Air Monitoring Data Quality Assessment Report
Fourth Quarter
2011

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Air Quality Program

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Introduction

The State of Washington Ambient Air Quality Monitoring Network (Network) is designed to collect vital air data for national, state, local, and tribal needs. It is important to people and organizations concerned with human health, planning, policy or research applications that ambient air data collected by personnel from various agencies are of known, acceptable, and comparable quality. Decision makers (data users) also need to be aware of the amount of error in the data to which their decision will apply. The data used in these decisions are never error free and always contain some level of uncertainty. Because of these uncertainties or errors, there is a possibility that decision makers may declare an area "nonattainment" when the area is actually in "attainment" or "attainment" when actually the area is in "nonattainment." There are serious political, economic, and health consequences of making such decision errors.

In order to provide decision makers with data of acceptable quality, the Air Monitoring Quality Assurance Plan describes Ecology's role as a Primary Quality Assurance Organization (PQAO). As a PQAO, it is the goal that measurement uncertainty among all stations in the organization be reasonably homogeneous as a result of common factors which include:

- Operation by a common team of field operators according to a common set of procedures.
- Use of common standard operating procedures.
- Common calibration facilities.
- Oversight by a common quality assurance organization.
- Support by a common management, laboratory, or headquarters.

The Quality Assurance regulations (Monitoring Rule), set forth in 40 CFR Part 58 Appendix A, have been developed to ensure that monitoring programs are planned so that it is known what data quality is needed, that checks are included to assess data quality, and corrective actions are in place to improve quality systems when needed. It is the goal of the Air Quality Program (AQP) to follow regulations and guidance from the United States Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards.

The Air Monitoring Data Quality Assessment Report for Fourth Quarter 2011 describes the quality of the data collected from October 1 through December 31, 2011.

Data Quality

To provide decision makers with data of acceptable quality, EPA implemented the Data Quality Objective (DQO) process and established acceptance criteria for precision and bias. DQOs are a set of performance measures used in data collection that specify the level of uncertainty (error) that the decision maker is willing to accept in the data to which the decision will apply. By knowing how much uncertainty is in the data, especially from locations that are on the boundary of being declared "in attainment" or "nonattainment," decision makers are provided additional confidence to make the correct environmental decision. DQOs are assessed through the use of data quality indicators (DQIs), which are the quantitative statistics and the qualitative descriptors used to interpret the degree of acceptability or utility of data to the user. The DQIs are used to establish the measurement quality objectives (MQOs). The data quality assessment is performed quarterly to determine whether the MQOs were achieved.

MQOs are based on confidence intervals. A confidence interval is a measurement of how good, or how accurate the measurement is. It is different to say the bias is 5% plus or minus 10% compared to saying the bias is 5% plus or minus 1%. Close attention to these intervals can be helpful in preventing data loss while providing decision makers greater confidence in the data and their decisions.

Sampling Methods

The assessment is divided into four categories, **Automated Data**, **Manual Data**, **Meteorological Data,** and **Washington Air Quality Advisory (WAGA) Data**, subdivided into specific monitoring methods specifying allowable uncertainty levels required to meet the DQOs.

Automated, manual, and meteorological data are collected using EPA tested and approved instruments that directly support rulemaking, enforcement, regulatory, or policy decisions. The data also supports research projects of significant national interest requiring the most formal DQOs including detailed and rigorous Quality Control (QC) and Quality Assurance (QA) for legal and scientific defensibility. Most instruments used in the collection of automated and manual data are listed as Federal Reference Methods (FRM) or Federal Equivalent Methods (FEM).

Data used for the National Air Monitoring Strategy require, at a minimum, routine QC and QA checks as required in the Monitoring Rule. Results from these checks are entered into the EPA Air Quality System (AQS) data base and aggregated on quarterly, annual, and three-year intervals to assess precision and bias on a state and national level.

WAGA and Air Quality Index Data are collected with a mix of non FRM/FEM and FRM/FEM instruments to report air quality to the public in a timely manner. However, one should use caution when using non FRM/FEM data to make decisions as it is of "lesser quality."

Automated Data

Data collected by instruments that continuously measure the ambient air is referred to as Automated Data. Automated instruments are designed to measure for specific pollutants including Ozone (O_3), Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Oxide (NO), fine and course particulate matter. Instrument calibrations are checked on a routine basis and the results are used to determine the quality of the data.

Data Quality Indicators for Gaseous Pollutants

One Point Quality Control Precision Estimate for Gaseous Pollutants (CV%)

On a routine basis, QC checks are performed on the station analyzer to determine the calibration drift of the instrument. The analyzer is challenged with gases traceable to National Institute of Standards and Technology (NIST) standards and the difference between the two is recorded by a data acquisition system and submitted to AQS.

To determine the measure of mutual agreement among the QC checks, the coefficient of variation CV% (precision estimate) is calculated every quarter as described in the Monitoring Rule to assess the precision of the instrument.

Bias Estimate (Bias)

The bias estimate is the systematic difference of the expected values and the actual measured values over time. Bias estimates are calculated, as described in the Monitoring Rule, to determine if there is a systematic or persistent distortion of the data which causes error in one direction. A positive (+) value indicates that the instrument is measuring above the actual (true) value. A negative (-) value represents the instrument is measuring below the actual value. A ± symbol represents the instrument "straddles the line" and is neither biased positive nor negative. The checks are aggregated over a three-month, one-year, and three-year period.

Completeness (% Valid Data)

Completeness is a term used to describe, in percentage, the actual amount of data collected compared to what was expected. The percentage of valid data is the measure of data (averaged in hours) obtained from a monitoring instrument (that meets the MQOs) calculated against the total number of hours in the calendar quarter.

Loss of data occurs on occasion, and may be a result of a calibration error, malfunction, power loss, telemetry communications, or operator error. The AQP data quality goal is that at least 80% of the expected data be collected each calendar quarter.

Performance Evaluation Audit

Performance evaluation audits are independent evaluations of the monitoring site operations conducted by AQP QA personnel. Site evaluations are performed biannually at all automated, manual, and meteorological monitoring sites. The primary purpose of the evaluation is to provide an independent check to determine if the checks made by QA personnel agree with previous QC checks. A large difference between the two may indicate an instrument or systematic problem.

Ozone (O_3)

The MQO for the measurement of O_3 is the precision estimate (CV%) and bias be within ±7%.

Table 1. Data Quality Indicator Results for Ozone Analyzers

Location	AQS Number	CV%	Bias	% Valid Data	Comments
Cheeka Peak	530090013	2.94	+2.42	96	
Mt. Rainier JVC	530530012	3.2	+5.7	**60**	*Failed QC Checks
Seattle Beacon Hill	530330080	2.72	+2.47	96	

* Measurement Quality Objectives were not met at the Mt. Rainer National Park monitoring station located at the Jackson Visitor Center. Beginning in October, a shift in the bias coupled with the relative variations of the QC checks resulted in the analyzer to exceed the QC limit on numerous checks. The performance evaluation confirmed the high bias.

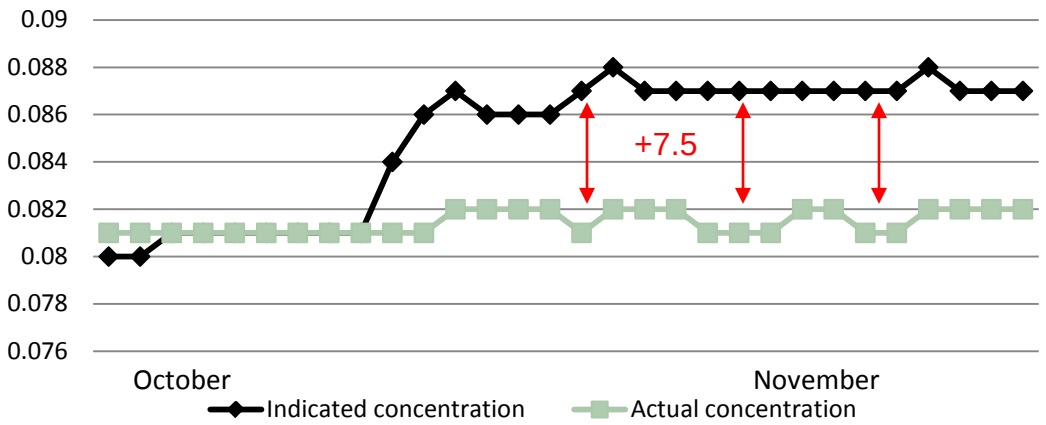

Figure 1. Example of high bias combined with QC variations

The QC check requires challenging the analyzer on a routine frequency with an O_3 concentration similar to the routine concentration normally measured at the site. Ambient ozone concentration recorded at Seattle, Cheeka Peak, and Mount Rainier average between 20 and 40 parts per billion (ppb) with maximums rarely exceeding 70 ppb. QC checks are being performed routinely at 80 ppb.

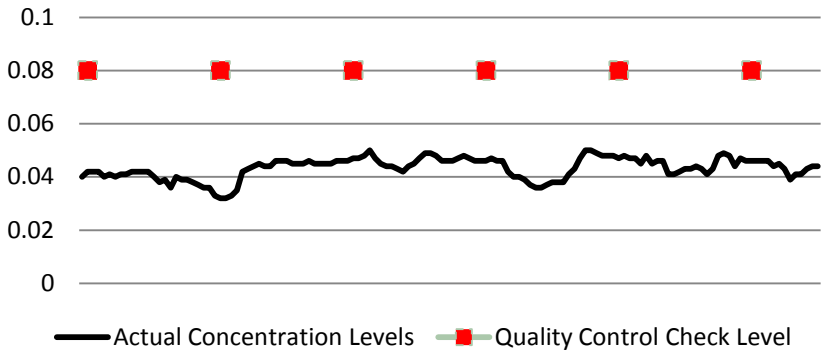

Figure 2. Example of QC check level outside bounds of routine concentrations

Performance Evaluation Audit for O_3

An evaluation involves an independent assessment by challenging the station analyzer with independent gas concentrations at levels that best reflects ambient concentrations observed at the monitoring site. The difference between the actual ozone concentrations (generated by the evaluator equipment) is compared against the station analyzer response.

The MQO for audit results is that the difference be within ±7% for Levels 4–6, ±15% for Level 3, and 1.5 ppb or 15% for Level 1.

Table 2. Audit Results for O_3 Analyzers (Percent Difference)

Location	Level 1 4–6 ppb	Level 2 6–20 ppb	Level 3 20–40 ppb	Level 4 40–70 ppb	Level 5 70–90 ppb	Level 6 90–120 ppb
Cheeka Peak	26.7	9.1	8.0	2.0	3.8	4.5
Mt. Rainier JVC	*	*	8.3	6.1	*	2.7
Seattle (BH)	0.0	0.0	0.0	2.0	1.3	0.9

* The MQO was not met at Mount Rainier as the auditor was unable to generate ozone concentrations at the required levels.

Carbon Monoxide (CO)

The MQO for the measurement of CO at NCore (NC) is the relative precision (CV%) and bias be within ±15%. For instruments measuring CO for NAAQS attainment (Spokane), the relative precision (CV%) and bias must be within ±10%.

Table 3. Data Quality Indicator Results for CO Analyzers

Location	AQS Number	CV%	Bias	% Valid Data	Comments
Cheeka Peak	530090013	9.25	+7.46	87	
Seattle	530330080	3.18	+7.21	97	
Spokane	530630049	2.68	+3.95	99	*Comment below

* The QC check requires challenging the analyzer on a routine frequency with a CO concentration similar to the routine concentration normally measured at the site. Average ambient CO concentrations in Spokane measure less than 700 ppb. Performance evaluations and QC checks are performed at 5000 ppb. Zero drift frequently exceeds 200 ppb.

Performance Evaluation Audits for CO

Evaluations for CO instruments were conducted at two locations during the quarter. The instruments were challenged with independent gas concentrations (Levels 1–5) to best reflect ambient concentrations observed at the monitoring site.

The MQO for audit results is that the difference be within ±15% for Levels 4–6, ±15% for Level 3, and within 30 ppb or 15% for Level 1.

Table 4. Audit Results for Carbon Monoxide Analyzers (Percent Difference)

Location	Level 1 20–59 ppb	Level 2 60–199 ppb	Level 3 200–899 ppb	Level 4 900–2999 ppb	Level 5 3000–7999 ppb
Cheeka Peak	44.00	13.33	0.0	*	*
Seattle	16.00	-7.00	-8.80	-3.80	1.06

* The auditor did not generate CO concentrations at this level.

Sulfur Dioxide (SO_2)

The MQO for the measurement of SO_2 is the relative precision (CV%) and bias be within ±15%.

Table 5. Data Quality Indicator Results for Sulfur Dioxide Analyzers				
Location	**AQS Number**	**CV%**	**Bias**	**% Valid Data**
Cheeka Peak	530090013	1.60	±1.25	91
Seattle	530330080	1.26	-3.82	95

The QC check requires challenging the analyzer on a routine frequency with a SO_2 concentration similar to the routine concentration normally measured at the site. Average ambient SO_2 concentrations at both sites averaged one ppb; QC checks are being performed at 15 ppb.

Performance Evaluation Audits for SO_2

The MQO for audit results is that the difference be within ±15% for Levels 3–6, and within 1.5 ppb or 15% for Levels 1–2.

Table 6. Audit Results for Sulfur Dioxide Analyzers (Percent Difference)						
Location	**Level 1 0.3–2.9 ppb**	**Level 2 3–4.9 ppb**	**Level 3 5–7.9 ppb**	**Level 4 8–19.9 ppb**	**Level 5 20–49.9 ppb**	**Level 6 50–99.9 ppb**
Cheeka Peak	*	-6.67	-6.67	-4.00	-3.91	*
Seattle	5.00	5.00	3.33	2.00	4.00	1.33

* The auditor did not generate SO_2 concentrations at this level.
* The Performance Evaluation requires challenging the analyzer at concentrations similar to routine concentrations normally measured at the site. The average ambient SO_2 concentrations at both sites are less than 1 ppb.

Nitrogen Oxide (NO)

The MQO for the measurement of NO is the relative precision (CV%) and bias be within ±15%.

Table 7. Data Quality Indicator Results for Nitrogen Oxide Analyzers				
Location	**AQS Number**	**CV%**	**Bias**	**% Valid Data**
Cheeka Peak	530090013	2.01	±1.66	93
Seattle	530330080	2.12	-8.95	97

Performance Evaluations Audits for NO

The MQO for audit results is that the difference be within ±15% for Levels 3–6, and within 1.5 ppb or 15% for Levels 1–2.

Table 8. Audit Results for Nitrogen Oxide Analyzers (In Percentage)							
Location	Level 1 .3–2.9	Level 2 .3–4.9	Level 3 .0050–.0079	Level 4 .0080–.0199	Level 5 .0200–.0499	Level 6 .0500–.0999	Level 7 .100–.2999
Cheeka Peak	10	2.5	8.3	3.3	-4.3	*	*
Seattle	-40	10	0.7	-0.7	-2.0	-2.7	-3.0
* The auditor did not generate NO concentrations at this level.							

Data Quality Indicators for Particulate Pollutants

Bias Estimate (Bias)

The bias estimate is the systematic difference of the expected values and the actual measured values over time. Bias estimates are calculated as described in the Monitoring Rule, to determine if there is a systematic or persistent distortion of the data which causes error in one direction.

Instrument flow rates can fluctuate over time. One–point flow rate check (QC check) of the instrument are performed monthly. The objective of the check is to measure the actual flow rate of the instrument, using NIST traceable standards, while recording the indicated flow rate of the instrument. The difference between the two is calculated (in percentage) to determine how close to "true" the indicated flow is. A positive (+) value indicates that the instrument flow rates are operating above the actual (true) value. A negative (-) value represents the instruments flow rate is below the actual value. A ± symbol represents the instrument "straddles the line" and is neither biased positive nor negative. The checks are aggregated over a three-month, one-year, and three-year period.

One Point Quality Control Precision Estimate for Particulate Pollutants (Average % D)

On a routine basis, QC checks are performed on the station analyzer by measuring the actual flow of the instrument. The instrument flow is measured by monitoring personnel using standards traceable to NIST Standards. The difference between the actual flow and the indicated instrument flow is calculated and recorded by monitoring personnel and submitted to the AQS.

Semi-Annual Flow Rate Audits (Audit % D)

In addition to monthly QC checks, an independent flow rate check is performed by QA personnel on a semi-annual basis. The objective of the auditor is to measure the actual flow rate of the instrument, using independent NIST traceable standards while recording the indicated flow rate of the instrument. The deviation between the two flows is calculated, recorded, and submitted to AQS.

Fine Particulate Matter ($PM_{2.5}$ TEOM)

The MQO for the measurement of $PM_{2.5}$ using a TEOM method sampler is that bias and precision (Average % D) be within ±4%. Audit results (Audit % D) must be within ±4%.

Table 9. Data Quality Indicator Results for FRM $PM_{2.5}$ Samplers

Location	AQS Number	Bias	Average % D	Audit % D	% Valid Data
Darrington	530610020	±1.97	1.00	-2.3	97
Kent	530332004	±1.54	0.68	*	92
Lynnwood	530610005	+1.32	0.45	-1.6	97
Marysville	530611007	+2.25	1.19	-0.9	98
Seattle (BH)	530330080	-2.76	1.31	+2.0	84
Seattle (Duwamish)	530330057	+0.89	0.56	*	98
Spokane	530630021	-3.52	2.59	*	94
Tacoma (South)	530530029	+1.45	1.12	-1.0	96
Tacoma (co-located)	530530029	+2.61	2.27	+0.7	97
Vancouver	530110013	+2.34	0.90	*	91
Yakima	530770009	±1.54	0.51	+0.3	80

* No evaluation performed during the quarter.

Particulate Matter (PM_{10} TEOM)

The MQO for the measurement of PM_{10} using TEOM method sampling is bias and precision (% D) be within ±10%. Audit results (Audit % D) must be within ±10%.

Table 10. Data Quality Indicator Results for FRM PM_{10} Samplers

Location	AQS Number	Bias	Average % D	Audit % D	% Valid Data
Burbank	530710006	±3.33	1.29	-1.8	97
Colville	530650004	+5.35	2.18	*	98
Kennewick	530050002	-4.81	3.00	+4.2	96

* No evaluation performed during the quarter.

Manual Data

Manual data refers to monitoring methods requiring an operator to physically install, retrieve, and mail to a laboratory, a sample filter that contains particulate matter collected over a 24-hour period. Dependant on the specific method used at the monitoring site, the instrument is designed to selectively collect particulate matter at a specific flow rate on scheduled days.

One-Point Flow Rate Bias Estimate (Signed Bias)

Manual data monitoring methods require accurate flow rate measurements. Particulate concentrations are calculated by the gross weight of the sample on a filter divided by the volume of air.

The volume of air is calculated by the flow rate of the instrument over time. Instruments are calibrated to operate at a designed flow rate. Differences in flow rates affect actual concentrations. Figure 2 illustrates how a 4% difference in flow rate impacts the actual concentration of a $PM_{2.5}$ sample. With the daily NAAQS for $PM_{2.5}$ set at 35 $\mu g/m^3$, actual flow rates become critical when measuring concentrations between 34 and 36 $\mu g/m^3$.

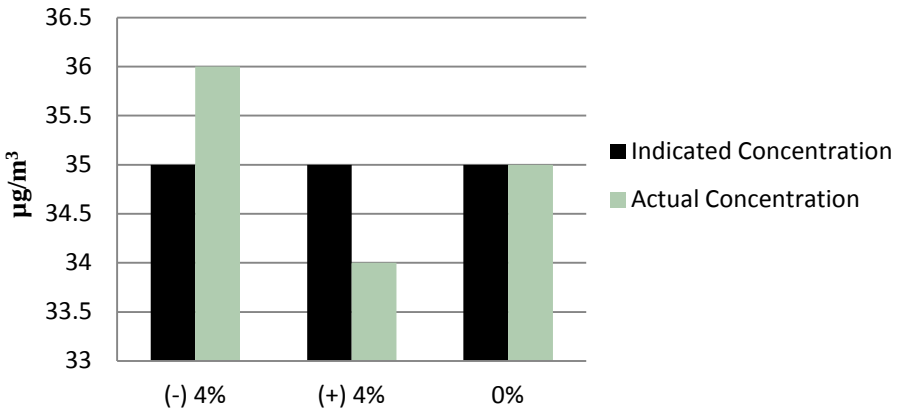

Figure 3. Effect of flow rates on $PM_{2.5}$ particulate concentrations

Instrument flow rates can fluctuate over time. Therefore, a monthly one–point flow rate check (QC check) on the instrument is required monthly. The objective of the check is to measure the actual flow rate of the instrument using NIST traceable standards while recording the indicated flow rate of the instrument. The difference between the two is calculated (in percentage) to determine how "true" the indicated flow is and aggregated over a 3-month period. A positive (+) value indicates that the instrument flow rate over time is operating above the actual (true) value. A negative (-) value represents the instruments flow rate is below the actual value. A ± symbol represents the instrument "straddles the line" and is neither biased positive nor negative.

One Point Quality Control Precision Estimate for Particulate Pollutants (% D)

Monthly QC checks are performed on the station analyzer by monitoring personnel. The difference between the actual flow and the indicated instrument flow is calculated, recorded, and submitted into the AQS.

Semi-Annual Flow Rate Audits (Audit % D)

In addition to monthly QC checks, an independent flow rate check is performed by QA personnel on a semi-annual basis. The objective of the auditor is to measure the actual flow rate of the instrument using independent NIST traceable standards while recording the indicated flow rate of the instrument. The deviation between the two flows is then calculated and submitted to the AQS.

Particulate Matter (PM_{10})

The MQO for the measurement of PM_{10} using the low volume manual method sampler is that bias and precision (% D) be within ±4%. Audit results (Audit % D) must be within ±4%.

The MQO for the measurement of PM_{10} using the high volume manual method sampler is that bias and precision (% D) be within ±10%. The audit results (Audit % D) must be within ±10%.

Table 11. Data Quality Indicator Results for PM_{10} Samplers

Location	AQS Number	Bias	% D	Audit % D	% Valid Data	Comments
Seattle	530330080	±1.55	1.02	-1.14	80	Low Vol
Spokane	530630021	+1.61	0.92	*	100	Hi Vol
Yakima	530770009	-1.77	0.81	-5.5%	100	Hi Vol
* No evaluation performed during the quarter.						

Fine Particulate Matter ($PM_{2.5}$)

The MQO for the measurement of $PM_{2.5}$ using FRM method sampling is that bias, precision (% D), and audit results (Audit % D) be within ±4%.

Table 12. Data Quality Indicator Results for $PM_{2.5}$ FRM Samplers

Location	AQS Number	Bias	% D	Audit % D	% Valid Data	Comments
Darrington	530610020	+3.00	2.35	-1.20	97	
Marysville	530611007	+3.51	3.18	*	97	

Table 12. Data Quality Indicator Results for $PM_{2.5}$ FRM Samplers						
Location	**AQS Number**	**Bias**	**% D**	**Audit % D**	**% Valid Data**	**Comments**
Seattle	530330080	±1.47	1.12	+2.2	100	
Spokane	530630021	±0.74	0.30	*	100	
Tacoma	530530029	+4.02	2.17	+1.0	93	Instrument replaced 12/5
Vancouver	530110013	+0.55	0.33	*	100	
Yakima	530770009	±1.21	0.79	+0.3	97	
* No evaluation performed during the quarter.						

Precision Estimate for Collocated Samples ($PM_{2.5}$ & PM_{10})

Precision for manual method sampling is estimated using collocated sampling. Unlike the gaseous criteria pollutants where one can use a standard of a known concentration to estimate instrument precision, duplicate measurements are made on-site for comparison. The precision (CV%) must be within ±10%.

Table 13. Precision Estimates for Collocated Samplers			
Location	**AQS Number**	**CV%**	**Comments**
Spokane $PM_{2.5}$	530630021	4.98	FRM
Spokane PM_{10}	530630021	4.54	FRM
Tacoma $PM_{2.5}$	530530029	6.83	FRM
Tacoma $PM_{2.5}$	530530029	9.27	TEOM

$PM_{2.5}$ Chemical Speciation Trends Network (STN)

The Speciation Trends Network is a national network of sites used to determine, over a period of several years, trends in concentration levels of selected ions, metals, carbon species, and organic compounds in $PM_{2.5}$. Flow checks are performed by personnel on a monthly basis and submitted to a national repository contracted by OAQPS.

In addition to monthly QC checks, an independent flow rate check is performed by QA personnel on a semi-annual basis. The primary objective of the audit is to measure the actual flow rate of the instrument using independent NIST traceable standards while recording the indicated flow rate of the instrument, similar to what the operator performs on a monthly basis. The deviation between the two flows is then calculated. The MQO for the STN is that the results be within ±10%.

Table 14. Audit Results for Speciation Samplers						
Location	**AQS Number**	**SASS CH 1 Audit % D**	**SASS CH 2 Audit % D**	**URG Audit % D**	**% Valid Data**	**Comments**
Marysville	530611007	2.05	1.03	.97	100	
Seattle	530330080	1.51	-.060	-1.7	**73**	*AT failure
Tacoma	530530029	-3.04	-1.90	-1.2	93	
Vancouver	530110013	1.18	1.18	1.87	100	
Yakima	530770009	*	*	*	100	
* The ambient temperature probe failed on the Speciation Air Sampling System (SASS). * No evaluation was performed during the quarter.						

Meteorological Data

To ensure data of sufficient high quality for modeling applications or permitting use, EPA guidelines for continuous monitoring for Prevention of Significant Deterioration (PSD) are followed for Wind Speed (WS), Wind Direction (WD), Ambient Temperature at two meters above the tower base (AT2), Ambient Temperature at 10 meters above the tower base (AT10), the difference between AT2 and AT10 (DT), Ambient Pressure (PA) and Relative Humidity (RH).

Table 15. Completeness Results for Meteorological Parameters								
Location	**AQS Number**	**WS**	**WD**	**AT2**	**AT10**	**DT**	**PA**	**RH**
Burbank	530710006	99	99	99	-	-	-	-
Cheeka Peak	530090013	99	99	99	-	-	99	99
Colville	530650004	75*	75*	99	-	-	-	-
Enumclaw	530330023	99	99	99	-	-	-	-
North Bend	530330017	98	98	98	-	-	-	-
Oakville	530270008	94	94	94	-	-	-	-
Omak	530470013	99	99	99	-	-	-	-
Seattle	530330080	99	99	99	99	99	99	86
Spokane	530630021	99	99	99	-	-	-	-
Tacoma	530531016	99	99	99	-	-	-	-
Toppenish	530770015	98	98	98	-	-	-	-
Vancouver	530110011	96	96	96	-	-	-	-
White Swan	530770016	98	98	98	-	-	-	-
* The wind speed/wind direction sensor failed at Colville.								

Washington Air Quality Advisory (WAQA) Data

Light Scattering of Fine Particulates (Nephelometer)

An AQP goal is to report to the general public the measure of particulate matter in the ambient air in near "real time" using instruments (nephelometer) that measure light scattering of particulates. The monitoring method requires specific methodologies approved by the EPA Region 10 Administrator to represent the data as "$PM_{2.5}$ like" for reporting purposes. Data collected at these sites are not used for compliance determination relative to the National Ambient Air Quality Standards. The data are displayed in "near real time" on Ecology and EPA internet sites for public information.

Table 16. Completeness Results for Nephelometers

Location	AQS Number	% Valid Data	Comments
Aberdeen	530272002	91	
Bellevue	530330037	99	
Bellingham	530730015	86	
Cheeka Peak	530090013	98	
Chehalis	530410004	99	
Chelan	530070007	99	
Clarkston	530030004	98	
Colville	530650004	99	
Dayton	530130002	99	
Ellensburg	530370002	99	
Goldendale	530390005	87	
Kennewick	530050002	99	
Lacey	530670013	99	
LaCrosse	530750005	88	
Lake Forest Park	530330024	99	
Leavenworth	530070010	99	
Longview	530150015	99	
Meadowdale	530351005	99	
Mesa	530210002	99	
Moses Lake	530251002	99	
Mount Vernon	530570015	99	
Naches	530770007	99	
Neah Bay	530090015	99	
North Bend	530330017	99	
Oakville	530270008	88	
Omak	530470013	99	
Port Angeles	530090009	99	

Table 16. Completeness Results for Nephelometers			
Location	**AQS Number**	**% Valid Data**	**Comments**
Pt. Townsend	530310003	99	
Pullman	530750003	99	
Puyallup, 66th Ave. E	530530022	99	
Puyallup, 128th Ave.	530531018	96	
Ritzville	530010003	99	
Rosalia	530750006	99	
Seattle, South Park	530331011	99	
Seattle, Olive Way	530330048	98	
Shelton	530450007	99	
Spokane	530630047	99	
Tacoma, Alexander Ave.	530530031	99	
Taholah	530270011	40*	Station discontinued 11/8/2011
Toppenish	530770015	99	
Twisp	530470009	99	
Vancouver, 4th and Plain	530110013	99	
Walla Walla	530710005	99	
Wellpinit	530650002	99	
Wenatchee	530070006	99	
White Swan	530770016	99	
Winthrop	530470010	94	
Yacolt	530110022	99	
Yakima	530770009	99	
* The nephelometer at Taholah was removed from the site on November 11, 2011.			

Acronyms and Abbreviations

AQP	Air Quality Program
AQS	Air Quality System
CO	Carbon Monoxide
CV	Coefficient of Variation
DQI	Data Quality Indicator
DQO	Data Quality Objective
EPA	United States Environmental Protection Agency
FEM	Federal Equivalency Method
FRM	Federal Reference Method
MQO	Monitoring Quality Objective
NAAQS	National Air Quality Standards
NCore	National Core Monitoring Network
NIST	National Institute of Standards and Technology
NO	Nitrogen Oxide
PE	Performance Evaluation
PQAO	Primary Quality Assurance Organization
$PM_{2.5}$	Particulate matter with diameter less than 2.5 microns
PM_{10}	Particulate matter with diameter less than 10 microns
$PM_{10-2.5}$	Particulate matter with diameter between 10 and 2.5 microns
ppb	parts per billion
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SASS	Speciation Air Sampling System
SO_2	Sulfur Dioxide
WAQA	Washington Air Quality Advisory