 15.0 Equipment Testing, Inspection and Maintenance Requirements.
119-120	Updated Section 12.0 Assessment of Measurement Uncertainty for Monitoring Data to Section 23.0 Verification and Validation Methods.
85-86	Updated Section 13.0 Corrective Actions to Section 13.0 Analytical Methods.
109-111	Updated Section 14.0 Quality Assurance Reports to Section 21.0 Reports Management.

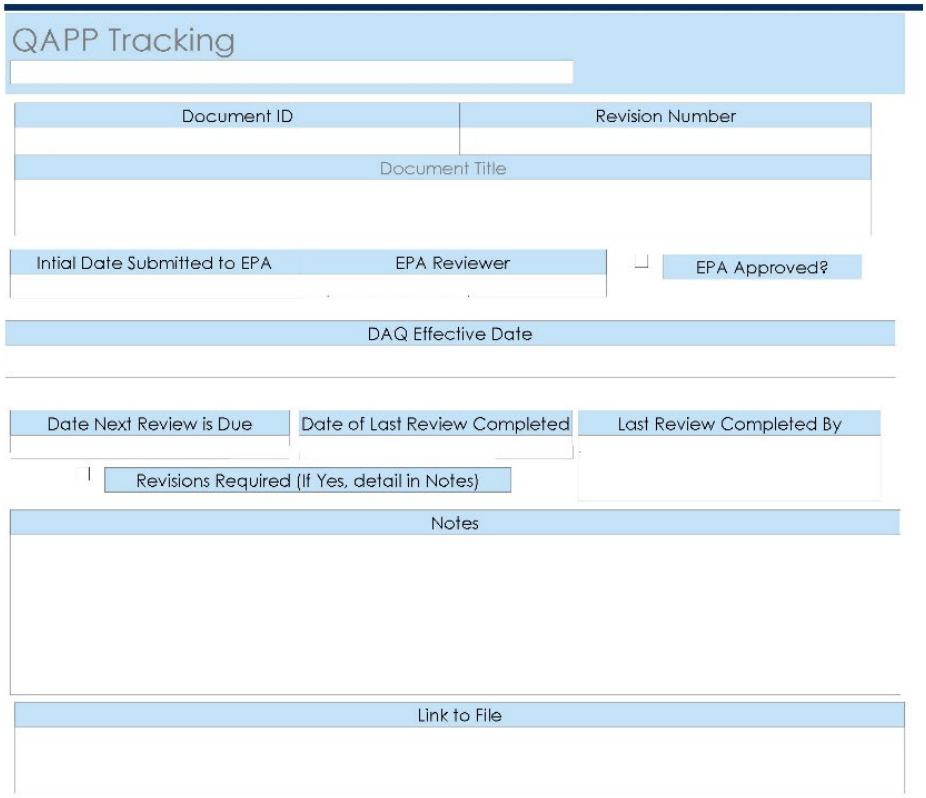
The following revisions were made between Revision 2 and 3:

Date	Person Revising Document	Revision	Page No.	Approved by/Date
11/30/2021	Travis Funderburk	Updated addressee and acronym list	1, 3-4	Joette Steger/ 3/28/2022
		Table 3.1, the distribution list was updated	13-14	
		Western North Carolina Regional Air Quality Agency (WNC) was changed to Asheville-Buncombe Air Quality Agency (ABAQA); hyperlinks were updated; minor grammatical and editorial changes were made throughout the document.	28-30, 32, 61-63, 65-71, 74-81, 93-95, 98, 106, 108-109	
		Maps showing the jurisdictions of the regional offices and local and tribal programs were added	15-17	
		The organizational structure was updated to show the closing of the on-site laboratory and its replacement with RTI	18	
		Responsibilities for the DAQ LAB personnel were changed based on new needs due to replacing the on-site lab with the RTI lab	22-23	
		Section 6.3 Laboratory Activities was updated for transition to the RTI Lab	33	
		Table *5.* North Carolina PM Site Locations was updated to add the Rockwell site and remove monitors that are no longer collocated	35	
		Figure 7 through Figure 18 and Figure 20 through Figure 22 were updated and Figure 19 was added	37-44	
		Table *7* was revised to remove DAQ goals and replace references to DAQ documents to references to RTI documents	52-60	
		Table 8, Table 9, and Table 10 were revised to correct the criteria for the leak check to match what is in the BAM operation manual	62, 69, 75	
		Table 8, Table 9 and Table 11 were revised to update the shelter temperature requirements	64, 71, 83	
		Table 11 was revised to match the EPA validation table for the T640X	80-87	

		Section 8 was revised to be accordant with current DAQ policies and procedures	88-90	
		Section 9 was revised to be accordant with current DAQ policies and procedures and add information about RTI documents and records	91-98	
		Table 16 was revised to list the most current SOPs	107-108	
		Section 11.3.2 was revised to change the shelter temperature criteria for the BAM1020	109	
		Sections 12 and 13 were updated for the transition to the RTI Laboratory	110-115	
		Section 14 was updated to include RTI QC	116-124	
		Section 14.2 was edited to remove the discussion about a collocated monitor	117	
		Section 15.2.1 was updated to include RTI procedures	126	
		Section 15.3 was updated to include RTI procedures	127	
		Sections 16.3 through 16.5 were updated to include RTI procedures	131	
		Section 19 was revised to be accordant with current DAQ policies and procedures	135-141	
		Section 19.2 was updated to include changes for using RTI as the gravimetric lab	135	
		Section 20 was revised to be accordant with current DAQ policies and procedures and to add RTI TSAs	142-148	
		Section 21 was revised to be accordant with current DAQ policies and procedures and to add RTI TSA and corrective action reports	149-154	
		Table 19 was updated to contain the new qualifier and null data codes	154-160	
		Section 22.3, 22.5 and 22.7 were updated to include changes for the RTI gravimetric lab	159-160	
		Section 23 was revised to be accordant with current DAQ policies and procedures	162-171	
		Section 23.2.2 and 23.3.2 were updated to include changes for the RTI gravimetric lab	164 and 166	

QAPP Annual Review Documentation

QAPP and SOP Tracking Database



Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 14)

Grav QAPP 2021 Version 14 June 2021.pdf

Appendix B RTI SOP for PM Sample Receipt & Log-in Revision 9 Date: March 29, 2022

RTI SOP for PM Sample Receipt and Log-in 2022 Version.pdf

Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022

RTI SOP for PM Gravimetric Analysis 2022 Version.pdf

Appendix D RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022

RTI SOP for PM Chain of Custody 2022 Version.pdf

Appendix E DAQ Instructions and Checklists for review of RTI PM Data Packages

https://deq.nc.gov/media/20850/open

Appendix F Sample RTI Data Package

RTI Example Data Package