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Office of the Chief

Chuck Hoskin Jr.
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October 20, 2020

Frances Verhalen, Section Chief
Air Quality Analysis Section (6ARPM)
U.S. EPA Region 6
1201 Elm Street, Suite 500
Dallas, Texas 75270-210

RE: QAPP FOR CHEROKEE NATION'S CRITERIA POLLUTANT AND METEOROLOGICAL MONITORING PROGRAM

To Whom It May Concern:

Enclosed please find the revised sections of the Quality Assurance Project Plan for the Cherokee Nation's Criteria Pollutant and Meteorological Monitoring Program for your review. These revisions address the "EPA QAPP Comments (Technical Comments for future QAPPS)" document we received on June 18, 2019 as well as some minor revisions that have been made to the Clean Air Program. A new signature page has been included. Please sign and date the signature page and return a copy of it to me. The QTRAK number for this QAPP is QTRAK# 19-307.

Minor revisions were made to the QAPP which pertain to the discontinuation of the Newkirk air monitoring station and procurement of a new nitrogen oxide monitor and new trace carbon monoxide monitor. These revisions including EPA comments are addressed and incorporated primarily in Sections 5, 6, 7, 10, 11, 13, 14, 15, and 16.

If you have any questions or concerns, please contact me at (918) 453-5098. Thanks for your time and effort in reviewing the QAPP.

Sincerely,

April Hathcoat

April Hathcoat, Director
Cherokee Nation Environmental Programs

Enclosure

Cc: CNEP Air Program Files

QUALITY ASSURANCE PROJECT PLAN (QAPP)
for the
CRITERIA POLLUTANT AND METEOROLOGICAL MONITORING PROGRAM

Cherokee Nation Environmental Programs (CNEP)

and the

Inter-Tribal Environmental Council (ITEC)

Tahlequah, Oklahoma

October 2020

1 Quality Assurance Project Plan Approval

Wayne Isaacs ______________________ Date: 10/21/2020
Wayne Isaacs, Senior Director
Environmental Programs
Cherokee Nation

April Hathcoat ______________________ Date: 10/20/20
April Hathcoat, Director
Environmental Programs
Cherokee Nation

Danielle Keese ______________________ Date: 10-20-20
Danielle Keese, Environmental Specialist III
Environmental Programs
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Frances Verhalen, Section Chief
Air Monitoring & Grants Section
U.S. EPA, Region VI Office

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Aunjanee Gautreaux, Project Officer
Air Monitoring & Grants Section
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______________________ Date:____________
Mark Sather, Environmental Engineer
Air Monitoring & Grants Section
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5 Problem Definition/Background

5.1 Problem Background

The Inter-Tribal Environmental Council (ITEC) is a consortium of federally-recognized tribes (**Figure 5.1**). As a consortium, ITEC's primary goal is the protection of the health, safety and welfare of the Indian population. This goal includes the proper management of Indian environmental resources, e.g., land, air and water. As the lead technical agency for the consortium, the Cherokee Nation Environmental Programs (CNEP) is committed to providing environmental management services to the ITEC member tribes.

5.2 Problem Definition

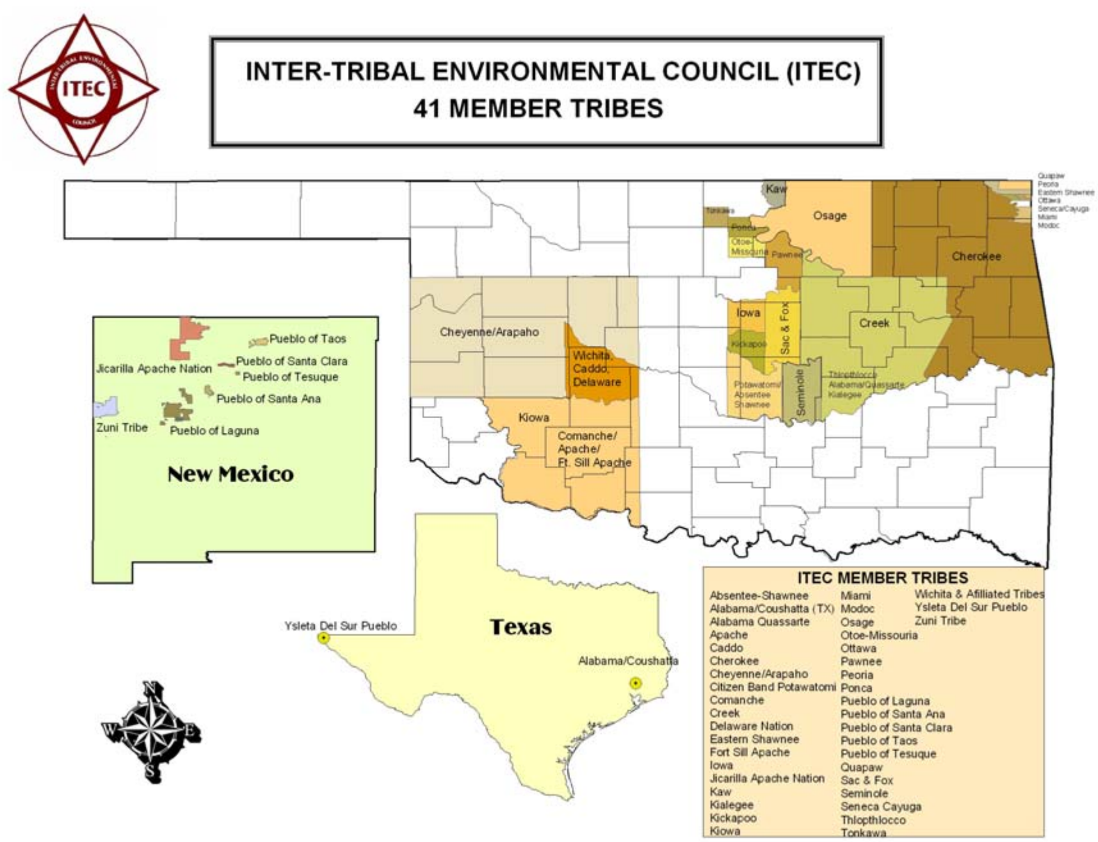
In 1997, the EPA Office of Air & Radiation prepared a draft document titled "Strategy for Implementing the Clean Air Act in Indian Country." Within the context of the document the EPA acknowledged that there was a lack of real reservation-specific data to quantify or qualify air quality issues; an incomplete federal regulatory authority in Indian Country; an increased need for technical support in the regions; and a problem of variable tribal capacity. The document identified the following in its strategic solution for tribes: the need to develop regulatory authority; build regional agency capacity; work with tribes to build their own capacity; and provide technology information transfer. The EPA Region VI Office began to address some of these environmental issues and other concerns through the Inter-Tribal Environmental Council (ITEC) and through funding to individual tribes, such as the Cherokee Nation (CNEP).

In 1997, the EPA Region VI Office provided Clean Air Act (CAA) 103 grant funding to the CNEP to begin ambient air monitoring of criteria pollutants, meteorological parameters, and some hazardous air pollutants (HAPs) on tribal lands. The criteria pollutants currently being monitored by the CNEP include five of the six principal pollutants that have established National Ambient Air Quality Standards (NAAQS). They are particulate matter (PM10, PM2.5), sulfur dioxide, carbon monoxide, nitrogen dioxide and ozone. However, at this time, our current PM network is not intended for regulatory NAAQS comparison. In addition, the CNEP is monitoring for NOy, Mercury (Hg), and Ammonia (NH3). The meteorological parameters are wind direction, wind speed, temperature, relative humidity, and precipitation. The CNEP also has instruments with the capabilities to monitor for hazardous air pollutants (HAPs) that use summa canisters, filter-based samplers, and wind vector monitoring techniques. When instruments are in operation, all HAPs monitoring performed by the CNEP will be addressed in a separate QAPP.

The primary purpose of the CNEP/ITEC ambient air monitoring network (fixed locations at Stilwell, Pryor, Newkirk (will be discontinued in September 2020), and Roland in Oklahoma, and mobile monitoring on lands of various tribes in Oklahoma, Texas, and New Mexico) is to collect air quality data on tribal trust and individual trust lands within the jurisdictional boundaries of the Cherokee Nation reservation and various ITEC member tribes. Other purposes for the ambient air monitoring network include:

- educational training and tribal air program development
- special purpose monitoring (e.g., source, local, and regional transport, trends analysis, population exposure, health impact, environmental impact, rural impact)
- tribal participation in National Air Monitoring Networks & initiatives (NCore, CASTNet, IMPROVE, CENRAP (Regional Haze), HAPs, Mercury Deposition (MDN), Mercury speciation, AirNow Ozone and PM Mapping, National Trends Network (NTN), Passive Ammonia Monitoring Network (AMon))
- provide technical services to ITEC member tribes (e.g. writing technical documents, site/instrument setup, data management (AQS), independent audits, technical support (maintenance/troubleshooting))

Figure 5.1 shows the location of the ITEC member tribes' jurisdictional boundaries.



6 Project Description

6.1 Project Background

The Cherokee Nation ambient air monitoring network originally had five air monitoring sites in Oklahoma; however, it currently has four active air monitoring sites in the network. The criteria pollutant sites are located in or near Stilwell, Pryor, Newkirk, and Roland in Oklahoma. [The Newkirk site will be discontinued in September 2020.] Three of the sites are located on individual or tribal trust land while the Roland site is located on fee simple land owned by Cherokee Nation Businesses. The Tahlequah site went online in December 1998, was discontinued in September 2018, and the shelter was removed in April 2019. The Stilwell & Newkirk sites went online in March 2002. The Pryor site went online in November 2003. The Marble City site went online in March 2006; however, it has since been moved to Roland and went online in June 2010. All of the sites are designated as Special Purpose Monitoring Sites (SPMS) under the Tribal Ambient Monitoring Site (TAMS) designations with the Stilwell site serving as a national program site. The Stilwell site is designated as a CASTNet dry deposition site and an NCore site; as well as an IMPROVE regional haze site. [The NCore site is voluntary and not federally required by EPA.] CNEP technicians operate and maintain the sites.

The sites are designed to collect data from continuous gas analyzers and continuous particulate matter samplers. Each site has a temperature controlled shelter with analyzers that monitor for one or more of the following pollutants: SO_2, CO, NOx, NOy, NH_3, Ozone, PM2.5, and PM10. Each site continuously monitors for the following meteorological parameters: wind speed, wind direction, temperature, relative humidity, and precipitation. [Precipitation is not measured at Roland and the mobile monitoring station.] In addition, the Pryor site can be equipped to monitor for specific Hazardous Air Pollutants (HAPs) over defined time intervals using summa canisters, filter-based samplers, and regular meteorological instruments and vector directed instruments. When CNEP is sampling for HAPs, such as volatile organic compounds and metals, it will be covered in a separate QAPP.

The Stilwell site consists of two monitoring shelters, CASTNet and NCore. The Stilwell CASTNet monitoring shelter has ozone and trace NH_3 instruments as well as meteorological equipment. [Even though the ozone is housed in the CASTNet shelter, it is part of the NCore network.] The Stilwell site has additional meteorological monitoring for solar radiation and moisture. The CASTNet and IMPROVE monitoring is covered in separate, approved QAPPs. The CASTNet and IMPROVE programs will be responsible for updating their national QAPPs with any changes that are made to their networks. When the amendments are available, CNEP will ensure that EPA Region VI receives a copy. The ammonia monitoring is conducted for non-regulatory purposes in accordance with the operating instructions for the Ecotech 9842T continuous trace ammonia analyzer.

The Stilwell NCore shelter has trace level CO, SO_2, and NOy monitoring instruments as well as a Tekran mercury speciation monitoring system, Met One PM2.5 Federal Equivalent Method (FEM) Beta Attenuation Monitor (BAM), and Met One PM10 FEM BAM. The CNEP Tekran monitor is addressed in a separate QAPP, "Atmospheric Mercury Monitoring OK99-AMNet Stilwell, OK."

The four currently active fixed sites are registered with the EPA's Air Quality System (AQS), and data has been reported to AQS for all active sites since the third quarter of 1999. Both criteria pollutant and meteorological data are being submitted to AQS. The collected criteria pollutant data will be used to determine compliance with the EPA's National Ambient Air Quality Standards (NAAQS) and to determine attainment/non-attainment status for each airshed. **Table 6.1** identifies the primary and secondary NAAQS for the criteria pollutants. This data will also be used in conjunction with meteorological data to determine local and regional transport trends and issues. Trace-level pollutant data from the NCore site will be used for assessment, research, and compliance with revisions to the ambient air monitoring regulations promulgated on October 17, 2006 (71 FR 61236).

The mobile shelter went online in July 2006 and monitors continuous PM2.5, continuous PM10, continuous PMcoarse, and ozone (since May 2009) as well as meteorological parameters (wind speed, wind direction, temperature, relative humidity). The mobile shelter will be stationed for 9 to 12 months on tribal lands of various ITEC members that are located throughout Oklahoma, Texas, and New Mexico; however, the time period may be extended at the request of the host tribe. Data from the mobile shelter will also be reported to AQS. Such data will be used primarily for screening purposes; that is, to determine if future monitoring is warranted.

Table 6.1 National Ambient Air Quality Standards

National Ambient Air Quality Standards			
Pollutant	**Averaging Time**	**Standard Value**	**Standard Type**
Carbon Monoxide (CO)	8-hour average	9 ppm	Primary
	1-hour average	35 ppm	Primary
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm	Primary & Secondary
	1-hour average	0.100 ppm	Primary
Ozone (O_3)	1-hour average*	0.12 ppm	Primary & Secondary
	8-hour average	0.070 ppm	Primary & Secondary
Sulfur Dioxide (SO_2)	3-hour average	0.50 ppm	Secondary
	1-hour average	0.075 ppm	Primary
Particulate Matter (PM2.5)	Annual Arithmetic Mean	12 μg/m^3	Primary
	Annual Arithmetic Mean	15 μg/m^3	Secondary
	24-hour average	35 μg/m^3	Primary & Secondary
Particulate Matter (PM10)	24-hour average	150 μg/m^3	Primary & Secondary

*EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard.

6.2 Project Site Locations

The Stilwell, Newkirk and Pryor sites are located at the following coordinates and locations on Cherokee Nation trust land:

- CASTNet, NCore, and IMPROVE (Stilwell – AQS ID: 40-001-9009): Cherokee Nation jurisdiction. Adair County, Oklahoma, north latitude 35° 45’ 5.0004”, west longitude -94° 40’ 18.9978”, elevation 878 feet. Located approximately 3.9 miles (6.3 km) south of Stilwell on the Dahlonegah School grounds.

- TAMS (Newkirk – AQS ID: 40-071-9010): Cherokee Nation jurisdiction. Kay County, Oklahoma, north latitude 36° 57’ 24.231”, west longitude -97° 02’ 3.7278”, elevation 1,162 feet. Located approximately 3.0 miles (4.8 km) north of Newkirk on tribal trust lands. [Site will be discontinued in September 2020.]

- TAMS (Pryor – AQS ID: 40-097-9014): Cherokee Nation jurisdiction. Mayes County, Oklahoma, north latitude 36° 13’ 42.2292”, west longitude -95° 14’ 59.9316”, elevation 627.28 feet. Located approximately 4.2 miles (6.7 km) southeast of Pryor on tribal trust lands.

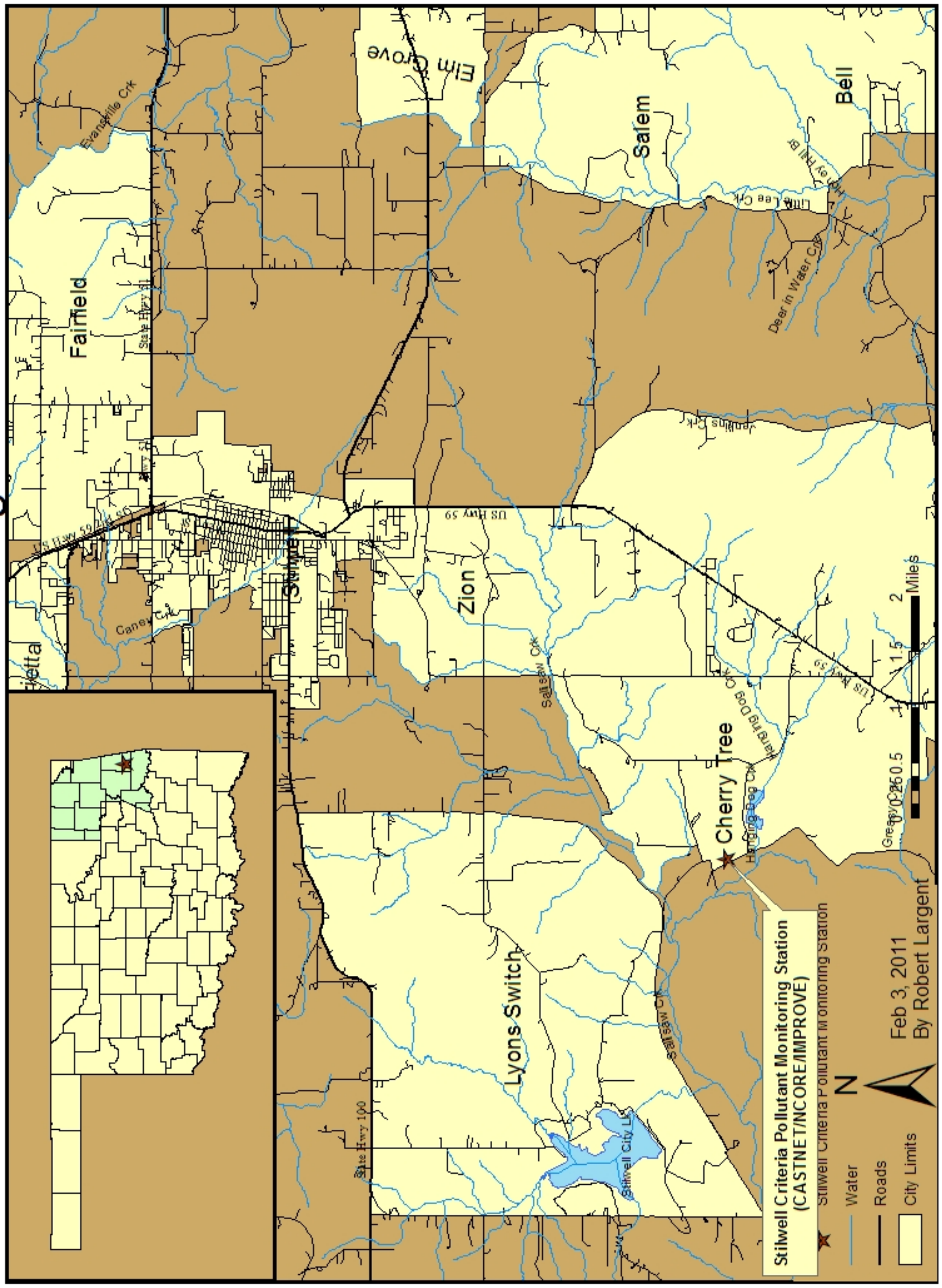
The Roland site is located on fee land owned by Cherokee Nation Businesses at:

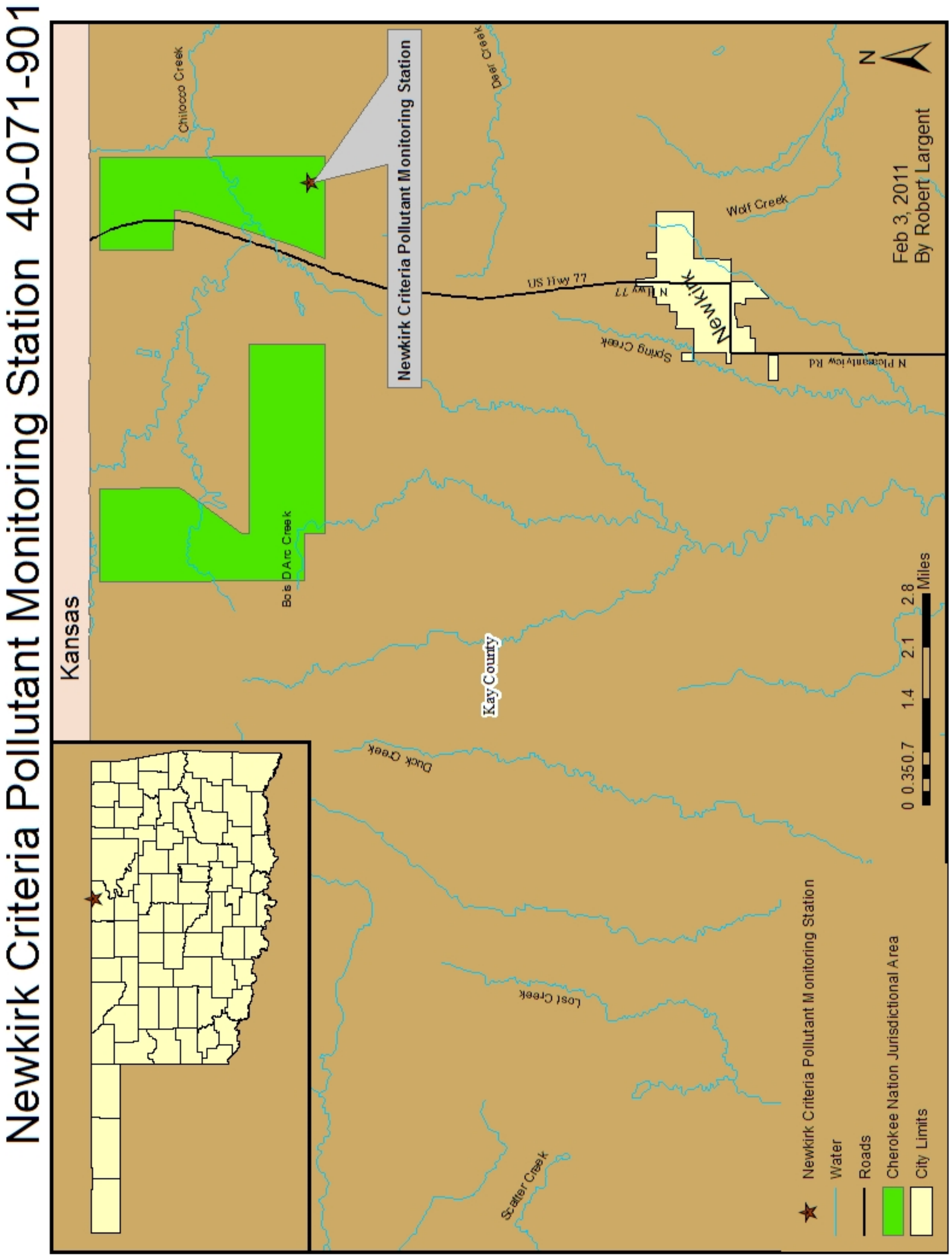
- TAMS (Roland – AQS ID: 40-135-9021): Cherokee Nation jurisdiction. Sequoyah County, Oklahoma, north latitude 35° 24’ 29.304”, west longitude -94° 31’ 27.8862”, elevation 448.98 feet. Located approximately 0.15 miles (0.24 km) southwest of Roland on individual fee land.

The mobile shelter will be placed at several locations for a period of 9 to 12 months; however, the time interval may be extended at the request of the host tribe. Each location will be on land of an ITEC member tribe (host tribe) in Oklahoma, Texas, or New Mexico. The mobile shelter went online in July 2006 and monitors continuous PM2.5, continuous PM10, continuous PMcoarse, and ozone (since May 2009) as well as meteorological parameters.

The following pages depict the four fixed site locations on maps.

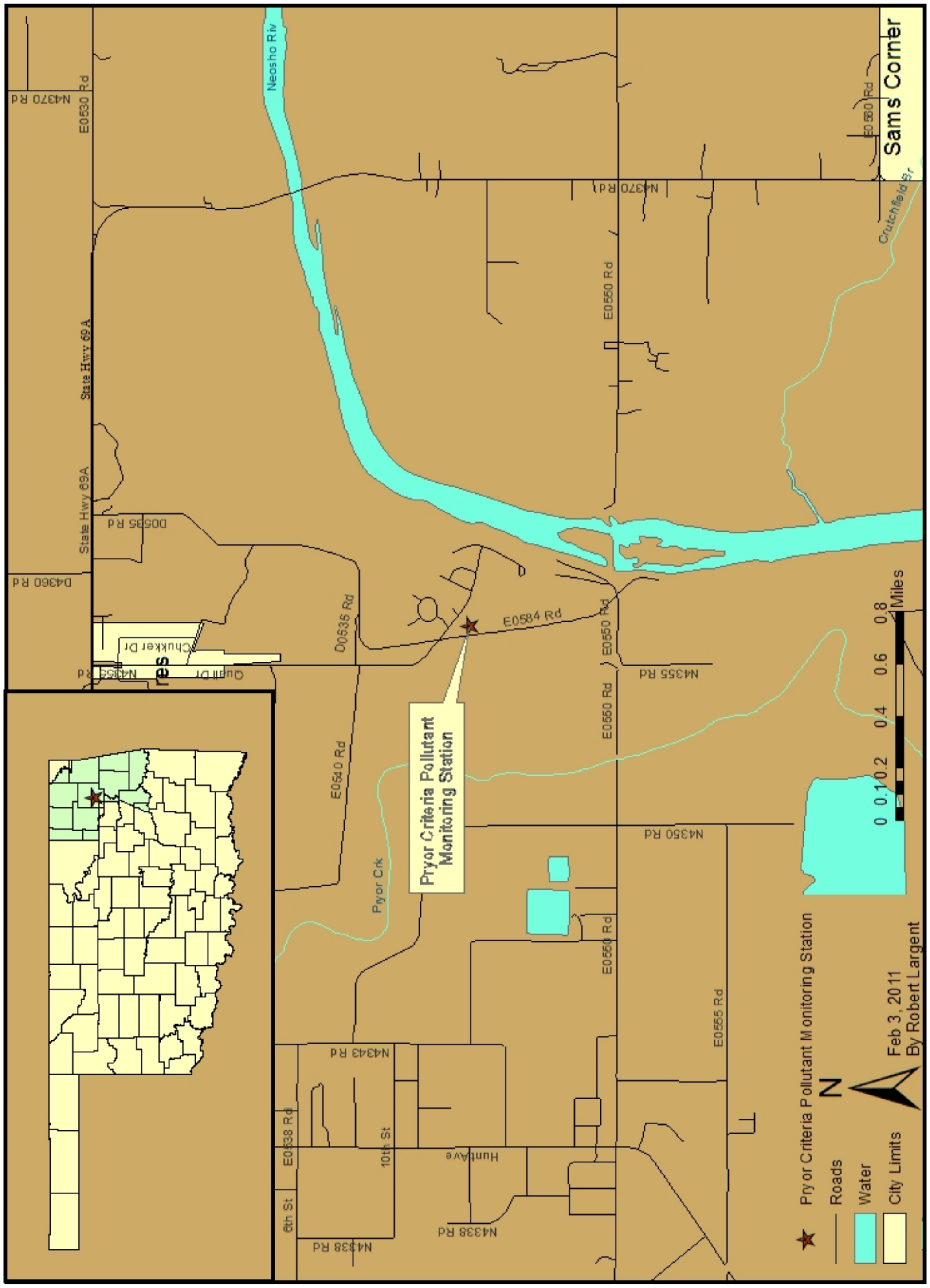
Stilwell Criteria Pollutant Monitoring Station 40-001-9009

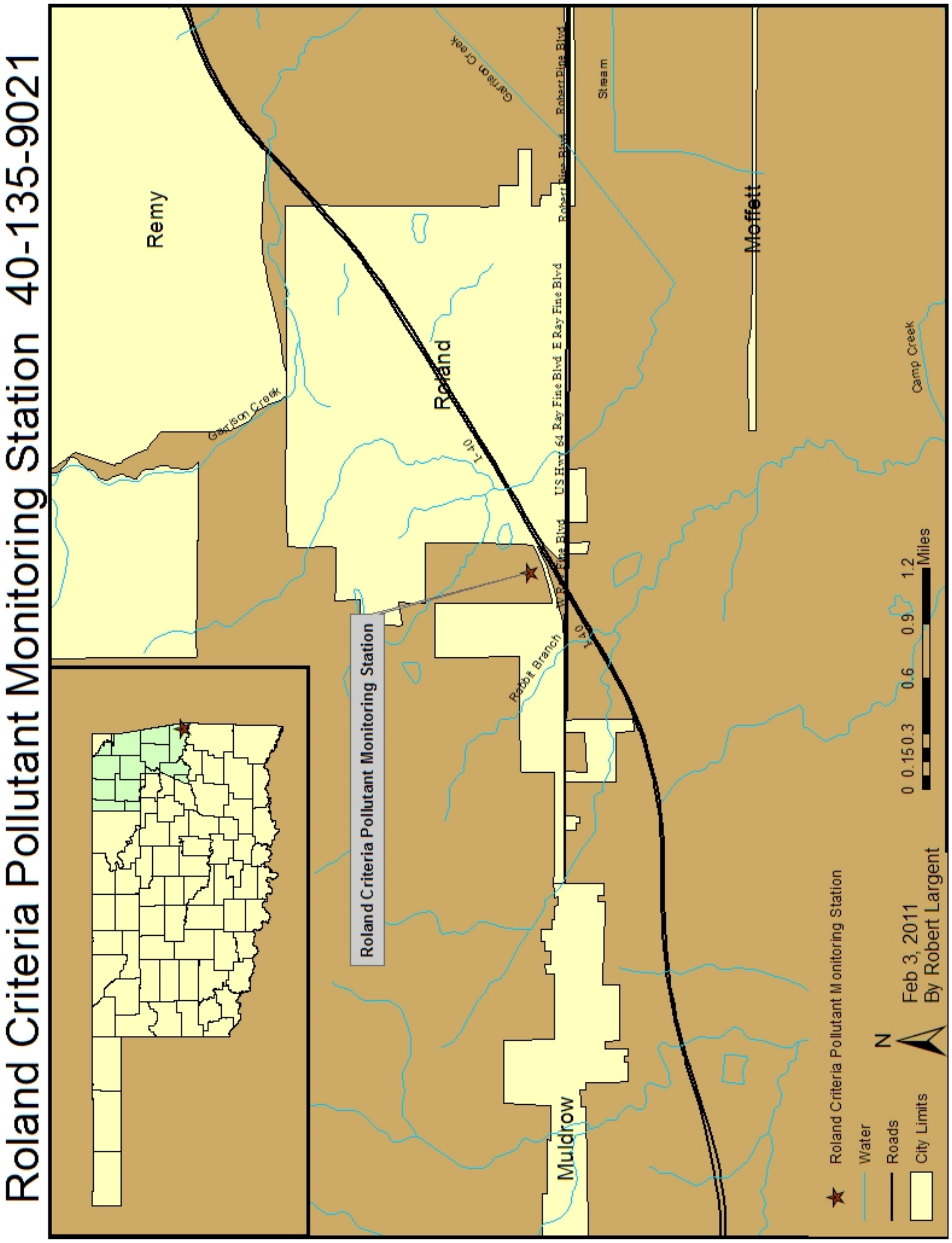




Site will be discontinued in September 2020.

Pryor Criteria Pollutant Monitoring Station 40-097-9014




Roland Criteria Pollutant Monitoring Station 40-135-9021
Remy
Roland
Moffett
Muldrow
Garrison Creek
Camp Creek
Rabbit Branch
Stream
I-40
US Hwy 64 Ray Fine Blvd
E Ray Fine Blvd
Robert Fine Blvd
Roland Criteria Pollutant Monitoring Station
Roland Criteria Pollutant Monitoring Station
Water
Roads
City Limits
N
0 0.15 0.3 0.6 0.9 1.2 Miles
Feb 3, 2011
By Robert Largent

7 Data Quality Objectives and Criteria for Measurement of Data

7.1 Purpose & Background

Data Quality Objectives (DQOs) are qualitative and quantitative statements that clarify monitoring objectives, define appropriate types of data, define the most appropriate conditions in which to collect data, and specify the tolerable levels of decision errors for a particular monitoring program.

The primary DQO for the Cherokee Nation's ambient air monitoring network is to compare the monitoring data collected for criteria pollutants (SO_2, CO, NO_2, Ozone, PM2.5, and PM10) to their respective National Ambient Air Quality Standard (NAAQS) for attainment/non-attainment purposes. The collection of data for NCore trace gas analyzers (SO_2, CO, and NO_y) and for NOy, NH_3, Hg, Hg species, and meteorological parameters (wind speed, wind direction, temperature, relative humidity and precipitation) supplements the criteria pollutant data and is subject to secondary DQOs. Secondary DQOs include collecting ambient air data for use in research and in identifying trends, regional transport, and health impacts. The EPA has established a control measurement of 95% certainty or 5% uncertainty as the acceptance rate for this monitoring objective.

Another DQO is to produce data that is precise, accurate, complete, representative and comparable. This DQO can be controlled and evaluated so that it meets established acceptance criteria. Thus, Data Quality Indicators (DQIs) are designed and used to evaluate and control various phases of the measurement process. For the Cherokee Nation's ambient air monitoring network, the DQIs are defined in terms of the following: precision, accuracy, completeness, representiveness, and comparability.

7.2 Data Precision and Accuracy

The method detection limits and acceptable ranges for precision (CV) and accuracy (bias) of the ambient air analyzers and meteorological instruments used in the Cherokee Nation's ambient air monitoring network (including the mobile monitoring station) are specified by the instrument manufacturers and in the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

Revisions to Ambient Air Monitoring Regulations, Final Rule. U.S.EPA, 40 CFR, Parts 53 and 58, October 17, 2006.

Revisions to Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards. U.S. EPA, 40 CFR, Part 58 Appendix A, March 28, 2016.

Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1. U. S. EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

Table 7.1 identifies the method detection limits and acceptable ranges for precision and accuracy of these instruments. These Measurement Quality Objectives (MQOs) meet or exceed the MQOs specified in the Data Validation Templates that are included in the latest revision of the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP). Method detection limits and acceptable ranges for precision and accuracy of NCORE trace gas analyzers are explained in the paragraphs that follow **Table 7.1**.

Table 7.1 Instrument Detection Limits, Precision and Accuracy

Instrument Detection Limits, Precision and Accuracy			
Parameter	**Measurement Detection Limits**	**Measurement Precision (CV)**	**Performance Accuracy (Bias)**
SO_2	0.2 ppb	< 10.1% CV*	< ± 10.1%*
CO	0.02 ppm	< 10.1% CV*	< ± 10.1%*
NOx, NO, NO_2	5 ppb	< 15.1% CV*	< ± 15.1%*
NOy	0.4 ppb	< 15.1% CV*	< ± 15.1%*
O_3	0.005 ppm	< 7.1% CV*	< ± 7.1%*
PM10	4.0 $\mu g/m^3$		± 5% design flow rate ± 2.5% mass (TEOM)
PM2.5	5.0 $\mu g/m^3$		± 5% design flow rate ± 2.5% mass (TEOM)
Wind Speed	0.5 mph	± 1% or 0.15 mph whichever is greater	± 0.5 mph < 10mph or ± 5% > 10 mph
Wind Direction	1.0 degree	± 3 degrees	± 5.0 degrees
Temperature	0.5 degree		± 0.5° C ambient
Relative Humidity	1.0 percent	± 3 percent	± 1.5° C of dew point temp
Precipitation	0.01 inches per switch closure	± 1% at 1-3" per hour	± 10% of observed

*The measurement quality objectives (MQOs) for criteria gases changed in October 2006 in accordance with 40 CFR, Parts 53 and 58, *Revisions to Ambient Air Monitoring Regulations, Final Rule*. Measurement precision is now expressed in terms of the coefficient of variance (CV) and performance accuracy is now expressed in terms of bias. The MQOs for ozone analyzers are now as follows: CV < 7.1%; bias < ± 7.1%. The MQOs for SO_2 and CO are now as follows: CV < 10.1%; bias < ± 10.1%. The MQOs for NO_2 are now as follows: CV < 15.1%; bias < ± 15.1%. Although NOx, NO, and NOy aren't criteria pollutants, EPA guidance suggests the following MQOs for those gases: CV < 15.1%; bias < ± 15.1%. The CV and bias values for each ozone, SO_2, NO_2, CO, NOx, NO, and NOy analyzer are determined by averaging the precision and accuracy values for three consecutive years of Level I checks, multipoint checks, and audits for each analyzer. The precision and accuracy values (acceptance limits) for zero, span, precision, and other points in any single Level I check, multipoint check, or audit may exceed the three-year average MQO for bias of < ± 7.1%, 10.1%, or 15.1% without causing the invalidation of any data. The CNEP will automatically invalidate affected data for an analyzer if the measured accuracy of a zero, span, precision, or other point of a Level I check, multipoint check, or audit exceeds the acceptance limits. If the measured accuracy of such a point is between acceptance limits of 4% to 7.1% for an ozone analyzer, between 7% and 10.1% for SO_2 and CO analyzers, or between 7% and 15.1% for NO_2, NOx, NO, and NOy analyzers, then CNEP will take appropriate steps (such as recalibrating the analyzer within the following two-week period) to improve the accuracy, but will NOT invalidate the affected data for that analyzer unless there are other circumstances (equipment defect, etc.) that suggest such data *should* be invalidated.

The CNEP will use the MQOs for precision (CV) and bias recommended for the NCore program by the OAQPS. These recommended MQOs are the same as for the non-trace-level gas analyzers. To the extent feasible, the CNEP will use the MQOs for method detection limits (MDLs) recommended for the NCore program by the OAQPS. The MDLs for trace level gas analyzers are as follows: SO_2 = 0.055 ppb; CO = 18 ppb; NOy [and NO] = 0.058 ppb. The CNEP can meet the MDL for total reactive oxides of nitrogen with its Ecotech trace level gas analyzer, but it may not be able to meet the MDLs for SO_2 and CO because its Ecotech trace level SO_2 analyzer has a lower detectable limit of 0.200 ppb and its Ecotech trace level CO analyzer has a lower detectable limit of 20 ppb (see **Table 16.2** of this QAPP, and see **Appendix D** of this QAPP).

7.3 Data Completeness

The completeness goal for the Cherokee Nation's ambient air monitoring network is 75% or greater for the criteria and non-criteria pollutant data for each quarter. For the meteorological data, the completeness goal is 90% or greater. Data completeness will be calculated as a percentage of the actual valid data collected compared to the amount of data that could have been obtained under normal operations. Data completeness will also be reported as a quarterly and annual average. The following table shows the minimum requirements for data completeness based on various time period averaging. This information is typical for instrument parameters throughout the network having more than one point of collection.

The OAQPS has recommended a data completeness goal of greater than 90% for NCore trace gas data, with a minimum data completeness requirement of greater than 75%.

Table 7.2 Data Completeness

Data Completeness		
Parameter	**Averaged Time Period**	**Minimum Number of Data**
SO_2, CO, NOx, NO, NO_2, NOy, O_3, PM2.5, PM10	Hourly	45 minutes of valid data
	8 Hour	6 consecutive, 1 hour averages
	Daily	18 1-hour averages
	Monthly	21 daily averages
	Quarterly	3 consecutive monthly averages
	Yearly	9 monthly averages with at least 2 monthly averages per quarter
Meteorological	15 minute average	14 consecutive minutes
	1 hour average	4 15-minute averages
	Daily	22 consecutive hours
	Monthly	28 consecutive months
	Quarterly	3 consecutive months
	Yearly	11 consecutive months

7.4 Data Representativeness

Representativeness measures the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. For the Cherokee Nation's ambient air monitoring network, it is a process condition, and all of the instruments (criteria pollutants) are either federal reference methods or equivalent methods. The instruments and their federal or equivalent methods are shown in **Table 7.3**.

Table 7.3 Instrument & Federal Reference or Equivalent Method

Instrument & Federeral Reference or Equivalent Method		
Parameter	**Manufacturer**	**EPA Method Code**
SO_2 (trace level)	Ecotech EC9850T	592
CO (trace level)	Teledyne API T300U	593
NOx, NO, NO_2	Ecotech Serinus 40	186
NOy (trace level)	Ecotech EC9841T	690
NH_3 (trace)	Ecotech EC9842T	592
O_3	Teledyne API 400E	087
	Monitor Labs ML9810	091
	Monitor Labs ML9810B	091
	Ecotech EC9810B	091
	Ecotech Serinus 10	187
PM10 (STP)	Met One BAM 1020	122
	Thermo 1405-D Dichotomous TEOM	792
PM2.5 (Local Conditions)	Met One BAM 1020	733
	Thermo 1405-D Dichotomous TEOM	792
PMcoarse (Local Conditions)	Met One BAM 1020	185
	Thermo 1405-D Dichotomous TEOM	208
Wind Speed (WS)	Met One Model 010C	020
Wind Direction (WD)	Met One Model 020C	020
WS/WD Sonic	Met One Model 50.5	061
Temperature	Met One Model 592	040
	Met One Model 083D-1-35	040
Relative Humidity	Met One Model 593	011
	Met One Model 083D-1-35	011
Precipitation	Met One Model 375	091

7.5 Data Comparability

Comparability is the measure of confidence with which one data set can be compared to another. The preferred units of measurements are summarized in the following table. This information is typical for all parameters throughout this network having more than one point of collection.

For comparison purposes, all gas monitors (O_3, SO_2, CO, NOx, NOy, NH_3), including NCore trace gas monitors, at all sites collect data under local (ambient) conditions of temperature and pressure. All FRM particulate monitors (PM2.5, PM10) collect data under local (ambient) conditions of temperature and pressure. All PM2.5 FEM particulate monitors (TEOM and/or BAMs at Stilwell NCore, Roland, and mobile) collect data under local (ambient) conditions of temperature and pressure. All PM10 FEM particulate monitors (TEOM and/or BAM at Stilwell NCore and mobile) collect data under EPA standard temperature and pressure (STP) conditions (25ºC, 101.3 kPa). In addition, the data will be compared to the National Ambient Air Quality Standards (NAAQS) for each specific criteria pollutant. The NAAQS are identified in **Table 6.1** of this QAPP. Finally, Stilwell site (IMPROVE and CASTNet) is considered to be a Special Purpose Monitoring Site (SPMS) under Tribal Ambient Monitoring Site (TAMS) and has been sited and registered in AQS based on EPA siting requirements. The EPA Region VI Office has approved the siting of the one SPMS, as has the EPA OAQPS.

Table 7.4 Data Comparability

Data Comparability			
Instrument Parameter	**EPA AQS Parameter Code**	**Measurement Unit**	**EPA AQS Unit Code**
SO_2 (trace level)	42401	ppb	008
CO (trace level)	42101	ppb	008
NO	42601	ppm	007
NO (trace level)	42601	ppb	008
NO_2	42602	ppm	007
NOx	42603	ppm/ppb	007/008
NOy (trace level)	42600	ppb	008
NOy-NO (trace level)	42612	ppb	008
NH_3	42604	ppb	008
O_3	44201	ppb	008
PM10 (STP)	81102	$\mu g/m^3$	001
PMcoarse (Local)	86101	$\mu g/m^3$	105
PM2.5 (Local)	88502	$\mu g/m^3$	105
Wind Speed	61101	mph	012
Wind Direction	61102	degrees, compass	014
Temperature	62101	degrees, centigrade	017
Relative Humidity	62201	percent	019
Precipitation	65101	inches	021

10 Sampling Process Design

10.1 Purpose/Background

There are two basic assumptions for the Cherokee Nation's ambient air monitoring network. First, the state of Oklahoma lacks dominating land features, which are more characteristic of the western states' basin and mountain range geomorphological features. Thus, there is only one distinct air basin in the state of Oklahoma. Second, Oklahoma's wind patterns, variable winds, and topography create conditions which are conducive to dispersing emissions from various air pollution sources on several scales of magnitude (middle, neighborhood, urban, regional). Thus, the Tribal Ambient Monitoring Sites (TAMS) and the CASTNet and IMPROVE site can be influenced by different scales of magnitude. With these assumptions in mind, the Cherokee Nation's ambient air monitoring network is designed to meet any of the following monitoring objectives:

- Determine compliance with the National Ambient Air Quality Standards
- Determine baseline data for attainment/non-attainment status
- Determine the impact of significant point sources on Indian populations and areas
- Determine the extent of regional pollutant transport
- Determine the welfare-related impacts on Indian populations and tribal lands
- Conduct air pollution trends analysis

10.2 Site Names, Zone of Representation, and Locations

There originally were five sites in the Cherokee Nation's ambient monitoring network; however, there are currently only four active sites in the network: Tahlequah, Stilwell, Pryor, Newkirk, and Roland. [The Tahlequah site was discontinued in September 2018 and was removed in April 2019. The Newkirk will be discontinued in September 2020.] Section 6 of this QAPP has descriptions and map locations for these sites. In addition, the CNEP has one mobile station for continuous monitoring of PM2.5, PM10, PMcoarse, O_3, and meteorological parameters on lands of ITEC-member tribes. The mobile station will be rotated from one host tribe to another, being stationed with each host for 9 to 12 months; however, the time period may be extended at the request of the host. The sites are EPA approved and registered with the EPA's Air Quality System (AQS) and are designated as to monitor type, monitoring objective, and zone of representation in **Table 10.1**

Table 10.1 Monitor Type, Objective, and Zone of Representation

Monitor Type, Objective, and Zone of Representation			
Site Name	**Monitor Type**	**Monitoring Objective**	**Measurement Scale**
Stilwell	Tribal	trace gas, acid rain dep.	regional
Pryor	Tribal	emissions impact	neighborhood
Newkirk*	Tribal	regional transport	regional
Roland	Tribal	regional transport	regional
Mobile	Tribal	regional transport	neighborhood

*Site will be discontinued in September 2020.

10.3 Monitoring Sampling Design

The one neighborhood scale site (Pryor) is designed to monitor continuously for ozone (O_3) as well as the following meteorological parameters: wind speed, wind direction, temperature, relative humidity, and precipitation.

The three regional scale sites are located near Stilwell, Newkirk, and Roland. The Stilwell (CASTNet/NCore/IMPROVE) site is set up to meet dry deposition and trace gas monitoring requirements as well as set up for regional haze monitoring requirements. The three regional scale sites have been designed to monitor continuously for one or more of the following: ozone (O_3) at Stilwell, Newkirk, and Roland; trace sulfur dioxide (SO_2), trace carbon monoxide (CO), and trace nitrogen oxide (NOy) at NCore; nitrogen oxides (NOx, NO, NO_2) at Roland; particulate matter (PM10 via BAM at NCore and PM2.5 via BAM at NCore and Roland); and meteorological parameters (wind speed, wind direction, temperature, relative humidity, precipitation). [Precipitation is not measured at Roland.] The CASTNet site is designed for continuous monitoring of ammonia (NH_3, via Ecotech 9842T trace ammonia analyzer), as well as sampling of depositional mercury for the Mercury Deposition Network (MDN), monitoring of regional haze for the Interagency Monitoring of Protected Visual Environments (IMPROVE), and passive ammonia for the Ammonia Monitoring Network (AMoN). The NCore site is also designed for continuous monitoring of mercury species (via Tekran mercury speciation instruments).

The Pryor site has design capabilities to monitor for various Hazardous Air Pollutants (HAPs) over defined time intervals using an Environmental Systems RM910A sampling instrument with summa canisters for volatile organic compounds as well as R&P 2025 sequential samplers and Tisch TE-5000 high volume samplers for filter-based sampling for metals. At this time, CNEP does not monitor for HAPs.

The mobile station provides continuous monitoring of PM2.5 (via TEOM), PM10 (via TEOM), PMcoarse (via TEOM), ozone (O_3), and meteorological parameters (wind speed, wind direction, temperature, relative humidity) on lands of ITEC-member tribes. The mobile station is rotated from one host tribe to another, being stationed with each host for 9 to 12 months; however, the time period may be extended at the request of the host tribe. The station is capable of wireless data transfers to the CNEP office.

Environmental parameters monitored at each site are summarized in **Table 10.2** while the instruments and EPA methods used for monitoring each parameter are summarized in **Table 10.3**.

Table 10.2 Environmental Parameters Monitored at Each Site

Site	Parameters **(Criteria pollutants and Meteorological parameters in boldface)** [All other parameters, except for NOy and other species of gaseous nitrogen oxides, are covered under separate QAPPs]
Stilwell (NCore, CASTNet, IMPROVE)	NCore: continuous monitoring of trace level **SO_2**, **CO**, NOy, NO, and NOy-NO; continuous monitoring of **O_3**; continuous monitoring of **PM2.5** via FEM BAM, **PM10** via FEM BAM, PMcoarse
	Mercury speciation via Tekran instrument (continuous monitoring)
	CASTNet program (dry deposition sampling for aerosol sulfate, nitrate, and ammonium; dry deposition sampling for gaseous SO_2 and nitric acid)
	Continuous monitoring of NH_3, NOx, and Nx
	Depositional mercury via MDN sampling
	Passive ammonia sampling via AMoN
	IMPROVE (speciated components affecting visibility, including PM2.5, PM10, Na, Mn, Fe, Pb, carbon, nitrate, nitrite, chloride, sulfate)
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**, solar radiation, moisture) via CASTNet instruments
Newkirk*	Continuous monitoring of **O_3**
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**)
Pryor	Continuous monitoring of **O_3**
	Hazardous air pollutants (HAPs) via time-weighted average sampling methods (VOCs via summa canisters; metals, including lead, via filter-based sampling)**
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**)
Roland	Continuous monitoring of **O_3**, **NO_2**, NOx, NO, **PM2.5** (via BAM)
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity**)
Mobile monitor	Continuous monitoring of **O_3, PM10** (via TEOM), **PM2.5** (via TEOM), PMcoarse
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity**)

*Site will be discontinued in September 2020.
**At this time, CNEP does not monitor for hazardous air pollutants (HAPs).

Table 10.3 Continuous Network Instruments and Methods

Continuous Network Instruments and Methods		
Parameter	**Instrument Manufacturer & Model Number**	**EPA Method Code**
SO_2 (trace)	Ecotech EC9850T	592
CO (trace)	Teledyne API T300U	593
NOx, NO, NO_2	Ecotech Serinus 40	186
NOy (trace)	Ecotech EC9841T	690
NH_3 (trace)	Ecotech EC9842T	592
O_3	Monitor Labs ML9810, ML9810B	091
	Ecotech EC9810B	091
	Ecotech Serinus 10	187
	Teledyne API 400E	087
	Teledyne API T703	Primary Standard
	Thermo Anderson 49CPS, 49*i*-PS	Transfer Standard
	Environics 6103	Transfer Standard
PM10 (STP)	Met One BAM 1020	122
	Thermo 1405-D Dichotomous TEOM	792
PM2.5 (Local Conditions)	Met One BAM 1020	733
	Thermo 1405-D Dichotomous TEOM	792
PMcoarse (Local Conditions)	Met One BAM 1020	185
	Thermo 1405-D Dichotomous TEOM	208
Wind Speed (WS)	Met One Model 010C	020
Wind Direction (WD)	Met One Model 020C	020
WS/WD Sonic	Met One Model 50.5	061
Temperature	Met One Model 592, 083D-1-35	040
Relative Humidity	Met One Model 593, 083D-1-35	011
Precipitation	Met One Model 375	091
Datalogger	ESC 8816, 8832, 8872	N/A
	Ecotech WinAQMS	N/A
Calibrator	Ecotech GasCal 1000GPT	N/A
	Ectoech GasCal 1100GPT	N/A
	Ecotech Serinus Cal 2000	N/A
	Environics 6103 Multi-Gas	N/A
Zero Air Generator	Ecotech 8301LC	N/A
	Perma Pure ZA-750-12 (portable)	N/A
	Teledyne API 701	N/A
HAPs	RM910A (for VOCs)	TO-15

Each site has a temperature controlled shelter enclosure that is designed for the instruments to be mounted either inside the shelter in a rack or on a bench or outside the shelter on a tower or the roof. The gas analyzers, particulate monitors, gas calibrator, and datalogger are located inside the shelter. The meteorological instruments (wind speed, wind direction, temperature, and relative humidity) are located outside the shelter on a tower while the precipitation gauge is located on the shelter roof. [The precipitation gauge is located at 1.2 meters above ground level at Stilwell.]

For the one neighborhood scale site at Pryor, the O_3 analyzer is plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the shelter roof.

The regional scale site at Stilwell has two shelters (CASTNet, NCore). For the CASTNet shelter, the O_3 analyzer has its own intake located at the top of a 10-meter tower, which is the design for CASTNet network sampling. The NH_3 analyzer and gas calibrator are plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the shelter roof. For the NCore shelter, the trace gas analyzers (SO_2, CO) are plumbed into a glass manifold with a pump exhaust system, with the glass manifold intake being located on the shelter roof. The trace NO_y analyzer has an external molycon with its own intake system that is located at the top of a 10-meter tower. The gas calibrator in the NCore shelter is plumbed into a switching valve that allows calibration gas to flow to either the glass manifold for the trace (SO_2, CO) analyzers or directly up the tower to the intake of the trace NOy analyzer.

For the regional scale sites at Newkirk and Roland, the O_3 analyzers and NOx analyzer (at Roland) are plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the roof of the shelter. The gas calibrator at Roland is plumbed directly into the NOx analyzer.

The meteorological instrument sensors at all four of the fixed neighborhood and regional sites are attached to a 10-meter tower at the following heights:

At Newkirk and Pryor:

- wind speed & wind direction — 10-meter level
- relative humidity & temperature — 10-meter level
- precipitation gauge — shelter roof

At Roland:

- wind speed & wind direction — 10-meter level
- relative humidity & temperature — 9-meter level

At Stilwell:

- wind speed & wind direction — 10-meter level
- relative humidity — 9-meter level
- temperature — 9-meter & 2-meter level
- precipitation gauge — 1.2-meter above ground level

The PM monitor at the mobile station has an intake located on the shelter roof. The O_3 instrument has its own intake system, which is plumbed through the shelter wall and has its inlet three feet above the shelter roof. Meteorological instruments (wind speed, wind direction, relative humidity, and temperature) at the mobile station are attached to the top of a 7-meter tower.

For audit/calibration purposes, gas calibrators and EPA protocol gas cylinders are used to conduct nightly zero/span audits (Level II checks) and zero/span/one-point QC audits (Level I checks) on the NOx, trace NH_3, trace SO_2, trace CO, and trace NOy analyzers every two weeks. [Level II checks are not conducted on the trace NH_3 analyzer.] The O_3 analyzers perform nightly zero/span audits (Level II checks) utilizing internal ozone generators that are independent of the gas calibrators. A verified ozone transfer standard instrument is used to conduct the zero/span/one-point QC audits (Level I checks) on ozone analyzers every two weeks.

CNEP staff will perform flow checks and other routine QA/QC checks on the PM2.5 and PM10 instruments at the two fixed regional sites (Stilwell NCore, Roland) every two weeks. Performance checks of the meteorological instruments at the four fixed neighborhood and region sites will be done once each year or more often if necessary.

CNEP staff will visit the mobile station every month during the duration of its residency at a host site. [The data from the mobile station is primarily used for screening purposes.] CNEP staff will perform flow checks, temperature checks, barometric pressure checks, leak checks, TEOM microbalance filter changes, and other routine QA/QC checks on the PM2.5/PM10/PMcoarse instrument. The O_3 analyzer performs nightly zero/span audits (Level II checks) utilizing an internal ozone generator. A verified ozone transfer standard instrument is used to conduct the zero/span/precision audit (Level I checks) on the ozone analyzer. A performance check of the meteorological instruments will be done at the beginning and conclusion of each residency, or more often if necessary. The host may also be trained to perform some of these QA/QC checks, including TEOM microbalance filter changes, in order to minimize the need for site visits by CNEP staff.

At each site, including the mobile station, the gas analyzers, particulate monitors, and meteorological instruments are wired directly into an ESC datalogger (Newkirk, Stilwell CASTNet, Pryor, Roland, mobile) or an Ecotech datalogger (Stilwell NCore). The datalogger is programmed to capture continuous data and is connected to either a telephone modem, cellular modem, or a wireless Ethernet allowing for remote data retrieval directly into a CNEP desktop computer.

The CNEP has an R&M 910A canister sampler for VOC (HAP) sampling and R&P 2025 sequential samplers and Tisch TE-5000 high volume samplers for filter-based sampling of HAP metals. When CNEP samples for HAPs, it will be covered in a separate QAPP.

11 Sampling Method Requirements

11.1 Purpose/Background

The sampling methods and equipment used for continuous (automated) and non-continuous (manual) monitoring will be identified in this section. Furthermore, the specific performance requirements for the continuous and non-continuous monitoring will be identified in this section.

11.2 Continuous Sampling Methods Requirements

The type of instruments and sampling methods used to monitor for criteria pollutants and meteorological parameters are identified in **Table 10.3**, Section 10.3 of this QAPP. The continuous monitoring for NOx (NO, NO_2), trace NH_3, O_3, trace SO_2, trace CO, trace NOy, PM2.5, PM10, and meteorological parameters (WS, WD, temperature, relative humidity, precipitation) will be conducted in accordance with the manufacturer's standard operating procedures (SOPs) identified in their respective instrument operational manuals. The monitoring will also be conducted in accordance with the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I A Field Guide to Environmental Quality Assurance. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/R-94/038a.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

In addition, the continuous monitoring will be conducted for CO, NOx (NO, NO_2), NOy, PM2.5, and PM10 by adhering to the requirements identified in 40 CFR Part 50 Appendices C, F, and L and 40 CFR Part 58 Appendix A. Continuous monitoring will be conducted for SO_2 and O_3 by adhering to 40 CFR Part 53.

11.3 Non-Continuous Sampling Method Requirements

Sampling method requirements for Hazardous Air Pollutants (HAPs) will be covered in a separate QAPP. Sampling method requirements for non-continuous monitoring of PM2.5 and PM10 will also be discussed in a separate QAPP. At this time, CNEP does not operate the HAPs sampler or the non-continuous, filter based samplers for particulate matter.

13 Analytical Methods Requirements

13.1 Purpose/Background

This section identifies the analytical methods required for continuous monitoring of criteria pollutants. The analytical methods are identified by parameter, instrument, federal reference method, method code, and analysis method. Continuous monitoring will be conducted for SO_2, CO, NO_2, NOy, NH_3, Ozone, PM10, PM2.5, and meteorological parameters. Non-continuous monitoring is currently not being conducted for identified Hazardous Air Pollutant (HAP) parameters; however, when CNEP decides to begin sampling for HAPs again, it will be covered under a separate QAPP.

13.2 Analytical Methods

Sulfur dioxide (SO_2) concentrations are measured by means of ultraviolet fluorescence spectrometry in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of SO_2 when UV radiation excites SO_2 molecules and produces fluorescent radiation. A reference detector and photomultiplier tube measure the SO_2 molecules.

Carbon monoxide (CO) concentrations are measured by means of gas filter correlation and a non-dispersive infrared photometer in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of CO by passing infrared broadband radiation through a rotating gas filter wheel filled with CO and nitrogen. The CO produces a reference beam and the nitrogen produces the measurement beam as CO sample gases pass through the filter wheel.

The concentrations of nitrogen oxides are measured by means of gas-phase chemiluminescence in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of NO_2, NO, NOx and NOy. This method incorporates a single low pressure reaction cell and photomultiplier tube to measure the chemiluminesence (light) produced by the reaction between NO and O_3. The measurement sample is alternately switched either through or around a NO_2-NO heated converter.

Ozone (O_3) concentrations are measured continuously by means of a non-dispersive ultraviolet photometer. An instrument-generated reference sample of ozone is passed through an ozone scrubber (catalyst) and converted to oxygen. The amount of UV radiation emitted from the reference sample is then measured in an absorption cell. The actual ambient gas sample bypasses the scrubber and is measured in the absorption cell. A microprocessor uses the Beer-Lambert relationship to calculate the ambient ozone concentration by comparing the reference sample to the actual sample.

Two analytical methods are being used for continuous monitoring of particulate matter (PM2.5 and PM10). One method uses a Met One BAM 1020 Beta Attenuation Monitor and the other method uses a Thermo 1405-D Dichotomous TEOM. The Beta Attenuation method uses a radiation source to produce beta particles that correlate to either PM10 or PM2.5 concentrations. The method is based on the ability of beta particles to penetrate either PM10 or PM2.5 particles as they accumulate on filter tape. The accumulation of PM10 or PM2.5 particles decreases the amount of beta particles that can be measured in the instrument's measurement chamber. This decrease is compared to uninhibited beta particles measured in the compensation chamber (reference standard). A comparison and correlation of the decreased beta particles to the reference standard determines the PM10 or PM2.5 concentration value. The TEOM method uses a tapered element oscillating microbalance (TEOM). The frequency of oscillation of the microbalance decreases as particulate mass accumulates on the microbalance filter. Changes in the frequency of oscillation are used to calculate the PM2.5, PM10, and PMcoarse concentration.

Concentrations of ammonia are measured continuously by means of gas-phase chemiluminescence. This analytical method measures low concentrations of ammonia (NH_3), oxides of nitrogen (NO_X) and total nitrogen compounds (N_X). The analyzer utilizes an external thermal oxidizer to convert NH_3 to NO. The resulting NO reacts with O_3 and produces chemiluminesence (light) which is measured by a photomultiplier tube and a single low pressure reaction cell.

Wind speed is measured by means of a thin-film capacitor sensor coupled directly to an anemometer. A sealed magnetic reed switch that is connected to the anemometer produces a series of pulses at a rate proportional to wind speed.

Wind direction is determined by means of a potentiometer sensor coupled directly to an aluminum vane that can swivel through a 360º range of motion. Variations in wind direction produce a corresponding change of voltage that is proportional to wind direction.

A combination method for determining wind speed and wind direction involves using a sonic sensor. A sonic sensor consists of four sensors that measure changes in frequency of wind speed and wind direction. The frequencies are converted to corresponding voltages using a wind distortion algorithm and factoring process, and the voltages are converted to values for wind speed and wind direction.

Temperature is measured by means of a solid-state thermistor sensor. The sensor produces a large change in electrical resistance for each degree of temperature change.

Relative humidity is measured by means of a thin-film polymer capacitor sensor. A one-micron-thick dielectric polymer layer absorbs water molecules through a thin metal electrode, which in turn causes capacitance change proportional to relative humidity.

Precipitation (rain and snowfall) is measured by means of a heated tipping bucket. The bucket is designed to funnel precipitation to a tipping mechanism that measures 0.01 inch of precipitation with each tip. A magnet attached to the tipping mechanism actuates a magnetic reed switch with each tip of the bucket.

HAPs are sampled by methods described in Section 10.3 of this QAPP. When CNEP is sampling for HAPs, a separate QAPP will describes these sampling methods in detail.

Table 13.1 identifies the analytical methods used in criteria pollutant monitoring by the CNEP.

Table 13.1 Parameters, Instruments, Method Codes & Analysis Methods

Parameters, Instruments, Method Codes & Analysis Methods			
Parameter	**Manufacturer**	**Method Code**	**Analysis Method**
SO_2 (trace)	Ecotech EC9850T	592	UV Fluorescence Spectrometer
CO (trace)	Teledyne API T300U	593	Infrared Photometer
NOx, NO, NO_2	Ecotech Serinus 40	186	Chemiluminescence
NOy (trace)	Ecotech EC9841T	690	Chemiluminescence
NH_3 (trace)	Ecotech EC9842T	592	Chemiluminescence
O_3	Teledyne API 400E	087	UV Photometer
	Monitor Labs ML9810	091	UV Photometer
	Monitor Labs ML9810B	091	UV Photometer
	Ecotech EC9810B	091	UV Photometer
	Ecotech Serinus 10	187	UV Photometer
PM10 (STP)	Met One BAM 1020	122	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	792	Oscillating Microbalance (mass)
PM2.5 (Local Conditions)	Met One BAM 1020	733	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	792	Oscillation Microbalance (mass)
PMcoarse (Local Conditions)	Met One BAM 1020	185	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	208	Oscillation Microbalance (mass)
WS	Met One Model 010C	020	Thin Film Capacitor Sensor
WD	Met One Model 020C	020	Potentiometer Sensor
WS/WD	Met One Model 50.5	061	Sonic Sensor
Temperature	Met One Model 592	040	Thermistor Sensor
	Met One Model 083D-1-35	040	Thermistor Sensor
RH	Met One Model 593	011	Thin Film Capacitor Sensor
	Met One Model 083D-1-35	011	Thin Film Capacitor Sensor
Precipitation	Met One Model 375	091	Tip Bucket
HAPs	RM910A	TO-15	VOC Collection System

14 Quality Control Requirements

14.1 Purpose/Background

This section describes the quality control requirements for the continuous and non-continuous monitoring instruments within the Cherokee Nation's ambient air monitoring network. The quality control requirements for the non-continuous instruments are based on the manufacturer's manuals, CNEP protocols, and the laboratory contractor's QA/QC requirements. The quality control requirements for the continuous instruments are based on manufacturer's manuals, CNEP protocols, *Revisions to Ambient Air Monitoring Regulations, Final Rule* (40 CFR, Parts 53 and 58, October 17, 2006), and the following guidance document:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

This guidance document and the 2006 *Revisions to the Ambient Air Monitoring Regulations* identify the protocols, frequencies, corrective actions, and documentation process for instrument certifications, verifications, and audits. For the CNEP, these would include manufacturer certifications, EPA certifications, NIST certifications, Level II (Zero/Span) checks, Level I (Zero/Span/One-Point QC) checks, quarterly audits, independent audits, and national performance audits (through the probe audits, TTP). In addition, the audit protocols and measurement quality objectives (MQOs) described in this section of the QAPP meet or exceed the MQOs specified in the Data Validation Templates that can be found in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

14.2 Instrument Certifications & Verifications

The CNEP maintains the manufacturer certifications for all of its instruments and support instrumentation. This includes the criteria instruments (SO_2, CO, NO_2, O_3, PM2.5, PM10), meteorological instruments, primary O_3 standard, transfer O_3 standards, calibrators, EPA protocol gas cylinders, RM 910A instrument, and reference standard instruments (e.g. flow, temperature). This also includes other instruments, such as the ammonia analyzer and NOy instrument. The CNEP also maintains annual verifications, re-certifications and/or maintenance records for the instruments and support instrumentation. These are limited to the:

- U.S. EPA Regional Lab annual verification for the O_3 primary standard
- replacement of EPA protocol gas cylinders
- maintenance for the primary/transfer O_3 standard instruments when needed
- annual certification for the reference standard instruments (e.g. flow, temperature)

14.3 Instrument Audits & Frequency

The CNEP or independent auditors conduct different levels of audits for the continuous and non-continuous instruments and their support instrumentation. The following table summarizes the instruments that are audited, type of audit, frequency of the audit, and who conducts the audit.

Table 14.1 Instrument, Audit Type, Frequency, and Entity

Instrument, Audit Type, Frequency, and Entity			
Instrument	**Audit Type**	**Frequency**	**Auditor**
NO_2, O_3	Level II	Nightly	CNEP
NCore trace gas (SO_2, CO, NOy)	Level II	Nightly	CNEP
NO_2, NH_3, O_3, PM2.5/10	Level I	Bi-weekly	CNEP
NCore trace gas (SO_2, CO, NOy)	Level I	Bi-weekly	CNEP
NO_2, NH_3, O_3, PM2.5/10	Quarterly	Quarterly	CNEP
NCore trace gas (SO_2, CO, NOy)	Quarterly	Quarterly	CNEP
Calibrator Checks		Quarterly	CNEP
RM 910A		Semi-annually	CNEP
NO_2, O_3, Trace (SO_2, CO, NOy), PM2.5/10	Independent*	Quarterly	Contractor
NO_2, O_3, Trace (SO_2, CO, NOy)	NPAP**	Every 5 years	U.S. EPA/Contractor
WS, WD, RH, Temperature, Precipitation		Annually	CNEP/Contractor***

*The independent audits are conducted at various rotating sites each quarter, so that each site's instruments, including NCore instruments, are audited at least once a year (gas analyzers) or twice a year (PM2.5 and PM10). Ozone is independently audited at each site at least once during the ozone season.

**The National Performance Audit Program (NPAP), "through the probe (TTP)" audits, only audits 20% of the monitoring sites in its SLAMS network each year or a minimum of one site per year. Also, the NPAP audits 20% of the National NCore network sites per year. Therefore, Cherokee Nation's NCore site may be audited once every 5 years by NPAP.

***WOOD audits meteorological instruments at the Stilwell CASTNet site semi-annually while INQUEST audits meteorological instruments at all other sites annually. CNEP audits all of its meteorological instruments once each year, excluding Stilwell CASTNet site.

Level II Checks

Automated Level II (zero/span) checks are conducted each night for the NO_2 and the NCore trace gas (SO_2, CO, NOy) analyzers using EPA Protocol gases that are NIST traceable and certified. Automated Level II checks are conducted each night for the O_3 instruments using the instrument's own internal photometer to generate ozone. An ESC datalogger (Ecotech WinAQMS at NCore) initiates the Level II checks each day at a specified time and records the results, which are then retrieved utilizing an on-site modem system to a CNEP desktop computer and printed out the next workday. A site operator uses the Level II checks as an initial quality control check to determine if a particular instrument is operating within specification. The determination is based on how an instrument is responding to the zero and span reference gas challenges each night. For NO_2 and trace gases (SO_2, CO, NOy), the span check is 80% of full scale. For O_3, the span check is generally 20% of full scale, because it will allow for the instrument to be checked at a point closer to the typical ambient range. As a general rule, if the nightly checks are within the limits identified in **Table 14.2** then no corrective actions are required. However, if they exceed these limits, then the site operator initiates a corrective action by comparing the differences to other nightly audit records, Level I check/calibration records, independent audit reports, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning, then maintenance, a Level I check, and/or recalibration are conducted for the instrument or instruments in question.

Level I Checks

Level I (zero/span/one-point QC) checks are conducted every two weeks for the NO_2, trace NH_3, O_3, and NCore trace gas (SO_2, CO, NOy) instruments using EPA Protocol gases (NIST traceable and certified) and/or an O_3 transfer standard. In the case of the mobile monitoring station, a Level I check can be performed with an O_3 transfer standard only when CNEP personnel visit the mobile monitoring station each month. The instruments are challenged by known gas concentrations that can be found in **Table 14.2** for non-trace and **Table 14.3** for trace. A site operator uses the Level I checks as a quality control check to determine if a particular instrument is operating normally or if an instrument needs maintenance, recalibration, or repairs. The Level I checks are recorded on audit/calibration forms and site logbooks that are kept at the CNEP office and at each shelter (**Appendix C** for non-trace analyzers, **Appendix D** for NCore trace gas analyzers). The documentation on each audit/calibration form includes the following information:

- site identification
- instrument and calibration system serial numbers
- date
- site operator
- instrument gains and offsets
- standard gas cylinder info (e.g. serial number, concentration, expiration date)
- expected instrument values
- actual (unadjusted) instrument values
- percent difference values
- instrument parameters (e.g. gas flow/pressure, temperatures, etc.)

If a non-trace instrument fails a Level I check it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails a Level I check if the zero, span, and/or one-point QC drift values identified in **Table 14.2** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for the gas analyzers (O_3, NO_2) are within the limits, then no corrective action is necessary. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; O_3 drift at 5-7.1%; NO_2 span drift at 8-10.1%; NO_2 one-point QC drift at 7-15.1%) or exceeding the limits (i.e. zero drift ≥ 3.1 ppb; O_3 drift ≥ 7.1%; NO_2 span drift ≥ 10.1%; NO_2 one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration and/or maintenance will be conducted on the instrument or instruments in question. The corrective actions (multipoint check, calibration, and/or maintenance) are documented on audit/calibration forms and site logbooks that are kept at CNEP office and at the site. The audit/calibration forms are maintained for a minimum of 3 years at our office while the on-site forms will be maintained for a minimum of 5 years and the logbooks are kept for an indefinite amount of time.

If a trace gas instrument fails a Level I check it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails a Level I check if the zero, span, and/or one-point QC drift values specified in **Table 14.3** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for trace gas analyzers (SO_2, CO, NOy, NH_3) are within the limits, then there is no action. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; trace gas (SO_2, CO, NH_3) drifts at 8-10.1%; trace gas (NOy) span drift at 8-10.1%; trace gas (NOy) one-point QC drift at 7-15.1%) or surpasses the limits (i.e. zero drift ≥ 3.1 ppb; trace gas (SO_2, CO, NH_3) drifts ≥ 10.1%; trace gas (NOy) span drift ≥ 10.1%; trace gas (NOy) one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration, and/or maintenance will be conducted on the instrument or instruments in question. Documentation of the corrective action taken is the same for trace and non-trace gas instruments as well as the retention time for the documents.

Table 14.2 Audit Concentration Levels and Drifts for Non-Trace Gas Analyzers

Non-Trace Gas Analyzers						
Parameter	**O_3**					**NO_2**
Site	**Newkirk**	**Pryor**	**Stilwell**	**Roland**	**Mobile**	**Roland**
Instrument	Serinus 10	Serinus 10	EC 9810B	API 400E	API 400E	Serinus 40
Level I Checks						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%

Table 14.3 Audit Concentration Levels and Drifts for Trace Gas Analyzers

Trace Gas Analyzers				
Parameter	**SO_2**	**CO**	**NOy**	**$*NH_3$**
Instrument	EC 9850T	API T300U	EC 9841T	EC 9842T
Level I Checks				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%
Multi-Point Check (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%
Multi-Point Calibration (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%

* NH_3 is a trace gas analyzer but is NOT included among the NCore network

For PM2.5 and PM10, a Level I precision check for the instrument's flow rate is performed every two weeks. The check is conducted using either the instrument's internal flow meter or an external flow reference standard. In the case of the mobile monitoring station, a Level I check can be performed with an external flow reference standard only when CNEP personnel visit the mobile monitoring station each month. Level I checks performed on the mobile monitoring station instruments at other times must be performed remotely by CNEP personnel (by means of modem) or by a representative of the host tribe using only the instrument's internal flow meter. When a Level I check is performed remotely by means of a modem connection, only the PM2.5 flow rate and the PMcoarse flow rate can be checked. A minimum of three flow checks are obtained to verify that the flow rate is stable and accurate to ± 4.1%. See the Continuous PM2.5 Local Conditions Validation Template and the Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP for MQOs pertaining to the PM2.5 TEOMs, PM2.5 Beta Attenuation Monitor (BAMs), PM10 TEOMs, and PM10 BAMs.

In addition, third standard deviation values are determined and evaluated for each instrument. The values are recorded after each Level I check and quarterly audit and reestablished after each instrument recalibration. The 3rd standard deviation values are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors.

Quarterly Audits

The CNEP conducts a quarterly audit (multipoint check) for each of the NO_2, NH_3, O_3, and NCore trace gas (SO_2, CO, NOy) analyzers at all sites including the mobile. The quarterly audit is the same as a Level I check, but has at least two additional precision point checks (see **Tables 14.2** and **14.3** for drift values and other parameters pertaining to multipoint checks). The results are treated the same as a Level I check. The third standard deviation values are determined and evaluated for each instrument after a quarterly audit.

The CNEP also conducts PM2.5 and PM10 instrument audits each quarter at all sites including the mobile using a flow reference standard. If the flow rate of either instrument is found to be outside of a ± 4.1% tolerance limit for the expected flow rate (16.7 Lpm), then the instrument is recalibrated within the next 0 to 5 business days; however, at the mobile the instrument will be recalibrated at the next available opportunity, which is dependent on location (maximum time: 1 month). If the TEOM instrument's mass transducer exceeds the expected known response by more than ± 2.5%, then it is replaced by the manufacturer. The TEOM and BAM are also audited for ambient temperature and barometric pressure. The audit results, recalibration and/or repair results are recorded on individual audit/calibration forms and in site dedicated logbooks kept at each site. The on-site forms are retained for five years at all sites excluding the mobile (retained for 3 years). The dedicated logbooks for each site are retained for an indefinite amount of time.

Independent Audits

Independent audits for the NO_2, O_3, trace gas (SO_2, CO, NOy), PM2.5, and PM10 instruments are conducted by INQUEST contractors during the scheduled quarter. Meteorological instruments are audited once each year by INQUEST at all sites except the Stilwell CASTNet site. Meteorological instruments at the Stilwell CASTNet site are audited twice each year by WOOD. INQUEST's SOPs are identified in **Appendix E** of this QAPP. These audits are conducted using independent instruments and independent EPA Protocol gases that are also NIST traceable and certified. Different shelters and their associated instruments are selected for audit during the scheduled quarter, so that all of the shelters' instruments within the Cherokee Nation's air monitoring network (6 shelters) are audited at least once each year (gas analyzers) or twice each year (PM2.5 and PM10). Ozone is audited at every site at least once during ozone season. The independent audit schedule is included in **Appendix E** of this QAPP. The audits are conducted "as is" which means that no calibrations will be performed. If an independent audit fails, then the CNEP is notified within 24 hours and its site operator conducts a Level I audit within the next 0 to 5 business days and subsequent recalibration, maintenance and/or repair if it is needed. Any subsequent instrument recalibrations or maintenance by the CNEP are recorded in the site logbooks.

The EPA Region 6 Office periodically conducts site performance audits and/or technical reviews for the air monitoring program. These audits and/or reviews will be conducted when necessary and if resources are available. The audit and/or review results will be summarized and reported to the CNEP when they are finalized by the EPA Region 6 Office. These audits and/or reviews are described in Section 20.3 of this QAPP.

At its option, the EPA may provide independent audit devices (flow audit devices and gas reference standards) each year under its contract with Alion.

In accordance with the latest revisions to 40 CFR, Part 58, Appendix A (March 28, 2016), CNEP will participate in the Ambient Air Protocol Gas Verification Program (AA-PGVP) by completing an annual survey of the gas cylinders utilized by our monitoring program using the Battelle website, https://www.sdas.battelle.org/AirQA/, and by sending one unused EPA protocol gas cylinder to a regional air verification laboratory (Region 2 or Region 7) for verification at least once every 5 years.

15 Maintenance Requirements

15.1 Purpose/Background

This section describes how preventive and/or corrective maintenance of the instruments will be performed and documented. The site operator is responsible for daily polling (by modem) of the fixed shelters and mobile shelter instruments from the CNEP office. In addition, the site operator is responsible for biweekly site inspections which are documented in the shelter logbook. Scheduled maintenance and corrective maintenance conducted by the site operator is documented in detail on a tag attached to each instrument.

The site operator maintains various spare parts at the CNEP office and has blanket purchase orders with manufacturers for instrument spare parts, instrument repair, miscellaneous supplies, and tools.

15.2 Scheduled Instrument Maintenance Requirements

The site operator conducts scheduled maintenances for each instrument. Instrument spare parts for these maintenances are inventoried and kept at the CNEP office. The following table identifies the instrument, type of maintenance, and when it is conducted.

Table 15.1 Instrument Maintenance & Interval

Instrument Maintenance and Interval		
Instrument	**Maintenance Requirement**	**Interval**
Trace SO_2	Replace inlet particulate filter	monthly
	Perform pneumatic leak check	monthly
	Check pump vacuums	quarterly
	Replace charcoal scrubber media	semi-annually
	Replace PMT desiccant packs	annually
	Replace DFU filter	annually
	Check flow calibration	annually
NOx, Trace NOy, & NH_3	Replace inlet particulate filter	monthly
	Perform pneumatic leak check	monthly
	Check pump vacuums	quarterly
	Replace exhaust scrubber media	semi-annually
	Replace PMT desiccant packs	annually
	Replace DFU filter	annually
	Replace sintered filter	annually
	Clean reaction cell and valve manifold	annually
	Check flow calibration	annually

Table 15.1 Instrument Maintenance & Interval (continued)

Instrument Maintenance and Interval (continue)		
Instrument	**Maintenance Requirement**	**Interval**
Trace CO	Replace inlet particulate filter	monthly
	Perform pneumatic leak check	monthly
	Replace pump diaphragm	annually
	Check flow calibration	annually
O_3	Replace inlet particulate filter	monthly
	Perform pneumatic leak check	monthly/annually
	Check pump vacuums	quarterly
	Replace sintered filter	annually
	Inspect purge filter/orifice	annually
	Check UV lamp	annually
	Check ozone scrubber	annually
	Replace DFU filter	annually
	Replace charcoal scrubber in IZS	annually
	Replace exhaust scrubber	annually
	Check flow calibration	annually
Calibrators	Replace desiccant in scrubbers	semi-annually
	Replace DFU filter	annually
	Mass flow controller check	annually
*** PM2.5 & PM10**	Inspect inlet o-rings	quarterly
	Inspect filter tape	bi-weekly
Air Intake Unit	Clean glass manifold	quarterly
R&M 910A	Replace pump	annually
	Perform pneumatic leak check	annually
Meteorological Instruments	Replacement is dependent on annual audit results	

*See Continuous PM2.5 Local Conditions Validation Template and Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP for maintenance schedule and MQOs for PM2.5 TEOMs, PM2.5 BAMs, PM10 TEOMs, and PM10 BAMs.

The CNEP has an operator's manual from the manufacturer for each analyzer and instrument in its inventory. The CNEP follows the recommendations of these manuals with respect to instrument maintenance, troubleshooting, and repairs. Also, the CNEP follows the recommendations of the Data Validation Templates located in Appendix D of the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

15.3 Miscellaneous Supplies

The CNEP keeps adequate supplies at each shelter and at the CNEP office. These supplies may include:

- various instrument replacement parts
- Teflon tubing
- plastic ties
- tubing fittings & ferrules
- instrument cables & connectors
- electrical tape
- fuses
- filters & charcoal
- meteorological tower guy wires, anchors & toggle bolts
- pumps & pump repair kits
- gas cylinder regulator
- air conditioner air filters
- desiccant
- tools

16 Instrument Calibrations & Frequency

16.1 Purpose/Background

This section describes the standards, frequency, and procedures for calibrating the continuous and non-continuous instruments in the Cherokee Nation's ambient air monitoring network. The continuous instruments include NO_2 (NOx & NO), NH_3, O_3, PM2.5, PM10, NCore trace gas (SO_2, CO, NOy) analyzers, and meteorological instruments. The non-continuous instruments include the R&M 910A. The CNEP conducts all instrument calibrations, excluding met, with the exception of factory (initial & repair) calibrations and, if applicable, the independent contractor's initial instrument installation at each site. The CNEP's audit standard operating procedures (SOPs) and forms are identified in **Appendix C** and **Appendix D** of this QAPP. The independent contractor's calibration SOPs are identified in **Appendix E** of this QAPP.

The standards and frequencies used for calibrating the continuous instruments are identified in the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I A Field Guide to Environmental Quality Assurance. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/R-94/038a.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone – Technical Assistance Document. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-13-004, October 2013.

Technical Assistance Document for the Calibration of Ambient Ozone Monitors. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/4-79-057.

Revisions to Ambient Air Monitoring Regulations, Final Rule. U.S.EPA, 40 CFR, Parts 53 and 58, October 17, 2006.

In addition, the calibration requirements described in this section of the QAPP meet or exceed the MQOs specified in the Data Validation Templates that can be found in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

The standards and frequencies used for calibrating the non-continuous instruments are based on the manufacturers' specifications and manuals.

The CNEP conducts a multi-point calibration for the continuous instruments (5-6 points for NO_2 and O_3; 6-7 points for trace gas (SO_2, CO, NOy, NH_3) analyzers) or a single-point calibration for the non-continuous instrument (R&M 910A) for any of the following reasons:

- initial instrument installation at a site (CNEP and independent contractor)
- instrument zero/span/one-point QC drift tolerances are exceeded during a Level I check
- instrument design specifications are exceeded during an audit
- maintenance or repairs affect instrument calibration
- instrument is physically relocated
- an instrument is taken offline or placed online (e.g., ozone season, March 1-November 30); instrument recalibrated only if necessary
- O_3 transfer standard calibration (audit each quarter, recalibrate if necessary)

16.2 SO_2, CO, NO_2 & NOy Instrument Calibration & Frequency

A multi-point (5 points for non-trace; 6-7 points for trace) check and/or calibration is conducted for the NO_2 instrument, as well as for the trace gas analyzers (SO_2, CO, NOy, NH_3), using zero air and known EPA Protocol (G1) gas concentrations. The individual gases (CO, SO_2, NO, NH_3) are kept in high pressure cylinders that are certified and NIST traceable. The gas cylinder is connected to a two-stage regulator, which allows the gas to be supplied at a low pressure to the calibrator.

An Ecotech GasCal 1000GPT, Ecotech GasCal 1100GPT, Ecotech Serinus Cal 2000, or Environics 6103 (portable) multi-dilution calibrator is used to perform a multi-point check and/or calibration on the NO_2 and trace gas (SO_2, CO, NOy, NH_3) instruments. The calibrators have zero air supplied to them by external zero air generators, which are used to recalibrate the zero range and dilute the EPA Protocol gases at known concentrations. In addition, NOx and trace gas NOy instruments undergo a multi-point converter efficiency check using a constant concentration of NO protocol gas in combination with various concentrations of ozone. The NH_3 instrument also undergoes a multi-point converter efficiency check using NH_3 protocol gas at various concentrations. Each multi-point check and/or calibration must have at least four points, including a zero (zero air) point. The CNEP uses five points in its multi-point checks and calibrations for non-trace gas analyzers and six or seven points for trace gas analyzers.

If a non-trace instrument fails a Level I check, a quarterly audit, and possibly an independent audit, it will be recalibrated, maintenance and/or repaired within the next 0 to 5 business days. An instrument fails an audit if the zero, span, and/or one-point QC drift values identified in **Table 16.1** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for the gas analyzers (O_3, NO_2) are within the limits, then no action is necessary. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drifts at 2.5-3.1 ppb; O_3 drift at 5-7.1%; NO_2 span drift at 8-10.1%; NO_2 one-point QC drift at 7-15.1%) or exceeding the limits (i.e. zero drifts $\geq$ 3.1 ppb; O_3 drift $\geq$ 7.1%; NO_2 span drift $\geq$ 10.1%; NO_2 one-point QC drift $\geq$ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration and/or maintenance will be conducted on the instrument or instruments in question. The corrective actions (multipoint check, calibration and/or maintenance) are documented on audit/calibration forms and site logbooks that are kept at CNEP office and at the site. The audit/calibration forms are maintained for a minimum of 3 years at our office while the on-site forms are maintained for 5 years and logbooks are kept for an indefinite amount of time. In addition, if an instrument is placed "online" for the first time, has had maintenance or been repaired, then it is calibrated. In any of these cases, new fixed "universal" baseline values are established each time a multi-point calibration is conducted for an instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If an instrument does not calibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3rd standard deviation values. The site operator will repair the instrument or have it sent to the manufacturer for repair.

Table 16.1 Audit Concentration Levels and Drifts for Non-Trace Analyzers

Non-Trace Gas Analyzers						
Parameter	**O_3**					**NO_2**
Site	**Newkirk**	**Pryor**	**Stilwell**	**Roland**	**Mobile**	**Roland**
Instrument	Serinus 10	Serinus 10	EC 9810B	API 400E	API 400E	Serinus 40
Level I Checks						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	75 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%

If a trace gas instrument fails a Level I check, a quarterly audit, and possibly an independent audit, it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails an audit if the zero, span, and one-point QC drift values specified in **Table 16.2** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for trace gas analyzers (SO_2, CO, NOy, NH_3) are within the limits, then there is no action. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; trace gas (SO_2, CO, NH_3) drifts at 8-10.1%; trace gas (NOy) span drift at 8-10.1%; trace gas (NOy) one-point QC drift at 7-15.1%) or surpasses the limits (i.e. zero drift ≥ 3.1 ppb; trace gas (SO_2, CO, NH_3) drifts ≥ 10.1%; trace gas (NOy) span drift ≥ 10.1%; trace gas (NOy) one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration, and/or maintenance will be conducted on the instrument or instruments in question. Documentation of the corrective action taken is the same for trace and non-trace gas instruments as well as the retention time for the documents. In addition, if an instrument is placed "online" for the first time, has had maintenance or been repaired, then it is calibrated. In any of these cases, new fixed "universal" baseline values are established each time a multi-point calibration is conducted for an instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If an instrument does not calibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3rd standard deviation values. The site operator will repair the instrument or have it sent to the manufacturer for repair.

Table 16.2 Method Quality Objectives, Audit Concentrations and Drifts, And Recalibration Specifications for Trace Gas Analyzers

Per recommendations of Ecotech and EPA RTP

Trace Gas Analyzers				
Parameter	**SO_2**	**CO**	**NOy**	***NH_3**
Instrument	EC 9850T	API T300U	EC 9841T	EC 9842T
Level I Checks				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	500 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	900 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
General MQOs				
Precision (CV)	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Bias	< ± 10.1%	< ± 10.1%	< ± 10.1%	< ± 10.1%
Method Detection Limit (MDL), per Ecotech	200 ppt (EPA recommends 55 ppt)	20 ppb (EPA recommends 18 ppb)	50 ppt (exceeds EPA recommendation of 58 ppt)	400 ppt
Zero Air	< 0.1 ppb SO_2	< 40 ppb CO	< 0.10 ppb NOx	< 0.1 ppb NO
Gaseous Standards	10-13 ppm ± 1%	200-300 ppm ± 1%	10-13 ppm ± 1% NO_2 < 0.1% NO	50-100 ppm

*NH_3 is a trace gas analyzer but is NOT included among the NCore network.

16.3 Ozone Instrument Calibration & Frequency

The calibration process for the ozone monitoring involves three principal instruments: a primary standard (API T703), an ozone transfer standard (Thermo-Anderson 49CPS, Thermo-Anderson 49*i*-PS, Environics 6103), and an ozone analyzer (API 400E, Monitor Lab 9810, 9810B, Ecotech 9810B, Ecotech Serinus 10). Any recalibration involves a multi-point (5-6 points) calibration using a NIST traceable zero air supply and ozone generated by the transfer standard. The ozone concentrations are approximately 0%, 30%, 50%, 65%, and 80% of the calibration scale of the ozone analyzer. [Ozone calibration scale is 100 ppb.] The standard operating procedures for the ozone instrument audits are identified in **Appendix C** of this QAPP.

The API T703 primary (Level 2) standard is considered to be a bench instrument and is maintained at the CNEP office. It serves to audit and calibrate the ozone transfer standard. The primary standard is not calibrated by the CNEP. It is however, sent to a U.S. EPA Regional Lab [either Region VI (Houston Lab) or Region VII (Kansas City Lab)] for a performance verification against the regional Standard Reference Photometer (SRP) (Level 1 standard) on an annual basis. If the primary standard fails verification, the EPA Regional Lab will calibrate the instrument. CNEP has the ability to maintenance the primary standard in house; however, if we are unable then it is sent to the manufacturer for repair. If maintenance or repair has been performed on the primary standard, then it will be sent to EPA Regional Lab [either Region VI (Houston Lab) or Region VII (Kansas City Lab)] for re-verification. The verification and/or maintenance results are recorded in the ozone verification logbook that is housed at CNEP office and retained for an indefinite amount of time.

The transfer (Level 3) standard (Thermo 49CPS, Thermo 49*i*-PS, Environics 6103) is transported between the CNEP and each of the monitoring sites to audit and/or calibrate the onsite ozone instruments. If the transfer standard fails a quarterly audit against the primary standard it will be pulled out of rotation, meaning it will not be used to audit/calibrate equipment, until such time corrective measures (i.e. calibration/maintenance) can be made by the CNEP. The transfer standard is also recalibrated anytime it has had maintenance or been repaired. The audit, calibration, and/or maintenance results are recorded in the ozone verification logbook.

The shelter ozone instruments (Level 4 standard) are used for continuous monitoring during the ozone season (March 1 through November 30). The onsite ozone instruments are calibrated at the beginning of the ozone season, any time there is a failed Level I check or quarterly audit (**Table 16.1**), and after the instruments have had maintenance or repairs. A failed independent audit does not necessitate a recalibration of the instrument, but is considered after review of the instrument records and consultation with the auditor.

Again, new fixed "universal" baseline values are established each time a calibration is conducted for a transfer standard or an on-site instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If the instruments do not recalibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3rd standard deviation values. Then, the site operator will adjust or repair the instrument or have it sent to the manufacturer for repair.

16.4 Calibrator, Calibration & Frequency

Flow audits are performed each quarter by the CNEP on the Ecotech GasCal 1000GPT, Ecotech GasCal 1100GPT, and Ecotech Serinus Cal 2000, which are used as multi-dilution calibrators on site. A flow audit is also performed on the Environics 6103 portable multi-dilution calibrator (transfer standard). Each calibrator is audited using a verified reference standard flow meter (Bios DryCal Definer) at pre-selected flow rates. The mass flow controller is recalibrated on any on-site calibrators that fail a flow audit; however, if the mass flow controller will not calibrate to specifications, then it is replaced.

16.5 PM Instrument Calibration & Frequency

The PM2.5, PM10, and PMcoarse instruments [Met One BAM 1020; Thermo 1405-D Dichotomous TEOM] are designed to operate within ± 5.1% of their designed flow rate of 16.7 liters per minute (Lpm). However, recalibrations will occur anytime their designed flow rates are exceeded by ± 4.1% after a Level I check or quarterly audit has been conducted. The recalibration is accomplished by using a verified reference standard flow meter (Bios Dry Cal Definer, BGI DeltaCal, or Streamline Pro MultiCal System) and by following the manufacturer specifications and manuals.

The Met One BAM 1020 utilizes a small ^{14}C (Carbon 14) source to measure particulate matter. The ^{14}C (Carbon 14) source and beta particle detector can only be calibrated or serviced by the manufacturer; however, this service is rarely needed. The instrument's measuring system can be examined by performing a test of the reference membrane span check. This check is performed by CNEP annually. If an annual audit indicates that the instrument response exceeds the calibration mass equivalent by more than 5%, then the instrument's reference membrane will either be cleaned or replaced by CNEP or the manufacturer.

The Thermo 1405-D Dichotomous TEOM instrument utilizes two mass transducers to measure for PM2.5 and PMcoarse. The mass transducers each consists of a hollow tapered element with a natural frequency and vibration (similar to a tuning fork) that has a filter cartridge attached to it. When additional mass is added, the frequency of the vibration decreases and the instrument records the difference for the two parameters as well as calculates the PM10. A calibration verification kit consisting of pre-weighed calibration filters is used to verify the instrument's mass transducers. The manufacturer will be contacted if a quarterly audit indicates that the instrument response exceeds the calibration mass equivalent by more than ± 2.5%.

Method quality objectives (MQOs) for verification and calibration of PM2.5 TEOMs, PM2.5 BAMs, PM10 TEOMs, and PM10 BAMs are shown in the Continuous PM2.5 Local

Conditions Validation Template and in the Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP.

16.6 Meteorological Instrument Calibration & Frequency

The CNEP has Met One meteorological instruments for measuring wind speed, wind direction, temperature, relative humidity, and precipitation at each site. [Precipitation is not measured at Roland or the mobile monitoring station.] The CNEP will replace the meteorological instruments if they fail to meet their designed measurement specifications for accuracy (**Table 7.1** of this QAPP). Their accuracy is determined by an independent audit conducted once a year for each site excluding Stilwell. [The meteorological instruments at the Stilwell site are part of the CASTNet network, which is operated by WOOD, an EPA contractor, and are audited semi-annually. WOOD is responsible for the accuracy, audits, and repair/replacement of the instruments.] CNEP will perform an audit on the newly installed instrument(s) using NIST traceable temperature/humidity/altimeter instruments as well as a motor driven calibrator for wind speed, if applicable. The failed meteorological instruments will be replaced by CNEP and sent to the manufacturer for repair.

16.7 Non-Continuous Instrument Calibration & Frequency

The calibration of instruments (R&M 910A) used for HAP monitoring will be described in a separate QAPP. The calibration of instruments used for non-continuous sampling of particulate matter will be described in a separate QAPP. At this time, CNEP does not operate the HAPs sampler or the non-continuous, filter based samplers for particulate matter.