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State of Washington

Washington State Implementation Plan Revision

Interstate Transport of Fine Particulate Matter

Addressing requirements for the 2006 24-hour National Ambient Air Quality Standard

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Interstate Transport of Fine Particulate Matter

Addressing requirements for the 2006 24-hour National Ambient Air Quality Standard

by

Air Quality Program
Washington State Department of Ecology
Olympia, Washington

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Executive Summary

The "good neighbor" or "interstate transport" provisions of the Federal Clean Air Act (CAA) protect downwind states from harmful pollution that originates in upwind states. This State Implementation Plan (SIP) revision document contains Washington's analysis of the interstate transport of fine particles ($PM_{2.5}$). It finds that Washington's sources do not significantly contribute to $PM_{2.5}$ air pollution in other states. No new rules are proposed.

Exposure to $PM_{2.5}$ is associated with respiratory diseases, decreased heart and lung function, asthma attacks, heart attacks, strokes and premature death. In 2006, Environmental Protection Agency (EPA) strengthened the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$. The revised 2006 standard triggered the requirement to assess Washington's contributions to areas with $PM_{2.5}$ concerns in neighboring states.

$PM_{2.5}$ are particles of 2.5 micrometers in diameter or smaller. $PM_{2.5}$ is emitted in combustion processes (e.g. wood stoves, fireplaces, exhaust from vehicles, ships and trains, and industrial processes), or can also be formed in the atmosphere from other elements and compounds, for example nitrogen oxides and sulfur dioxides. $PM_{2.5}$ can be transported and dispersed over hundreds of miles depending on the weather, wind patterns, and terrain and water features.

Ecology reviewed existing monitoring data, emissions inventories, topography and meteorology, technical support documents, and the latest design values to establish potential "red flags" indicative of a significant $PM_{2.5}$ transport to neighboring states. Ecology's findings are similar for all areas of $PM_{2.5}$ concern in neighboring states. Stagnation events in combination with localized sources — particularly wood smoke from residential heating activities — are the most common factors resulting in high levels of $PM_{2.5}$.

Significant distance between state borders and the areas of $PM_{2.5}$ air quality concerns in other states further supports that transport from Washington sources is unlikely to contribute significantly to these episodes. Only one exceedance in St. Luke's Meridian (ID) was traced back to a Washington wildfire. The 2012 National Interagency Coordination Center (NICC) annual report identified lightning as the cause of this particular wildfire. As a natural event, it could not be reasonably controlled or prevented.

Ecology found no evidence of significant transport of $PM_{2.5}$ pollution across the state border. Ecology concludes that it is safe to assume that Washington sources do not contribute significantly to $PM_{2.5}$ pollution in any other state.

Introduction

Washington State Department of Ecology (Ecology) submits this State Implementation Plan (SIP) revision to address the requirements of the Clean Air Act (CAA) with regard to the 2006 24-hour ($PM_{2.5}$) National Ambient Air Quality Standard (NAAQS). This revision addresses section 110(a)(2)(D)(i) of the CAA that requires a SIP to:

> *(D) contain adequate provisions –*
>
> > *(i) prohibiting, consistent with the provisions of this subchapter, any source or other type of emissions activity within the State from emitting any air pollutant in amounts which will –*
> >
> > > *(I) contribute significantly to nonattainment in, or interfere with maintenance by, any other State with respect to any such national primary or secondary ambient air quality standard….*
> > >
> > > *(II) interfere with measures required to be included in the applicable implementation plan for any other state….to prevent significant deterioration or to protect visibility*

The requirements to control interstate transport of pollutants are often referred to as "good neighbor" provisions of the CAA. The intent of the provisions is to ensure that residents and the welfare of downwind states are protected from harmful emissions originating in upwind states.

The Washington SIP, codified in 40 CFR 52 Subpart WW, prohibits any source or type of emissions within the state from significantly contributing to nonattainment or interfering with maintenance in another state. The analysis developed by Washington in support of this SIP revision showed no indication of a significant $PM_{2.5}$ transport across state borders. Based on our assessment and findings, we assert that Washington does not contribute significantly to nonattainment, or interfere with maintenance, in another state with respect to the $PM_{2.5}$ NAAQS.

Background

Particulate matter is one of the "criteria pollutants" for which EPA has promulgated NAAQS under the CAA. In particular, fine particulate matter, or $PM_{2.5}$, describes particulate matter that is 2.5 micrometers in diameter and smaller. Primary fine particles are directly emitted by sources, while secondary fine particles form in the atmosphere from gases emitted by sources. Sulfur dioxide (SO_2), ammonia (NH_4), and nitrogen oxides (NO_X) are the precursors for ammonium bisulfate ($(NH_4)HSO_4$), ammonium sulfate ($(NH_4)_2SO_4$), and ammonium nitrate (NH_4NO_3) particles that often constitute major fractions of $PM_{2.5}$. Volatile Organic Compounds (VOC) may also contribute to Secondary Organic Aerosol (SOA).

The nation's air quality standards for particulates were first established in 1971 (measured Total Suspended Particulates) and were not significantly revised until 1987, when the U.S. Environmental Protection Agency (EPA) established the PM_{10} NAAQS. In 1997, for regulatory purposes, EPA decided to separate particles into $PM_{2.5}$ and PM_{10} because of the differing health effects. The primary and secondary NAAQS for $PM_{2.5}$ were set as 65 $\mu g/m^3$ averaged over a 24-hour period, and an annual concentration of 15 $\mu g/m^3$ based on a three year average of the annual arithmetic mean $PM_{2.5}$ concentration from one or more community-oriented monitors. On September 21, 2006, EPA revised the 24-hour standard for $PM_{2.5}$ from 65 $\mu g/m^3$ to 35 $\mu g/m^3$, and retained the annual fine particle standard at 15 $\mu g/m^3$ (71 FR 61144).

Under sections 110(a)(1) and (2) of the CAA, within three years of the promulgation of the new standards, states are required to submit a SIP revision providing for the implementation, maintenance, and enforcement of the new standards. The SIP revision was due in October 2009. Due to limited resources and competing priorities, Washington missed the deadline.

On May 28, 2010, EPA notified certain states and territories (including Washington) that they have failed to meet CAA deadlines for submitting SIP revisions satisfying section 110(a) nonattainment and maintenance transport requirements for the 2006 24-hour $PM_{2.5}$ NAAQS. In the Federal Register Notice published on July 9, 2010 (75 FR 32673), EPA issued a finding of failure to submit this SIP. This finding started a 2-year deadline for the promulgation of a Federal Implementation Plan (FIP) by EPA unless, prior to the deadline, a state makes a submission and EPA approves such submission. The finding did not trigger a sanction clock.

For the eastern part of the continental United States, EPA developed a regional air quality modeling analysis and promulgated two rules: 2005 Clean Air Interstate Rule (CAIR) and its replacement 2011 Cross-State Air Pollution Rule (CSAPR). Both rules were challenged in courts and the Transport Rule was vacated in August 2012. In the meantime, CAIR continued to be implemented. In September 4, 2013, the U.S. Supreme Court reversed the D.C Circuit opinion that vacated CSAPR and in June 26, 2014, the U.S. government filed a motion with the U.S. Court of Appeals for the D.C. Circuit to lift the stay of the CSAPR. The court is considering the motion and in the meantime, CAIR remains in place.

In September 2009, EPA issued a *Guidance on SIP Elements Required Under Section 110(a)(1) and (2) for the 8-hour Ozone and $PM_{2.5}$ NAAQS* (Harnett Guidance). In this guidance, EPA directed states to develop an adequate technical analysis to support state's findings and conclusions. In regards to the contribution to nonattainment requirement, the guidance stated:

> *Information to support state's determination with respect to significant contribution to nonattainment might include, but is not limited to, information concerning emissions in the state, meteorological conditions in the state and the potentially impacted states, the distance to the nearest area that is not attaining the NAAQS in another state, and air quality modeling.*

With respect to the interference with maintenance requirement, the guidance stated:

A state's submission for the requirement should provide the technical information with the state deems appropriate to support its conclusions. Suitable information might include, but is not limited to, information concerning emissions in the state and the potentially impacted states, monitored ambient concentrations in the state and the potentially impacted states, and air quality modeling.

The transport and dispersion of air pollutants in the ambient air are influenced by many complex factors such as global and regional weather and climate patterns, topography, and location of emission sources. In general, the concentration of the pollutant decreases as it travels from the point of release and is dispersed by wind and other natural phenomena. Air quality modeling is the best tool to estimate the amount of pollutants transported regionally. Such modeling requires significant technical resources which are not currently available at the state level.

The regional modeling performed originally for CAIR assists the Eastern states in understanding interstate transport of $PM_{2.5}$. No such modeling is available for the Western States, which are responsible for developing each their own technical analysis and methodology to support their findings.

Washington's approach

In the absence of a regional-scale modeling specifically for $PM_{2.5}$ transport in Western states, Washington's approach was to assess existing data and relevant factors for potential "red flags" indicative of a significant $PM_{2.5}$ transport. Ecology felt this approach was warranted due to the following factors:

- Washington did not receive notification from any other state or EPA indicating that Washington sources significantly contribute to nonattainment or interfere with maintenance of the $PM_{2.5}$ NAAQS in those states.
- The Western part of the U.S. does not have $PM_{2.5}$ transport problems to the extent comparable to the Eastern states, for which regional modeling is available.

As part of this analysis, Ecology reviewed:

- Washington's topography, meteorology and sources related.
- Current and projected $PM_{2.5}$ precursors' emission inventory for the state.
- Technical Support Documentation for the $PM_{2.5}$ in nonattainment areas as well as for interstate transport in surrounding states.
- Latest design values for Oregon and Idaho counties neighboring Washington.

Factors impacting transport of $PM_{2.5}$ such as topography, meteorology, and regional sources are reviewed in the following section. A revision of the current and projected emission inventories of precursors for the state of Washington is included, as well. The technical assessment and the ambient data supporting our conclusions are presented in the last section and Appendices, respectively.

Factors impacting transport of $PM_{2.5}$

Topography, meteorology and relevant sources1

The State of Washington is located on the windward Pacific coast. The climatic elements combine to produce a predominantly marine-type climate west of the Cascade Mountains and a mixed continental and marine climate east of the Cascades. Considering its northerly latitude, 46° to 49°, Washington's climate is mild.

There are several climatic controls which have a definite influence on the climate: (a) terrain, (b) Pacific Ocean, and (c) semi-permanent high and low pressure regions located over the North Pacific Ocean. The effects of these controls combine to produce entirely different conditions within short distances.

The Cascade Mountains, 90 to 125 miles inland and 4,000 to 10,000 feet in elevation, are a topographic and climatic barrier separating the state into eastern and western Washington. The wet season begins in October, reaches a peak in winter, and then gradually decreases in the spring. High peaks in the Cascades are snowcapped throughout the year. The Columbia River, draining approximately 259,000 square miles in the Pacific Northwest and second only to the Mississippi River in volume flow, enters near the northeastern corner of the state and flows in a semi-circular pattern through eastern Washington. Before reaching the Pacific Ocean, it drains all of eastern Washington and the western slope of the Cascade Mountains between Mt. Rainier and the Oregon border.

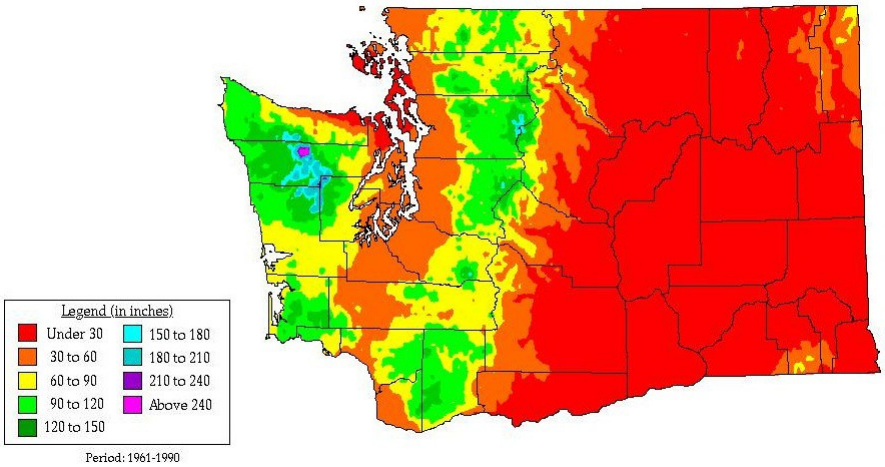

Figure 1 Average annual precipitation in Washington.[2]

Reservoirs on the windward slopes of the mountains provide an abundance of water for metropolitan areas, and hydroelectric projects have been developed along several rivers. Hydroelectricity supplies about two thirds of Washington's electricity requirements.

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[1] Adapted from *2010 Washington State Ambient Air Monitoring Network Assessment*, publication no. 10-02-016 and *Climate of Washington*, Western Regional Climate Center, (www.wrcc.dri.edu/narratives/WASHINGTON.htm)
[2] Adapted from http://www.wrcc.dri.edu/pcpn/wa.gif

The mountainous areas over the entire state and a major portion of the lowlands west of the Cascades are covered by timber. Species include both conifers (Douglas fir, spruce, hemlock, cedar) and deciduous (big leaf maple and alder). A dense undergrowth of fern and moss is found in the rainforest on the Olympic Peninsula. The lower elevations in eastern Washington consist of open stands of Ponderosa pine. Logging and other forest management practices are major activities in these areas.

The Washington State Department of Natural Resources regulates silvicultural burning, while Ecology and the local air agencies regulate agricultural and other outdoor burning.

Western Washington

West of the Cascade Mountains, summers are cool and comparatively dry, and winters are mild, wet, and cloudy. Snowfall is light in the lower elevations and heavy in the mountains. In the interior valleys, measurable rainfall is recorded on 150 days each year and on 190 days in the mountains and along the coast. During July and August, the driest months, it is not unusual for two to four weeks to pass with little or no precipitation. However, during the wettest months November and December, precipitation is frequently recorded on over 20 days each month.

The highest summer and lowest winter temperatures are usually recorded during periods of easterly winds. Agriculture is confined to the river valleys and well-drained areas in the lowlands. Although the Cascade Range divides the state into two major climatic regions, there are several climatic areas within each of these regions:

- The *West Olympic Coastal* area includes the coastal plains and the western slope of the coastal range from the Columbia River to the Strait of Juan de Fuca. This area receives the full force of storms moving inland from over the ocean, thus heavy precipitation and gale force winds occur frequently during the winter season. The “rainforest” area along the southwestern and western slopes of the Olympic Mountains receives the heaviest precipitation in the continental United States, with annual precipitation exceeding 150 inches along the windward slopes. Air pollution sources in this sparsely populated area include a few industries, outdoor/ silvicultural burning, and smoke from woodstoves and other home heating devices in some communities.
- The *Northeast Olympic-San Juan Islands* area includes the lower elevation along the northeastern slope of the Olympic Mountains extending eastward along the Strait of Juan de Fuca from near Port Angeles to Whidbey Island and then northward into the San Juan islands. The area is shielded from winter storms moving inland from the ocean by the Olympic Mountains and the extension of the Coastal Range on Vancouver Island. This belt in the “rain shadow” of the Olympic Mountains is the driest area in western Washington. The coldest weather is usually associated with outflows of cold air from the interior of Canada. The few air quality concerns in the area are mostly caused by smoke from woodstoves and other home heating devices in larger communities, outdoor burning, and by some industrial facilities.

- The *Puget Sound Lowlands* area includes a narrow strip of land along the west side of Puget Sound southward from the Strait of Juan de Fuca to the vicinity of Centralia and Chehalis and a somewhat wider strip along the east side of the Sound extending northward to the Canadian Border. Variations in the temperature, length of the growing season, fog, rainfall, and snowfall are due to such factors as distance from the Sound, the rolling terrain, and influx of air from the ocean through the Strait of Juan de Fuca and the Chehalis River valley. Most of this area is near the eastern edge of the rain shadow of the Olympic Mountains. The prevailing wind direction is south or southwest during the wet season and northwest in summer. This is the most densely populated and industrialized area in the state. Vehicular, industrial, domestic, and marine sources (shipping, ferries), and both vessels and traffic at ports are among the main anthropogenic sources in the area. Summertime $PM_{2.5}$ concentrations are usually low due to sufficient atmospheric mixing, but PM2.5 can be elevated under conditions of clear skies, light wind and a sharp temperature inversion during the home heating season (October – March) when woodstoves and other heating devices are typically used. Some sheltered locations (such as Darrington, Kent, and the Duwamish valley) can experience a buildup of pollutants even when most other areas are moderately ventilated. Some areas with a high density of woodstove use (South Tacoma, Marysville, Lynnwood, Darrington, and Bremerton) frequently experience rapid rises of $PM_{2.5}$ levels in the home heating season, during periods of poor dispersion.

Eastern Washington

This section of the state is part of the large inland basin between the Cascade and Rocky Mountains. East of the Cascades, summers are warmer, winters are colder, and precipitation is less than in western Washington. The major agricultural areas are in eastern Washington. During most of the year, the prevailing direction of the wind is from the southwest or west. The frequency of northeasterly winds is greatest in the fall and winter. Melting snow provides irrigation water for orchards and other agricultural areas in the Okanogan, Wenatchee, Methow, Yakima, and Columbia River valleys. Dry land farming practices are generally followed in the small-grain growing areas.

- The *Okanogan-Big Bend* area includes fruit-producing valleys along the Okanogan, Methow, and Columbia rivers, grazing land along the southern Okanogan highlands, the Waterville Plateau, and part of the channeled scablands. Major air pollution sources are outdoor burning (year round, except during summer fire safety burn bans), agricultural burning (spring and fall burn seasons), orchard heaters, smudge pots, silvicultural burning, and woodstove use. In rare instances, smoke from some burns may become entrained in evening downslope flow and settle in sheltered valleys (examples include Wenatchee, Twisp, Winthrop, Omak, and Leavenworth). Smoke from any combination of these sources, if coupled with a strong temperature inversion and calm conditions, often result in elevated $PM_{2.5}$ concentrations.

- The *Central Basin* area includes the Ellensburg valley, the central plains area in the Columbia Basin south from the Waterville Plateau to the Oregon border and east to near the Palouse River. This is the lowest and driest section in eastern Washington. Wheat and barley are the most widely grown crops in this area, while alfalfa, lentils and potatoes are also grown on a smaller scale. Agricultural and outdoor burns are the main $PM_{2.5}$

sources. Except for the larger populated cities of Spokane, the Tri Cities, Ellensburg and Walla Walla, smoke from home heating devices and prescribed burning is not a major concern in this sparsely populated area. Tilling operations, windblown dust and re-suspended road dust sometimes gives rise to elevated levels of PM_{10}.

Emissions Inventory

Ecology reviewed data published from the NEI 2011[3] for the main $PM_{2.5}$ precursors. Figure 1 and 2 present emissions by sector and emission density maps for NOx and SO_2 for the state of Washington:

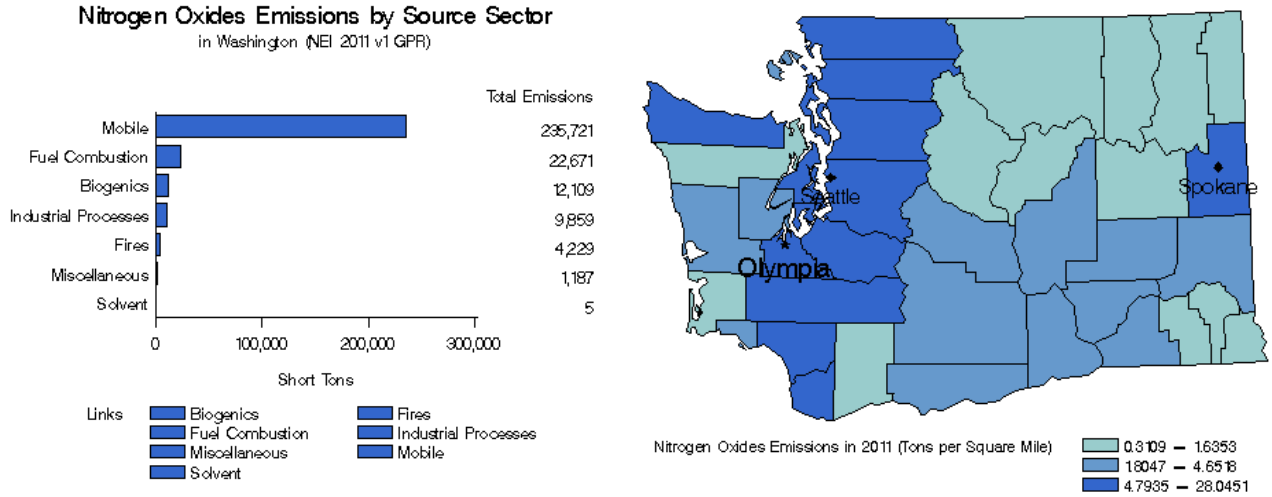

Figure 2 Summary of NOx emissions for the year 2011 for the state of Washington.

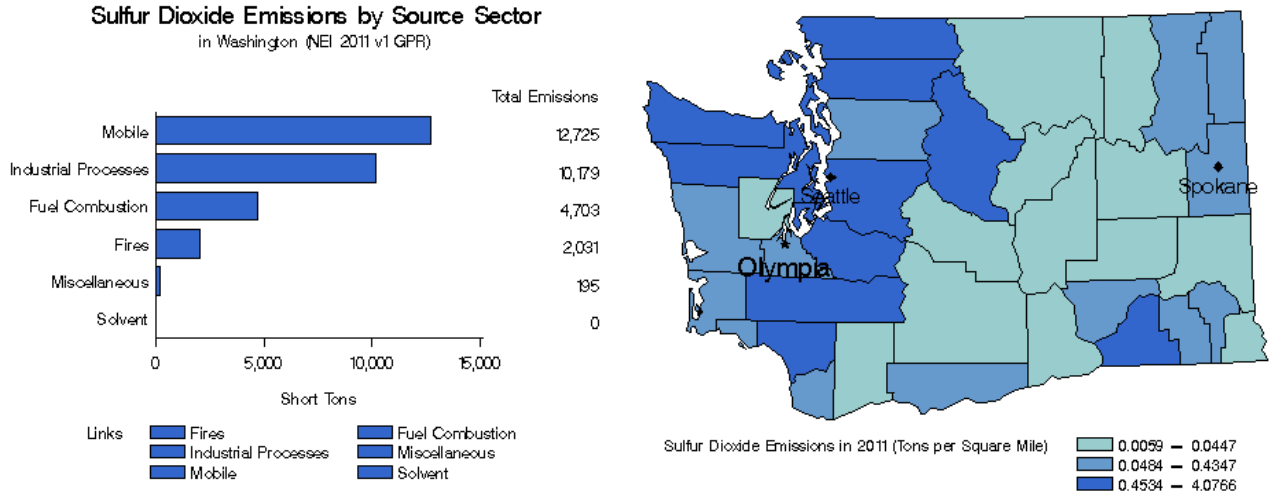

Figure 3 Summary of SO_2 emissions for the year 2011 for the state of Washington.

[3] EPA website, Air Emission Sources, State and County Emission Summaries (http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1.sas&pol=NOX&stfips=53)

In addition, Ecology reviewed $PM_{2.5}$ emissions for the year 2011 as well as the statewide emission inventory developed by Ecology in 2005. Figure 3 shows $PM_{2.5}$ emissions by sector and emission density map:

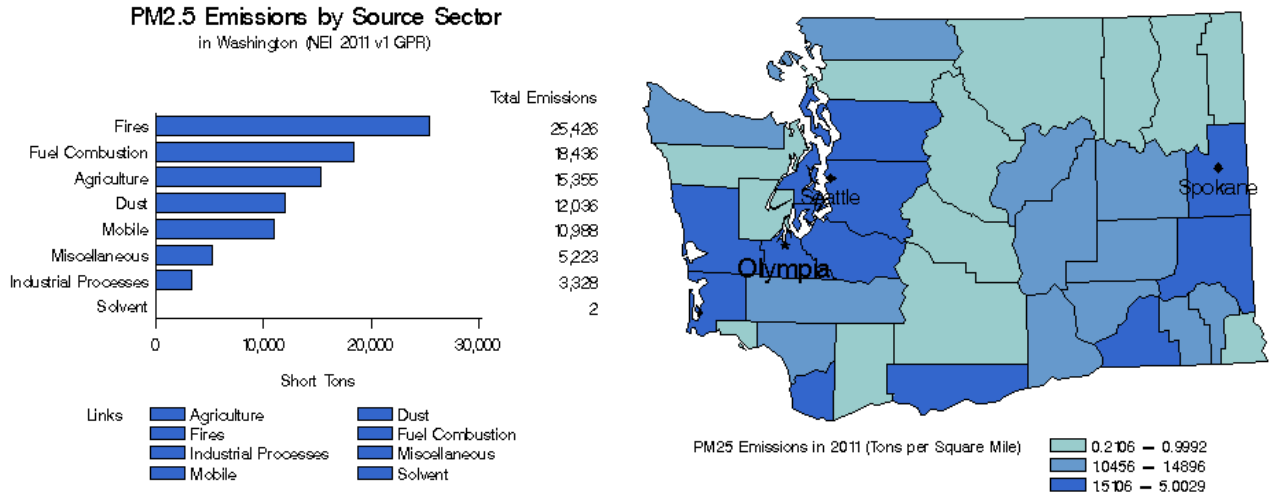

Figure 4 Summary of $PM_{2.5}$ emissions for the year 2011 for the state of Washington.

Table 1 lists anthropogenic source categories used in the 2005 EI. Asphalt paving, pesticide usage, fugitive emissions from construction sites, fugitive emissions from agricultural windblown dust, land clearing burning, and aircraft emissions were not included in the Ecology's 2005 EI.

Table 1 Anthropogenic source categories of $PM_{2.5}$ Emission in WA (2005 EI, Ecology)

Source Category		Emissions (Tons per year)
Woodstoves, fireplaces, inserts		14,544
Agricultural tilling and harvesting		13,118
Industrial, commercial or institutional sources (point sources)		5,773
Others	*Paved and unpaved road dust*	4,891
	Land-based non-road mobile(except locomotives)	3,865
	Agricultural, silvicultural and rangeland burning	3,698
	Residential outdoor burning: yard waste, trash	3,167
	On-road mobile sources	2,711
	Commercial marine vessels	1,440
	Locomotives	583
	Recreational boats	368
	Residential fuel use(natural gas, oil, propane, butane)	362

According to Table 1, woodstoves, fireplaces and inserts are responsible for about a quarter (27%) of all primary $PM_{2.5}$ emissions in the state. They are closely followed by agricultural

tilling and harvesting (24%). The third largest group category for primary $PM_{2.5}$ emissions is point sources (11%).

Finally, Ecology also reviewed the emission inventories used in the CSAPR modeling analysis[4]. The 2005 base case used in the CSAPR analysis included values for NOx and SO_2 emissions of 357,674 tons and 57,580 tons, correspondingly. The NOx and SO_2 values for Washington in 2012 are 268,870 tons and 38,581 tons, indicating that Washington's emissions were reduced by 24.8% and 33%, respectively.

Interstate Transport Technical Assessment

Consistent with previous EPA's approach followed in the 1998 NOx SIP call, the 2005 CAIR and the 2011 Transport Rule[5], the following analysis evaluates the impact of Washington on specific monitors in neighboring states that have been identified as having nonattainment and/or maintenance areas, which are referred to as "receptors".

Nonattainment and Maintenance Receptor Selection Methodology

For this analysis, a receptor may be a downwind location that is currently violating the $PM_{2.5}$ NAAQS, has violated in the past, is projected to violate in the future, or may have trouble maintaining the NAAQS in the future. The nonattainment and maintenance receptors identified here were selected based on recent ambient air quality monitoring data.

The particular ambient data analyzed spanned a period of 5 years to allow examination of the year to year variability. The three most recent consecutive official three-year design value periods available[6] are 2009-2011, 2010-2012, and 2011-2013, and were used to identify receptors relevant to this analysis. The particular selection criteria for both nonattainment and maintenance receptors are described below[7]:

- A nonattainment receptor is defined as a monitoring site that is violating the NAAQS in the most recent three-year period (i.e. 2011-2013).
- A maintenance receptor is defined as a monitoring site that shows attainment in the most recent three year design value period (i.e. 2011-2013) but violated the NAAQS in at least one of the previous two design value periods (i.e. 2009-2011 and/or 2010-2012).

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[4] See *Emissions Inventory Final Rule TSD*, Technical Support Document (TSD) for the final Transport Rule, Docket ID No. EPA-HQ-OAR-2009-0491, June 28, 2011, at Tables 7-1 and 7-2

[5] See NOx SIP Call, 63 FR 57371 (October 27, 1998); CAIR, 70 FR 25172 (May 12, 2005); and Transport Rule or Cross-State Air Pollution Rule, 76 FR 48208 (August 8, 2011)

[6] See http://www.epa.gov/airtrends/values.html

[7] Air quality designations are not relevant to the methodology for identifying these "receptors". See *TSD for the EPA's Proposed Action on the State of Oregon's 2010 Interstate Transport SIP for the 2006 24-hour Fine Particulate ($PM_{2.5}$) National Ambient Air Quality Standard*, Docket ID no EPA-R10-OAR-2011-0446-0005

Table 2 presents a list of monitoring sites in neighboring states that are currently designated nonattainment areas or classified as nonattainment receptors according to the criteria described before. The selection criteria resulted in no maintenance receptors for the neighboring states. It is worth mentioning that the design values published do not include exceptional events that have been flagged by States, Tribes, and local agencies, and concurred by the associated EPA Regional office:

Table 2 Design values for nonattainment receptors for the 2006 24-hour NAAQS

State	County	Site ID	Site name	Distance to WA (miles)	2009-2011 (μg/m^3)	2010-2012 (μg/m^3)	2011-2013 (μg/m^3)	Receptor Type
ID	**Ada**	160010010	St. Luke's Meridian	170[a]	19	27	53	Nonattainment (not designated)
	Lemhi	160590004	Salmon	160[a]	38	75	38	Nonattainment (not designated)
	Shoshone	160790017	Pinehurst	40[b]	38	38	40	Nonattainment (not designated)
	Franklin	160410001	Franklin	380[a]	50	47	42	Nonattainment (designated)
OR	**Crook**	410130100	Prineville	110[c]	31	31	39	Nonattainment (not designated)
	Klamath	410350004	Klamath Falls	245[c]	39	35	40	Nonattainment (designated)
	Jackson	410290133	Medford	245[c]	28	26	42	Nonattainment (not designated)
	Lake	410370001	Lakeview	250[c]	36	34	56	Nonattainment (not designated)
	Lane	410392013	Oakridge	145[c]	39	38	40	Nonattainment (designated)

(a) Measured from OR-ID-WA border junction
(b) Straight line from eastern border
(c) Measured from Columbia River Gorge

Factors considered in the Transport Analysis

In order to determine whether the CAA section 110(a)(2)(D)(i)(I) requirement is satisfied, a state needs to evaluate if its emissions contribute significantly to nonattainment or interfere with maintenance in downwind areas.

To evaluate the potential for significant contribution to nonattainment in other states, Ecology evaluated the potential transport to the neighboring states with the nearest identified nonattainment receptors. The states bordering Washington with nonattainment receptors are Oregon and Idaho. No maintenance receptors were identified in neighboring states.

Ecology reviewed ambient data from IMPROVE sites located in relatively remote ambient areas as representative of the regional background $PM_{2.5}$ levels. Table 3 lists the IMPROVE site selected for the study:

Table 3 IMPROVE sites

Site Name	State	Latitude	Longitude	Elevation (m)	Dates of operation
Cabinet Mountains	MT	47.954771	-115.671925	1441	2000-present
Columbia River Gorge	WA	45.664223	-121.001945	179	1993-present
Hells Canyon	OR	45.079864	-116.844808	655	2000-present
Starkey	OR	45.224748	-118.513962	1259	2000-present
Mount Hood	OR	45.288616	-121.784861	1531	2000-present
Three Sisters Wilderness	OR	44.19982	-122.044547	885	1993-present
Crater Lake National Park	OR	42.91	-122.139722	0	1990-present

Cabinet Mountains were selected as the nearest site to Pinehurst, ID. The Columbia River Gorge site, as well as, Mount Hood, was selected to represent the Oregon-Washington border. Hells Canyon and Starkey were chosen because they are the closest to the Cache Valley. The Three Sisters Wilderness site was selected because it is the nearest IMPROVE site to the Oakridge area, and the Crater Lake National Park site is the nearest to the Klamath falls area. Figure 5 presents a map with the location of the nonattainment receptors, nonattainment designated areas and the nearest IMPROVE monitoring sites to each identified receptor:

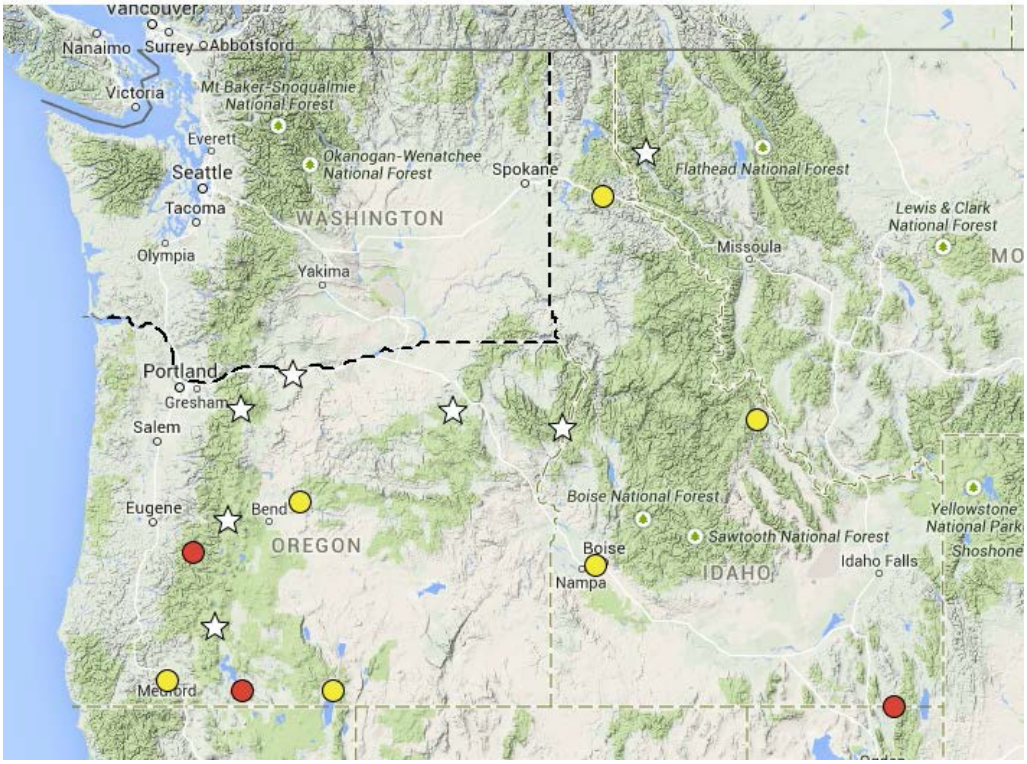

Figure 5 Map of receptors and IMPROVE sites used in this analysis. Red circles indicate designated nonattainment areas (NAA), yellow circles indicate non-designated NAA and stars represent IMPROVE sites.

Transport Assessment for Nonattainment Receptors

Based on the methodology for selecting nonattainment receptors described earlier, Ecology has identified nonattainment receptors in both Idaho and Oregon. Ecology evaluated $PM_{2.5}$ monitoring data, from selected IMPROVE sites, to understand the regional background levels near the nonattainment receptors, as well as, other IMPROVE sites along the Washington-Oregon border and those between the southern border of Washington and Idaho. Ecology also reviewed $PM_{2.5}$ data from each of the nonattainment receptors, to understand when high levels of $PM_{2.5}$ are observed, and how they relate to the background levels observed at the IMPROVE sites.

Idaho

The general finding for the receptors in Idaho is that elevated levels of $PM_{2.5}$ are observed during the winter season, particularly during the month of January (see Appendix B). Air quality data from IMPROVE sites shows generally low levels of $PM_{2.5}$ during the periods with high levels of fine particulate matter (see Appendix A). Both findings, as well as technical information from the State of Idaho indicating that local emissions during winter stagnation events are the main contributor to high levels of $PM_{2.5}$, lead us to believe that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS at these receptor locations. A more detailed analysis for each receptor is presented below:

Ada County (St. Luke's Meridian)

Ada County is situated in southwest Idaho within Treasure Valley, which is located in a shallow basin. The Boise front, a mountain range, extends generally east-west and is approximately 6,000 feet high. This range creates a barrier to air flow on the northern edge of the valley. To the south, the Owyhee Mountain range constitutes a further barrier to air flow. Temperature inversions are common in the winter season, particularly in late December and early January. These stagnation events have been cited previously by the State of Idaho as factors affecting the buildup of pollutants in the area[8]. Northern Ada County is currently a maintenance area for CO and PM_{10} and an area of concern for $PM_{2.5}$[9]. The design value for the period 2011-2013 is the first one violating the $PM_{2.5}$ 24-hour NAAQS (see Table 2), and a closer look at local ambient data at the St. Luke's monitor indicates that concentrations contributing to the high design value occurred during the late fall and winter in the 2012-2013 and 2013-2014 seasons. St. Luke's monitor represents the CBSA of Boise-Nampa.

IMPROVE data from the Hells Canyon and Starkey stations show values within the average (<10 $\mu g/m^3$ for last quarter) for the periods when St. Luke's violates the 24-hour $PM_{2.5}$ NAAQS, with the exception of a period in late September of 2012, where both IMPROVE sites show a high amount of $PM_{2.5}$ (>45 $\mu g/m^3$), composed mainly of organic carbon. The particular date is September 21, which coincides with one of St. Luke's violation days (66 $\mu g/m^3$).

[8] See *Northern Ada County Carbon Monoxide maintenance Plan and Redesignation Request*

[9] https://www.deq.idaho.gov/media/662796-nonattainment_map.pdf

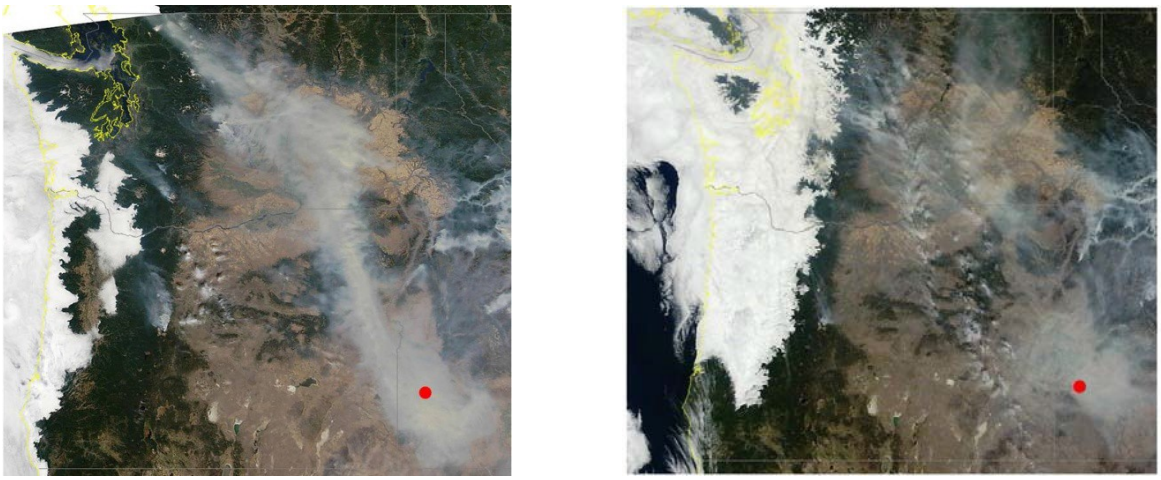

Figure 6 Sequence of MODIS satellite images on September 20 (left) and 21 (right), 2012. Red dot indicates the approximate location of St. Luke's Meridian monitor.[10]

Further research indicates that the most likely reason for this increase in $PM_{2.5}$ is due to the plume from the Wenatchee Complex wildfire (WA), started September 9, 2012 and contained on October 30, 2012[11]. Figure 6 shows a satellite composite image capturing the fire plume traveling southwards on September 20 (left), and the remaining smoke in the area of the St. Luke's monitor on September 21 (right). This fire was part of an exceptionally large amount of wildfires that affected the region (Washington, Oregon, western Montana and Idaho) during the 2012 wildfire season.

The St. Luke's monitor also showed two other violations in August (8/13 and 8/23) of the same year. However, MODIS images show smoke plumes traveling from Oregon and/or California during those days (Figure 7).

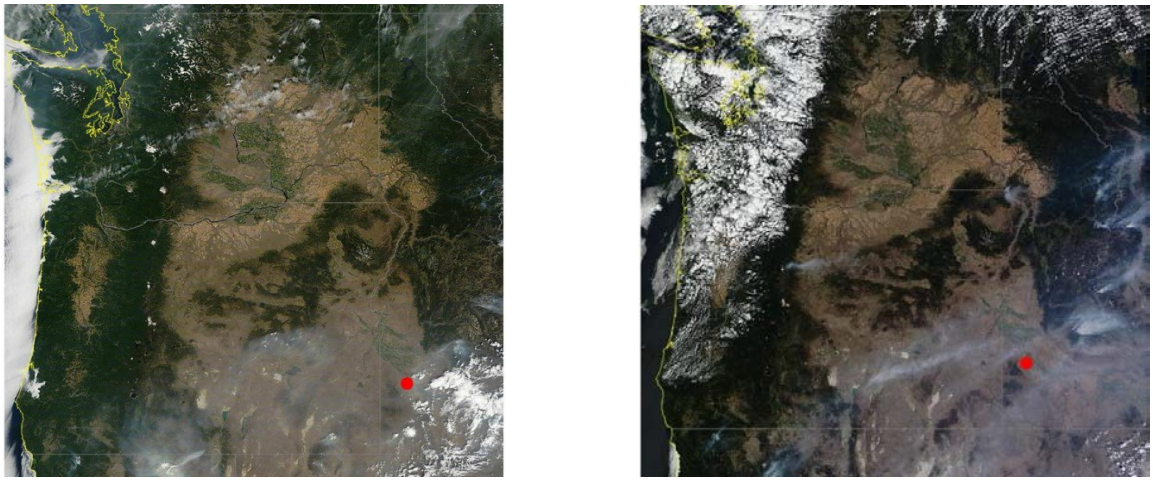

Figure 7 MODIS satellite images for August 13 (left) and August 23 (right), 2012. Red dot indicates the approximate location of St. Luke's Meridian monitor.[12]

[10] Downloaded from MODIS Today http://ge.ssec.wisc.edu/modis-today/index.php
[11] See *2012 Annual Report of Wildland Fire*, National Interagency Coordination Center (NICC)
[12] Downloaded from MODIS Today http://ge.ssec.wisc.edu/modis-today/index.php

Ecology believes it is reasonable to assume that controllable Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in St. Luke's station.

Lemhi County (Salmon)

This area is currently listed by the Idaho Department of Environmental Quality as an area of concern for $PM_{2.5}$[13]. However, the highest violations in this monitor were also associated with the 2012 wildfire season, particularly the Halstead fire that burned nearly 20,000 acres in the Salmon-Challis National Forest in August 2012. In fact, Idaho's Department of Environmental Quality (IDEQ) has submitted a request to EPA to exclude these exceptional events affecting the air quality in Salmon.

Despite these exceptional events, the design values for the first and last periods were still violating the $PM_{2.5}$ 24-hour NAAQS. IDEQ recognizes that wood burning stoves used for home heating, in combination with strong winter inversions, are a cause of concern for air quality in the Salmon area.

The factors described above, together with the large distance between this receptor and Washington, lead us to assume that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Salmon, ID.

Franklin County (Franklin)

Portions of the Franklin County, Idaho and Cache County, Utah are designated as part of the Cache Valley 2006 24-hour $PM_{2.5}$ two-state nonattainment area. EPA's technical analysis determined the $PM_{2.5}$ problem is dominated by ammonium nitrate aerosol. Transport of $PM_{2.5}$ precursors from near rural regions is small and the majority of the observed $PM_{2.5}$ is formed in-situ (and trapped due to strong inversions) from local emission sources.

Ecology believes it is safe to assume that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in the Cache Valley.

Shoshone County (Pinehurst)

Pinehurst is located in a small, enclosed, bowl-shaped area of the Coeur d'Alene River, known as Silver Valley. Stagnation events during winter season are one of the main reasons behind the violations to the 2006 24-hour $PM_{2.5}$ NAAQS. It must be noted that Pinehurst is currently under EPA's recommendation for nonattainment area for the 2012 annual $PM_{2.5}$ NAAQS[14].

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[13] https://www.deq.idaho.gov/media/662796-nonattainment_map.pdf

[14] See http://www.epa.gov/airquality/particlepollution/designations/2012standards/eparesp/10_ID_120resp.pdf

Technical analysis performed by the State of Idaho[15] determined, through dispersion modeling, that Pinehurst is largely cut off from the Silver Valley airshed, implying that there is little to no exchange of air between Pinehurst and other towns in the main Silver Valley. The greatest contributing emissions source to $PM_{2.5}$ concentrations above the 24-hour standard that occurs consistently is residential wood heating. Slash burning was also established as a large emissions source that can contribute to a violation of the 24-hour $PM_{2.5}$ standard. However, the location and time of occurrence vary from year to year.

EPA's technical analysis for Shoshone County[16] established that the days with the highest fine particle concentrations occur predominantly in winter, with carbonaceous $PM_{2.5}$ and nitrate being the largest components of the fine particle mass. These components are consistent with emissions from various combustions sources, such as woodstoves, fireplaces with various inserts, wood pellet stoves, open and slash burning, and vehicle tailpipe emissions. The facts described lead EPA to believe that combustion related sources present in the local area may have a large contribution to the $PM_{2.5}$ values in the violating monitor. Analysis of wind direction data off Spokane was not considered here as EPA's technical analysis (mentioned before) determined that, due to the complex terrain and meteorology of Pinehurst, data from locations as far as Spokane is not representative of local conditions, and thus would be misleading.

After reviewing all the information described above, Ecology believes it is reasonable to assume that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Pinehurst, ID.

Oregon

The general conclusion for the receptors in Oregon is similar to the findings described for Idaho. The majority of the violations to the 24-hour PM2.5 NAAQS occur in the winter season, particularly in the month of January. Ecology reviewed ambient data from the receptors and regional background data from IMPROVE sites. In addition, Ecology reviewed technical information from the State of Oregon (Oregon Department of Environmental Quality, ODEQ) and EPA determining that local sources in conjunction with strong inversions are the main contributors to violations of the 24-hour $PM_{2.5}$ standard, at least in the already designated NAA. The information reviewed leads us to believe that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in any of the receptors located in Oregon. A more detailed analysis for each receptor is presented below:

Crook County (Prineville)

Crook County is located in the center of Oregon. The Cascade Mountain range runs through the western part of the region, while high desert comprises the eastern part. The Ochoco Mountains are located in the northeastern area. Prineville is located in the rain shadow of the Cascades and has a mild and relatively dry climate.

[15] See *Idaho Area, Designation Recommendations for the 2006 $PM_{2.5}$ NAAQS*, Docket ID no. EPA-R10-OAR-2008-0336-0012

[16] See *EPA Technical Analysis for Shoshone County*, Docket ID no. EPA-HQ-OAR-2007-0562-0369, Attachment 2

Within Central Oregon, Crook County is the third highest wood burning county, with its neighboring county Deschutes being the first[17]. There is no $PM_{2.5}$ speciation data for the Prineville monitoring station, but daily mean $PM_{2.5}$ concentration time series between 2009 and 2013 (see Appendix B) show that the highest values are centered on December-January, indicating a likely association with wood combustion from residential heating activities. It is interesting to note that the 2011-2013 design value is the first time that this monitor has violated the 24-hour $PM_{2.5}$ NAAQS.

Background regional levels at the Three Sisters Wilderness IMPROVE station are generally low during the winter months, with levels <10 µg/m^3. Background levels at the IMPROVE sites along the Oregon-Washington border show overall very low levels (<5 µg/m^3 at Mount Hood) during winter months. The Columbia River Gorge station presents a higher background throughout the year, with a less clear seasonality. However, looking at the composition data, a clear increase in ammonium nitrate is observed for the winter season (see Figure 8):

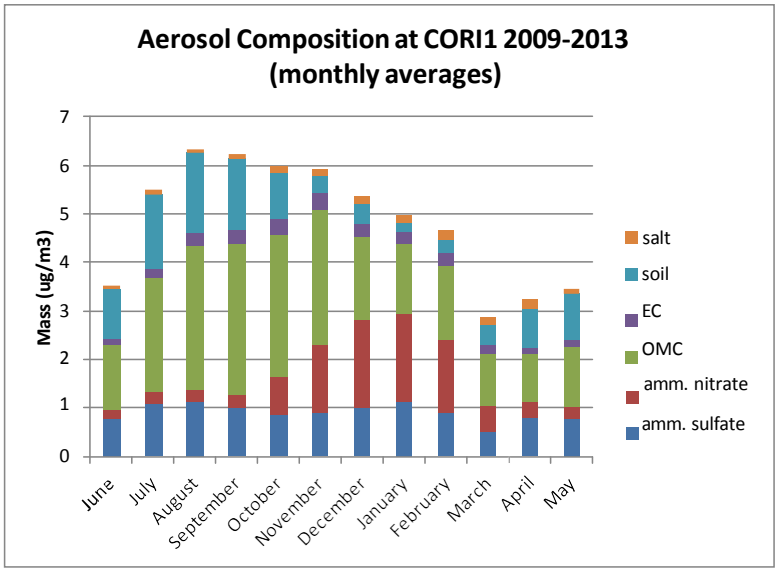

Figure 8 Composition of $PM_{2.5}$ at Columbia River Gorge station

The winter increase in ammonium nitrate is likely due to mixture of emissions from local agricultural and industrial activities. The range of maximum ammonium nitrate concentrations observed at CORI1is less than 3 µg/m^3 for the months of December and January. Prineville is approximately 95 miles south from CORI1, thus it is unlikely that contributions from these local activities will reach Prineville during the times that exceedances occur. This is further confirmed by the fact that the majority of the high concentrations observed at the Prineville monitor occur at low wind speeds, likely associated to stagnation events (see Figure 8).

[17] See *Oregon 2005 Residential Wood Combustion Emission Inventory*, ODEQ

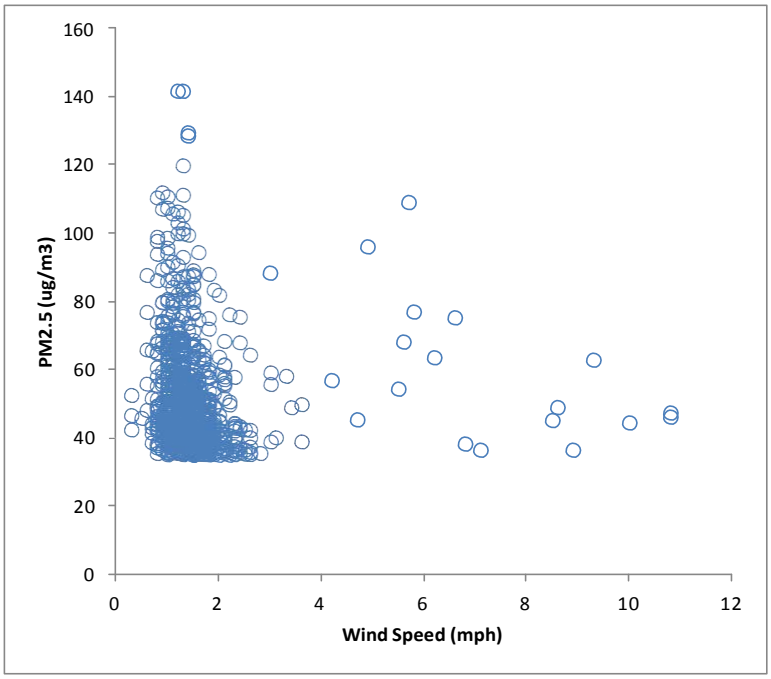

Figure 9 Correlation between $PM_{2.5}$ and wind speed at Prineville, OR (hourly data) [18]

Because of the factors reviewed before, Ecology believes it is reasonable to assume that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Prineville, OR.

Klamath County (Klamath Falls)

Klamath Falls is located in the Klamath basin surrounded by mountains on three directions and the Upper Klamath Lake on the other. These features are conducive for air stagnation episodes[19]. Strong wintertime temperature inversions are common. The core of high concentrations is observed during the winter months (see Appendix B). The area has been declared nonattainment for the 24-hour $PM_{2.5}$ NAAQS. A combination of strong inversions and cold temperatures increasing hours with residential heating activities has been cited as the cause behind the current designation. In addition, EPA's analysis shows that Klamath Falls is topographically isolated from other areas further confirming that local sources are the main cause for pollution events[20].

For the reasons mentioned, as well as due to the considerable distance to this receptor, Ecology believes it is reasonable to assume that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Klamath Falls, OR.

[18] Data from ODEQ, LASAR Database, http://deq12.deq.state.or.us/lasar2/

[19] See *Klamath Falls PM2.5 Attainment Plan Appendix 9 Topography and Winter Meteorology and 2008 as a Base Year*, ODEQ, submitted to EPA, December 2013

[20] See *EPA Technical Analysis for Klamath Falls Oregon*, Docket ID No.EPA-HQ-OAR-2007-0562-0370

Jackson County (Medford)

Medford lies in a topographic bowl in the Rogue Valley in southern Oregon, sharing its airshed with the city of Ashland. Mountains surround the valley on all sides; to the east the Cascades, range up to 9,500 feet; to the south, the Siskiyous, range up to 7,600 feet; and to the west and the north, the Coast Range and the Umpqua Divide, range up to 5,500 feet. Winds exceeding 10 mph during winter nearly always come from the southwest[21] while more common, light valley winds are mostly northerly or northwesterly. Inversions are a common occurrence in winter, causing episodes of pollution and the stagnation conditions that can last several days. Jackson County is at the top of the list in estimated tons of wood fuel burned within Southwest Oregon[22] suggesting that wood burning for residential heating activities during stagnation periods is the likely reason for the violations to the 24-hour $PM_{2.5}$ NAAQS. Medford is currently a maintenance area for CO and PM_{10}. The PM_{10} SIP maintenance plan highlighted control measures particularly focused on wood smoke from residential heating, open burning, industrial emissions, and mobile sources (on-road and non-road).

The design value for the period 2011-2013 is the highest value reported for this location. Air quality data available for Medford shows an increase in concentrations during the winter season (Appendix B). Three other events in August and September 2013 seem to be related to the Douglas Complex wildfire that started July 26th and was not contained until October 23rd. The impact of the fires can also be observed at the Crater Lake National Park IMPROVE station, which otherwise shows extremely low values (<5 $\mu g/m^3$) during the period of increase in $PM_{2.5}$ at Medford.

Considering the topographic and meteorological features of the Medford-Ashland area, plus the considerable distance from Washington border, Ecology believes that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Medford, OR.

Lake County (Lakeview)

Lakeview is located about 96 miles east of Klamath Falls, at an elevation of 4,800 feet, in Goose Lake Valley, at the foot of the Warner Mountains. Strong winter inversions can occur and reoccur for many days in a row. The Lakeview Urban Growth Boundary is currently a maintenance area for PM_{10}.

Lakeview has not been formally designated as a nonattainment area. But, since the 24-hour $PM_{2.5}$ NAAQS was revised in 2006, Lakeview has, more than once, come close to or exceeded the standard. In consequence, Lakeview and Lake County have voluntarily signed to participate in the EPA's PM Advance Program to reduce $PM_{2.5}$, and recently submitted the Advance Action Plan to EPA.

[21] See *State Implementation Plan for PM10 Medford-Ashland Air Quality Maintenance Area*, ODEQ
[22] See *Oregon 2005 Residential Wood Combustion Emission Inventory*, ODEQ

Considering EPA studies[23] show a significant contribution of wood smoke to the annual average of $PM_{2.5}$, and that an emissions inventory performed by ODEQ shows the majority of the direct $PM_{2.5}$ emissions coming from residential wood combustion[24], Ecology assumes that local sources, in combination with meteorology are the main reason behind the nonattainment conditions.

In conclusion, Ecology believes it is safe to say that Washington sources do not contribute significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Lakeview, OR.

Lane County (Oakridge)

Oakridge is located in a valley oriented east-west in the foothills of the Cascade Range, surrounded by the Willamette National Forest. The Oakridge Urban Growth Area is currently a maintenance area for PM_{10} and nonattainment for $PM_{2.5}$.

Oakridge is a rural mountainous community. Analysis performed by EPA[25], related to the recommendation for NAA designation, shows that the majority of the exceedances occur during extended night time inversions and low wind speed. $PM_{2.5}$ levels generally increase in late afternoon, reach a peak at midnight, and then begin to decrease. This profile is characteristic of residential wood combustion. In addition, the analysis also determined that there is no correlation between concentrations in Oakridge and concentrations in surrounding urban areas, thus demonstrating that there is no transport from nearby counties.

For the reasons stated above, Ecology believes that it is highly unlikely that transport from Washington sources contributes significantly to nonattainment of the 2006 24-hour $PM_{2.5}$ NAAQS in Oakridge, OR.

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[23] See Kotchenruther R.A., *A regional assessment of marine vessel PM2.5 impacts in the US Pacific Northwest using a receptor-based source apportionment method*, Atmospheric Environment 68, 2013, pp103-111

[24] See *Lakeview Area - Particulate Matter (PM2.5) Advance Action Plan*, by Town of Lakeview, Lake County and ODEQ, submitted to EPA, September 2014

[25] See *EPA Technical Analysis for Oakridge Oregon*, Docket ID No.EPA-HQ-OAR-2007-0562-0370

Appendices

Appendix A. IMPROVE $PM_{2.5}$ data for the period 2009-2013

1. Northern Idaho – closest station is Cabinet Mountains (CABI1)
2. Oregon-Washington border – closest stations are Columbia River Gorge (CORI1) and Mount Hood (MOHO1)
3. Eastern Oregon – closest stations to Idaho border are Hells Canyon (HECA1) and Starkey (STAR1)
4. Southern Oregon – closest stations to designated NAA are Three Sisters Wilderness (THSI1) and Crater Lake National park (CRAL1)

Data can be downloaded from http://views.cira.colostate.edu/fed/DataWizard/

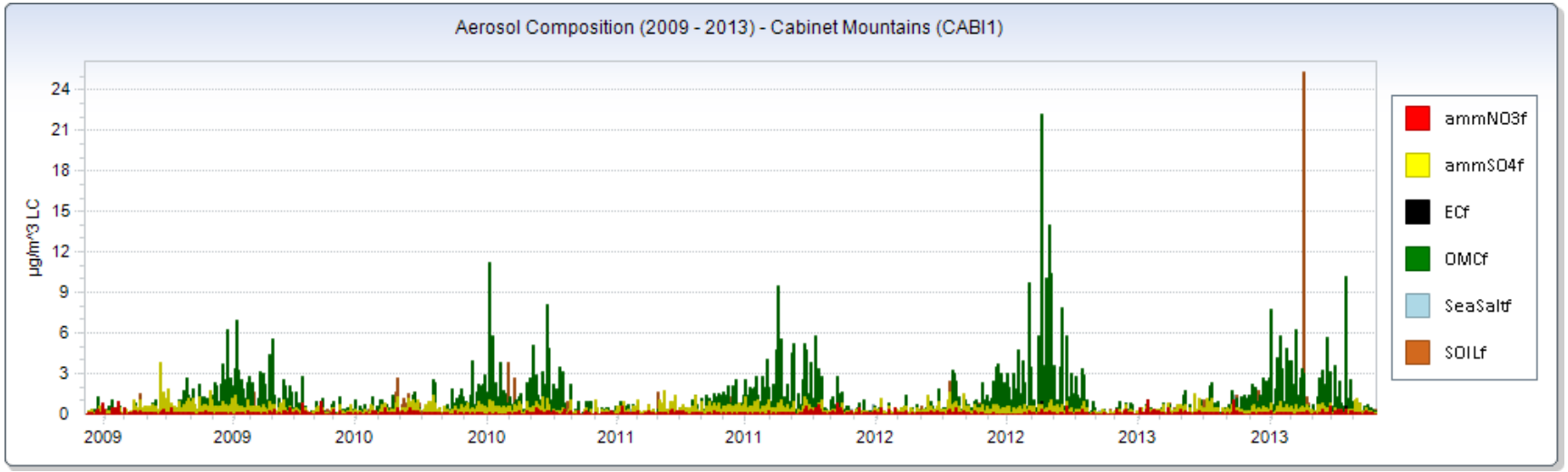


Figure A- 1 Northern Idaho, Cabinet Mountains station

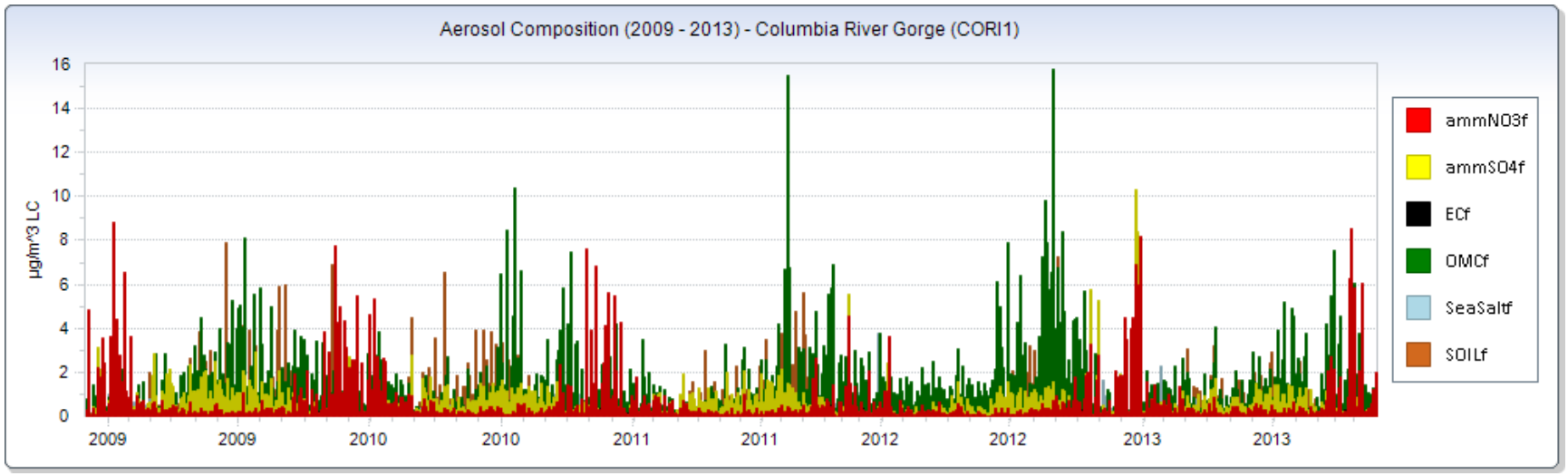


Figure A- 2 Washington-Oregon border, Columbia River Gorge station

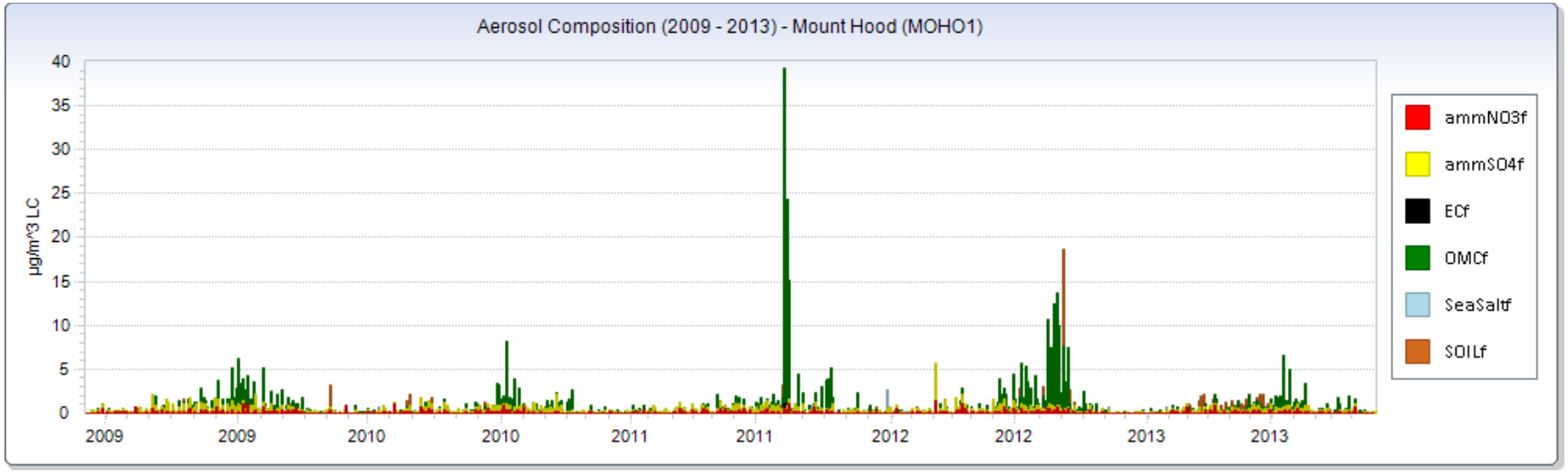


Figure A- 3 Washington-Oregon border, Mount Hood station

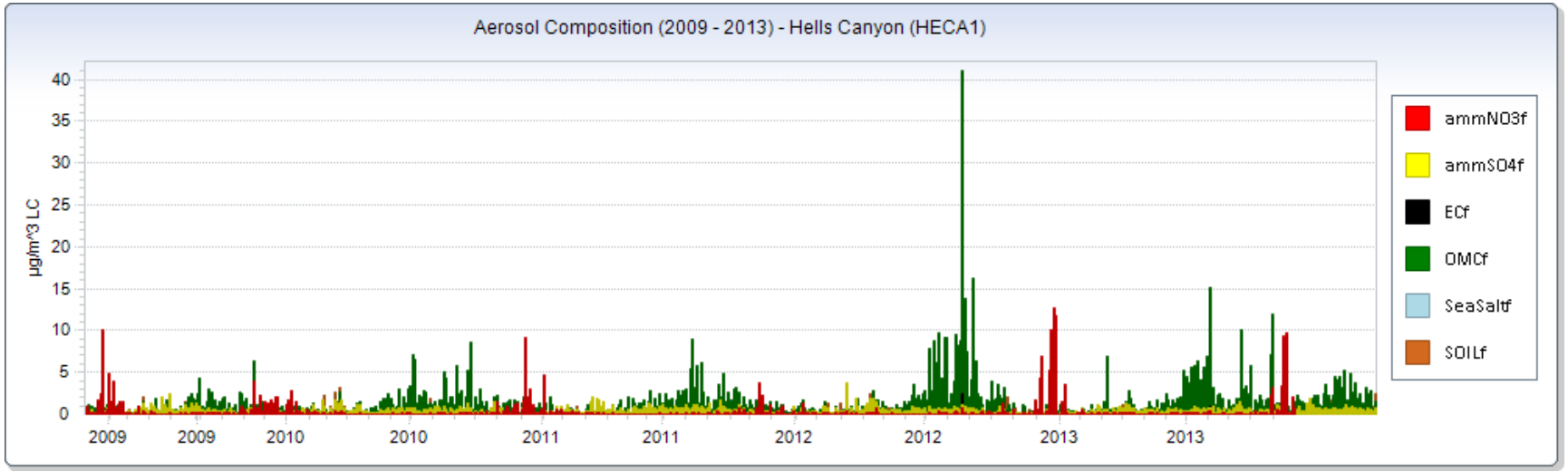


Figure A- 4 Eastern Oregon, Hells Canyon station

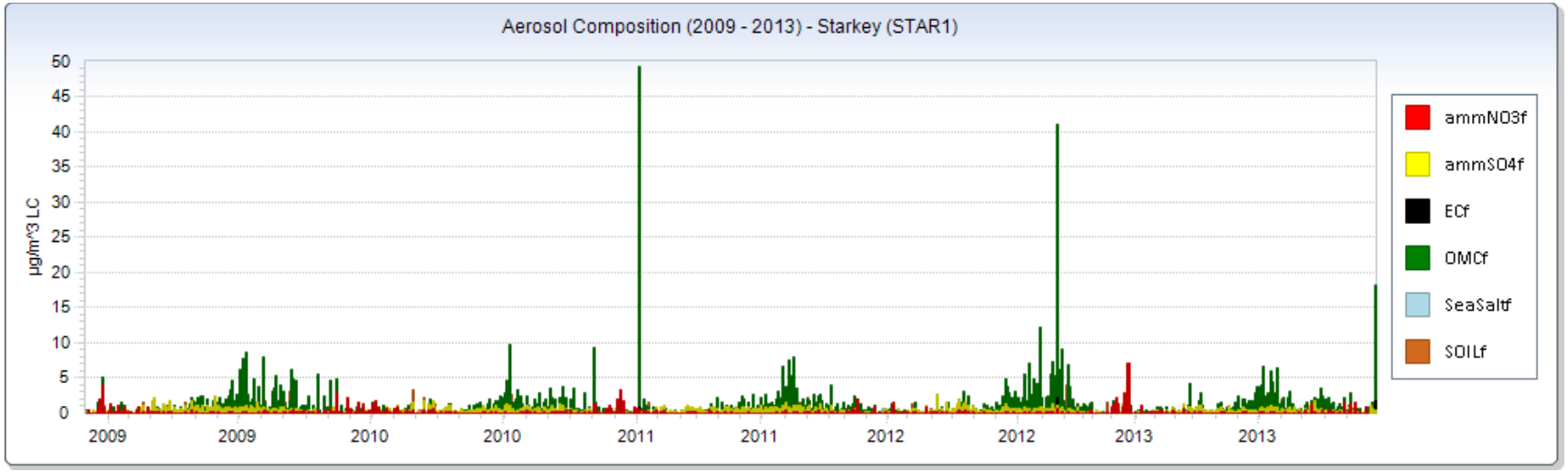


Figure A- 5 Eastern Oregon, Starkey station

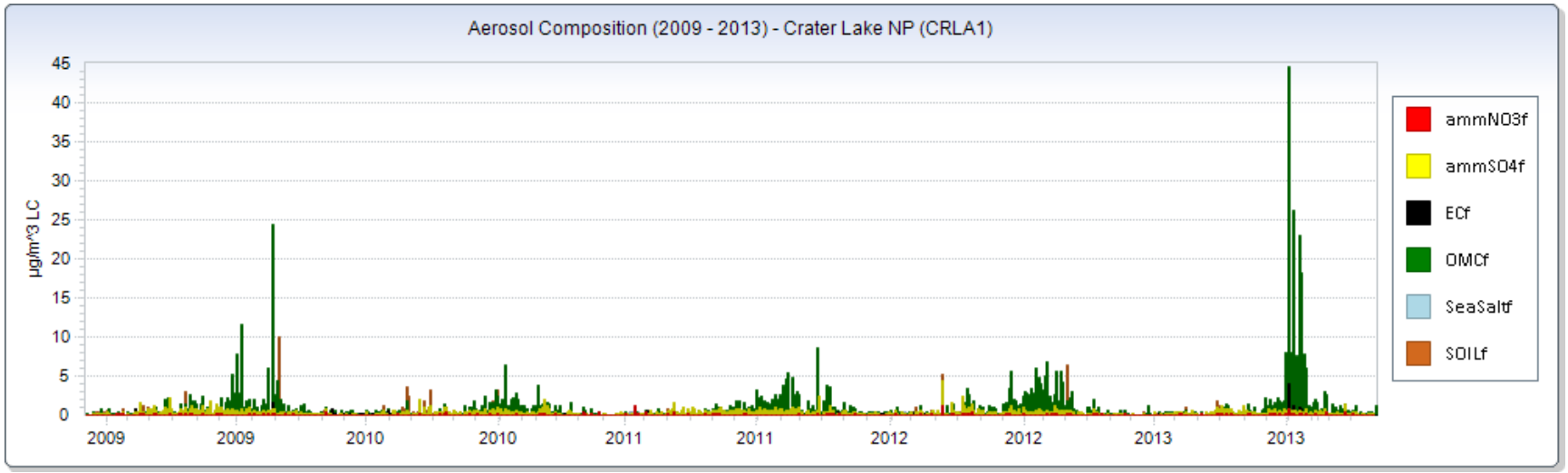


Figure A- 6 Southern Oregon, Crater Lake National Park station

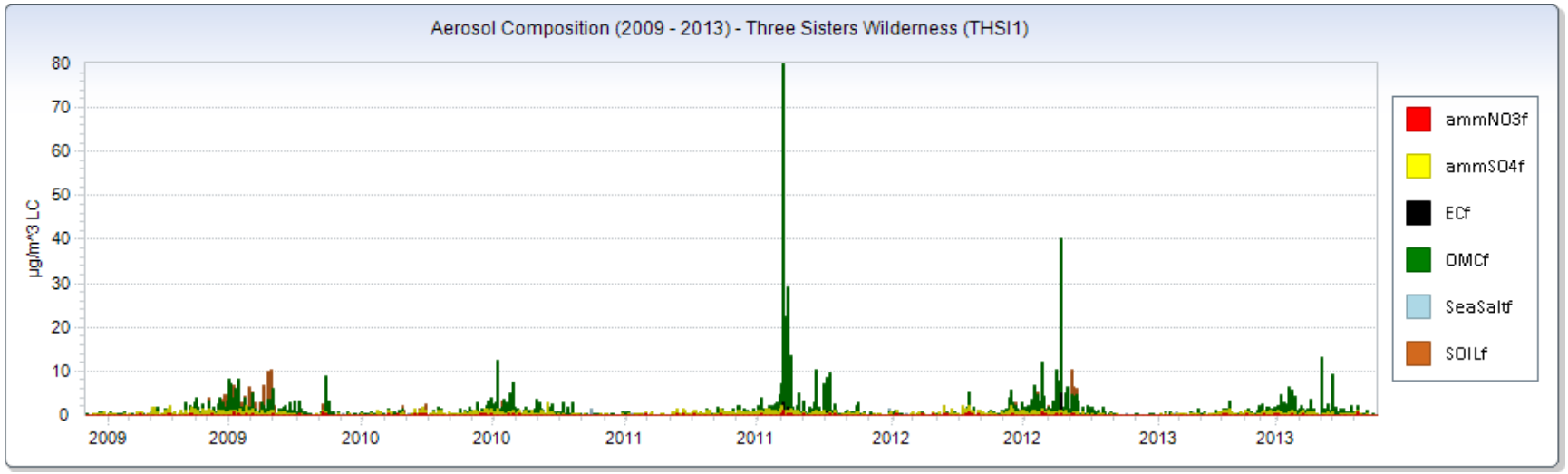


Figure A- 7 Southern Oregon, Three Sisters Wilderness station

Appendix B. $PM_{2.5}$ data for the period 2009-2013

Data can be downloaded from AirData website http://www.epa.gov/airdata/

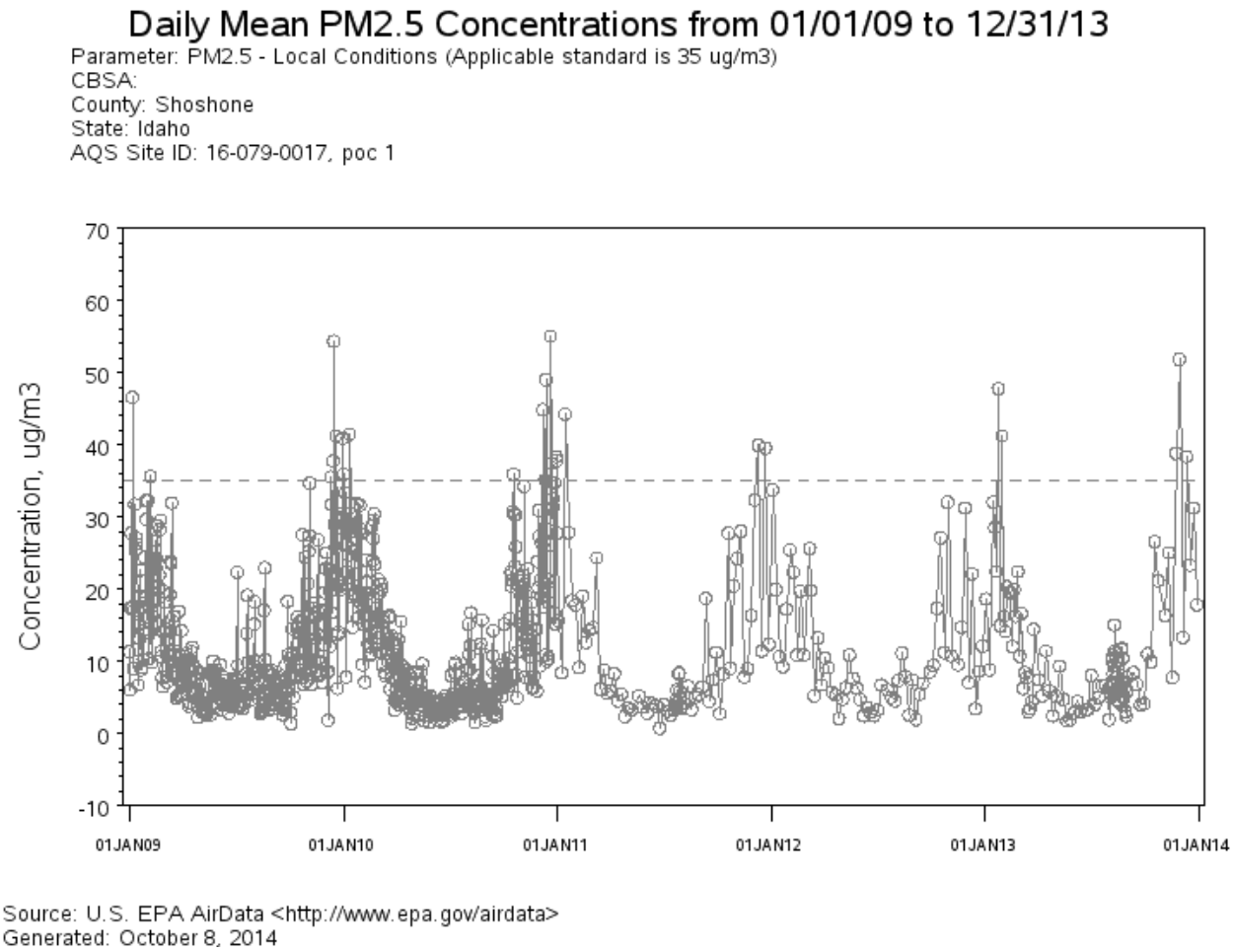


Figure B- 1 PM2.5 data for Pinehurst site, Shoshone County, ID

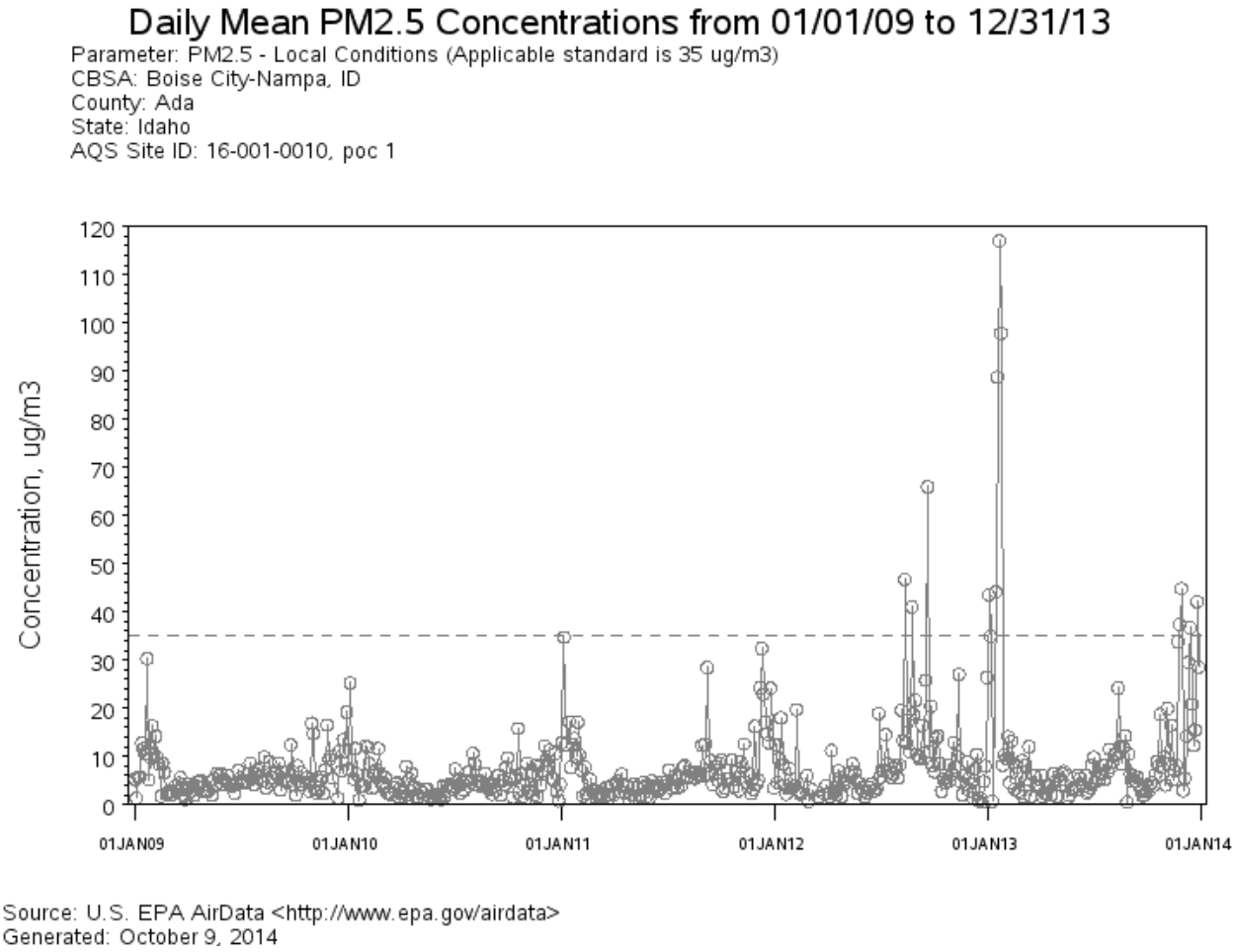


Figure B- 2 PM2.5 data for St. Luke's Meridian site, Ada County, ID

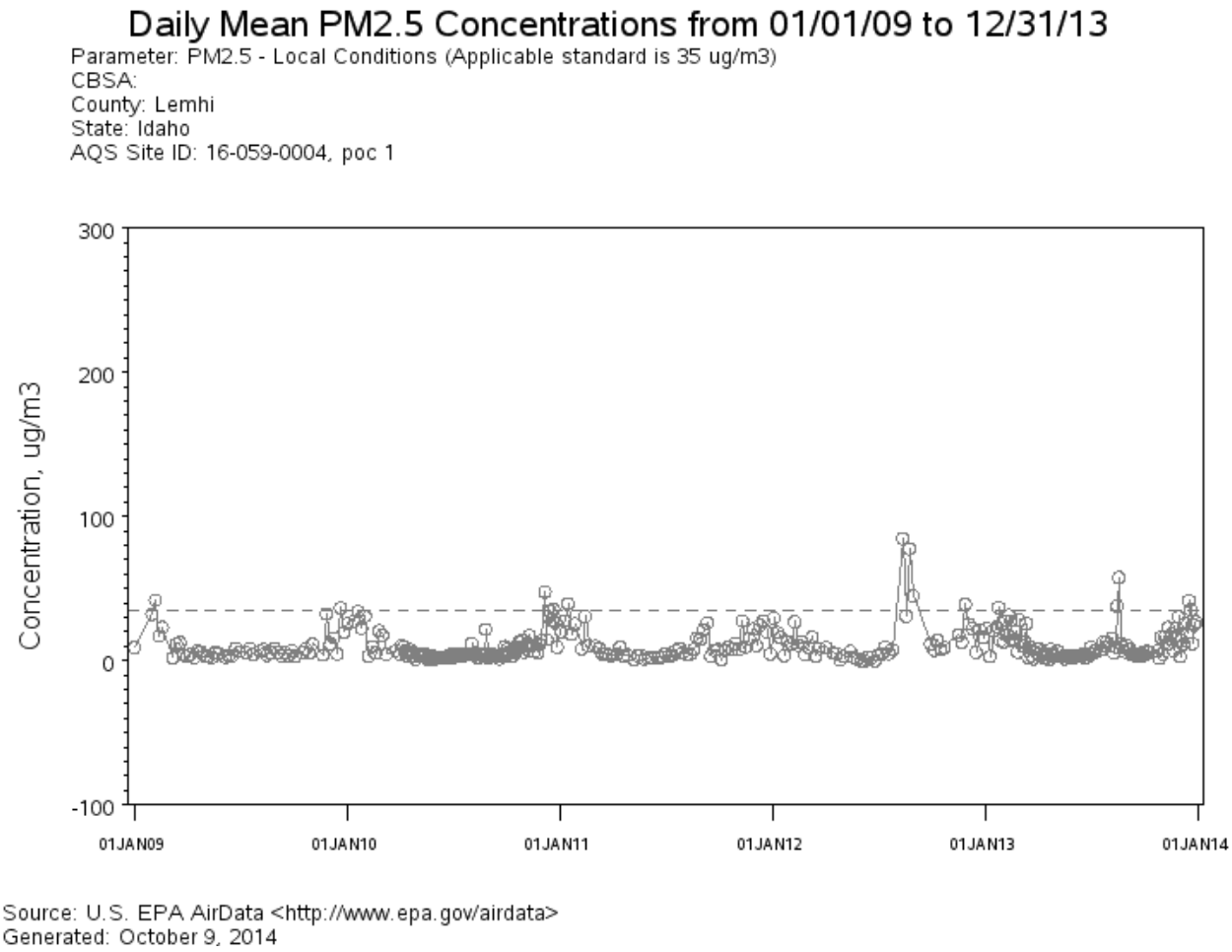
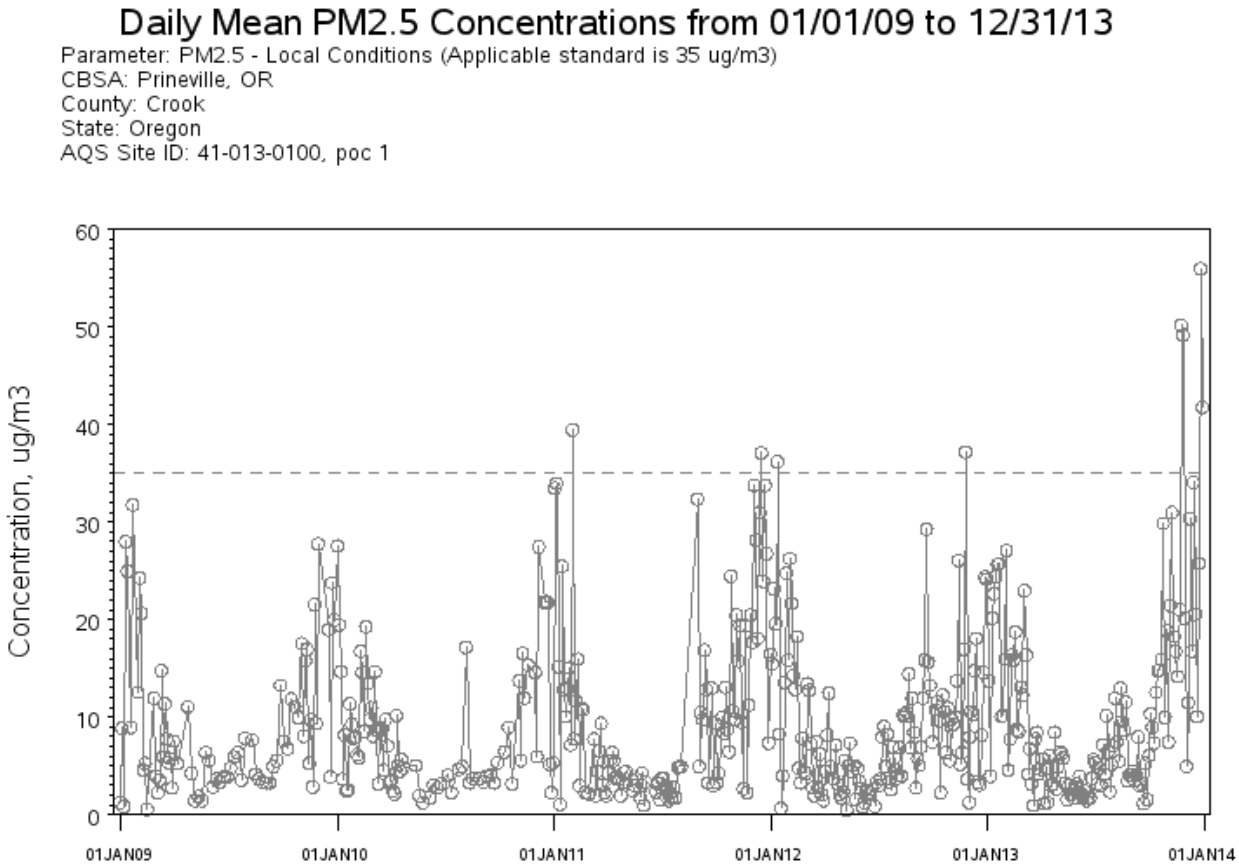


Figure B- 3 PM2.5 data for Salmon site, Lemhi County, ID



Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: October 9, 2014

Figure B- 4 PM2.5 data for Prineville site, Crook county, OR

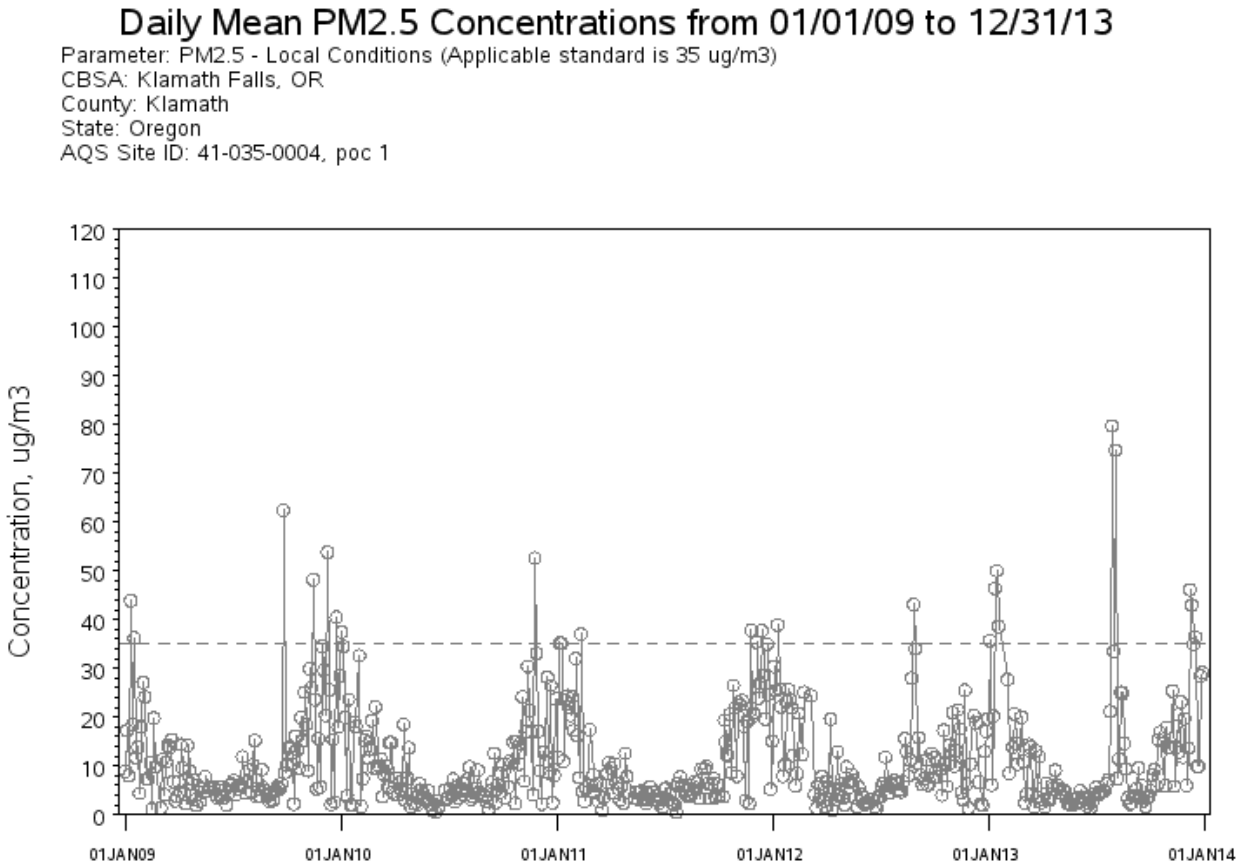
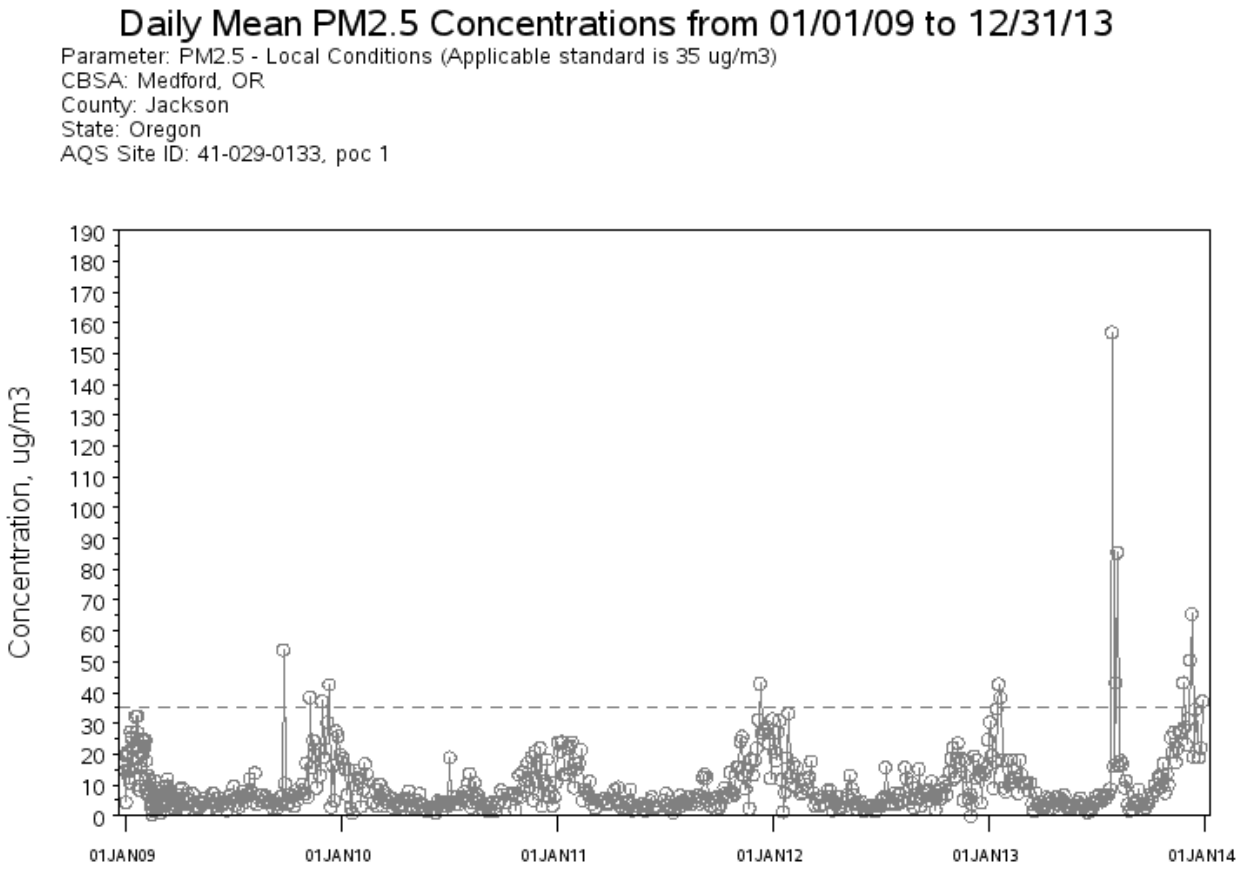


Figure B- 5 PM2.5 data for Klamath Falls site, Klamath county, OR



Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: October 9, 2014

Figure B- 6 PM2.5 data for Medford site, Jackson County, OR

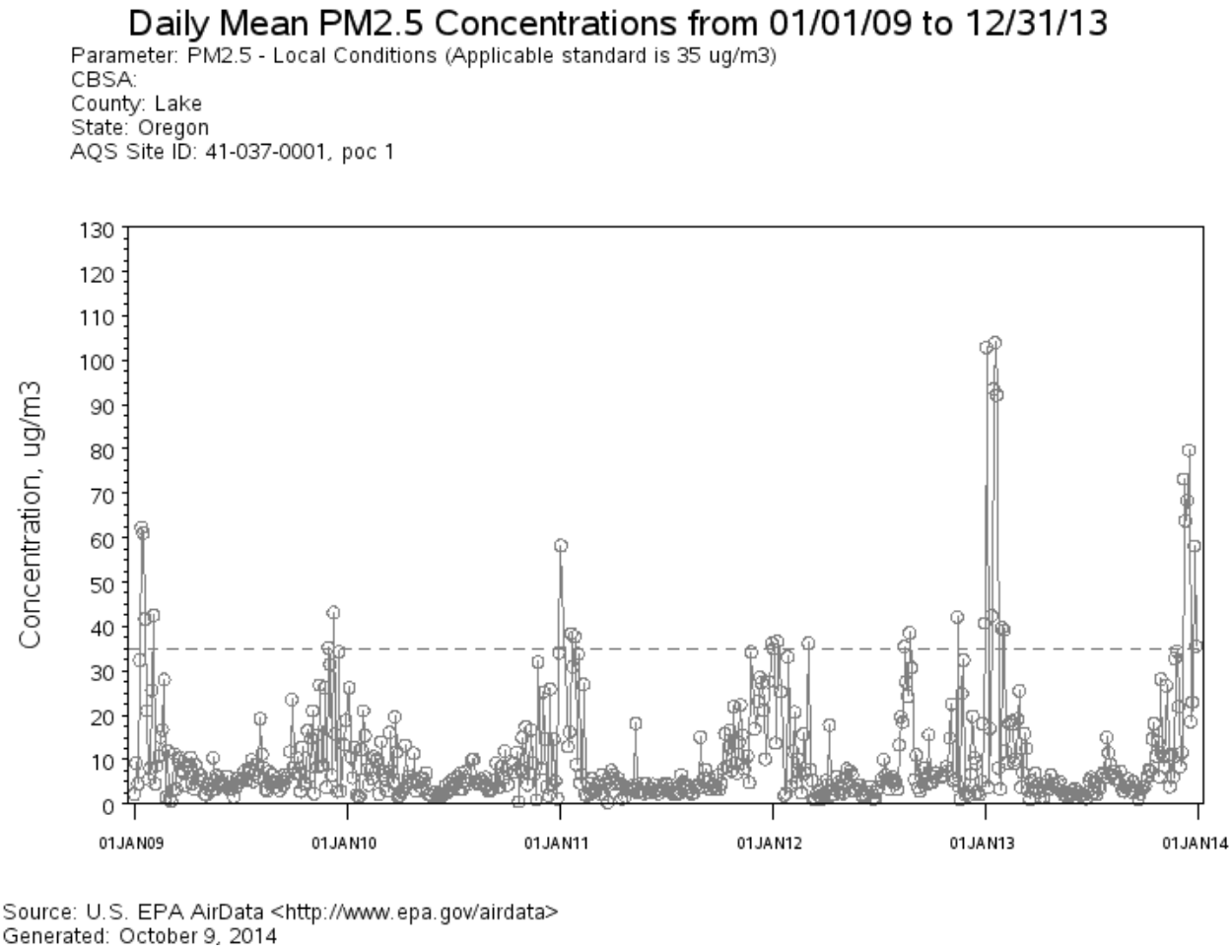
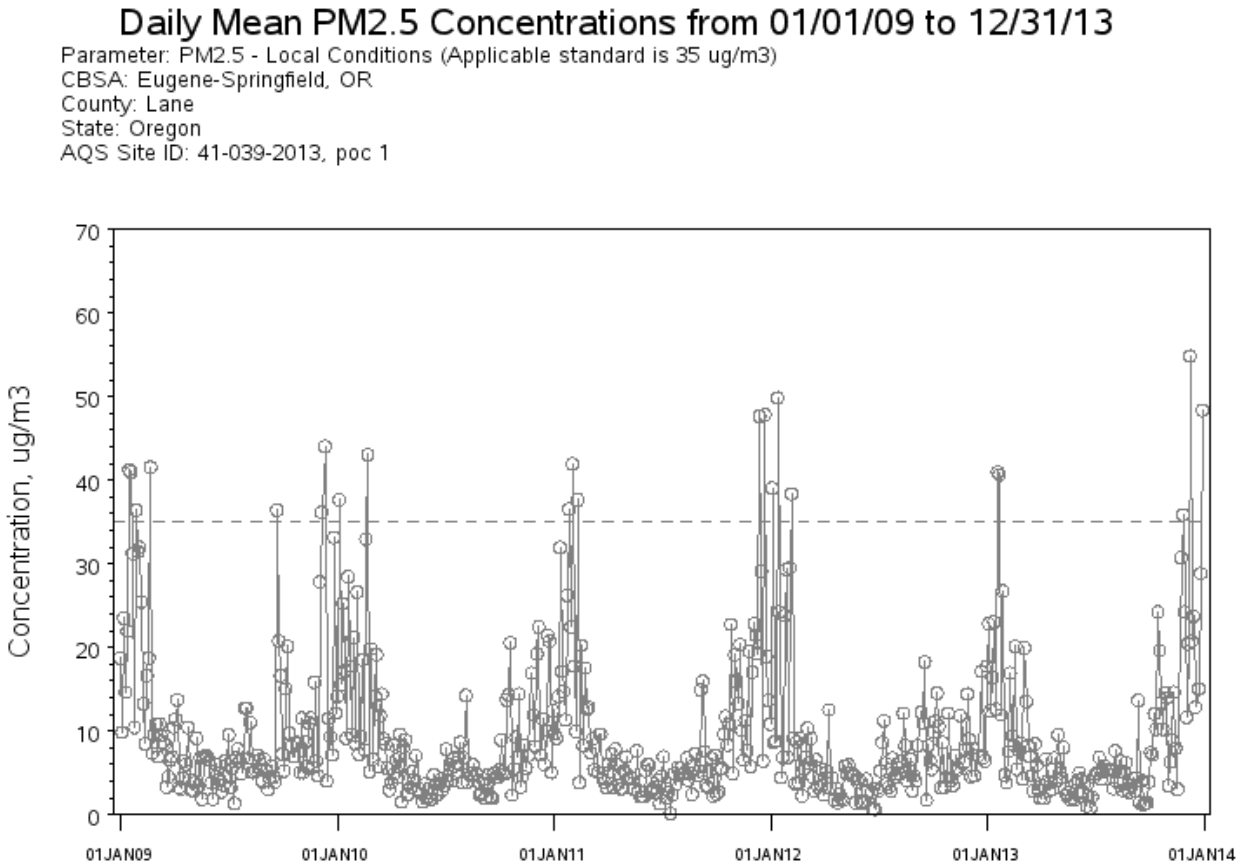


Figure B- 7 PM2.5 data for Lakeview site, Lake County, OR



Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: October 9, 2014

Figure B- 8 PM2.5 data for Oakridge site, Lane County, OR