Quality Assurance Project Plan

PM2.5 and BTEX Air Quality Monitoring for the CNX Resources Radical Transparency Program

Prepared By:
Clean Air Engineering, Inc.
500 West Wood Street
Palatine, Illinois 60067

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ACRONYM GLOSSARY

ADQ - Audit of Data Quality
AMS - Advanced Monitoring Solutions
AQS - Air Quality System (EPA's Air database)
ARM - Approved Regional Method
CFR - Code of Federal Regulations
CleanAir - Clean Air Engineering, Inc.
COC - Chain of Custody
CV - Coefficient of Variation
DEC - New York State Department of Environmental Conservation
DQA - Data Quality Assessment
DQI - Data Quality Indicators
DQO - Data Quality Objectives
EDO - Environmental Data Operations
EPA - The United States Environmental Protection Agency
FAT - Factory Acceptance Test
FEM - Federal Equivalent Method
FRM - Federal Reference Method
ICP/MS - Inductively Coupled Plasma/Mass Spectrometry
ICR - Information Collection Request
II&S - Integrated Iron and Steel Manufacturing
mmHg - Millimeters of Mercury
IO - Inorganic Compounds
km - Kilometers
LDL - Lower Detection Limit
lpm - Liters per minute
m - Meters
mph - Miles per hour
m3/hour - Cubic meters per hour
MFC - Mass Flow Controller
MQO - Measurement Quality Objective
MSR - Management Systems Review
NAAQS - National Ambient Air Quality Standards
NIOSH - National Institute of Occupational Safety and Health
NIST - National Institute of Science and Technology
PEP - Performance Evaluation Program
PM10 - Particles with an average aerodynamic diameter of 10 microns or less
PQAO - Primary Quality Assurance Organization
QA - Quality Assurance
QAPP - Quality Assurance Project Plan
QC - Quality Control
QMP - Quality Management Plan
QMS - Quality Management System
QSA - Quality Systems Audit
RSD - Relative Standard Deviation
RTD - Resistance Temperature Detector
SAT - Site Acceptance Test
STDEV - Standard Deviation
SLAMS - State and Local Air Monitoring Station
SOP - Standard Operating Procedure
TSA - Technical Systems Audit
XRD - X-Ray Diffraction
ug/m^3 - Micrograms per cubic meter (at local conditions)

A. PROJECT MANAGEMENT

A.1 Approval Sheet

_______________________________ 7/2/2024
Jim Locke
Director, Air Quality
CNX Resources Corporation

Date

_______________________________ 07/03/2024
Volker Schmid
Program Manager
CleanAir Engineering, Inc.

Date

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Table A-1. Revision History

Revision No.	Date	Summary of Change	Responsible Person
0	12/11/2023	Initial Version	D. Goetz
1	02/24/2024	Changes throughout the document to address PA DEP comments. Restructuring of QAPP to push site-specific information into the Appendices. Minor editorial changes.	V.Schmid
2	7/2/2024	Changes to restructure QAPP to include site-specific information in appendices on a site-by-site basis. Minor editorial changes throughout.	D. Goetz

A.3 Distribution List

Key individuals involved in the monitoring project are identified in Table A-2. The list contains names, organizational affiliations, professional titles, as well as contact information, and will be used to distribute the approved Quality Assurance Project Plan (QAPP) and any subsequent revisions.

Table A-2. Quality Assurance Project Plan Distribution List

Key Personnel and Affiliations	Contact Information
Jim Locke Director, Air Quality CNX Resources	1000 Horizon Vue Drive Canonsburg, PA 15317 (724) 485-3046 JimLocke@cnx.com
Volker Schmid Program and Quality Assurance Manager Clean Air Engineering, Inc.	110 Technology Drive Pittsburgh, PA 15275 (724) 227-0148 vschmid@cleanair.com
Doug Goetz Project Manager Clean Air Engineering, Inc.	110 Technology Drive Pittsburgh, PA 15275 (724) 227-0144 dgoetz@cleanair.com
Soudabeh Gorjinezhad Field Service Engineer & Data Manager Clean Air Engineering, Inc.	110 Technology Drive Pittsburgh, PA 15275 (724) 227- 0274 sgorjinezhad@cleanair.com
Joshua Gillespie Field Service Engineer Clean Air Engineering, Inc.	110 Technology Drive Pittsburgh, PA 15275 (724) 227-0159 jgillespie@cleanair.com

A.4 Project / Task Organization

CNX Resources Corporation (CNX) contracted Clean Air Engineering, Inc. (CleanAir) to install and operate two monitoring systems for fine particulates, i.e. particles with an average aerodynamic diameter of 2.5 micrometers or less (PM2.5), four samplers for the measurement of benzene, toluene, ethylbenzene, and xylenes (BTEX), and one peripheral meteorological measurement system per site for sites with ongoing natural gas development (NGD) activities within CNX's area of operations in the Appalachian Basin. The sites include well pads in active production, well pads in their development phase, and midstream compressor stations.

To ensure the successful execution of this monitoring program, CleanAir has dedicated a team of experienced and qualified individuals. Names of key CleanAir project personnel and a brief description of their responsibilities are listed below. In addition to the list, Figure A-1. outlines the organizational structure of the project team for the implementation of the monitoring program and delineates authorities and lines of communication.

Dr. Volker Schmid (Program Manager) provides program direction and maintains oversight of all quality assurance (QA) activities. He has the organizational authority to make decisions on behalf of CleanAir to address CNX's requests as they occur. Other duties include, but are not limited to:

- Ensuring conformance with the Quality Management System (QMS) at all locations where CleanAir performs ambient air monitoring work
- Development, updating, and approval of the QAPP and related Standard Operating Procedures (SOPs), as well as their implementation
- Coordinating and performing independent performance audits and communicating audit results to the Project Manager for further action
- Performing CleanAir's internal technical system audits (TSAs)
- Meeting regularly with the Project Manager to evaluate project status and performance benchmarks to ensure sufficient project staffing and resource allocation
- Assuring personnel training to meet project qualification needs
- Covering responsibilities of the Project Manager, as needed

Dr. Doug Goetz (Project Manager) has direct access to the Program Manager on all matters related to the monitoring project and serves as the primary point of contact with CNX. The Project Manager is responsible for resource management and personnel scheduling to ensure an uninterrupted monitoring station operation in line with the data quality objectives (DQOs) established in this QAPP. Other responsibilities include, but are not limited to:

- Ensuring that operations are covered by appropriate quality assurance (QA) planning documentation (i.e. the QAPP) and SOPs
- Ensuring that SOPs are followed for a consistent environmental data operation (EDO)
- Scheduling all quality assurance (QA) activities, transfer standard certifications, maintaining traceability to standard reference at the National Institute of Standards and Technology (NIST) for all station/audit standards, and equipment
- Spare parts and consumables management
- Ensuring that corrective actions are resolved
- Providing training to field service personnel
- Monthly data summary report review before submission to CNX.

- Meeting with Program Manager to review project status, performance benchmarks, and resource needs
- Covering application engineering responsibilities, as needed.
- Covering responsibilities of the Field Service Engineer and Data Manager, as needed.

Soudabeh Gorjinezhad and Joshua Gillespie (Field Service Engineers) report directly to the Project Manager. The Field Service Engineer is responsible for the regular station operation, maintenance, and QA activities. Other responsibilities include, but are not limited to:

- Commissioning of ambient monitoring systems and performing and documenting Site Acceptance Tests (SAT)
- Performing routine monitoring station operations, including routine or emergency site visits, preventive maintenance, troubleshooting, and repairs
- Conducting preventive maintenance, quality control (QC) checks, and calibrations
- Maintaining a hard copy or electronic logbook and associated site documentation, as well as QA activity forms and checklists

Soudabeh Gorjinezhad (Data Manager) has direct access to the Project Manager on all matters related to the quality of data acquired during the project and its validation, analysis, reporting, and documentation. Specific responsibilities include, but are not limited to:

- Organizing the collection, verification, validation, analysis, and reporting of all monitoring data
- Collecting, maintaining, reviewing, and archiving all documents and records associated with the environmental data operations (EDO)
- Verifying that all required QA activities are performed and that measurement quality standards are met consistently
- Conducting statistical analysis of the data to ensure consistent data quality by early identification of data quality concerns
- Generation of data summary reports

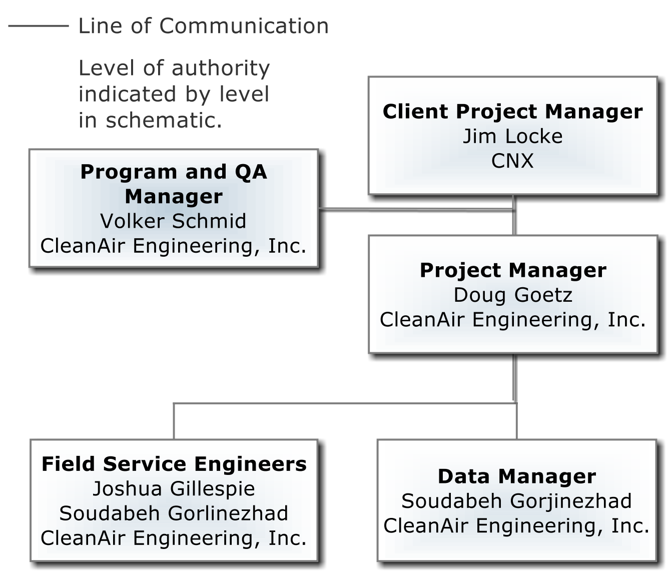

Figure A-1. CleanAir Project Team Organization

A.5 Project Background

CNX Resources Corporation is a natural gas company headquartered in Canonsburg, Pennsylvania, with operations in the Appalachian Basin, primarily in the Marcellus Shale and Utica Shale in Pennsylvania, Ohio, and West Virginia. As part of its radical transparency program, CNX has elected to pursue ambient air monitoring for PM2.5 and BTEX around several of its sites with ongoing NGD activities. To ensure that the generated monitoring data is of high quality, representative, complete, and defensible, the monitoring project is to be conducted in accordance with guidelines approved by the United States Environmental Protection Agency (EPA) and within the framework of a defined quality system.

A.6 Project / Task Description

A.6.1 Fine Particulate (PM2.5) Real-Time Monitoring

For the monitoring of PM2.5, CleanAir was contracted to install and operate two Met One Instruments Inc. model BAM-1022 real-time beta attenuation mass monitors per site selected to participate in the monitoring program. These BAM-1022 monitors have been designated by the EPA as an automated FEM (method designation: EQPM-1013-209) when configured for 24 1-hour average measurements of PM2.5 by beta attenuation, using a glass fiber filter tape roll and a sample flow rate of 16.67 liters/min, a standard EPA PM10 inlet and a Very Sharp Cut Cyclone (VSCC). The BAM 1022 employs an in-situ sampling technique where the beta measurement is kept at a near-fixed temperature above ambient conditions, thereby minimizing measurement error due to loss of semivolatile particulate material or due to excessive moisture in the sample stream. Per manufacturer specifications, each BAM-1022 is capable of operation within a temperature range of -30 to +50 °C.

To be compliant with its FEM requirements, each monitor reports a 1-hour average measurement for PM2.5, resulting in 24 PM2.5 mass concentration readings per day and instrument. The 1-hour measurements are saved locally and made available immediately upon completion of the measurement at the top of the hour via a cloud-based environmental data management system. Besides hourly concentrations, the BAM-1022 also reports PM2.5 concentration data every 5 minutes. However, these short-term concentrations should be considered as a trend indication only, as the numerical values recorded are an approximation and cannot be used to calculate the expected hourly concentration value.

For each site, one PM2.5 continuous air quality monitor is installed in the direction of the prevailing winds (Station ID: BAM-2, downwind location), and is likely to represent air quality impacts associated with ongoing NGD activities at each site. The second continuous air quality monitor is located in the direction of the origin of the prevailing winds (Station ID: BAM-1, upwind location), measuring PM2.5 concentrations that are likely to represent local background concentration levels.

There are several monitor operating parameters that are vital to high-quality PM2.5 mass concentration measurements. One of these parameters is the ambient air sample flow rate through the sampling inlet which determines the size of the particles that are collected. Others are supporting measurements of ambient temperature, relative humidity, and barometric pressure, as well as filter tape temperature and filter tape relative humidity. Each of these parameters is continuously measured by the monitor and saved locally as 5-minute block averages. Once available, the 5-minute measurements are uploaded to a cloud-based environmental data management system to provide supplementary information to the PM2.5 measurement.

A.6.2 BTEX Sampling and Analysis

In addition to PM2.5 concentrations, CleanAir was also contracted to perform measurements of local BTEX concentrations in ambient air around each selected site. The BTEX measurements are conducted using a passive time-integrated sampling approach via sorbent traps guided by EPA Method 325A (Volatile Organic Compounds from Fugitive and Area Sources: Sampler Deployment and VOC Sample Collection) and EPA Method 325B (Volatile Organic Compounds from Fugitive and Area Sources: Sampler Preparation and Analysis).

Per EPA Method 325A guidelines, each BTEX sampling event consists of a 14-day-long sampling episode (24 hours per day) at each sampling location. For each site, there is one passive sampler located within each quadrate for a total of four samplers. Quadrate selection is guided by seasonal prevailing winds with one quadrate representing approximate upwind and another one downwind conditions. The upwind and downwind sampling locations are collocated with the BAM-1022 monitoring locations as described in Section A.6.1. Once retrieved, each sorbent trap is analyzed by an accredited laboratory per EPA Method 325B via Thermal Desorption Gas Chromatography.

A.6.3 Meteorological Measurements

Wind speed and wind direction at each site are monitored via an AIO-2 or 30.5 sonic anemometer sensor from Met One Instruments, Inc. The sonic anemometers are installed on top of a 10-meter meteorological tower sited in accordance with EPA siting guidelines for meteorological measurement systems. The data generated by each anemometer is used to determine horizontal wind speed and direction as vector averages, as well as the standard deviation of the wind direction (sigma theta).

Ambient air temperature, barometric pressure, and relative humidity are measured by each FEM sampler as part of the PM2.5 measurement using temperature, barometric pressure, and relative humidity sensors sited consistent with EPA guidelines. All meteorological measurement results are acquired continuously and averaged to 5-min block averages.

A.6.4 Data Acquisition System and Transmission

All meteorological measurements, real-time PM2.5 mass concentrations, and other diagnostic and operating parameters are continuously captured and saved locally by each instrument (BAM-1022) or a designated data logger (Automet 580, Met One Instruments Inc.). Once collected, all data is transmitted to a cloud-based secure environmental management platform for further storage and visualization.

The timestamp for each completed measurement corresponds to the start of the measurement period in local standard time.

A.6.5 Site Overview

A sampling station siting survey is conducted for each monitoring site prior to the mobilization of all monitoring and sampling equipment to the site. This is done to finalize monitor and sampler locations. The final monitor/sampler and meteorological measurement system locations for each site are shown in the aerial views included in Appendix A.

A list of parameters and target compounds to be measured at each site, measurement frequency, and key monitoring system/sampler components and support equipment can be seen in Table A-3. For a more detailed discussion on site selection and monitor/sampler equipment performance specifications consult Section B.

Table A-3. Key Monitoring System Components and Support Equipment

Parameter / Function	Station	Equipment	Monitoring Frequency
Key Monitoring System Components			
PM2.5	BAM-1 (Upwind Station) BAM-2 (Downwind Station)	Met One Instruments, Inc. BAM-1022 Real-Time Beta Attenuation Mass Monitor Automated Equivalent Method Designation: EQPM-1013-209	Continuous
Ambient Air Temperature	BAM-1 / BAM-2	Met One Instruments, Inc. BX-597 Ambient Combination Sensor	Continuous
Relative Humidity	BAM-1 / BAM-2	Met One Instruments, Inc. BX-597 Ambient Combination Sensor	Continuous
Barometric Pressure	BAM-1 / BAM-2	Met One Instruments, Inc. BX-597 Ambient Combination Sensor	Continuous
Wind Speed	Meteorological Station	Met One Instruments, Inc. AIO 2 or 30.5 Weather Sensor	Continuous
Wind Direction	Meteorological Station	Met One Instruments, Inc. AIO2 or 30.5 Weather Sensor	Continuous
BTEX	Sampler 1 – 4	Passive Sorbent Sampler (Modified EPA Method 325 A/B)	Continuous 14-Day Sampling Duration
Support Equipment			
Data Logger	Meteorological Station	Met One Instruments, Inc. AutoMet 580 Data Collection Platform	N/A
Data Telemetry	BAM-1 / BAM-2 / Meteorological Station	Microcontroller connected to site modem for internet access	N/A

A.6.6 Reporting Format of Measurements

Raw unvalidated meteorological and real-time PM2.5 mass concentration data is collected and transmitted to a secure cloud-based environmental data management platform every 5 minutes. Once received, the management platform performs some basic automated integrity checks on the incoming data such as out-of-range checks, instrument status checks, and checks for missing data, among others. Following those checks, 5-min PM2.5 mass concentration trend data and 1-hour PM2.5 mass concentration measurements, as well as 5-minute block-averaged meteorological measurements (wind speed, wind direction, sigma theta, ambient temperature, barometric pressure, and relative humidity) are made available via the secure cloud-based data management platform.

Once a month, all PM2.5 and meteorological measurement results are verified and validated in accordance with procedures and processes detailed in this QAPP. Validated PM2.5 mass concentrations are reported as 1-hour measurements. All PM2.5 measurements are recorded in local conditions. Validated meteorological parameters are reported as 1-hour block-averages.

All BTEX measurements are continuously verified and validated. Validated analytical results from an accredited laboratory, as well as concentrations, are reported for the duration each sampler was operating, typically 14 days. The concentration reported for each BTEX compound represents the mean concentration for the entire sampling duration corrected to a reference temperature of 25 °C and a reference pressure of 760 millimeters of mercury (standard conditions). A complete list of reported parameters is listed in Table A-4.

Table A-4. Reporting Format of Key Raw and Validated Measurements

Parameter	Data Average	Reporting Units	Data Resolution Rounded To
RAW, UNVALIDATED REAL-TIME DATA			
Resultant Vector Wind Speed	5 min	mph	0.1
Resultant Vector Wind Direction	5 min	Degrees Azimuth	1
Sigma Theta	5 min	Degrees Azimuth	1
Ambient Temperature	5 min	°C	0.1
Relative Humidity	5 min	%	1
Barometric Pressure	5 min	mmHg	0.01
PM2.5 Mass Concentrations (Local Conditions)	1 hour	ug/m^3	0.1
VALIDATED DATA			
Resultant Vector Wind Speed	1 hour	mph	0.1
Resultant Vector Wind Direction	1 hour	Degrees Azimuth	1
Sigma Theta	1 hour	Degrees Azimuth	1
Ambient Temperature	1 hour	°C	0.1
Relative Humidity	1 hour	%	1
Barometric Pressure	1 hour	mmHg	0.01
PM2.5 Mass Concentrations (Local Conditions)	1 hour	ug/m^3	0.1
BTEX Concentrations (Standard Conditions)	14 days	ug/m^3	0.01

A.6.7 Project Activities and Schedule

The tasks related to this monitoring project are performed by the experienced and trained personnel of CleanAir's Advanced Monitoring Solutions (AMS) group and include project planning, implementation, and assessment activities. These activities are described in this QAPP and include, but are not limited to, field service activities such as conducting periodic routine system checks, sample recovery, preventive and corrective maintenance, data review, and management activities such as data verification, validation, documentation, and reporting. All monitoring project activities are conducted in conformance with processes detailed in this QAPP, its accompanying SOPs, and instrument manufacturer's manuals and guidance.

Periodic project assessments are conducted to evaluate the performance and effectiveness of all aspects of the monitoring program to ensure that it meets the required objectives. An assessment may include audits, performance evaluations, as well as quality and technical system reviews. Table A-5 lists a generalized work schedule for this monitoring project, including the type of activity, the assigned personnel, the minimum activity frequency, and all pertinent documentation. All project management, system operation, maintenance, QA activities, and audits are performed by personnel from CleanAir's Pittsburgh, Pennsylvania, office.

Table A-5. Project / Work Schedule

Activity	Minimum Frequency / Description	Done By	Documentation
Field Activities - Meteorological Measurement System			
Routine Site Checks and Preventive Maintenance	Each site visit as per manufacturer guidelines, or as needed if: • Control limit exceedances • System malfunctions • Loss of power and telemetry, etc.	CleanAir	• Meteorological system service form • Electronic Logbook
Meteorological System Calibration (Wind Speed, Wind Direction)	Factory calibration before installation and then every 12 months	MetOne Instruments	• Sensor calibration certificate
Field Activities – Met One Instruments Inc. BAM-1022			
Routine Site Checks (Inlet Checks and Cleaning, etc.) and Preventive Maintenance (Filter Transport Cleaning, Pump Rebuilt, etc.)	Monthly or more frequent as needed if: • Control limit exceedances • System malfunctions • Loss of power and telemetry, etc.	CleanAir	• BAM-1022 field service form • Electronic logbook
Downtube Cleaning	Quarterly, or more frequently as needed	CleanAir	• BAM-1022 field service form • Electronic logbook
External / Basic Leak Check	• Before (as-found) each one-point flow rate verification/audit, or multipoint verification/calibration • Before (as-found) and after (as-left) and maintenance activities	CleanAir	• BAM-1022 field service form • Electronic logbook
Internal / Advanced Leak Checks (Total System, Lower System, & Filter Tape Leak Test)	If the external leak check fails	CleanAir	• BAM-1022 field service form • Electronic logbook
One-Point Flow Rate Verification	Monthly, and • As post-calibration check • To verify suspect PM2.5 readings	CleanAir	• BAM-1022 field service form • Electronic logbook
One-Point Temperature/Pressure/Relative Humidity Check	Monthly, or more frequent as needed if: • Suspect PM2.5 / temperature/pressure / relative humidity measurements	CleanAir	• BAM-1022 field service form • Electronic logbook
One-Point Pressure Sensor Check	Monthly, or more frequent as needed if: • Suspect PM2.5 / temperature/pressure / relative humidity measurements	CleanAir	• BAM-1022 field service form • Electronic logbook
One-Point Relative Humidity Sensor Check	Monthly, or more frequent as needed if: • Suspect PM2.5 / temperature/pressure / relative humidity measurements	CleanAir	• BAM-1022 field service form • Electronic logbook
Multi-Point Flow Rate Verification/Calibration	Semi-annual, or more frequent as needed if: • Major maintenance, pump rebuild, or system transport • One-point flow rate verification or audit fails	CleanAir	• BAM-1022 calibration form • Electronic logbook
Three-Point Temperature Sensor Calibration / Verification	Semi-annual, or more frequent as needed if: • One-point temperature verification or audit fails	CleanAir	• BAM-1022 calibration form • Electronic logbook
Pressure Sensor Calibration / Verification	Semi-annual, or more frequent as needed if: Pressure sensor verification or audit fails	CleanAir	• BAM-1022 calibration form • Electronic logbook
Filter Sensor Test/Calibration (Filter Temperature/Relative Humidity/Upper and Lower Pressure)	• Semi-annual	CleanAir	• BAM-1022 calibration form • Electronic logbook

Table A-5. Project / Work Schedule (Continued)

Activity	Minimum Frequency / Description	Done By	Documentation
Field Activities – Met One Instruments Inc. BAM-1022 (Continued)			
72-hour Zero Background Test (Mass Offset)	Annual, or more frequent as needed if: • Seasonal dewpoint changes • After major repairs • On system installation	CleanAir	• BAM-1022 zero background form • Electronic logbook
Span Mass Check	Semi-annual	CleanAir	• BAM-1022 calibration form • Electronic logbook
Independent Flow Rate, Temperature, Pressure, Relative Humidity, and Time Audit (Accuracy)	Semi-annual	CleanAir QA Manager	• BAM-1022 audit form • Electronic logbook
Time Verification	Monthly	CleanAir	• BAM-1022 field service form • Electronic logbook
Field Activities – EPA Method 325A Samplers			
Sorbent Trap Exchange	Every 14 days	CleanAir	• Chain of custody form • Field visit form
Sorbent Trap Field Blanks	One field blank per 14-day sampling period	CleanAir	• Chain of custody form • Field visit form
Sorbent Trap Duplicates	One co-located duplicate per 14-day sampling period	CleanAir	• Chain of custody form • Field visit form
Routine Site Checks	Each site visit	CleanAir	• Field visit form
Certification of Calibration Equipment and Standards			
Audit Flow Rate / Temperature / Rel. Humidity / Barometric Press. Standard	Annual	Manufacturer or Laboratory	• Certificates
Working Standards	Annual	Manufacturer, or Laboratory	• Certificates
Spare Parts and Consumables			
Inventory Review	Every quarter, or as needed	CleanAir	• Inventory form
Data Review and Project Assessment			
Station Acceptance Test	On install and then once a year	CleanAir	• Station Acceptance Test report • Electronic logbook
Meteorological Station Data Check	Every 5 minutes	CleanAir	• Automated checks by cloud-based data platform
BAM-1022 PM2.5 and Diagnostic/Operating Data & Flow Checks	Every 5 minutes	CleanAir	• Automated checks by cloud-based data platform
Data Verification	Every day	CleanAir	• Daily data check sheet • Online control charts
Meteorological Station Data Review and Validation	Once a month	CleanAir	• Monthly data validation form
BAM-1022 PM2.5 Data and Flow Review and Validation	Once a month	CleanAir	• Monthly data validation form
Laboratory Results Review / Verification / Validation	When received from the laboratory	CleanAir	• TBD
Validated Data Submission	Every month	CleanAir	• Data Summary Report
Internal Technical Syst. Audit	Annual	CleanAir	• Audit report

A.6.8 Project Records

The AMS group will follow a process that controls the generation, review, revision, approval, and distribution of critical documents and records. The type of documents and records that contain information critical to this monitoring project, and are maintained by CleanAir, are categorized and presented in Table A-6. Information on key documents in each category is explained in more detail in Section A.9.

Table A-6. Critical Documents and Records

Categories	Document/Record Types
Management & Organization	• Quality Assurance Project Plan • Personnel Qualifications and Training
Site Information	• Station Acceptance Test Report • Site Maps and Pictures (typically included as part of the Quality Assurance Project Plan and Station Acceptance Test Report)
Environmental Data Operations	• Standard Operating Procedures • Service and Maintenance Records (i.e. Logbooks, Check Sheets, Workbooks, Forms, etc.) • Chain of Custody Forms • Quality Assurance Records (i.e. Quality Control Check Forms, Calibration Forms, Audit Forms, Audit Reports, etc.) • Corrective Action Records
Monitoring Data	• Any Original Raw Data (Routine, Quality Control, Laboratory, Instrument Monitoring, Diagnostic Data, etc.,) • Verified and Validated Data
Data Management & Reporting	• Data Summary Reports • Data Management System Records

A.7 Data And Measurement Quality Objectives and Criteria

40 CFR Part 58 Appendix A Section 2.3.1 defines Data Quality Objectives (DQOs) of a monitoring project as qualitative and quantitative statements that clarify the monitoring objectives and intended use of the data, dictate the monitoring station siting and sampling schedule, define the appropriate type of data to collect and how to acquire it, and specify the acceptable margin of measurement error for the monitoring program. These acceptable limits of measurement errors are established as Measurement Quality Objectives (MQOs) and are designed to evaluate and control each phase of the measurement process or system. MQOs can be defined in terms of Data Quality Indicators (DQIs) such as precision, bias, representativeness, detection limit, completeness, and comparability.

A.7.1 Data Quality Objectives

For this monitoring program, the primary goal is to generate monitoring data that is of sufficient quality to qualify local ambient PM2.5 and BTEX concentration levels and site contributions during ongoing NGD operations.

To ensure representativeness, the real-time PM2.5 mass concentrations are determined during ongoing NGD operations at sampling locations discussed in a subsequent section of this QAPP. For comparability purposes, the measurements and samples are generated using well-characterized and understood FEM equipment, EPA Methodology, and meteorological measurement equipment with known accuracy outcomes.

For data completeness, the quality system described in this QAPP is designed to minimize data loss for the time-integrated passive sampling approach for BTEX and meet a monthly data availability of at least 80% for the PM2.5 and meteorological measurements.

A.7.2 Measurement Quality Objectives

For each monitoring project, a set of MQOs is established to evaluate and control the various phases of the measurement process and ensure that the measurement uncertainty is within acceptable limits. The MQOs are typically defined in terms of DQIs such as precision, bias, representativeness, detection limit, completeness, and comparability. For regulatory-driven criteria pollutant monitoring programs, the EPA developed acceptance criteria for each of the DQIs. These acceptance criteria address comparability by requiring a specific monitoring system design and the use of standard methodologies, representativeness via network design and monitoring system siting, as well as control precision, bias, and accuracy of the meteorological and target compound measurements via a variety of QA activities. CleanAir will use a subset of these MQOs to assess the quality of the data generated during this monitoring program. The assumption is that, as long as these MQOs are met, the measurement uncertainty is maintained within the limits required by the DQOs.

Key MQOs that relate to field activities performed by CleanAir are listed in Tables A-7 through A-9. Validation criteria listed in these tables are based on requirements detailed in the respective EPA sampling and monitoring methods and guidance, as well as equipment manufacturers' guidelines, and are adapted where appropriate to meet the DQOs of this monitoring program. The validation criteria in these tables are grouped into three categories: (1) *Critical Criteria* that are deemed critical to maintaining the integrity of a sample, (2) *Operational Criteria* that are important for maintaining and evaluating the quality of the data acquisition system, and (3*) Systematic Criteria* that are important for the correct data interpretation but do not usually impact the data validity.

Table A-7. Key Continuous PM2.5 Monitor Measurement Quality Objectives

Requirement	Minimum Frequency	Acceptance Criteria	Corrective Action if Deviation
CRITICAL CRITERIA			
Average Flow Rate (FR) (max. 5-minute Averages)	Every 24 hours of operation; alternatively, each hour can be checked	Average within 5% of 16.67 liters/minute at local conditions	• Run one-point FR check • Maintenance, as needed • Re-calibrate
FR Variability	Every 24 hours of operation	Coefficient of Variation (CV) ≤ 2% (standard deviation/mean)	• Run one-point FR check • Check other parameters / Maint. • Re-calibrate
One-Point FR Verification	Monthly	<±4.1% of transfer standard, and <±5.1% of FR design value	• Repeat • Troubleshoot / Maintenance • Re-calibrate
Design Flow Rate Check	After each multi-point calibration or verification	<±2.1% of design flow rate	• Repeat • Recalibrate
External / Basic Leak Check	Before (as-found) each FR verification/calibration Before and after (as-found/as-left) PM2.5 separator maintenance	<1.5 lpm Action Limit: 1.0 lpm	• Repeat • Run internal leak test • Maintenance • Repeat leak check
Internal / Advanced Leak Checks	Troubleshooting	<0.3 lpm	• Repeat • Maintenance / Clean assembly
OPERATIONAL CRITERIA			
Inlet System Cleaning	• Monthly	Cleaned	• Rebuild as needed
Downtube & Internal Nozzle Cleaning	• Every quarter	Cleaned	• Replace as needed
Nozzle, Vane, & Pinch Roller Cleaning	• Each filter tape replacement	Cleaned	• Replace as needed
One-Point Verification • Ambient Temperature • Barometric Pressure • Amb. Relative Humidity	• Monthly	• <±2.1 °C of standard • <±10.1 mm Hg of standard • <±10.1% RH of standard	• Repeat • Troubleshoot / Maintenance • Re-calibrate (offset adjustment for pressure sensor)
Temperature Multi-Point Verification / Calibration	• On installation, then semi-annual	<±2.1 °C of standard	
One-Point Pressure Calibration	On installation, then semi-annual	<±10.1 mm Hg of standard	
Multi-Point FR Verification/Calibration	On installation, then semi-annual	<±2.1% of transfer standard	
Filter Sensor Cal./Verification • Temperature • Relative Humidity (RH) • Upper/Lower Pressure	On installation, then semi-annual	• <±1 °C of standard • <±4%RH of standard • <±5 mm Hg of standard	• Repeat • Re-calibrate / Adjust Offset
72-hour Zero Background Test (Mass Offset)	On installation, then annually	Standard Deviation < 2.4ug/m^3	• Repeat • Contact Met One Instruments
Independent Audits • Ambient Temperature • Barometric Pressure • Flow Rate	Semi-annual	• <±2.1 °C of standard • <±10.1 mm Hg of standard • <±4.1% of audit standard, & <±5.1% FR design value	• Perform one-point verification using working standard • Maintenance • Re-calibrate
Span Mass Check	On installation, then semi-annual	<±5.1% of factory setting/span	• Repeat • Clean nozzle, and filter rollers
SYSTEMATIC CRITERIA			
Time Verification	Monthly	<±1 min of reference	• Sync time to a time server
Time Audit	Semi-Annual	<±1 min of reference	• Sync time to a time server
Siting	On installation	Meets siting criteria or waiver	• Document any deviation
Data Completeness	Monthly	≥80%	• Review QAPP and SOPs

Table A-8. Key BTEX Sampler Measurement Quality Objectives

Requirement	Minimum Frequency	Acceptance Criteria	Corrective Action if Deviation
CRITICAL CRITERIA			
Visual Check	Each sorbent trap	Loose or missing caps Damaged tubes, or tubes that appear to be leaking sorbent or container contamination	• Document any deviation • Use different media
Final Check	Each sampling event	Diffusion cap missing	• Sample is invalid • Document deviation
OPERATIONAL CRITERIA			
Duplicates	One per sampling event	Absolute relative deviation <30.1%	• Flag data set and document
Field Blank	One per sampling event, stored at the sampling location	must contain no greater than one-third of the measured target analyte for field samples	• Flag data set with a note that the associated results are estimated and likely to be biased high due to field blank background.
Sampling Period	Each sampling event	14 days ± 2 days	• Document any deviation
Operation Audit	Annually	Compliance with SOP / COC and Station Visit Form	• Document any deviation • Training
SYSTEMATIC CRITERIA			
Siting	On installation	Meets siting criteria or waiver documented	• Document siting and any deviation from siting criteria
Sampling Period	Each sampling event	14 days ± 2 days	• Document any deviation

Table A-9. Measurement Quality Objectives for Meteorological Tower Sensors

Requirement	Minimum Frequency	Acceptance Criteria	Corrective Action
CRITICAL CRITERIA			
Wind Direction and Wind Speed Sensor Factory Recalibration	Every 12 months	Wind Speed: ±0.5 m/s (1.1 mph) or 5% (whichever is greater) Wind Direction: <±5.1° Threshold: <0.2 m/s (0.5 mph)	• Fix or Replace
SYSTEMATIC CRITERIA			
Time Verification	Monthly	<±1 min of reference	• Adjust
Time Audit	Semi-Annual	<±1 min of reference	• Sync time to a time server
Data Completeness	Monthly	≥80%	• Review QAPP and SOPs

A.8 Training Requirements / Certification

Qualified and adequately trained personnel are key to the success of any monitoring program. For that reason, the project personnel responsible for implementing this monitoring project consists of Field Service Engineers and staff with backgrounds in air quality monitoring. Each employee has undergone training that is specific to the requirements of the assigned job duties. Training topics include instrumentation operation and service, preventive and corrective maintenance, quality assurance procedures, data processing, and management.

CleanAir also maintains a safety training program that provides ongoing and comprehensive safety training. The primary goal of CleanAir's safety program is to ensure a safe and healthy environment for its employees and clients. The safety program is maintained by CleanAir's Corporate Safety Director, who identifies specific training needs and maintains safety training records for each CleanAir employee per industry standards. In addition to this safety training, all personnel working on each monitoring site will receive site-specific safety training.

A.9 Documents and Records

The documentation and records maintained for this project are stored electronically by CleanAir and backed up routinely to various secure and access-controlled locations. All document and data management, including backups, is the responsibility of the project's Data Manager. A list of critical project documents and records maintained for this project was shown in a previous section (Table A-6). All documents and records listed in Table A-6 are backed up frequently to CleanAir's Corporate Data Server.

A.9.1 Quality Assurance Project Plan

The QAPP is the critical planning document for any environmental data collection operation. The purpose of the QAPP is to establish clear requirements, procedures, and guidelines necessary to successfully implement and maintain a monitoring project. It is intended to serve as a reference document and provides detailed operational procedures for tasks related to the monitoring project. The QAPP is revised as needed, subject to approval by all stakeholders.

Upon receiving stakeholder approval, the Project Manager will distribute the electronic version of the QAPP to all stakeholders named in the QAPP distribution list. An electronic version of the most current version of the QAPP is stored in CleanAir's Corporate Database under the respective monitoring project folder. It is the responsibility of the Project Manager to ensure that the QA activities detailed in this QAPP are implemented.

A.9.2 Station Acceptance Test Report

An SAT is performed for each monitoring station upon the initial installation on-site. The SAT report includes site information and pictures, equipment checks, startup calibrations, and tests, communication equipment, and local and cloud-based data storage checks (if applicable). The SAT report is made available to all stakeholders and stored electronically in CleanAir's Corporate Database under the respective monitoring project folder.

A.9.3 Annual Station Acceptance Test

An annual SAT is performed following the completion of each annual comprehensive preventive maintenance visit. The report includes equipment checks, and communication equipment checks, and compares data logged by each onsite data logger with the data displayed by each instrument. In addition, the report serves to document existing representative sampling and siting conditions at the monitoring site, which is achieved by taking pictures of the site from all cardinal directions and compiling the pictures as part of the report.

A.9.4 Records of Field Activities

CleanAir will maintain an electronic master logbook that documents all activities performed on each site, including routine and preventive maintenance visits, sample recovery, all QA activities, as well as any other pertinent comments related to the required monitoring. Entries into the logbook will be dated and in chronological order. Each entry is initialed by the individual adding the entry. In addition to the logbook, site activities may be captured in special forms and checklists developed as part of the monitoring project SOPs. Hardcopy documents are scanned and stored electronically with all other documents and records in CleanAir's Corporate Database under the respective monitoring project folder.

A.9.5 Calibration and Quality Control Checks

Field calibrations and quality control checks of each station's equipment are performed at regular intervals, and as needed, according to the Project/Work Schedule of Table A-5 and the respective SOPs. Calibrations and other QA activities are documented in the electronic logbook and corresponding forms and checklists. Copies of all completed calibration and QC forms and checklists are stored electronically in CleanAir's Corporate Database in the respective monitoring project folder.

A.9.6 Independent Audit Reports and Records

Independent audits of each air quality monitoring and meteorological measurement station may be conducted by the monitoring project's QA Manager to verify the performance of critical system components and to assess the accuracy of the data generated by each monitoring station. These audits are conducted per the applicable SOPs. All audit activities are documented in the electronic logbook and audit forms. Upon completion of each audit, the Project Manager will review the audit documents and initiate an investigation into any potential deviations via the corrective action process, as needed. All audit records are stored in CleanAir's Corporate Database under the respective monitoring project folder.

A.9.7 Maintenance Records

Preventive maintenance is performed at regular intervals. Corrective maintenance/repairs, on the other hand, are performed as needed and upon approval by the Project Manager. Both activities are documented by the Field Service Engineer in the respective electronic logbook and applicable forms and checklists. All maintenance records are stored in CleanAir's Corporate Database in the respective monitoring project folder.

A.9.8 Corrective Action Reports

A corrective action is initiated whenever an issue is identified that could compromise the safety of the project personnel or the validity of the monitoring data. Problems can include, but are not limited to, safety defects, monitor operational problems including those caused by events that are out of the operator's control (i.e. catastrophic weather events, power interruptions, etc.), non-conformance with established control limits, or a failure to comply with SOPs. The corrective action report documents the identified issue and summarizes information necessary for performing a root-cause analysis, and actions to address the issue. The report is updated frequently until the issue is resolved. A separate report will be required for each problem identified.

It is the responsibility of the individual discovering the issue to initiate a corrective action. Once initiated, it becomes the responsibility of the Project Manager to investigate the issue, develop a corrective action plan, inform the client contact as needed, authorize, and schedule corrective actions, and document these activities in the corrective action report. Corrective action reports are stored in CleanAir's Corporate Database under the respective monitoring project folder.

A.9.9 Raw Data

Raw meteorological measurement system data, and continuous real-time PM2.5 monitor data including diagnostic and operational data, are stored locally on each site's sampler or designated datalogger as 5-min, and 1-hour block-averages. Additional sampler and laboratory data are captured in the respective workbooks, chain of custody forms, or electronic files containing laboratory results. All raw data is backed up to CleanAir's Corporate Database and stored under the respective monitoring project folder.

A.9.10 Validated Data and Data Submission

All raw monitoring data is reviewed and verified each day and validated at the end of each operating month. Every month validated monitoring data is reported to CNX in an electronic format 30 days after the end of each month the data was collected.

B. DATA GENERATION AND ACQUISITION

B.1 Monitoring Network Design

The design of an ambient air monitoring station network requires understanding the monitoring objectives, identifying the spatial scale most appropriate for accomplishing the monitoring objectives, and identifying the monitor locations. For this project, there are two monitoring station locations for the measurement of PM2.5 for each program site, one in the direction of the prevailing winds (BAM-2, downwind location) and one in the direction of the origin of the prevailing winds (BAM-1, upwind location).

In addition to the PM2.5 monitoring stations, there are four passive samplers employed to sample for BTEX at each site. Each BTEX sampler is located within a separate quadrant around each site. The quadrant selection is guided by seasonal prevailing winds with one quadrant representing approximate upwind and another the approximate downwind conditions at each site. These monitors and samplers are complemented by one meteorological measurement system per site.

Sampling and Monitoring Site Selection

Site selection of this monitoring program follows EPA siting guidelines to the best extent practical. Monitor/sampler and meteorological measurement system locations are finalized during a site visit before monitor/sampler installation and onsite commissioning.

B.1.1 Monitoring Site Description

Continuous PM2.5 concentrations are monitored at two locations (BAM-1 and BAM-2) for each site. A 10-meter tall aluminum tower is installed at a third location (Meteorological Station) to support meteorological sensors. BTEX passive samplers are located at four sites around the fenceline of each site with one sampler collocated with each PM2.5 monitor. The inlets of each continuous PM2.5 monitor and BTEX sampler are installed within the breathing zone.

Site-specific information including monitor coordinates, siting descriptions, pictures of monitors, and climatology summaries are shown in the following Appendices for each affected facility.

1. Appendix A: NV110 Well Pad

B.2 Sampling and Measurement Methods

The purpose of this section is to identify the equipment used for collecting the required environmental data. All relevant equipment performance specifications are listed in this section. For more detailed information consult the individual manufacturer manuals.

B.2.1 Met One Instruments, Inc. BAM-1022 Real-Time Beta Attenuation Mass Monitor-Outdoor PM2.5 FEM Configuration

The Met One Instruments Model BAM-1022 Continuous PM2.5 Monitoring System uses beta ray attenuation to accurately measure and report the concentration of airborne particulate matter in ambient air. To determine ambient PM2.5 concentrations, the BAM-1022 draws air through a size-selective inlet, down an inlet tube, and deposits the particulate on a filter tape that is located between the beta source and a detector. The degree of beta-ray attenuation is used to determine the mass of particulate matter deposited on the filter tape. The sampling process is controlled via the sampling flow rate. The BAM-1022 calculates ambient PM2.5 concentrations based on the sampling flow rate and the PM2.5 mass deposited on the filter tape.

The BAM-1022 is designated a Class III Federal Equivalent Method (EQPM-1013-209) when configured for 1-hour average measurements of PM2.5 using a glass fiber filter tape roll and a precisely controlled sample flow rate of 16.67 lpm. Additional requirements include the use of a standard EPA PM10 inlet (meeting 40 CFR 50 Appendix L specifications) and a VSCC, as well as an external enclosure BX-597 ambient temperature/barometric pressure/relative humidity combination sensor. The BAM-1022 does not require any external temperature control to remain FEM-compliant, as it is designed to maintain a near-constant temperature difference between ambient and measurement conditions. Select BAM-1022 performance specifications are listed in Table B-1.

Table B-1. Met One Instruments BAM-1022 Specifications

Measurement Principle	Beta Attenuation
Beta Source	14C (Carbon14), 60µCi±15µCi (< 2.22 X 106 Beq), Half-Life 5730 yrs.
EPA Designations	EPA Class III Federal Equivalency Method (EQPM-1013-209)
Measurement Range	-15 ug/m3 – 10,000 ug /m3
Accuracy	Meets US-EPA Requirements for Class III PM2.5 FEM
Data Resolution	1.0 ug /m3
Lower Detection Limit	< 4.8 ug /m3 (Hourly, 2σ), < 1.0 ug /m3 (24 Hour, 2σ)
Measurement Cycles	Primary: Automatic Hourly PM Measurement (Required for PM2.5 FEM Operation), Secondary: User Selectable Short-Term Averages (15 to 60 minutes)
Sample Flow Rate	16.7 liters/minute
Flow Accuracy	±2.0%
Filter Tape	Continuous glass fiber filter, 30mm x 21m roll. Up to 2 months of operation per roll.
Span Check	Manual Audits Performed with Zero and Span Foils (Included)
Operating Temp. Range	-30° to +50° C
Operating Humidity Range	0 to 90% RH, non-condensing
Enclosure	Monitor housing meets all requirements for FEM sampling.
Data Logger Memory	22,528 records: 76.7 days @ 1 record/5 mins, 2.6 years @ 1 record/hr

The measurement cycle of the BAM-1022 is approximately one hour with a gap of one minute between measurements. However, given that the measurement occurs continuously while the PM2.5 mass accumulates on the filter tape, hourly results can be supplemented with shorter-term data that can be used for data trending purposes. For this project, the short-term concentration data period is set to 60 minutes, i.e. the instrument reports a 1-hour rolling average that is updated every five minutes starting at the end of the first sampling hour and until the sample is stopped. The 1-hour and 1-hour rolling average measurements are saved locally on the BAM-1022 and transmitted to a cloud-based environmental data management system for real-time visualization and archival. The timestamp of each completed hourly measurement corresponds to the start of the hour on local standard time. Data logged by each BAM-1022 are listed in Table B-2.

Table B-2. Data Logged by each BAM-1022

Parameter	Resolution / Unit	Average / Sampling Frequency
Local Time Stamp (Starting Time of Sampling Period)	N/A	N/A
Short-Term PM2.5 Mass Concentration (Local Conditions) / Updated every 5 Minutes	0.1 ug/m3	1 hour
Hourly PM2.5 Mass Concentration (Local Conditions)	0.1 ug /m3	1 hour
Hourly PM2.5 Mass Concentration (Standard Temperature and Pressure)	0.1 ug /m3	1 hour
Air Sampling Flow Rate (Local Conditions)	0.01 lpm	5 min
Ambient Temperature	0.1 °C	5 min
Filter Tape Temperature	0.1 °C	5 min
Barometric Pressure	0.1 mmHg	5 min
Ambient Relative Humidity	1%	5 min
Filter Tape Relative Humidity	1%	5 min
System Status Flag (1 = Tape Break, 2 = Low Beta Detector Count, 4 = Sensors out of Range, 8 = High Tape Advance Pressure, 16 = Flow Failure, 32 = Nozzle Failure, 64 = Ambient Sensor Comm Loss, 128 = Power Failure, 256 = Short Sample Cycle, 512 = Maintenance)	N/A	5 min

B.2.2 EPA Method 325A/B Passive Sorbent Trap Sampler

The BTEX samplers consist of a sorbent trap that is suspended within a plastic cap to provide cover from the elements. The sorbent trap is designed to maintain a constant uptake rate for the target compounds via the use of a diffusion cap. This cap is attached to each sorbent trap for the 14-day sampling duration. Each sorbent trap is suspended from a tripod to collect ambient air at the approximate breathing height of 2 meters.

B.2.3 Meteorological Measurement System

This section provides an overview of the equipment used for measuring meteorological parameters. Key sensor specifications are listed in Table B-3. For more detailed information consult the manufacturer's manual.

B.2.3.1 Met One Instruments, Inc. Model AIO2 and 30.5 Sonic Anemometers

One Met One Instruments Model AIO-2 and 30.5 Sonic Anemometers are installed on top of a 10-meter meteorological tower to measure wind speed and direction. Each sonic anemometer is designed for ambient wind sensing in harsh environments and industrial applications and operate on the principle of measuring the speed of sound in the air. Both models include a compass that provides for an automatic alignment of the anemometer to magnetic North. A correction for the magnetic declination (9 degrees West) is accomplished via the datalogger attached to each sensor.

Table B-3. AIO-2 and 30.5 Anemometer Specifications

Wind Speed	
Range	0-134 mph (0 - 60 m/s)
Starting Threshold	0.5 mph (<0.2 m/s)
Accuracy	±1.1 mph (0.5m/s) or 5% of reading (whichever is greater)
Resolution	0.1 mph
Temperature Range	-40 °C to +60 °C (-40 °F to 140 °F)
Wind Direction	
Range (Azimuth)	0 ° - 360 °
Starting Threshold	0.5 mph (<0.2 m/s)
Accuracy	±5 ° (per factory calibration)
Resolution	1 °
Temperature Range	-40 °C to +60 °C (-40 °F to 140 °F)

B.2.3.2 Tower and Support

The sonic anemometers (wind speed and wind direction) are mounted on the top of a 10-meter-tall aluminum tower of either telescoping round tapering tubular or open-frame design. Each tower base is firmly secured to the ground.

B.2.3.3 Met One Instruments, Inc. AutoMet 580 Data Collection Platform

The AutoMet is a weatherproof data logger designed to accept a variety of standard Met One Instruments and other sensors. Direct measurements recorded by the data logger are wind speed and wind direction. Based on the direct measurements, the data logger derives the resultant vector wind speed, direction, as well as sigma theta. Meteorological sensors connected to the data logger are sampled every second. The collected sensor signals are further processed into 5-minute averages and stored on the datalogger along with a data status flag indicating when data channels are offline, e.g. during QA activities and maintenance. The status flag can be toggled locally on the data logger by the performing field service technician.

The maximum local data logging capacity is 36 days for 5-minute averages before data values are overwritten. To avoid data loss, all logged data values are transmitted to a secure external cloud-based environmental data management platform via a communication port and attached telemetry. The timestamp for each completed measurement corresponds to the start of the measurement period at local standard time.

B.2.3.4 Met One Instruments, Inc. Model BX-597 Temperature / Relative Humidity / Barometric Pressure Sensor

The Model BX-597 multi-parameter weather sensor is an all-in-one sensor that measures ambient temperature, relative humidity, and barometric pressure. This is achieved by using a class 1/3B platinum resistance temperature detector (RTD), a microprocessor-controlled solid-state relative humidity sensor, and a piezo-resistive barometric pressure sensor. All components are housed in a multi-plate naturally aspirated radiation shield to reduce solar radiation heating errors. The radiation shield consists of a series of concentric white aluminum plates that allow airflow to pass through the shield while blocking direct solar rays.

The Model BX-597 ambient temperature, relative humidity, and barometric pressure sensors are connected to each PM2.5 monitor (BAM-1022), and the data is logged by the monitor. The reported meteorological measurements of ambient temperature, relative humidity, and barometric pressure are based on the reading of these sensors. BX-597 sensor specifications are listed in Table B-4.

Table B-4. Meteorological Sensor Specifications

Ambient Temperature	
Range	-50 °C to +70 °C (-58 °F to 158 °F)
Accuracy	±0.2 °C
Resolution	0.01 °C
Relative Humidity	
Range	0 - 100 %
Accuracy	±2 %
Resolution	0.1 %
Barometric Pressure	
Range	500 - 1100 mbar (14.8 to 32.5 inHg)
Accuracy	±0.5 mbar
Resolution	0.01 mbar

B.3 Sampling Handling and Custody

Handling of sampling media pre- and post-sampling will follow designated SOPs. The SOPs require that disposable, clean, lint-free nylon or cotton gloves be worn during the handling of all sorbent material/cartridges to aid in minimizing potential interferences. Designated COC forms are used for proper documentation of each sampling media (sorbent traps) throughout the sampling and shipping process.

Used BAM-1022 filter tapes are re-packaged into their designated storage containers and marked with the project number, well pad name, and dates when sampling commenced and ended. Sampled filter tapes are stored in CleanAir's Pittsburgh, Pennsylvania, office.

B.4 Analytical Methods

All exposed sample media (sorbent traps), including the field blanks and duplicates, are shipped to an accredited laboratory (Eurofins Air Toxics, LLC) for BTEX analysis via U.S. EPA Method 325B.

B.5 Quality Control Requirements and Procedures

There is uncertainty in every measurement. To minimize the uncertainty and produce acceptable data that is readily comparable, a monitoring program must operate under a QMS and control measurement processes through the implementation of routine quality control activities such as inspections, quality control checks, verifications, use of blanks, independent audits, etc. The goal of these activities is to measure the attributes and performance of a process, item, or service against defined standards to verify that they meet established acceptance criteria.

A complete listing of all quality assurance field activities is shown in a previous section in Table A-5, Table A-7, Table A-8, and Table A-9 together with their frequency of occurrence, applicable MQOs, and recommended corrective actions. All quality control requirements are conducted per applicable SOPs and noted in the electronic logbook. Results are recorded in the respective forms and checklists.

B.5.1 Quality Control Requirements for each BAM-1022 PM2.5 Monitor

Key field quality control requirements for each BAM-1022 PM2.5 sampler include but are not limited to, performing

- Visual intake system assembly checks and cleaning, including downtube cleaning
- Visual filter checks for signs of pinholes, tares, etc.
- System leak check to verify system integrity
- One-point flow rate checks to verify system performance
- One-point ambient temperature sensor checks to verify sensor performance
- One-point relative humidity sensor checks to verify sensor performance
- One-point barometric pressure sensor checks to verify sensor performance
- One-point filter temperature, pressure, and relative humidity sensor checks to verify sensor performance
- Span Mass Check
- Time check

B.5.2 Quality Control Requirements for each Passive Sampler

Key field quality control requirements for each passive sampler include but are not limited to, performing

- Visual checks on the sorbent trap and shelter
- Sorbent trap field blanks to determine the extent of any contamination
- Sorbent trap duplicates to evaluate the measurement precision

B.5.3 Quality Control Requirements for Meteorological Measurements

The field quality control requirements for the meteorological measurement system include performing

- Routine site checks and comparison of wind sensor readings to prevailing conditions
- Tower and signal cable integrity checks
- Time Check

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Every instrument requires acceptance testing when initially received and ongoing testing, inspection, and periodic preventive maintenance to ensure that it continues to operate within the manufacturer's specifications and generates quality data. This section describes the testing that is performed before the start of the project and details routine preventive maintenance efforts.

B.6.1 Proof of Performance Test

The monitoring equipment used in this monitoring program was acquired from manufacturers whose equipment meets all the relevant EPA ambient air and meteorological monitoring guidelines. The target compounds are measured using monitoring and sampling instrumentation that is designated as FEM or described in EPA reference methodologies. After ordering, all instrumentation is shipped to CleanAir's Pittsburgh, Pennsylvania, office for assembly and integration by experienced instrument technicians in accordance with the manufacturer's recommendations. Before assembly, all instrumentation is inspected and checked individually for any damage incurred during transport and non-conformance with manufacturer specifications.

Once assembled, manufacturer-recommended initial performance tests are conducted on the integrated units. All instruments are paired with a data acquisition system and associated telemetry that is programmed and configured to perform the site-specific monitoring tasks. All instruments and peripheral sensors, program functions, data acquisition, configurations, data storage, and transmission to a secure password-protected cloud-based environmental data management system are verified.

EPA Method 325A/B sampling stations and sorbent traps are purchased from accredited laboratories and checked for any signs of damage before transport to the site.

B.6.2 Station Acceptance Test

Following delivery to the site, all samplers and monitoring systems will be installed at the locations described in this QAPP. Once installed, CleanAir performs an on-site site acceptance test (SAT) to document station siting and confirm the proper operation of the equipment installed at each station. The SAT includes equipment and measurement data checks, initial sensor and equipment calibrations, communication equipment checks, and other applicable QC checks. All SAT activities are compiled into an SAT report. The report includes the results of all on-site tests and checks, as well as site pictures to document the sampler and monitoring system siting and status at the time of installation.

B.6.3 Routine Site Visits and Inspections

Routine site visits and inspections are conducted by Field Service Engineers based in CleanAir's Pittsburgh, Pennsylvania, office and include routine instrument inspections, operational status checks, routine QC checks, and preventive maintenance. All inspections and follow-up actions are performed according to applicable SOPs. Routine site visits are conducted initially every two weeks and then once a month. All checks are entered in the routine site visit check form and documented in an electronic logbook.

B.6.4 Preventive Maintenance

Preventive maintenance is scheduled per instrument-specific requirements and typically is performed during routine site visits. To some extent, scheduling is also influenced by near-real-time remote monitoring of monitoring system measurement results and system operating parameters. All preventive maintenance activities are documented in the electronic logbook and task-specific forms. Spare parts to complete the most common preventive maintenance tasks are maintained onsite or in CleanAir's Pittsburgh, Pennsylvania, office. Routine inspection and preventative maintenance activities are performed on-site per applicable SOPs and following manufacturers' and EPA guidelines. Applicable maintenance activities are listed in Table B-5.

Table B-5. Preventive Maintenance and Inspection Schedule

Maintenance Activity
Met One Instruments BAM-1022
• Check the sample inlet for any obstructions to the airflow and clean as needed (every visit) • Clean the sample inlet and VSCC / particle trap (every 30 days). • Empty the inlet water collection jar as needed (every 30 days) • Completely disassemble the inlet and clean the downtube (every 90 days) • Clean filter transport system: nozzle, vane, and pinch roller (every filter tape replacement) • Clean internal nozzle (every 90 days) • Clean internal enclosure filter (every 90 days). • Replace filter tape when about 10% of the tape is left, or as needed • Rebuild the sample pump once every 12 months, or as needed. • Verify operational settings (every visit)
Passive Sampler
• Check shelter for insect activity and any obstructions to the sorbent trap inlet and clean as needed(every visit)
Meteorological Station
• Visual inspection of the meteorological sensor (from ground level) and tower system/fasteners • Inspection of signal and power cables for deterioration • (every visit)

B.6.5 Corrective Maintenance and Response to Out-of-Control Conditions

It is expected that during the monitoring program, there will be unforeseen circumstances that negatively affect the availability and validity of monitoring data. If problems arise, prompt actions must be taken to correct any issues and return the affected sampling or monitoring station to an operational state that conforms to established acceptance criteria. Depending on the severity of the problem, corrective maintenance can be performed on-site, or in any of CleanAir's office locations. Any equipment returned into service undergoes a performance test followed by the applicable quality assurance on-site.

The best cause of action is typically determined on a case-by-case basis pending authorization by the Project Manager and, if necessary, plant personnel. All troubleshooting and corrective maintenance activities, as well as results of quality assurance activities performed during or as a follow-up to the corrective maintenance, are documented in the respective checklists, and forms, and noted in the electronic logbook. A Corrective Action must be initiated by the Field Service Engineer and the appropriate form forwarded to the Project Manager for further review and acknowledgment, per CleanAir's AMS group's corrective action process.

B.7 Instrument/Equipment Calibration and Frequency

All monitoring, sampling, and test equipment used for data generation or sample collection must be periodically calibrated to maintain performance within specified limits. These calibrations are conducted using transfer standards that can be traced to national standards maintained by NIST. To ensure continued traceability, transfer standards require regular comparison to their primary standards. This section identifies the calibrations performed during the monitoring project and the re-certification requirements and frequency for each transfer standard.

B.7.1 Met One Instruments BAM-1022 Calibrations

Calibrations of the PM2.5 monitoring equipment and associated sensors are performed to control deviations from existing standards to maintain high data quality and traceability. Calibrations are performed during initial installation and then at defined intervals or after major instrument repairs, including a

- Multi-point flow rate calibration/calibration verification
- Multi-point ambient temperature sensor calibration/calibration verification
- One-point barometric pressure sensor calibration/calibration verification
- One-point filter sensor calibration/calibration verification (temperature, relative humidity, upper and lower tape pressure)
- 72-hour zero background test

All calibrations are conducted per applicable SOPs and noted in an electronic logbook. Results are recorded in the respective forms and checklists. A complete listing of applicable calibrations including their frequency of occurrence for this project, applicable MQOs, and recommended corrective actions is shown in a previous section in Table A-7.

B.7.2 Meteorological Measurement System Calibrations

Sonic anemometers are not calibrated on-site. Instead, each sonic anemometer is removed from service at defined intervals and returned to the manufacturer for factory recertification. The factory recertification is documented via a certificate issued by the manufacturer. Applicable calibration requirements were listed in a previous section in Table A-9 together with the respective frequency of occurrence, applicable MQOs, and recommended corrective actions. All quality assurance activities are conducted per applicable SOPs and noted in the electronic logbook. Results are recorded in the respective forms and checklists.

B.7.3 Traceable Calibration Equipment and Standards

Transfer standards are categorized per their intended use as either working standards (calibrations, verifications, and QC checks) or audit standards. Both working and audit standards are compared to primary standards at required intervals. Depending on the standard and equipment purpose, this certification is either performed at CleanAir's in-house calibration laboratory, a reputable and accredited external laboratory, or by the original equipment manufacturer. Table B-6 identifies the transfer standards used in this project and their re-certification requirements and schedule.

While the specifications for standards used for calibrations, QC checks, and audits are identical, audit standards must be completely different from those used for routine calibrations and QC checks. This is required to maintain audit independence, which is a prerequisite for a meaningful equipment performance evaluation. However, the calibration and audit standards may be referenced to the same NIST primary standard (40 CFR Part 58, Appendix A, Section 3.2.2).

Table B-6. Calibration and Audit Standards Requirements

Equipment / Parameter	Frequency of Re-Certification	Standard Acceptance Criteria
Flow Rate Transfer Standards	Annual	≤ ±2.1% of NIST-primary standard
Thermometer / Probe	Annual	≤ ±0.2 °C of standard ≤ 0.1 °C resolution
Field Barometer	Annual	≤ ±5 mm Hg (0.2 inchHg) of standard ≤ 1 mm Hg (0.04 inchHg) Resolution
Relative Humidity	Annual	≤ ±2% RH
Timepiece	N/A	Access to NIST atomic clock with 1-sec resolution

B.8 Inspection/Acceptance of Supplies and Consumables

Key spare parts and consumables are obtained either directly from the original equipment vendor or from a vendor with products proven to be equivalent in quality. Before committing received spare parts and consumables into inventory, they are visually inspected for damage incurred during transport and tested (if applicable) for functionality and adherence to the manufacturer's specifications. Spare parts and consumables for this project are maintained onsite and at CleanAir's Pittsburgh, Pennsylvania, office.

B.9 Non-Direct Measurements

The use of data from non-direct measurement sources (e.g. existing data) is not required by this monitoring program. However, existing data, if available, can be used on occasions to assist in data review and validation by comparison with data generated by the monitoring stations of this project.

B.10 Data Management

Minimizing data loss is important to each monitoring program to meet and exceed the program's data completeness requirements. Data loss can result from missing or invalid data. This section gives an overview of the management of the data generated throughout the project and focuses on procedures to minimize missing or invalid data to the greatest extent possible.

B.10.1 Data Flow

The data generated during this project consists of real-time data as well as data recorded on applicable field service sheets, QC checks, audit sheets, the chain of custody forms, as well as laboratory results in electronic format. Real-time data is generated by the meteorological measurement system and each BAM-1022. Every 5 minutes, the raw real-time data is block-averaged and stored locally on each BAM-1022 and a designated station data logger for the meteorological measurement system.

Raw averaged data and system status identifiers are polled from each station data logger via a designated custom ethernet router with firewall protection and transmitted to a secure cloud-based environmental data management platform. This cloud-based data management platform provides for online data visualization and storage of the raw unedited data, as well as all project-related documentation and validated data. Locally stored raw data is retrieved during each site visit by a Field Service Engineer using a dedicated USB memory stick. This memory stick represents an additional data archive that is used to back-fill potential data gaps, as needed.

The passive sorbent tube data generated during this project consists of data recorded on applicable field service sheets, chain of custody forms, as well as laboratory results in electronic format. The laboratory results are checked and entered into the cloud-based data management platform for visualization and analysis.

Finally, all data and documents generated during the monitoring program are backed up to CleanAir's Corporate Server. A data flow overview is shown in Figure B-1.

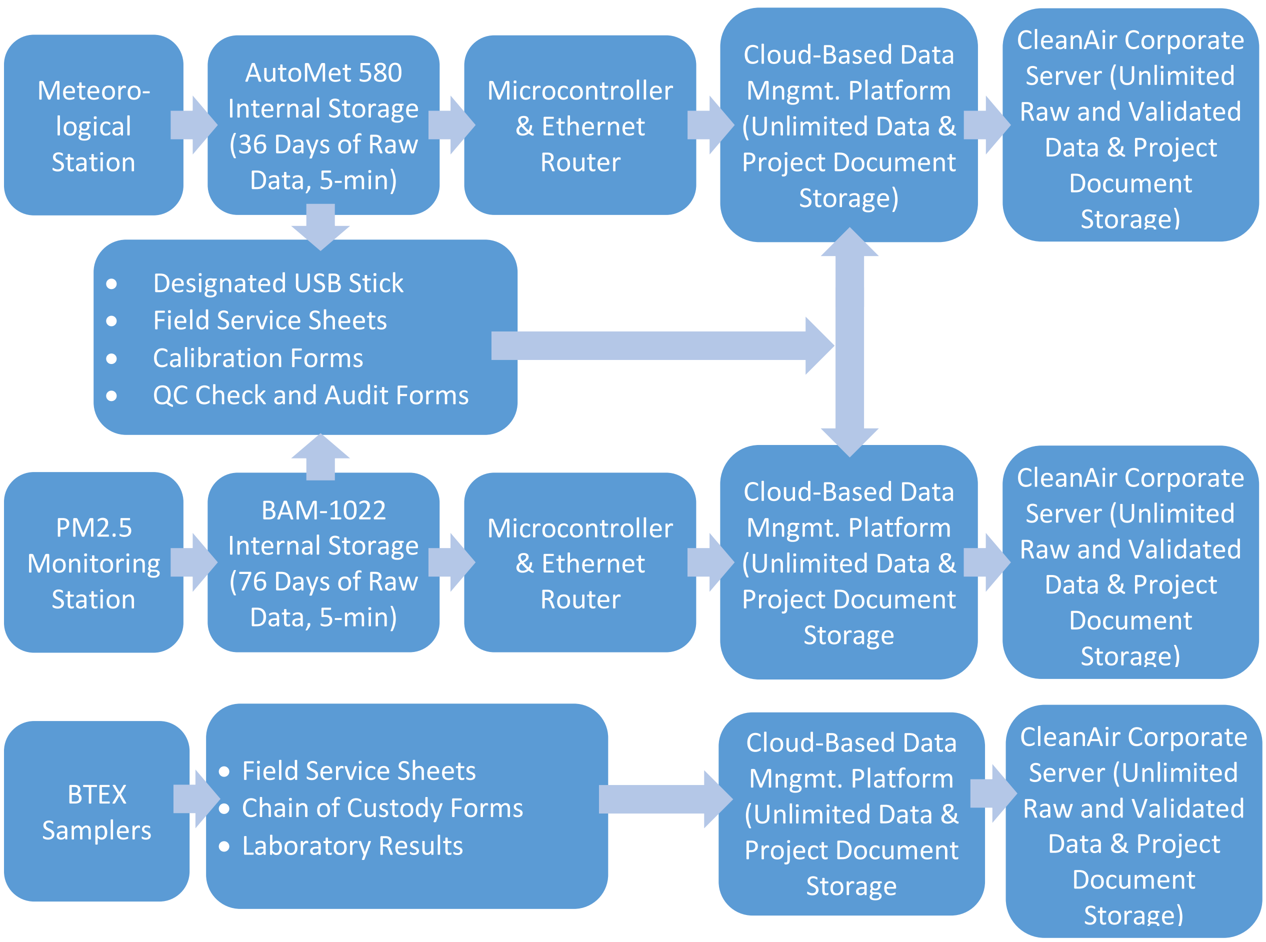

Figure B-1. Data Flow Diagram

B.10.2 Recordkeeping

All data files are named in a way that uniquely identifies their origin and time frame of acquisition, i.e. the filename will contain the station identification and the date of acquisition. Any quality assurance activity forms/sheets are scanned by the Field Service Engineer and forwarded to the

Data Manager for archival. The scanned documents are named to identify the date of service, station identifier, and purpose. Electronic laboratory results are identified by the station identification and corresponding chain of custody form identifier. All data and documents are stored on CleanAir's Corporate Server under the respective project folder identified by the unique project number and client/project description.

B.10.3 Missing and Invalid Data

Each business day, the Data Manager checks the cloud-based environmental data management platform to ensure that all data are polled and transmitted successfully from each monitoring station and stored in the database. In case of missing data, corresponding timestamps are recorded, and data are merged into the database once they are retrieved from the local monitoring station data loggers.

Once a month, the data manager will verify that all documents related to the monitoring and sampler systems operation (including the laboratory results) are complete and have been received in electronic format. Following the verification, all PM2.5 monitor data, meteorological measurements, and laboratory results are reviewed and validated, and a monthly data summary report is generated. Any missing or invalidated data is documented along with the reason for invalidation. The Project Manager conducts a final QA review before the data summary report and any associated data is submitted to CNX in electronic format.

C. PERFORMANCE ASSESSMENT AND OVERSIGHT

Every monitoring project includes periodic independent assessments to provide continuing verification that the project is being performed according to the procedures developed in the QAPP and that the data obtained meets the measurement quality and overall monitoring project objectives. The following sections detail the assessments performed for this project, their frequency, the personnel responsible, and the reports produced, as well as corrective actions taken based on the results of each assessment.

C.1 PM2.5 Monitoring System Audits

The assessments performed throughout the project consist of the following performance audits for each PM2.5 monitor:

- Performance audit of the monitor flow rate measurement
- Performance audit of the monitor-generated ambient temperature, relative, humidity, and barometric pressure audit
- Monitor time audit

PM2.5 monitor audit frequencies, acceptance criteria, and corrective actions were listed in a previous section in Table A-7 and Table A-9

C.2 Meteorological System Audits

There is no independent performance audit for the meteorological measurement system except for a time audit of the data logger conducted on each sonic anemometer. However, anemometers are sent annually for re-calibration to the equipment manufacturer. Calibrations and corrective actions are documented via calibration certification sheets.

Ambient temperature, relative humidity, and barometric pressure are determined continuously by each PM2.5 monitor. As a result, performance audits of the respective sensors are conducted as part of the PM2.5 monitoring system audits. Meteorological system calibration and audit frequencies, acceptance criteria, and corrective actions were listed in a previous section in Table A-7 and Table A-9.

C.3 Passive Sampler Operation Audit

The passive sampler operation is audited annually to ensure consistent sample collection and operation documentation.

C.4 Audit Responsibility, Standards, and Actions

All audits are performed without any special preparation or adjustments of the systems under evaluation. The auditor (QA Manager) is an individual with a thorough working knowledge of the monitoring equipment to be audited and/or measurement process but is not involved in routine operations. The QA Manager for this project is CleanAir's Ambient Air Monitoring Program Manager. The QA Manager is not directly involved with the routine monitoring station operation, maintenance, or the performance of QC checks.

All audit standards are certified NIST-traceable and different from those used for routine calibrations and QC checks (working standards). However, the calibration and audit standards may be referenced to the same NIST primary standard. All audit activities are conducted per their respective SOPs documented in the respective audit forms, noted in the electronic logbook, and archived together with the calibration certificates for each audit standard.

C.5 Corrective Actions

If an audit identifies areas of concern with respect to the monitoring program, the QA Manager must initiate the corrective action process to start an investigation. Once initiated, it becomes the responsibility of the Project Manager to investigate the event, develop a corrective action plan, authorize, and inform facility personnel, schedule any corrective actions, and document these activities in the corrective action report. Corrective action reports and their updates are stored with the other project documentation and records.

C.6 Assessment Reports

Performance audit reports are submitted to CNX as part of the respective month's data summary.

D. DATA VALIDATION AND USABILITY

Data review, verification, and validation is an ongoing process that is primarily the responsibility of the Data Manager. However, this process can also involve occasional onsite checks by the Field Service Engineers, as well as spot checks on monitoring data by the Project Manager. This section establishes the criteria used for accepting, rejecting, or qualifying data objectively and consistently.

D.1 Data Verification

For this project, the Data Manager verifies at the end of each month that all data was collected, recorded, and calculated correctly and that QA activities occurred at their scheduled times, were properly documented, and produced acceptable results.

D.2 Data Validation

Once the Data Manager verifies that all data and associated project documentation are complete, the data is validated by reviewing the data set and comparing the data against an established set of validation criteria. These criteria could be general such as looking for missing data, but also include criteria based on measurement system limitations or measurement results that would indicate system or sensor malfunctions. The results of the data validation process are documented, and invalid data is identified and flagged for further investigation.

D.3 General Data Validation Considerations

General data validation activities include but are not limited to

- Regular review of data to identify periods of missing data
- Review of QC checks, calibration forms, and maintenance records to verify that checks occurred at scheduled intervals
- Regular review of audit results to identify data potentially impacted by audit findings
- Graphing and visually examining time series critical operating parameters and QC check results to identify malfunctioning equipment
- Range checking of all sensor readings
- Applying statistical checking for potential data outliers (i.e. measurements that are extremely large or small relative to the rest of the data and are suspected of misrepresenting the population from which they were collected)
- Evaluation of goodness of fit and linearity (applicable to linear regression data such as for multi-point calibrations)

D.4 Continuous PM2.5 Monitor Data

Validation of the data generated by each continuous PM2.5 monitor includes but is not limited to

- Examining the continuous PM2.5 mass concentration measurements for spikes and extended periods of constant readings.
- Reviewing time series of sample flow rate, filter tape temperature, and filter tape relative humidity to determine whether action limits have been exceeded and to identify trends that indicate developing issues that may warrant further investigation.
- Identifying unusually high rates of change in subsequent measurements, or values that seem inconsistent with normal measurement ranges.
- Checking PM2.5 concentrations, sample flow rate, ambient temperature, barometric pressure, relative humidity, and filter tape temperature and humidity for data gaps.

- Checking for PM2.5 mass concentration values (hourly and near-real-time concentrations) for readings of 99.999 mg/m3 or 99999 ug/m3 indicating a critical alarm condition or the performance of quality assurance activities.
- Evaluating the daily average sample flow rate for deviation of more than 5% from the instrument design value of 16.67 lpm at local conditions.
- Evaluating the sample flow rate for variability of more than 2% over 24 hours as expressed by the Coefficient of Variation (CV = standard deviation/mean).
- Checking the BAM-1022 alarm status codes for equipment malfunctions (see Table D-1).

Table D-1. BAM-1022 Alarm Conditions

Alarm Code	Description	Cause
1	Tape Break	No tape movement was detected during the tape move process.
2	Beta Detector	The event occurs when the Beta detector count rate is less than 500 Hz during the sampling cycle.
4	Sensor Range	The event occurs when a sensor reading is outside the designated limits: • Ambient Temperature (AT): -50 to 70 °C • Relative Humidity (RH): 0 to 100% • Barometric Pressure (BP): 375 to 825 mmHg • Upper Filter Tape Pressure (UPPER): 228 to 818 mmHg • Upper Filter Tape Pressure (LOWER): 228 to 818 mmHg • Filter Tape Temperature (FT): -50 to 70 °C • Filter Relative Humidity (FRH): 0 to 98.9%
8	Tape Advance	The event occurs when the pressure drop across the tape exceeds the Tape Advance Pressure setting.
16	Flow Failure	The event occurs when the sample flow is • less than 1.0 SLPM for greater than 1 minute. • +/-10% out of regulation for 1 minute. • +/-5% out of regulation for 5 minutes.
32	Nozzle Failure	The event occurs when the nozzle fails to move and stops at the up or down position. The event will also occur when the foil device is inserted at the start of the operation.
64	Digital Link Failure	The event occurs when communication with the Model 597A combination sensor (AT, RH, BP) has ceased for greater than 10 seconds.
128	Power Failure	The event occurs for a power cycle or a microprocessor reset.
256	Short Sample	The event occurs when the first sample cycle is less than 1 hour.
512	Maintenance	The event occurs when the user stops normal operation.

* Per BAM-1022 Operating Manual (BAM-1022-9805 Rev C, 2020)

D.5 Passive Sampler Results

Validation of the data generated by each passive sampler includes but is not limited to

- Checking of laboratory reports quality control checks and any notes indicating deviation from expected outcomes
- Checking field blank and duplicate results

D.6 Meteorological Measurement System

Meteorological measurements are evaluated by comparing real-time measurement results to a set of criteria that are based on sensor limitations, values that would indicate sensor malfunctions or results that are improbable at the prevailing conditions at the site. Example evaluation criteria are shown in Table D-2. Criteria can be fine-tuned throughout the project based on local climate and meteorological conditions. Measurements are screened at the 1-minute level interval.

Table D-2. Meteorological Data Screening Criteria

Variable	Screening Criteria
Wind Speed	is less than zero or greater than 25 m/s (56 mph) does not vary by more than 0.1 m/s (0.2 mph) for 3 consecutive hours does not vary by more than 0.5 m/s (1.1 mph) for 12 consecutive hours
Wind Direction	are less than zero or greater than 360 degrees does not vary by more than 1 degree for more than 3 consecutive hours does not vary by more than 10 degrees for 18 consecutive hours

* Adapted from EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA 454/R 99 005. (2000).

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(1.) EPA QA/R-5 (March 2001), *Requirements for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, DC.
(2.) EPA QA/G-5 (December 2002), *Guidance for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, DC.
(3.) EPA QA/G-8 (November 2002), *Guidance on Environmental Data Verification and Data Validation*, U.S. Environmental Protection Agency, Washington, DC.
(4.) EPA-600/R-94/038a (April 1994), Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I - A Field Guide to Environmental Quality Assurance, U.S. Environmental Protection Agency, Washington, DC.
(5.) EPA-454/B-17-001 (January 2017), Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, U.S. Environmental Protection Agency, Washington, DC.
(6.) EPA-454/B-08-002 (March 2008), Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements Version 2.0 (Final), U.S. Environmental Protection Agency, Washington, DC.
(7.) EPA-454/R-99-005 (February 2000), *On-Site Meteorological Monitoring Guidance for Regulatory Modeling Applications*, U.S. Environmental Protection Agency, Washington, DC.

APPENDIX A:
NV110 WELL PAD

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Site Description

The NV110 well pad is located in East Finley Township, Washington County, Pennsylvania. East Finley Township is a rural community, located approximately 10 miles to the Southwest of Washington, Pennsylvania. The topography of the area around the well pad can be described as rolling hills with an elevation of approximately 1,300 ft above sea level. The local land use categories in the vicinity of the well pad include hay pastures, herbaceous grasslands, and deciduous forest, with low residential development and individual residences in all directions of the well pad within a radius of about 0.3 miles of the center of the well pad. An aerial view of the site with topography and monitoring site locations can be found in Figure AA-1.

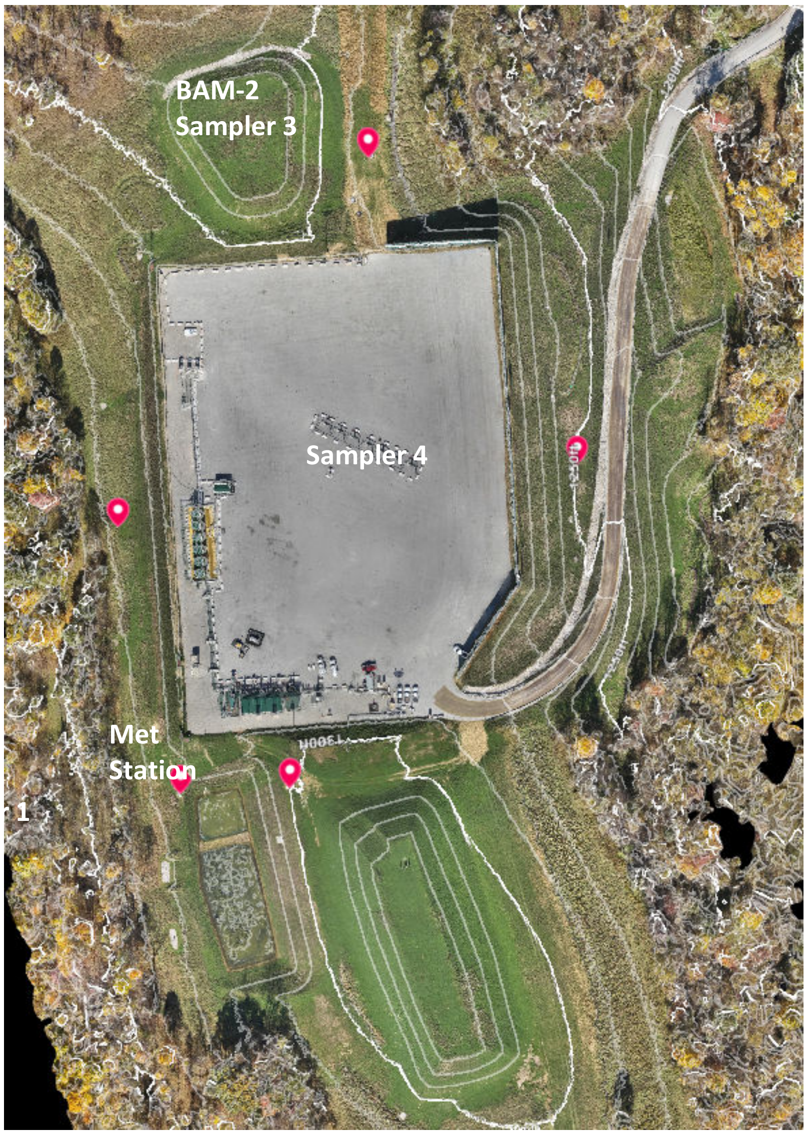

Figure AA-1. Aerial View of the NV-110 Well Pad and Monitoring Locations (BAM-1 and BAM-2: PM2.5 Monitors, Met Station: Meteorological Measurement System, Sampler 1 – 4: Passive BTEX Sampling Location). Contour Lines Represent a 10 ft Elevation Difference.

Monitoring Locations

A description of each monitor location can be found in Table AA-1 with details on the height of the sample intake, distance to roadways, distance to obstructions, and other important details. The spatial scale of the air sampled by the equipment installed at the station is anticipated to be of middle scale, potentially neighborhood scale. It should be noted that a sound wall with a height of approximately 20 feet boarded the Eastern edge of the well pad at the time of siting. All monitors are situated on relatively flat ground covered by grass. Pictures of each monitoring site are found below in Figures AA-2, AA-3, AA-4, AA-5, and AA-6.

Table AA 1. Monitoring Site Details

Monitor	Latitude [dd.dddd]	Longitude [dd.dddd]	Approx. Distance to Center of Site [m]	Approx. Sensor / Inlet Level [m]	Closest Obstruction Type	Approximate Distance, Direction, and Height of Obstruction [m, deg., m]	Distance to Road [m]
BAM-1	40.05341	-80.39303	140	3	Trees	25, 270°, 9	105
BAM-2	40.05567	-80.39241	120	3	Sound Wall	40, 150°, 6	120
Sampler 1	40.05342	-80.39291	140	2	Trees	25, 270°, 9	105
Sampler 2	40.05448	-80.39341	90	2	Trees	5, 270°, 9	150
Sampler 3	40.05566	-80.39253	120	2	Sound Wall	40, 150°, 6	120
Sampler 4	40.05434	-80.39136	95	2	Sound Wall	22, 270°, 6	30
Met Station	40.05346	-80.39255	130	10	Trees	60, 270°, 9	70

Looking towards the Site from the North

Looking towards the Site from the South

Looking towards the Site from the East

Looking towards the Site from the West

Figure AA-2. BAM-1 and Sampler 1 Site Photographs

Looking towards the Site from the North

Looking towards the Site from the South

Looking towards the Site from the East

Looking towards the Site from the West

Figure AA-3. BAM-2 and Sampler 3 Site Photographs

Looking towards the Site from the North

Looking towards the Site from the South

Looking towards the Site from the East

Looking towards the Site from the West

Figure AA-4. Sampler 2 Site Photographs

Looking towards the Site from the North

Looking towards the Site from the South

Looking towards the Site from the East

Looking towards the Site from the West

Figure AA-5. Sampler 4 Site Photographs

Looking towards the Site from the North

Looking towards the Site from the South

Looking towards the Site from the East

Looking towards the Site from the West

Figure AA-6. Meteorological Tower Site Photographs

Site Climatology

The climate at the NV110 Well Pad is classified as a warm-summer humid continental climate. This climate region is characterized by warm and humid summers and cold winters, which can be severe with snowstorms, strong winds, and cold from continental polar air masses. The average temperature of the warmest month is greater than 10 °C (50 °F), while the coldest month is less than -3 °C (27 °F). There are no significant precipitation differences between seasons.

The seasonal wind rose plots for the area for the last three years are shown in Figure AA-7. The data are taken from the Washington County Airport (AFJ), located approximately eight (8) miles to the Northeast of the well pad. These wind roses likely reflect the wind conditions across the entire area.

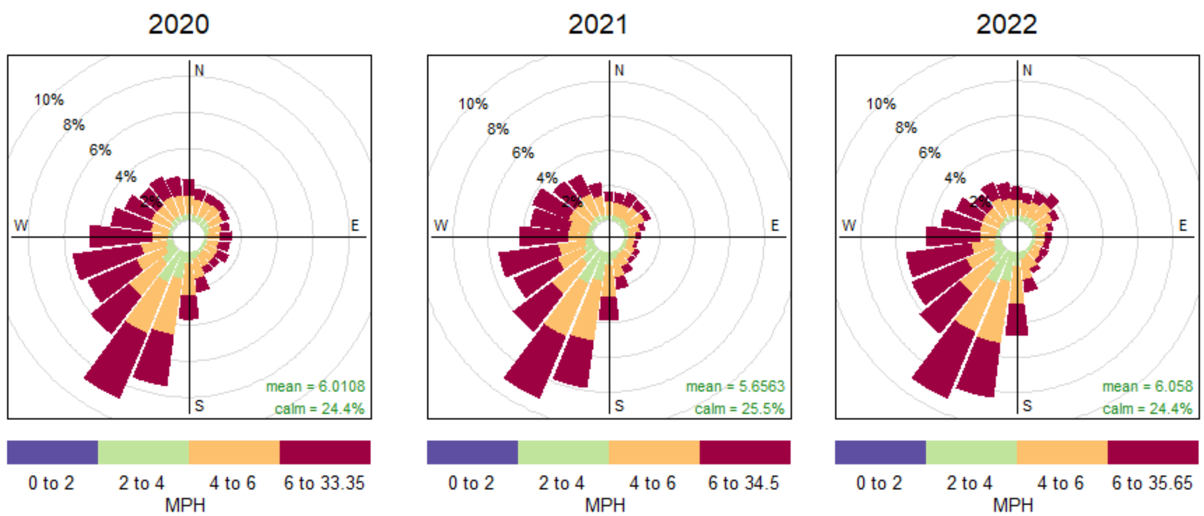

Figure AA-7. Annual Windrose Plots (Washington County Airport)