

Fine Particulate Matter Non-Attainment Area Recommendation for the Tacoma Area

October 26, 2007



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Background and Summary

The US Environmental Protection Agency (EPA) is required to review its national ambient air quality standards every five years. In December 2006, EPA set a stricter daily standard for fine particulate matter (PM_{2.5}).¹ EPA strengthened the daily standard considerably, from a previous daily standard of 65 micrograms per cubic meter (µg/m³) to 35 µg/m³. EPA based this change on the strength of evidence from various health studies that demonstrated the previous standard was not protective of human health. PM_{2.5}, comprised of small particles less than 2.5 microns in diameter, is associated with a variety of health effects, including:^{2,3,4,5,6,7,8,9,10,11,12 13,14,15,16}

- premature death,
- increased heart attack risk,
- increased stroke risk,
- lung inflammation and stress, reduced lung function, and
- asthma-like symptoms (or triggering asthma attacks).

Recent studies, published after EPA's promulgation of the new daily standard, further confirm the link between PM_{2.5} exposures and adverse health effects.^{17,18,19} Future revisions of PM_{2.5} ambient air quality standards may be stricter than 35 µg/m³, consistent with EPA staff, who have recommended a daily standard as low as 25 µg/m³.²⁰

Based on the current, stricter daily standard of 35 µg/m³, the South L Street federal reference method (FRM) monitor in the South Tacoma area (Pierce County, Washington) violates the EPA 24-hour standard for fine particulate matter (PM_{2.5}).

While there are other monitors in the Puget Sound Clean Air Agency (Agency) jurisdiction with concentrations close to the current daily PM_{2.5} standard, the South L Tacoma monitor is the only monitor that violates the standard based on 2004-2006 data. This document addresses setting a non-attainment designation area for the South L monitor.

Overwhelmingly, elevated concentrations at the South L monitor occur during the winter months, when meteorology is conducive to inversions that trap pollutants and some people are using wood to heat their homes. Continuous monitors indicate that concentrations are most elevated during evening hours, when, again, meteorology and heating activities are contributors. PM_{2.5} speciation data from the South L monitor indicate that organic carbon is a major contributor to the overall mass of PM_{2.5}, which also indicates wood smoke/combustion as a possible major contributor.

The Puget Sound Clean Air Agency evaluated EPA's nine factors from its June 8, 2007 memorandum (described in the following pages) to determine a designation area.²¹ EPA's nine criteria, evaluated in this report, include:

1. Emissions
2. Air Quality
3. Population Density
4. Traffic and Commuting Patterns
5. Expected Growth
6. Meteorology
7. Geography/Topography
8. Jurisdictional Boundaries
9. Level of Control of Emission Sources

The Clean Air Act requires that a non-attainment area include not only the area that is violating the standard, but also nearby areas that contribute to the violation. Given this requirement, the comprehensive urban growth area (CUGA), with the majority of the contributing population and

potential emission sources, provides a reasonable starting point for a non-attainment and air quality planning area.

The Agency began its analysis for the 9 criteria with the entire Pierce County CUGA as a starting point. Based on further analysis, the Agency determined that some portions of the CUGA did not meet the criteria for inclusion, and are recommended to be excluded from the non-attainment area. These areas include:

- Areas south and southwest of the monitor with minimal PM_{2.5} emissions, population density, and forecasted growth. These areas are not upwind of the violating monitor when it experiences elevated PM_{2.5} concentrations. These areas include the DuPont area, Fort Lewis, and McChord Air Force Base.
- The far eastern peninsula of the CUGA, east of the Puyallup River and White River valley. While these areas do likely have PM_{2.5} emissions, and potentially elevated PM_{2.5} concentrations, the topography and meteorology make it unlikely that these contribute to the violating South L monitor. These areas include the Bonney Lake, Orting, Sumner, and Auburn areas.

The Agency's proposed non-attainment area is shown in Figure 1, outlined in red. The proposed area largely includes the CUGA (hatched in orange), and excludes areas described above. The Agency's proposed non-attainment area includes the "holes" in the CUGA, so that emissions reductions planning can be as consistent as possible for the entire contiguous non-attainment area. The Agency acknowledges that Puyallup Tribal lands are within the recommended boundary, and is unclear how EPA and the Tribe intend to address these areas. The Agency will partner with EPA and the Puyallup Tribe as needed and desired.

The Agency prioritized including areas with high contributing PM_{2.5} emissions, elevated PM_{2.5} concentrations, and forecasted growth, as well as areas that are upwind of the violating South L monitor when concentrations are highest. Including these areas will ensure that a comprehensive implementation plan will successfully achieve emission reductions. Some of the areas the Agency prioritized including were:

- The area southeast of the violating monitor. This area is upwind of the violating monitor when concentrations are highest. This area is forecasted for population and household growth. Census data indicate that some people in this area use wood for heat.
- The Port of Tacoma/tide flats area, based on PM_{2.5} emissions, elevated PM_{2.5} concentrations, and immense forecasted growth (more than quadrupling from 1998 to 2015).
- Areas west of Interstate 5, based on elevated PM_{2.5} concentrations and population density. Census data indicate that some people in this area use wood for heat.

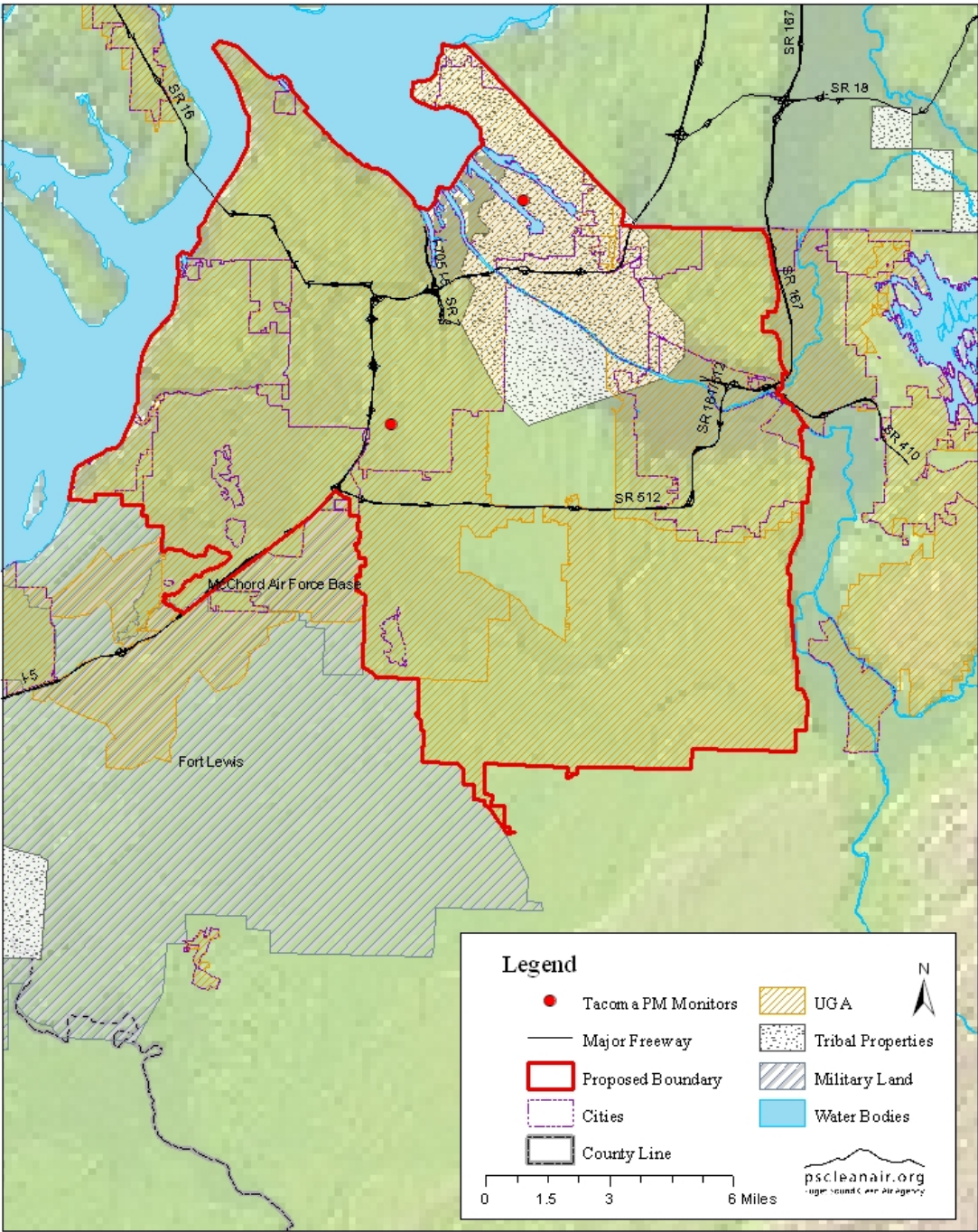
Cities within the CUGA and also within the proposed non-attainment boundary include: Tacoma, Lakewood, Steilacoom, Fircrest, University Place, Ruston, Milton, Edgewood, Puyallup, and Fife.

The Agency sought and received feedback from a variety of partners while setting a potential non-attainment boundary. Responses to feedback are included in Appendix B of this report.

Additionally, the Agency's strategies for PM_{2.5} emissions reductions are not and will not be limited to the non-attainment area.

Figure 1:

Proposed Boundary for Tacoma Non-Attainment Area



Factor 1: Emission Data

As shown in the figure and table below²², the winter season (December through February) air emissions of PM_{2.5} in Pierce County are balanced among:

- (1) outdoor open burning (202 tons per season, 24%),
- (2) mobile sources (230 tons per season, 27%),
- (3) fireplaces and woodstoves (326 tons per season, 39%), and
- (4) other sources (84 tons per season, 10%)

It is important to note that these are estimates for a countywide emission inventory, and that outdoor open burning (with an estimated 24% contribution) is likely not occurring in the urban portion of the county near the violating monitor. Open burning is prohibited in these areas.

Figure 2:

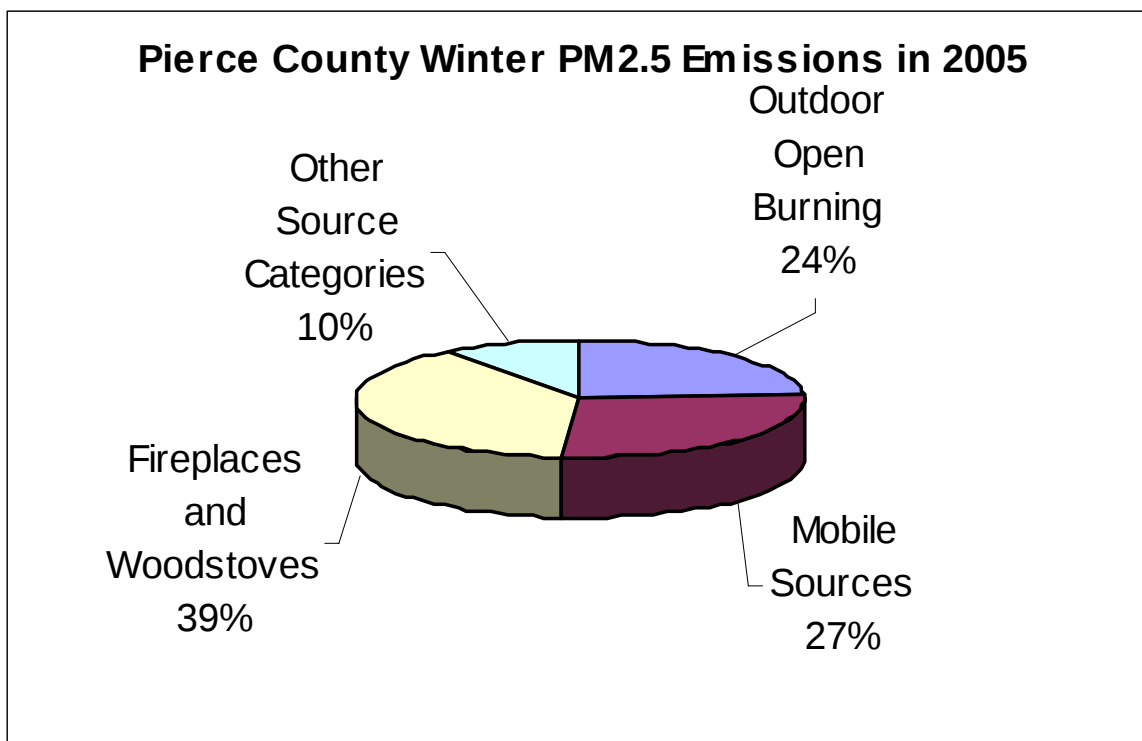


Table 1: Pierce County Seasonal PM_{2.5} Emission Sources in 2005

2005 Category PM2.5 Emissions					PM2.5 Emission Source Categories and Subcategories	2005 Subcategory PM2.5 Emissions				
tpy	tons/season					tpy	tons/season			
Annual	Summer	Fall	Winter	Spring		Annual	Summer	Fall	Winter	Spring
1,258	377	377	202	302	Outdoor Open Burning					
					Land clearing burning	941	282	282	151	226
					Yard waste burning	185	56	56	30	44
					Forest wildfires and managed burns	117	35	35	19	28
					Structural fires	11	3	3	3	3
					Agricultural waste burning	4	1	1	1	1
1,036	284	259	230	263	Mobile Sources					
					On-road gasoline vehicles	296	77	74	71	74
					Non-road diesel engines	280	78	67	62	73
					On-road diesel vehicles	201	52	50	48	50
					Non-road gasoline engines	80	22	19	18	21
					Ocean-going vessels	54	14	14	14	14
					Harbor vessels	35	9	9	9	9
					Railroad diesel engines	27	7	7	7	7
					On-road CNG and LPG engines	4	1	1	1	1
					Aircraft ground support engines	3	1	1	1	1
					Aircraft	2	1	1	1	1
					Non-road LPG engines	2	1	1	1	1
					Recreational boats	52	22	17	0	13
679	34	95	326	224	Fireplaces and Woodstoves					
					Wood stove wood burning	430	22	60	206	142
					Fireplace wood burning	165	8	23	79	54
					Fireplace and wood stove firelog burning	78	4	11	37	26
					Pellet stove wood burning	6	0	1	3	2
261	49	56	84	72	Other Source Categories					
					Industrial point sources	181	45	45	45	45
					Natural gas burning	67	3	9	32	22
					Boiler and furnace distillate oil burning	11	1	2	5	4
					Propane furnaces and boilers	2	0	0	1	1
3,234	744	787	842	860	Totals	3,234	744	787	842	860

The Pierce County seasonal emission inventory above is for calendar year 2005 with the seasons designated as summer (June-August), fall (September-November), winter (December-February) and spring (March-May).

The accuracy of these 2005 PM_{2.5} Pierce County emission inventory estimates, as always, is dependent on the completeness and the accuracy of the activity data, the emission factors, and the assumptions made. A table in the appendix gives detailed information concerning these uncertainties (see Table A-1 Pierce County Emission Inventory Assumptions). The Agency is currently improving its wood smoke emission inventory in the Tacoma area through telephone surveys. This survey is designed to help the Agency better understand burning behavior in the area: how often people are burning wood, what types of device they're using, what types of fuel, what hours of the day, etc. This information will help the Agency to better estimate emissions and target emissions reductions.

Because wood smoke is indicated as a large source of PM_{2.5} in winter months, the Agency conducted additional analyses to determine the spatial variation in wood burning activities. Figure 3 shows the number of people using wood as a primary source of heat in the immediate area of the South L monitor, per square mile. The information source is the 2000 census, and is presented at a block group level.²³ This information unfortunately does not capture those who use wood as a secondary heat source, or those who use fireplaces for ambiance. Also, the census data only contains activity level, but provides nothing about the types of devices being used to heat homes. Finally, it is highly likely that many respondents from the 2000 census have since re-located to another area. Figure 4 provides the same information, but shows a larger area of Pierce County.

Figure 3:

Tacoma Area Households
Using Wood for Primary Heat, per Square Mile

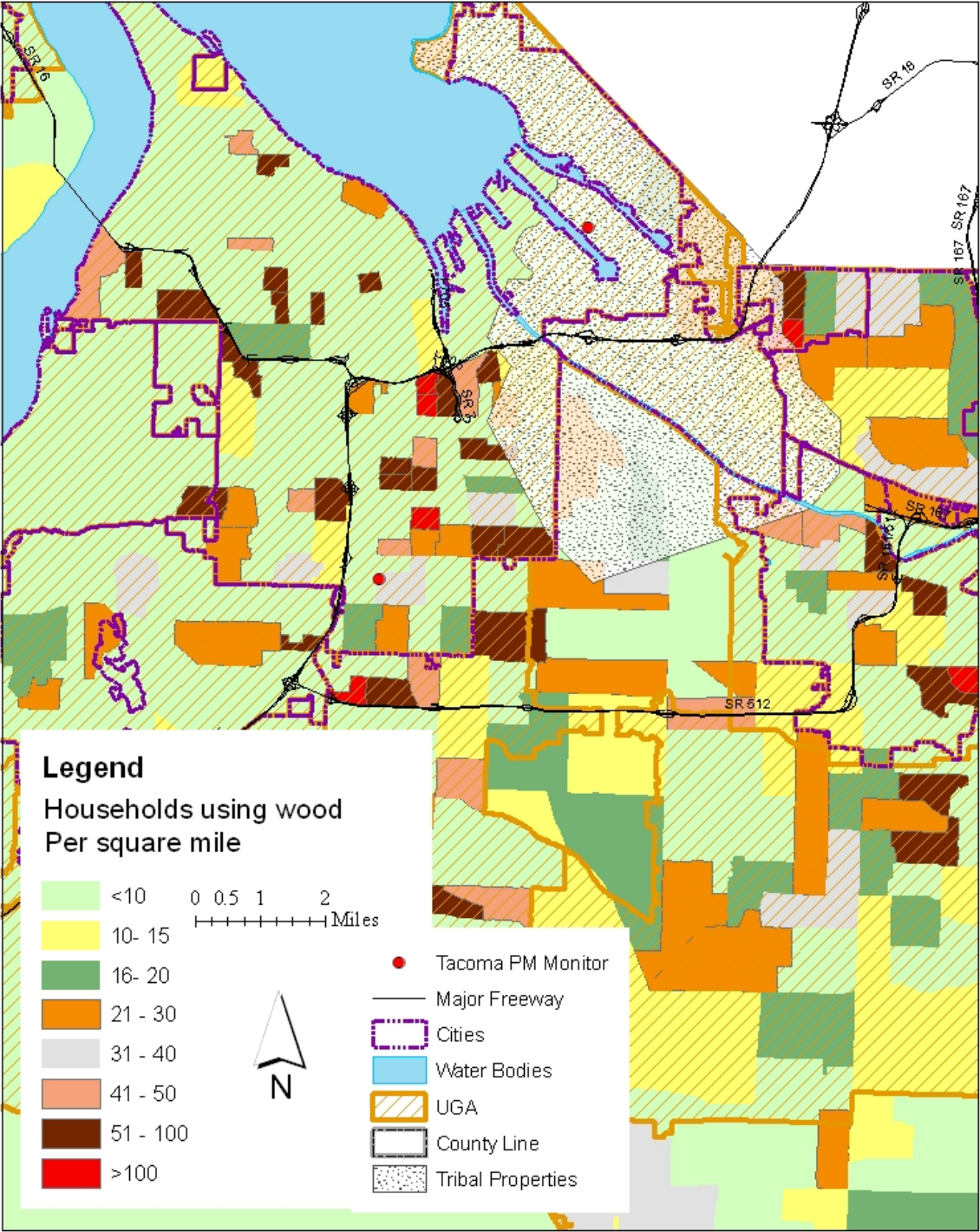
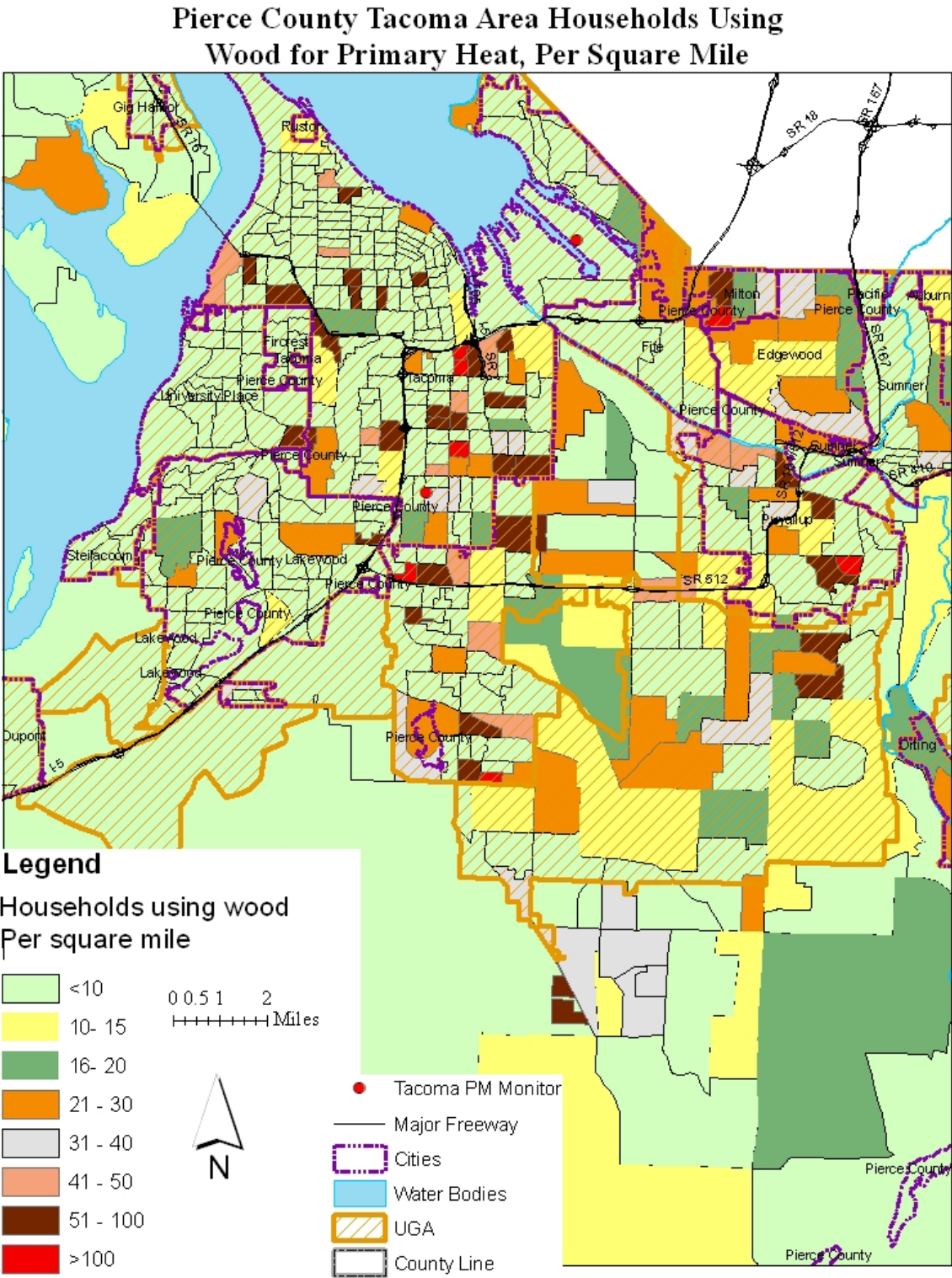


Figure 4:



Factor 2: Air Quality Data

Violating monitor

The Tacoma South L monitor, located in Pierce County, has recorded the highest PM_{2.5} levels (3 years of data as measured by federal reference method) in the Puget Sound Clean Air Agency's 4-county region, as shown in Figure 5. There are other monitors in the 4-county region with elevated PM_{2.5} concentrations, but none with three years of FRM data required to designate non-attainment. The Tacoma South L monitor is shaded red on the map and violates the daily standard. The 2006 design value (98th percentile averaged over 2004, 2005, and 2006) for the South L federal reference monitor is 43 micrograms per cubic meter (µg/m³). The Puget Sound Clean Air Agency operates this monitor.

The South L monitor is located in the South End of Tacoma, a city of approximately 201,700 people.²⁴ The monitor is sited in a largely residential neighborhood, and is located approximately a half mile east of Interstate 5.

Figure 5: 2006 Puget Sound Area Fine Particulate Concentrations

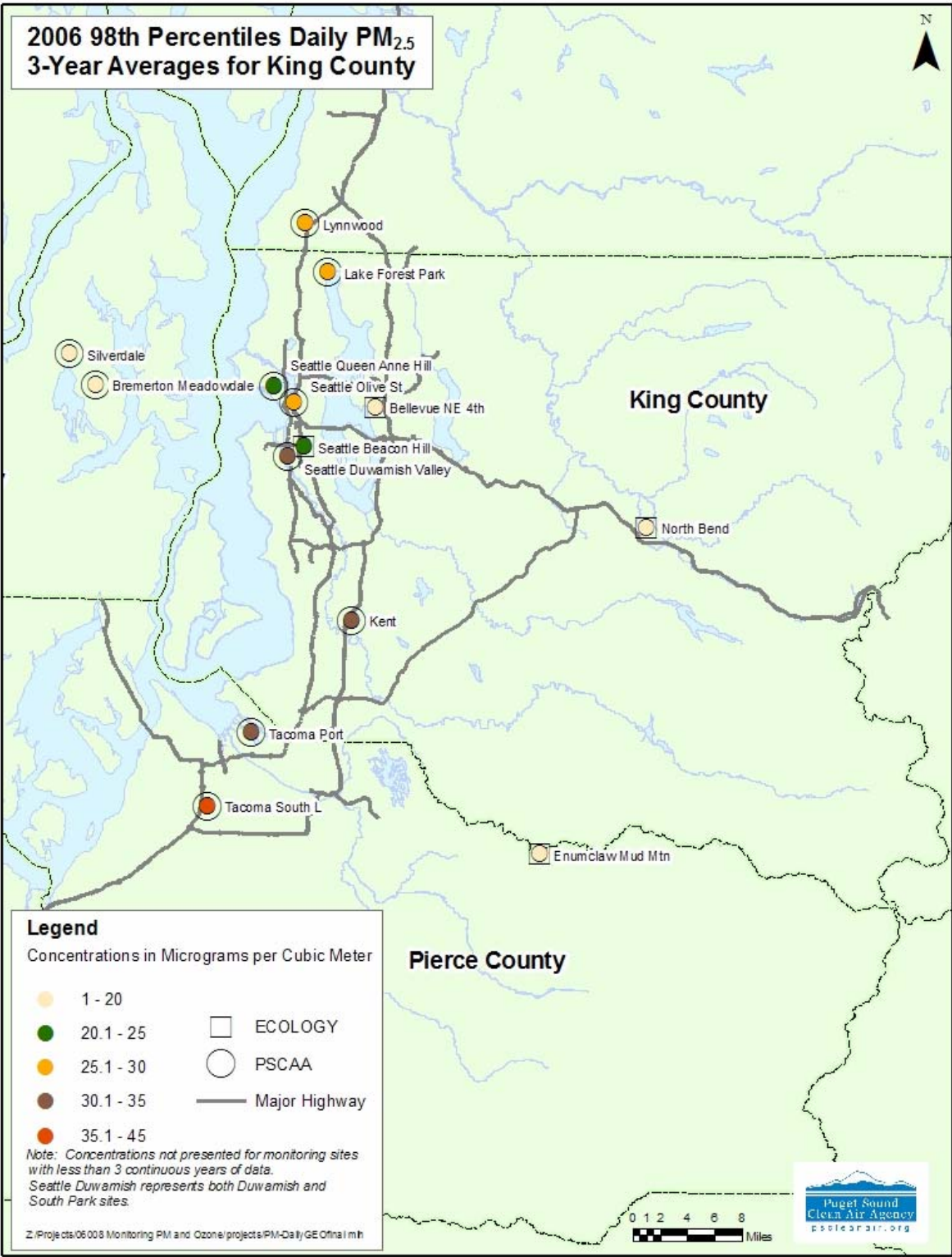
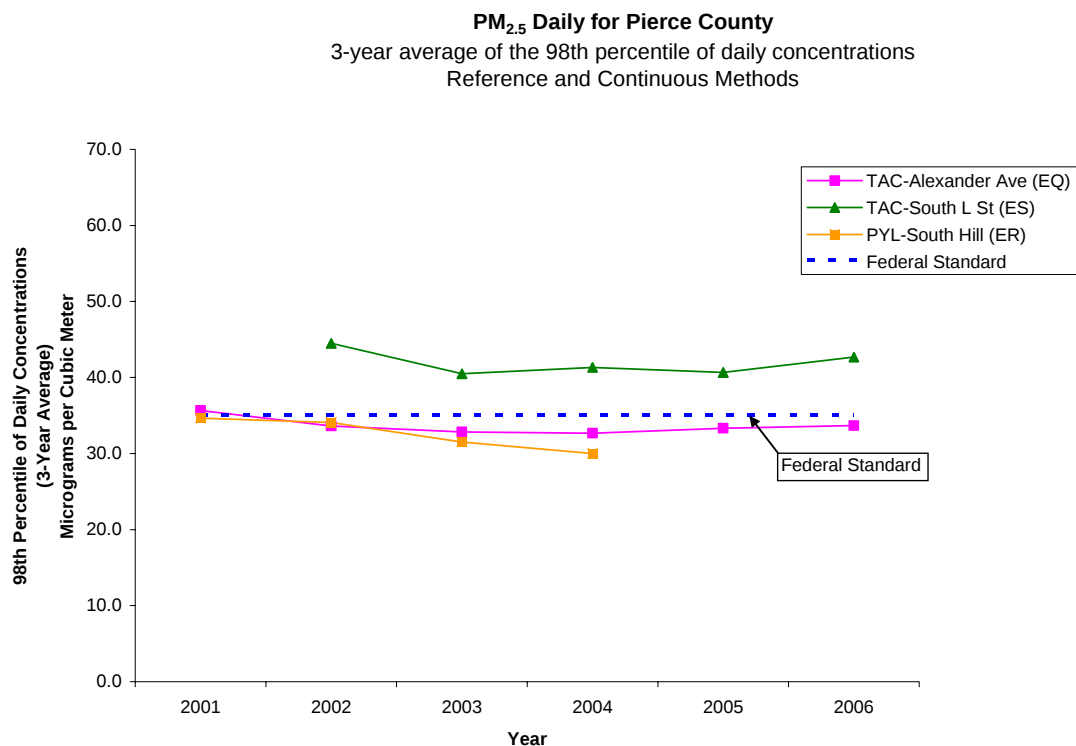


Figure 6, which shows the South Tacoma monitor design values in green triangles, clearly shows that the South Tacoma monitor violates EPA's $35 \mu\text{g}/\text{m}^3$ daily standard. The form of the standard, the 3-year average of the 98th percentile, is presented in Figure 6. For reference, concentrations at other Pierce County sites, Alexander Avenue and Puyallup South Hill, are also shown.²⁵ Alexander Avenue is also referred to as "Tacoma Port" in the map above, and is located in the tide flats near the Port of Tacoma, in an area that was historically industrial. The Puyallup South Hill monitor is not shown in the map above, because it did not have the requisite 3 years of complete data from 2004-2006 to show design values. The Puyallup South Hill monitor is located to the east of the South L monitor.

Figure 6: 2006 Pierce County PM_{2.5} Concentrations



Note: All South L data are FRM from 2000- 2006. Alexander Avenue data are FRM from 1999- 2002 and nephelometer from 2003-2006. South Hill data are FRM from 1999-2002 and nephelometer from 2003-2004; incomplete nephelometer data was collected from South Hill in 2005.

Temporary Monitoring

In order to better understand the area of elevated PM_{2.5} concentrations, the Puget Sound Clean Air Agency deployed four temporary sites surrounding the South L monitor in the winter of 2006/2007. The Clean Air Agency collected PM_{2.5} data from these four monitors from September 1, 2006 to March 1, 2007. The four temporary monitors are shown below in Figure 7, and results of the monitoring are shown in Figure 8. In Figure 7, semi-permanent sites such as South L, Alexander, and Chief Leschi (Puyallup tribe) are shown. The temporary monitoring sites are Stewart Heights Park, Lincoln High School, Edison Elementary, and the USGS Field office. These four temporary monitors were sited in primarily residential neighborhoods.

The results, with 6-month 98th percentile concentrations at temporary monitors ranging from 39 to 49 $\mu\text{g}/\text{m}^3$, indicate that the South L monitor represents the highest PM_{2.5} concentrations in the area (with a 6-month 98th percentile concentration of 56 $\mu\text{g}/\text{m}^3$). Clearly, results for only six months of study in Figure 8 cannot be directly compared to the daily federal standard because the length of the study is

not sufficient. Results also indicate that elevated concentrations exist over a larger area than the immediate South L monitor neighborhood, including residential areas to the east and west of Interstate 5. Concentrations presented in Figure 8 include elevated December 2006 concentrations following a windstorm that caused widespread power outages (and likely subsequent residential wood burning for heat) in the Puget Sound area. Elevated wintertime concentrations persist as far north as the Tacoma tide flats (Port) area.

Figure 7: Location of Four Temporary and Three Regular Network PM_{2.5} Monitors

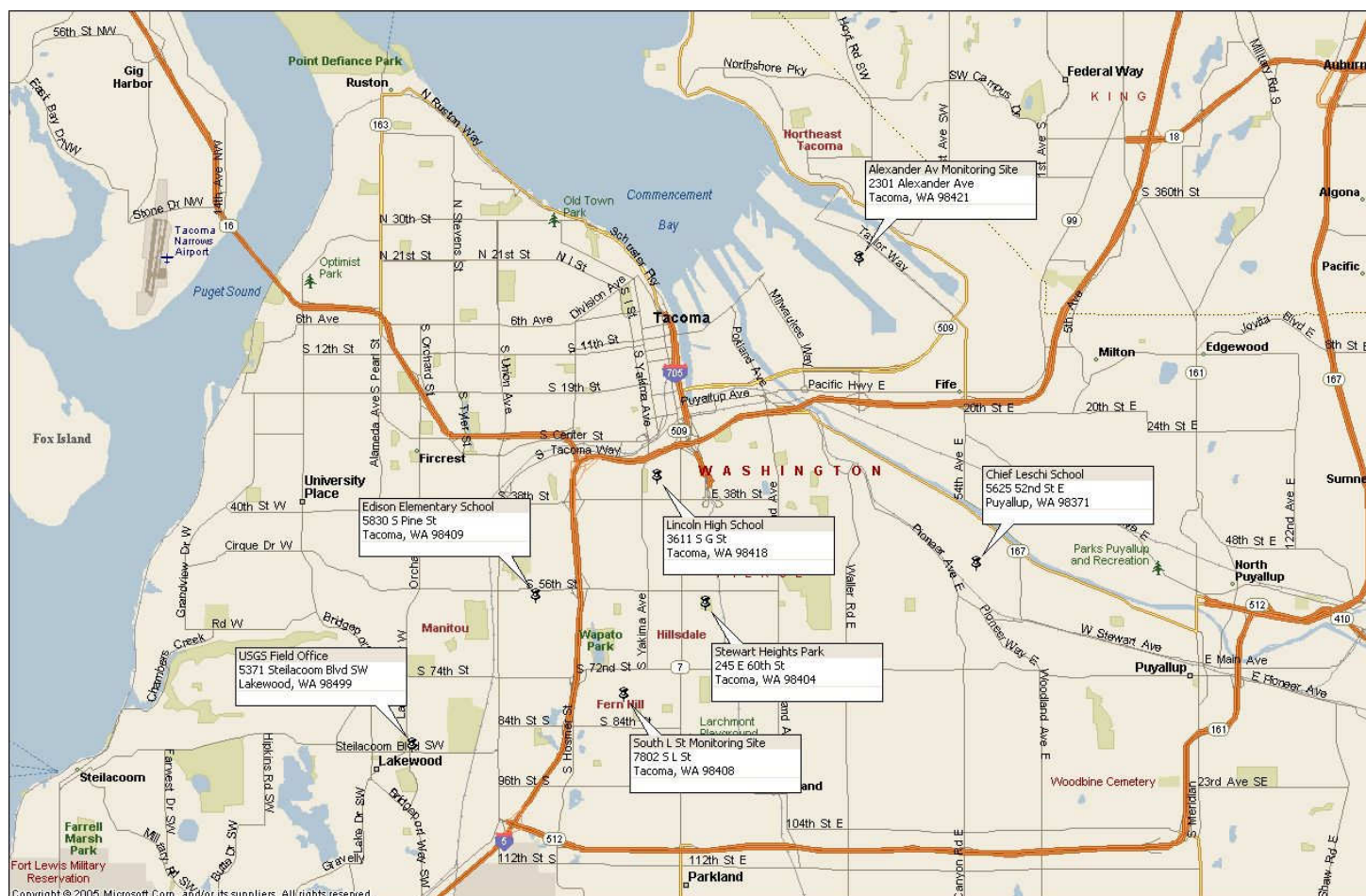
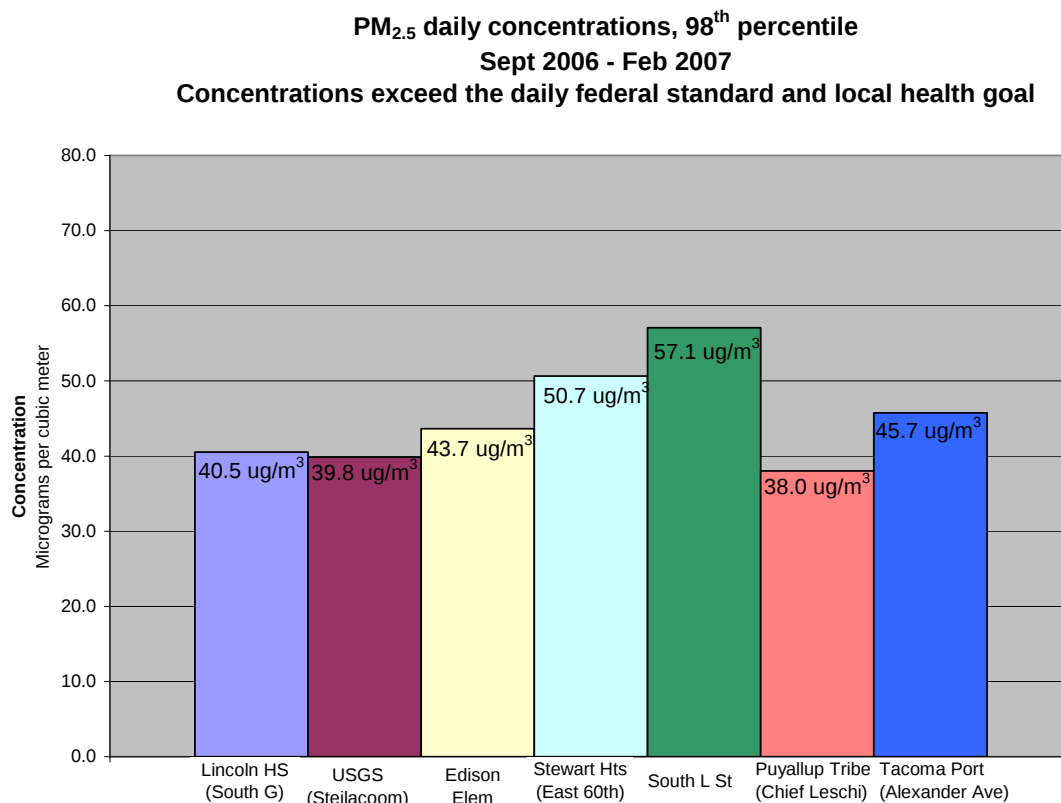


Figure 8: Monitoring Results, winter 2006/2007



Speciation monitoring and tracer study

In January 2006, the Washington State Department of Ecology began to collect speciation data for the South L site, as part of the speciation trends network (STN). Figure 9 below shows basic components, based on a mass reconstruction for elemental and organic carbons, as well as soil components, nitrates, and sulfates. Clearly a main contributor to PM_{2.5} mass at the monitor is organic carbon, shown in light blue.²⁶ The highly elevated PM_{2.5} concentrations in December 2006 were recorded shortly after a wind storm caused widespread power outages in the greater Puget Sound region. Many people likely used wood at this time for heat.

Figures 10 and 11 show PM_{2.5} mass contributions on average and maximum concentration days. Again, these indicate that organic carbon contributes significantly to overall mass, especially on high concentration days that would violate the daily federal standard. Wood burning is a main source of organic carbon, in addition to other combustion sources.

The Puget Sound Clean Air Agency recently contracted with the University of Washington to conduct a tracer study of levoglucosan, a tracer of cellulosic combustion. This study was made possible through PM_{2.5}, Sec 103 funds as part of a national study. The study will use filters collected in the Puget Sound area, including the South L St. federal reference monitor, and will help to further inform the Agency about the wood smoke component of total PM_{2.5}. The study is scheduled to begin in winter 2007.

Figure 9: Speciation Monitoring – Basic Components and Seasonal Variation

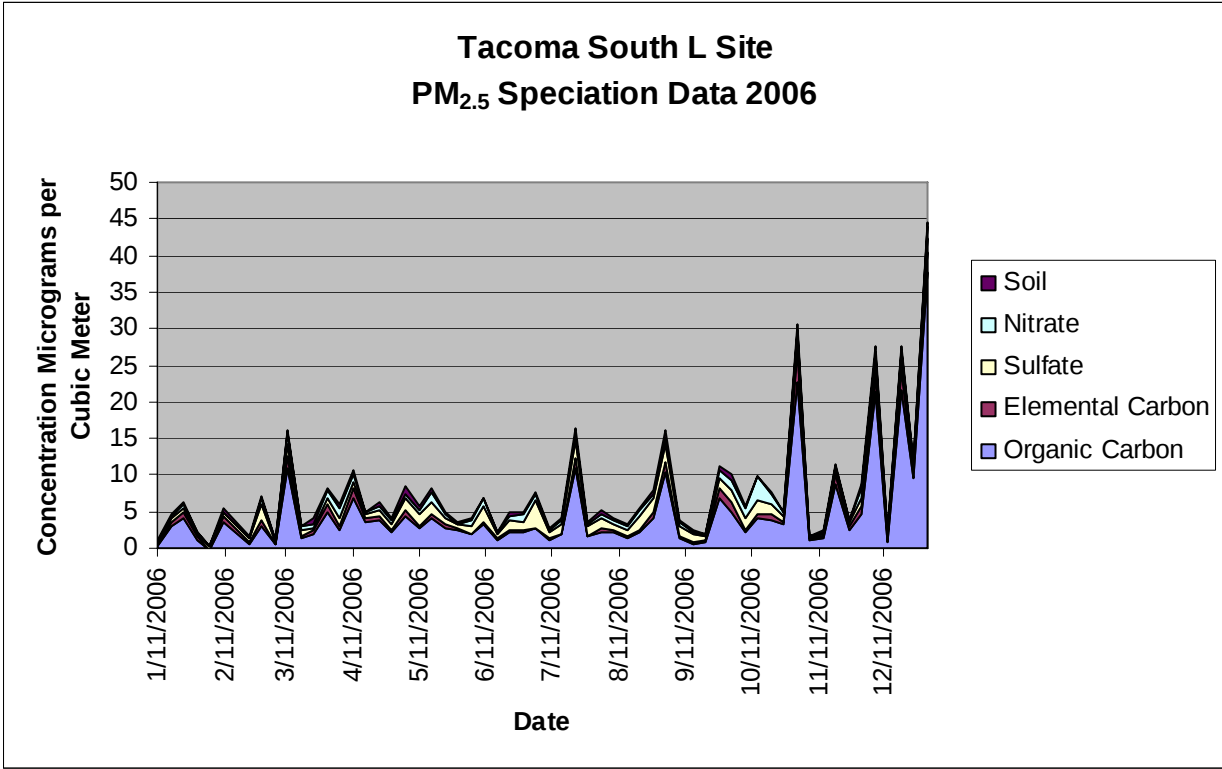


Figure 10: Average Components Contributing to PM_{2.5} Mass at South L Monitor

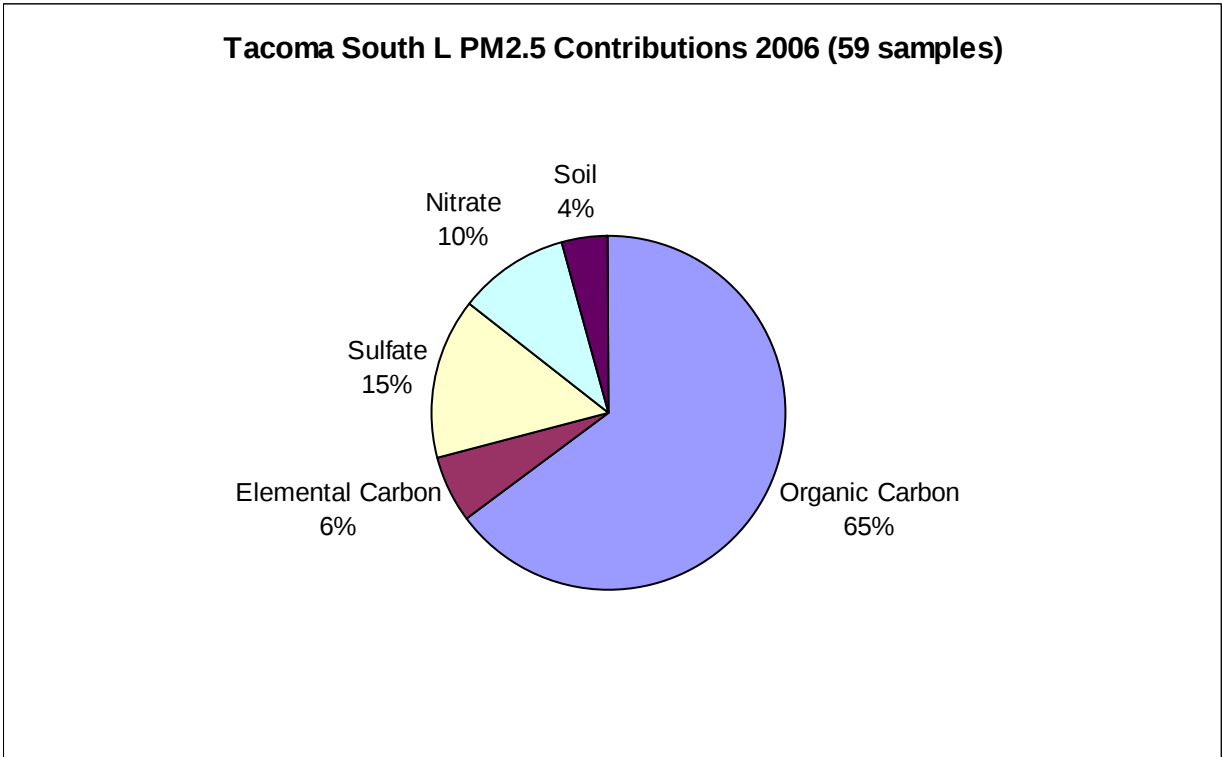
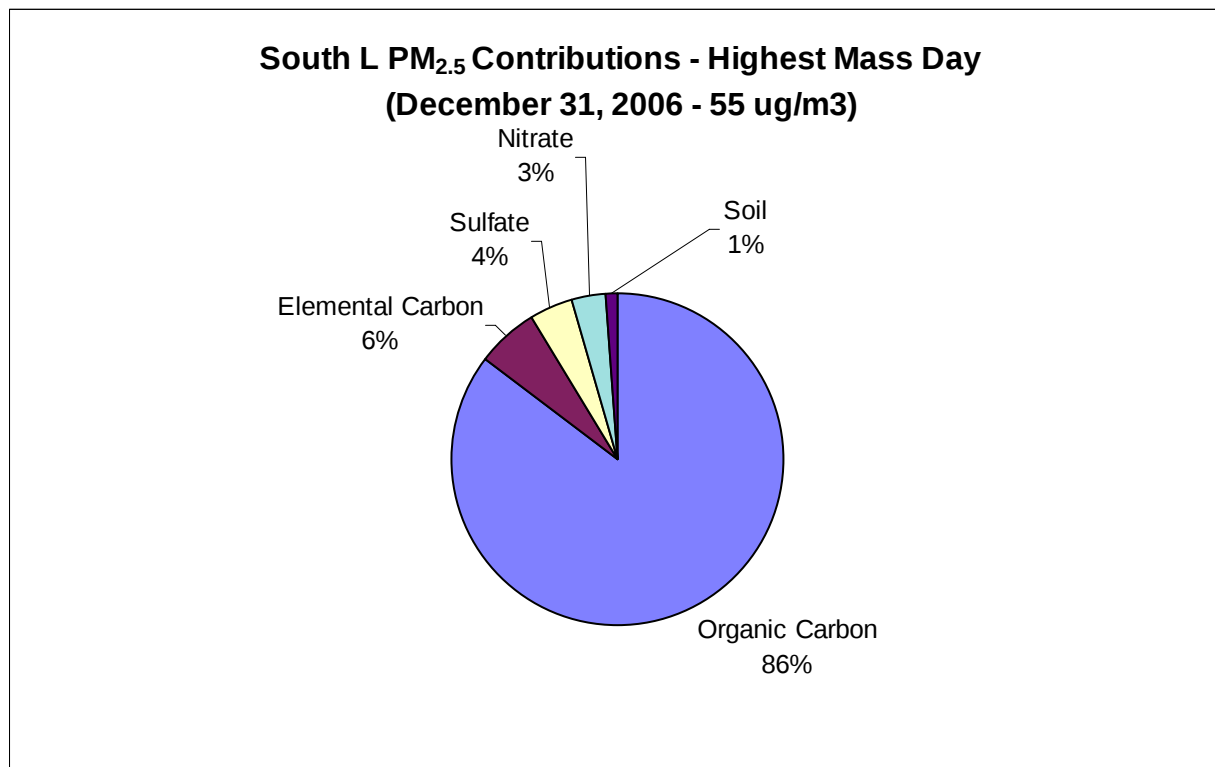


Figure 11: Components Contributing to PM_{2.5} Mass at South L Monitor on Highest Mass Day



Factor 3: Population Density and Degree of Urbanization

Figure 12 shows population density for the city of Tacoma and surrounding Pierce County areas, at the 2000 census block group level.²⁷ The Washington State Office of Financial Management forecasts population density on a city-basis for more recent years, as shown in Table 2.^{28,29}

Figure 12:

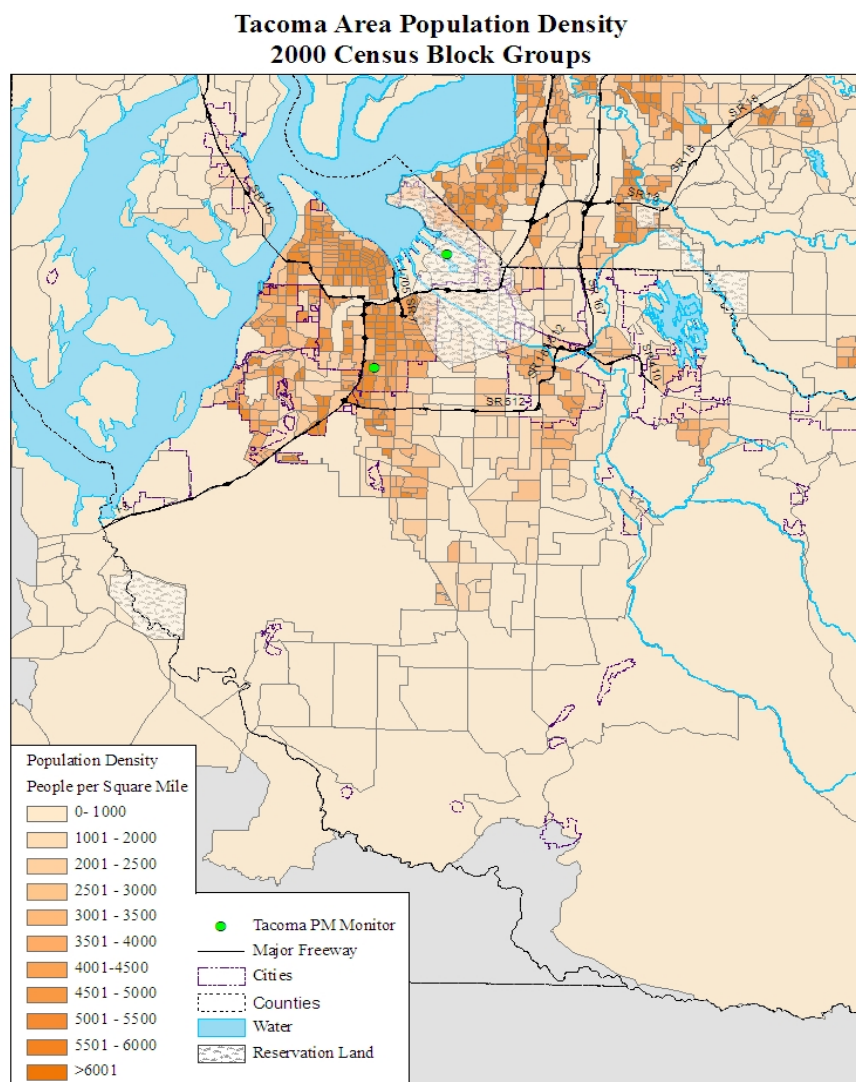


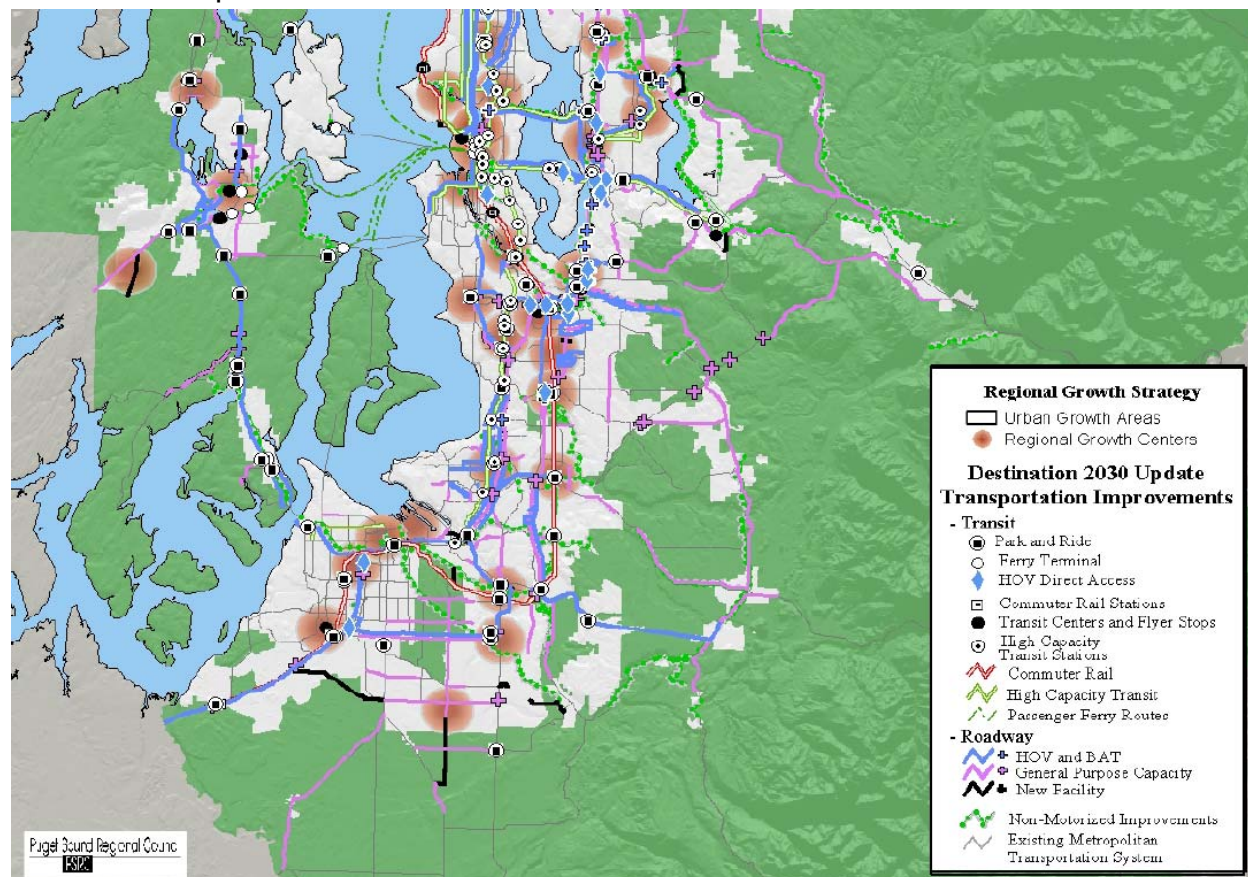
Table 2: City of Tacoma Population Density, People per Square Land Mile³⁰

Year	Population	Population Density
2000	193,556	3,946
2001	194,500	3,912
2002	194,900	3,920
2003	196,300	3,948
2004	196,800	3,959
2005	198,100	3,985
2006	199,600	4,014

Factor 4: Traffic and Commuting Patterns

The Puget Sound Regional Council shows in their Destination 2030 Update the extent of the transportation improvements related to the Tacoma/Pierce County area, as shown in Figure 13.³¹

Figure 13: Puget Sound Regional Council Destination 2030 Update Transportation Improvements



In addition, the Puget Sound Regional Council has recently released their draft Vision 2040³² plan for the region, incorporating known travel improvements and the preferred growth options emphasizing core centers for development. The output from PSRC's transportation demand model provides some travel growth estimates for the Pierce County area:

Table 3: Pierce County Daily Travel Measures by Category in 2000 and 2040³³

Daily Category of Travel	2000 Reference Data	2040	Units
Work Person Trips	293,886	535,330	Trips
Non-work Person Trips	1,757,784	3,183,447	Trips
Freeways Vehicle Miles Traveled	6,288,090	8,870,622	VMT
Arterials/Local Streets VMT	10,650,108	16,299,840	VMT
Freeways Vehicle Hours Traveled	129,929	191,106	VHT
Arterials/Local Streets VHT	363,175	617,769	VHT

Even with planned road and transit improvements, work and non-work person trips are estimated to increase by over 80%, while vehicle miles traveled and vehicle hours traveled are estimated to increase by 40% and 60%, respectively, from 2000 to 2040.

Factor 5: Growth Rates and Patterns

The Puget Sound Regional Council develops population and household forecasts for the Puget Sound area, based on forecast analysis zones (FAZ), built out of tracts from census.³⁴ The regional council has developed forecasts for 2010, 2020, 2030, and 2040. Figures 14 and 15 show household and population growth forecasts by FAZ for 2020. The shading indicates the increase in households or people per forecast analysis zone. Clearly, the area to the southeast of the South L monitor (shaded red) is predicted to have a substantial increase in both people and households in the next decade and a half. Figures 16 and 17 show the same information, normalized per square mile. For reference, the urban growth area boundaries and other boundaries are also included.

Figure 18 shows forecasted population growth for the Puget Sound region, from 2000 to 2040.³⁵ Pierce County increases are depicted with dark gray. Pierce County metropolitan cities and unincorporated areas have forecasted predictions of 32% and 22%, respectively.

Figure 14:

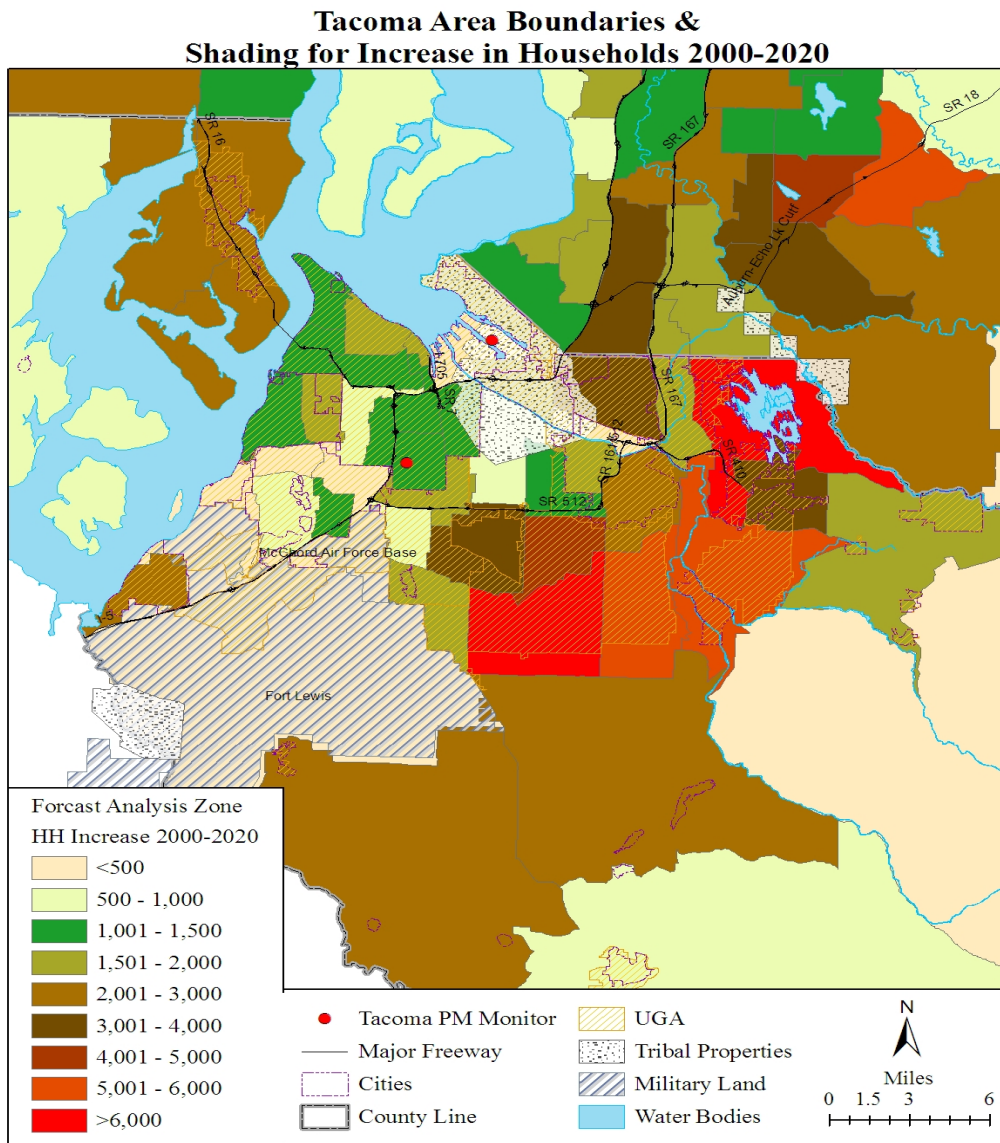


Figure 15:

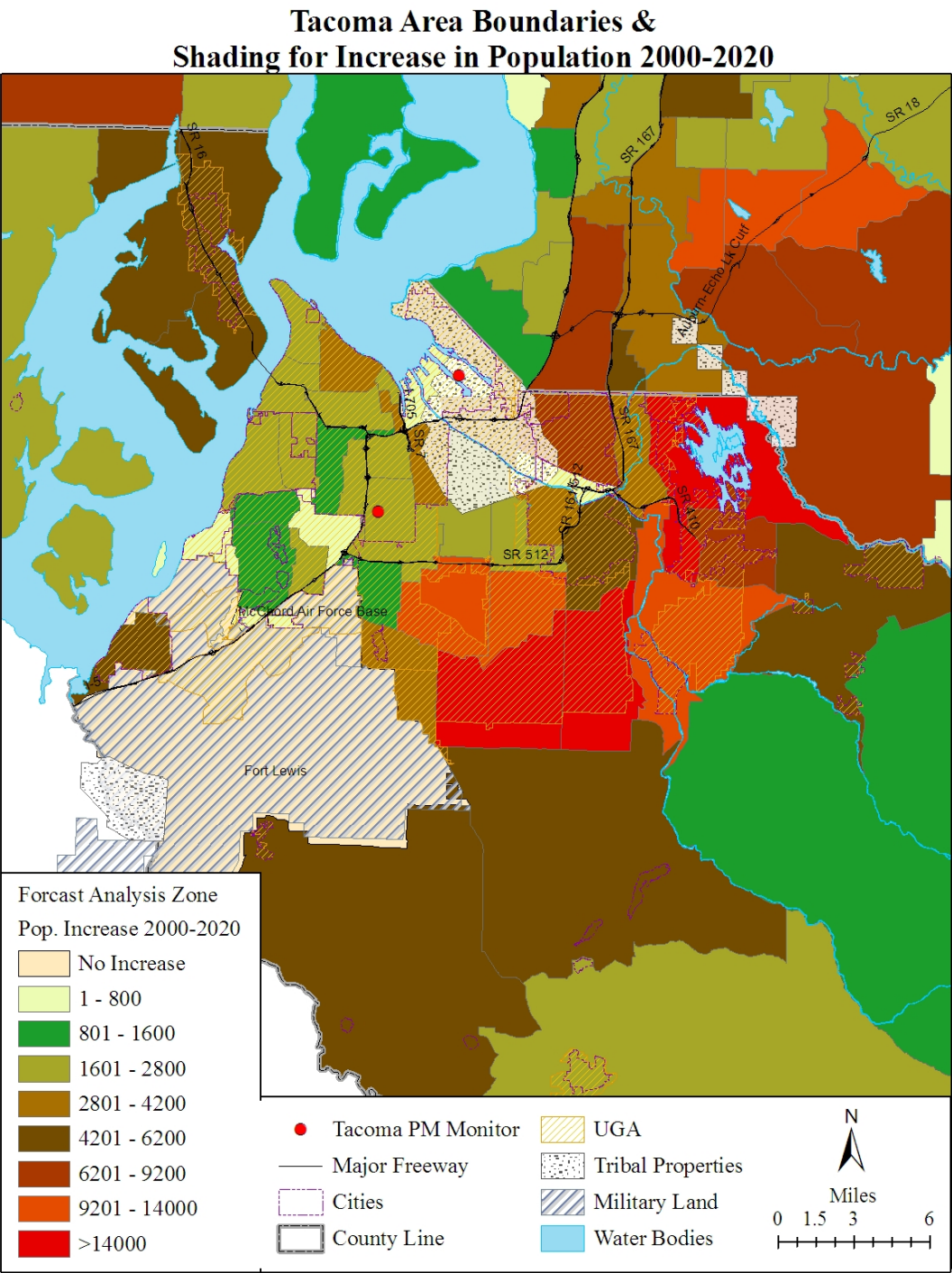


Figure 16:

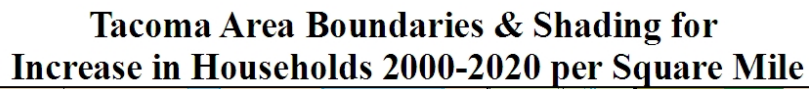


Figure 17:

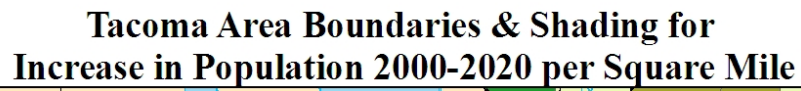
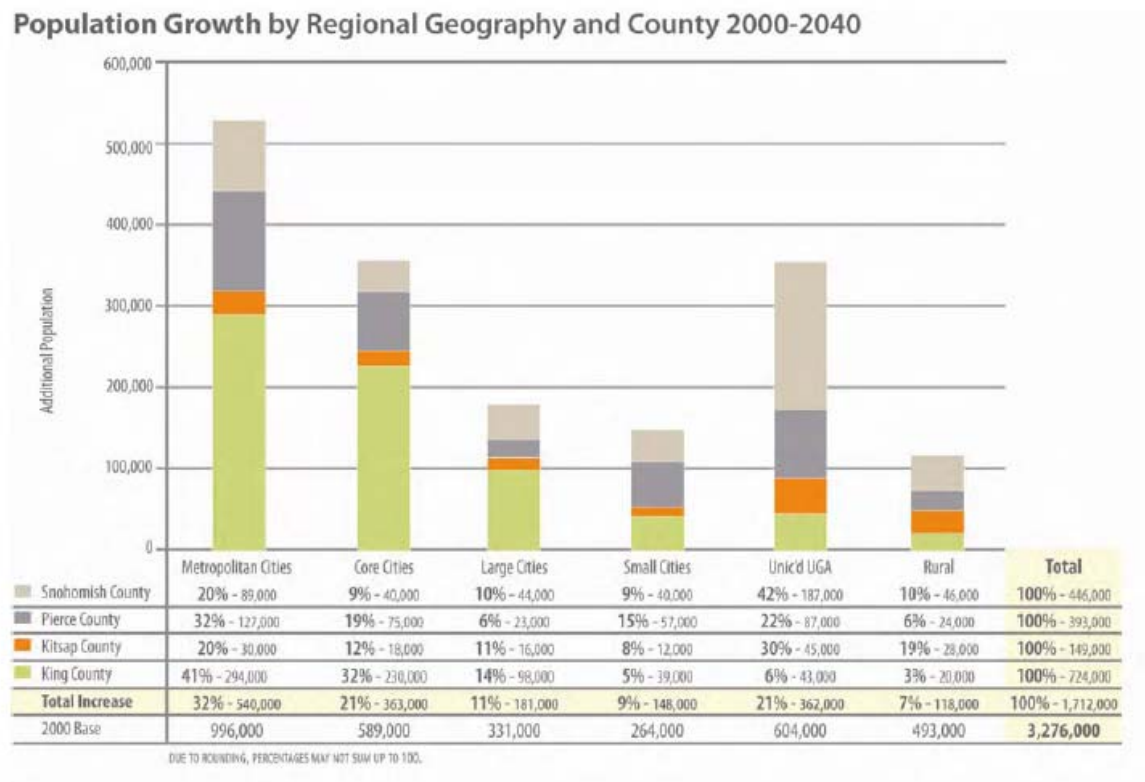


Figure 18:



Factor 6: Meteorology (weather/transport patterns)

Meteorology plays a critical role in PM_{2.5} concentrations at the South L Tacoma monitor and drives a consistent seasonal relationship to PM_{2.5} concentrations. Elevated levels of PM_{2.5} occur only during the fall and winter seasons, when regional air stagnations interrupt westerly wind flows and strong subsidence temperature inversions trap pollution levels. During these seasons, colder mean temperatures stimulate the use of residential heating devices.

Meteorological Patterns

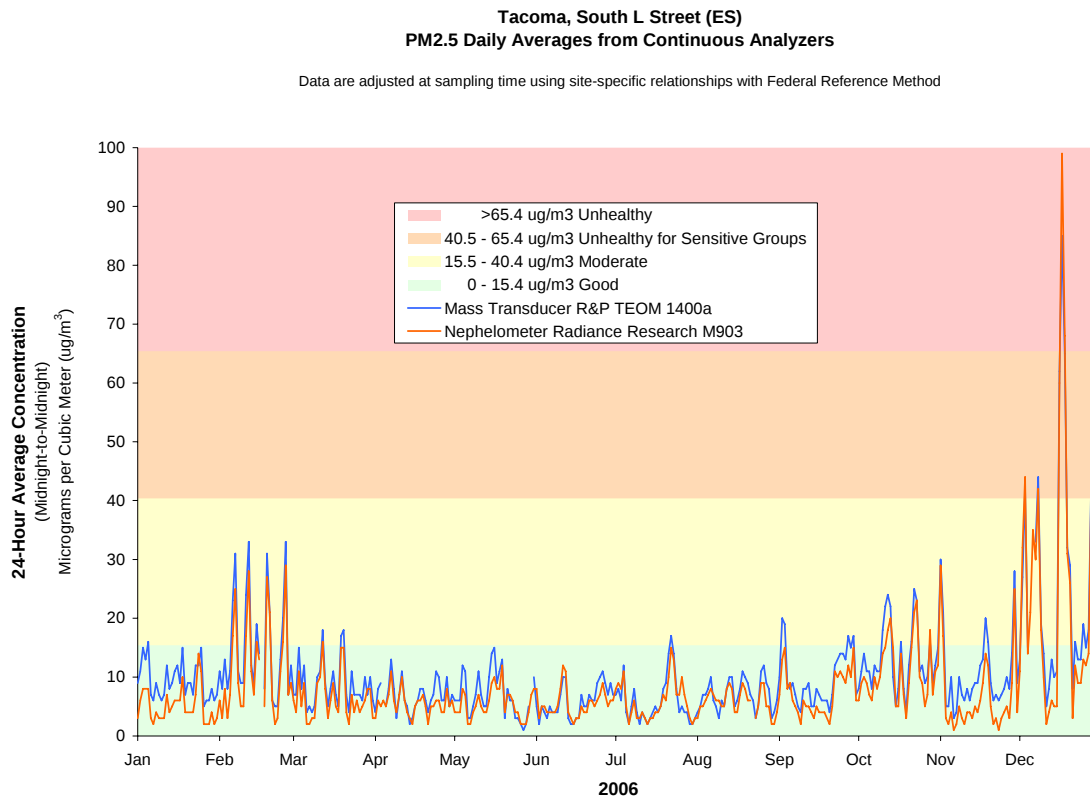
The weather pattern influencing the Tacoma area is typical of the mild Pacific Coast climate, which is modified by the Cascade Mountains to the east and to a lesser extent, by the Olympic Mountains to the Northwest. The area's climate is characterized by mild temperatures, a pronounced though not sharply defined rainy season, and considerable cloudiness, particularly during the winter months.

These three factors are heavily influenced by persistent Pacific onshore wind patterns and storm tracks. These features intensify in the late fall and diminish in the late spring. Periodically, the cleansing westerly flows are diverted away from the area and replaced by high pressure systems. During these periods, wind flows become offshore and the area's most extreme temperatures are observed. Temperature inversions of varying intensity form routinely during these patterns. These inversions change the mixing layer depth dramatically but generally lower the layer to less than 800m. During persistent winter stagnations, mixing heights less than 300m are frequently observed. The eastward movement of this synoptic pattern is variable. When stationary or slow moving, the area stagnates allowing air quality levels to decline. Typically these conditions occur when the duration of stable conditions extends beyond three days. This occurs approximately 3-4 times during the fall and winter seasons. The area surrounding the South L St. monitoring station is influenced by the same meteorological conditions.

The meteorological conditions during the 2006/07 temporary monitoring study were typical of the area's fall and winter seasons including periods influenced by moderate temperatures, strong Pacific storms, and air stagnations.

Figure 19 shows continuous fine particulate concentrations measured with a nephelometer and TEOM for the calendar year 2006. The shading represents the Air Quality Index. This graph shows that air quality in the area of the Tacoma monitor typically degrades only in the winter months, when the area is prone to inversions that trap pollution. Note that the unhealthy levels that occurred in December 2006 followed a wind storm and subsequent power outage, when many people were likely using wood heat for warmth.

Figure 19: Seasonal Variation



Wind direction

Wind at the South L monitor generally comes out of the south during the months with highest PM_{2.5} concentrations, as shown in Figure 20. The Figure 20 wind rose shows wind direction and speed during the winter season of 2006/2007. The wind rose in Figure 21 shows that winds also have a northerly and westerly component in summer months.

Figure 20: Wind Speed and Direction at Violating Monitor, winter months

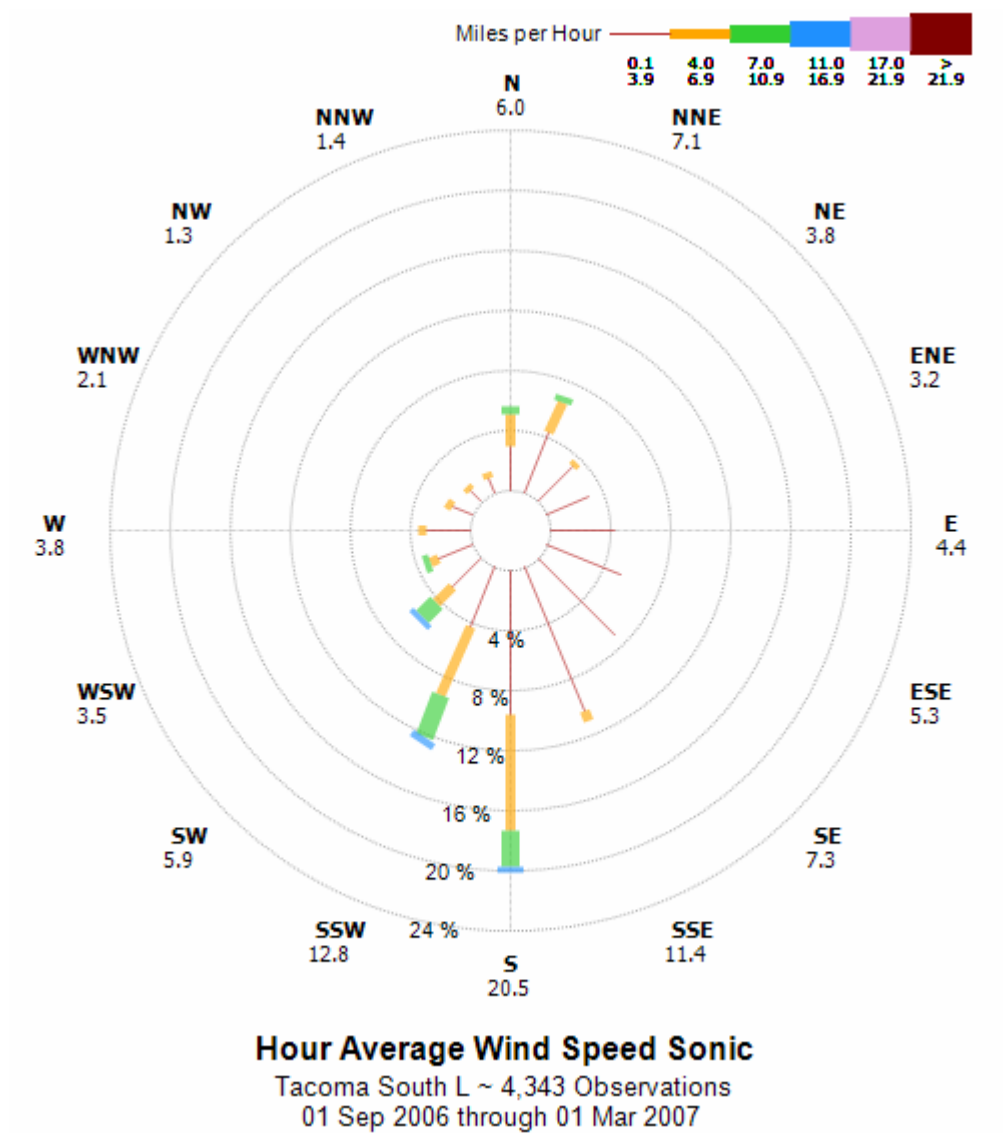


Figure 21: Wind Speed and Direction at Violating Monitor, summer months

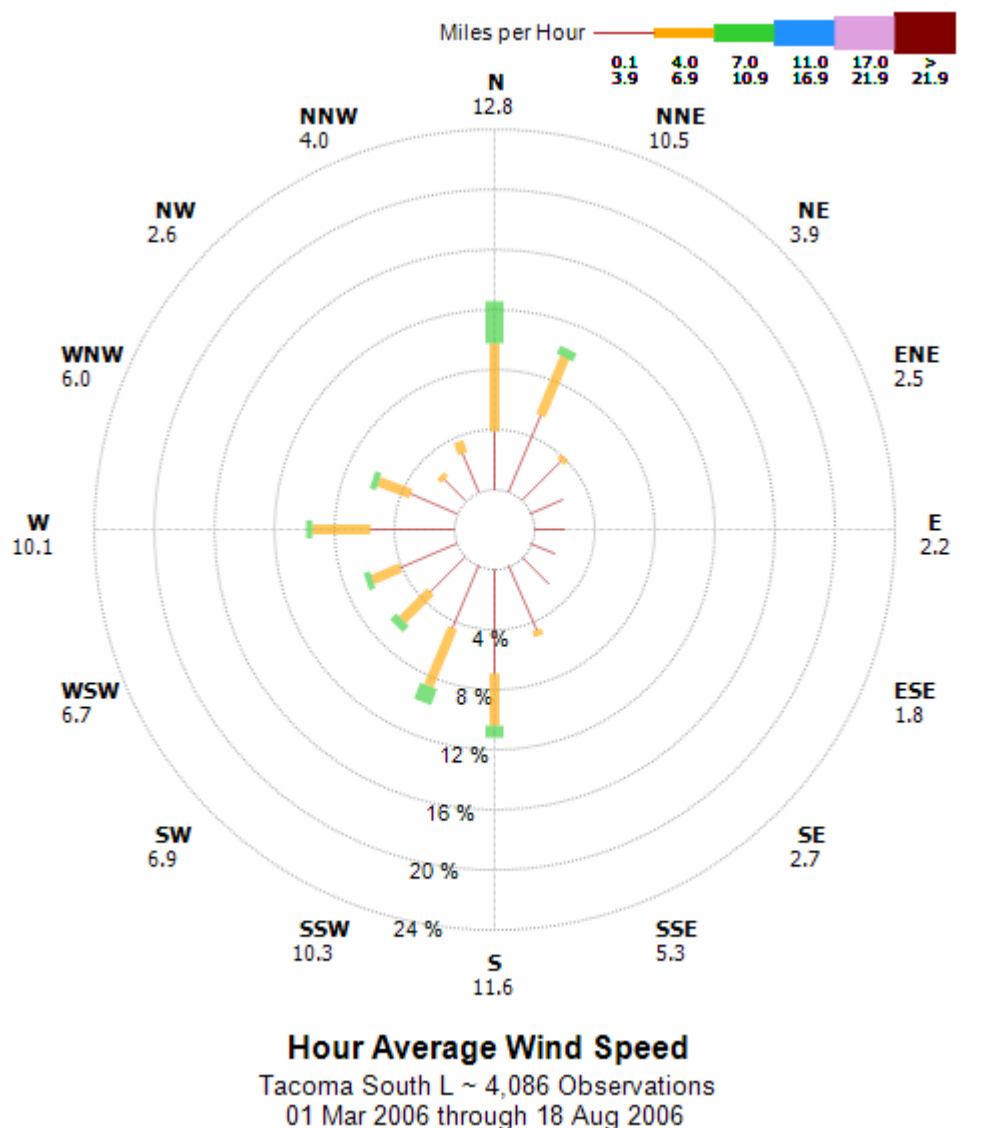


Figure 22 shows a PM_{2.5} concentration wind rose for the winter months 2006/2007. Highest PM_{2.5} concentrations occur when winds are out of the southeast, which also corresponds to when winds are lightest (close to stagnant conditions at 0.1 to 4 miles per hour). Figure 23 shows a summer 2006 concentration wind rose, and demonstrates that elevated PM_{2.5} levels rarely occur in summer, and are not associated with a particular wind direction.

Figure 22: PM_{2.5} Concentrations and Wind Direction at Violating Monitor, winter months

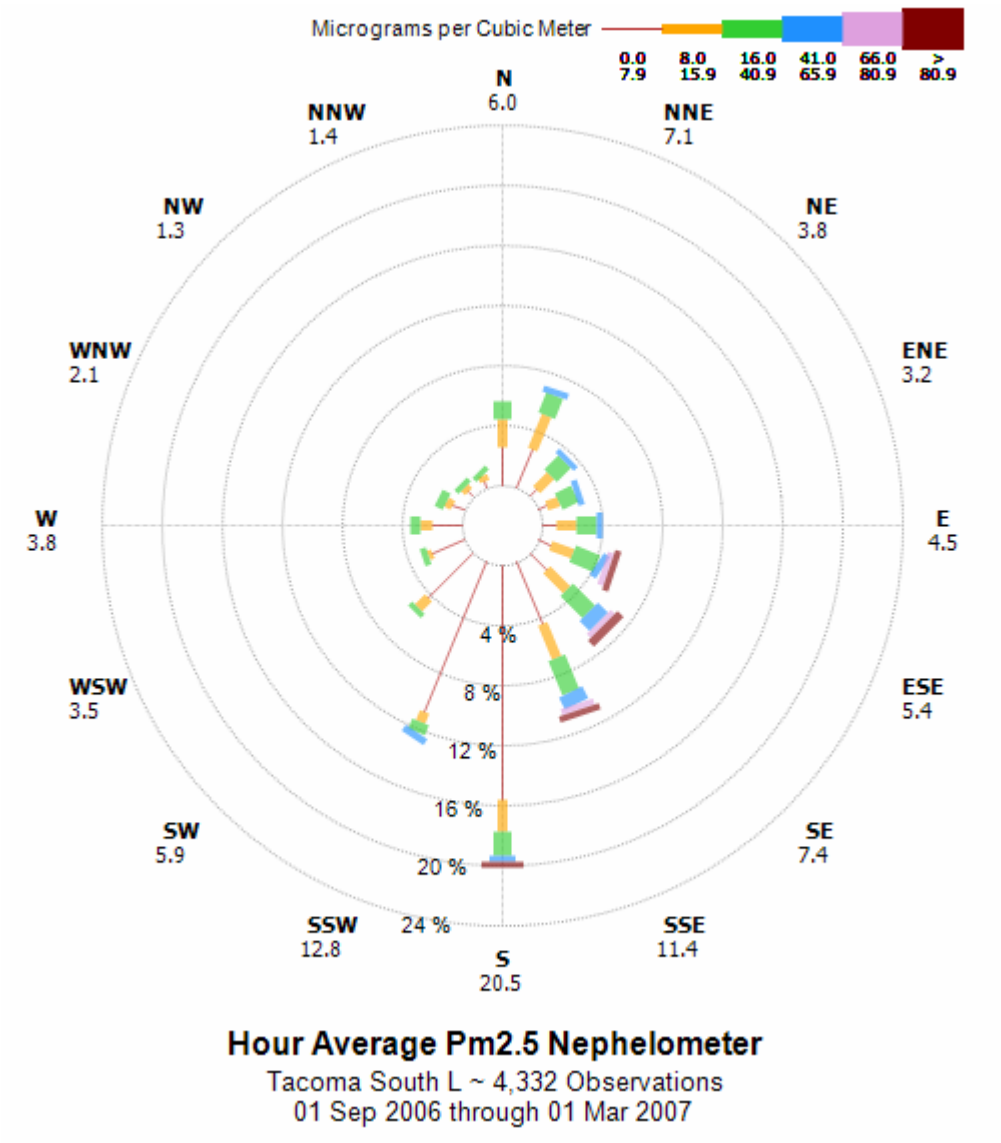
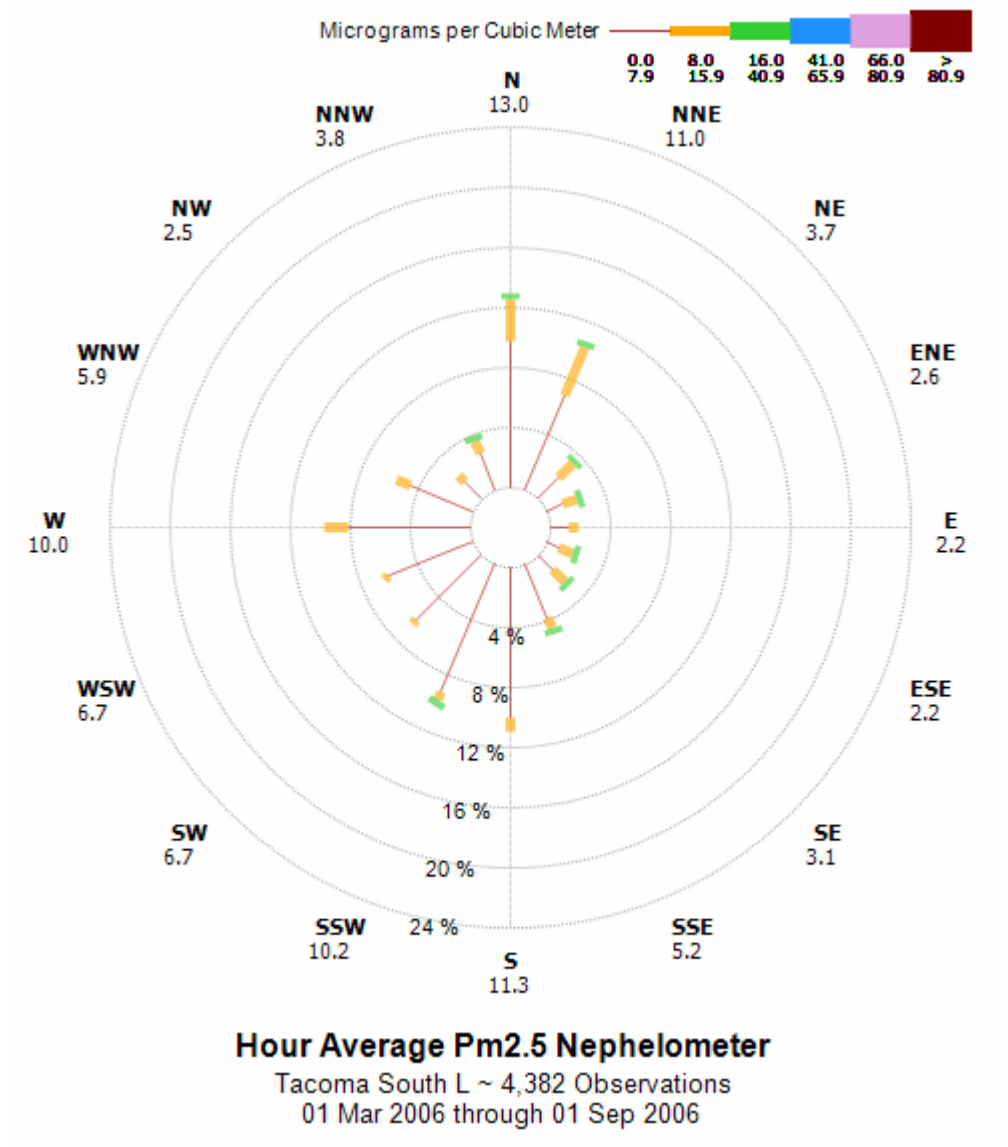


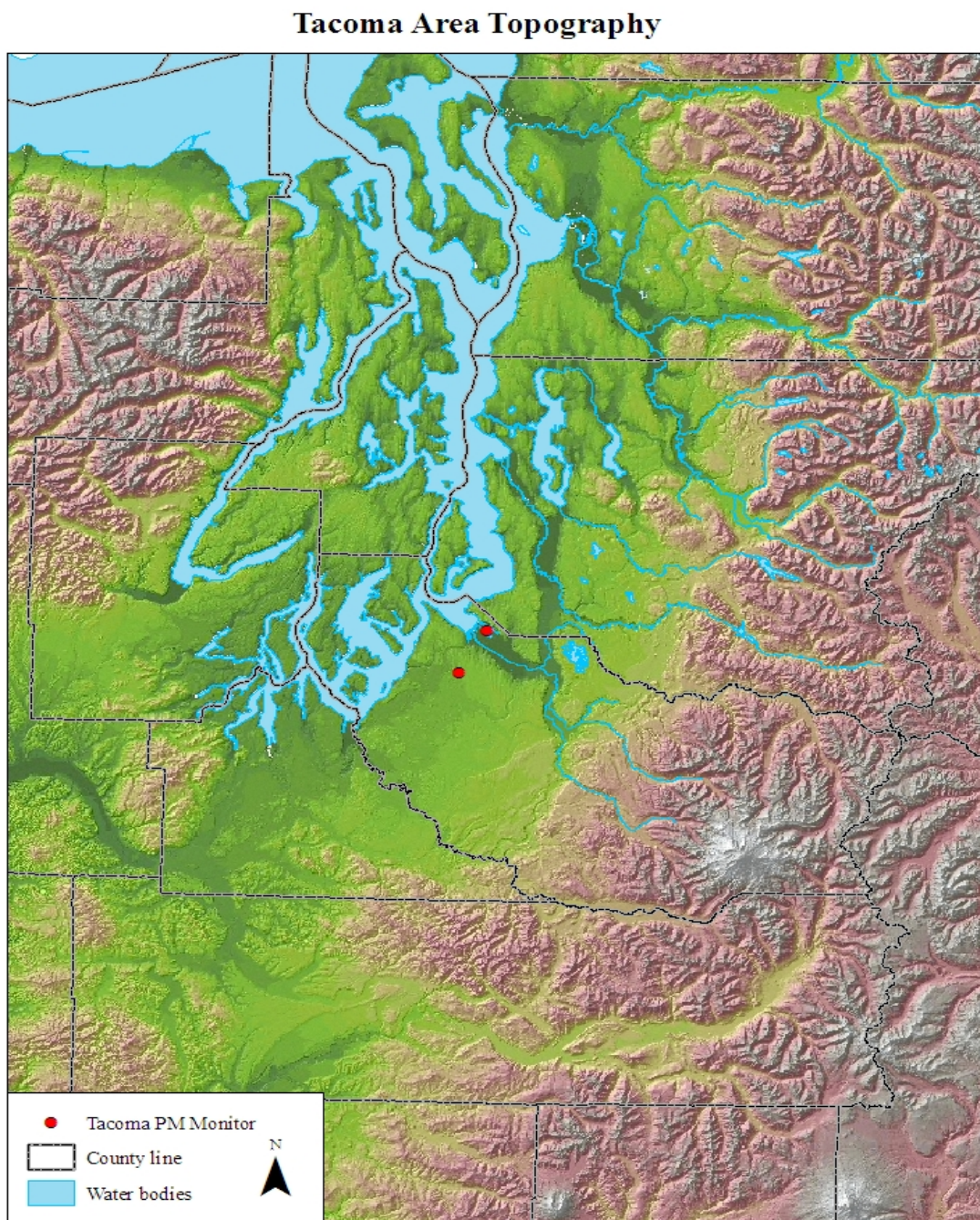
Figure 23: PM_{2.5} Concentrations and Wind Direction at Violating Monitor, summer months



Factor 7: Geography/Topography

Tacoma lies west of the Cascade Mountains. The South L monitor is sited at an elevation of 341 feet above sea level. Figure 24 shows the overall topography of the area, with the Puget Sound north and east of the violating monitoring site, and mountains to the east and south. This topography influences the meteorology of the area.

Figure 24:



Factor 8: Jurisdictional Boundaries

Several jurisdictional boundaries have already been presented in previous maps. Figure 25 includes boundaries for local cities, the comprehensive urban growth area (CUGA), local military sites, tribal lands, as well as major highways. The advantage of using the urban growth area boundary partially to designate the non-attainment area is that, by design, it captures the greatest density of the population and potential emission sources. Also, as was seen in the section with forecast analysis zones, the urban growth area generally captures the regions of greatest forecasted growth. Unfortunately, the Pierce County urban growth area boundary does include some "holes" in it – these areas would be included in a non-attainment designation, as their omission is potentially confusing and presents a challenge for a planning area.

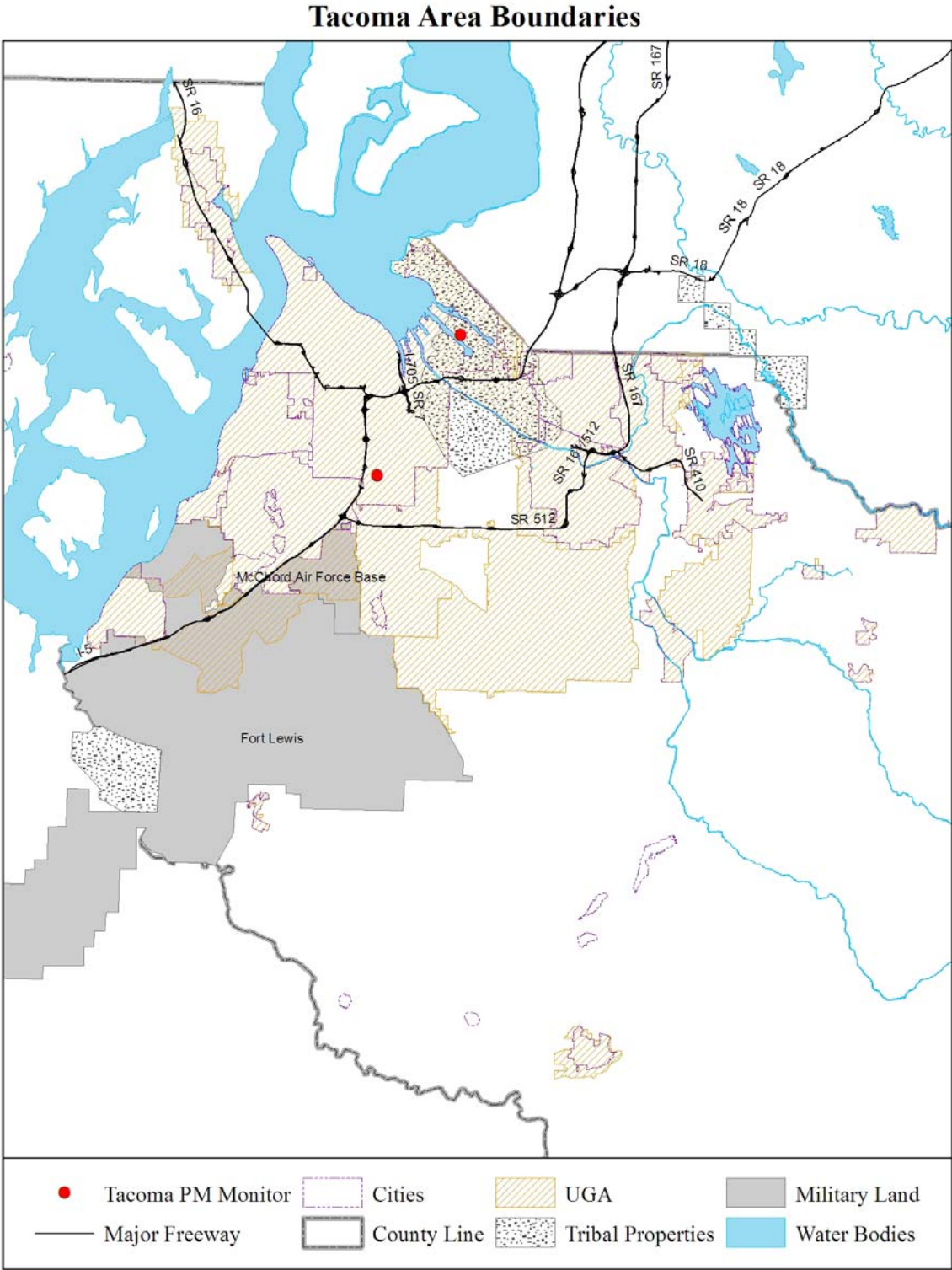
As noted in the summary, the Agency acknowledges that Puyallup Tribal lands are within the recommended boundary, and is unclear how EPA and the Tribe intend to address these areas. The Agency will partner with EPA and the Puyallup Tribe as needed and desired.

The Agency largely defaulted to the CUGA in its proposal, with some omissions to the southwest area and to the far eastern “peninsula” of the CUGA.

The omissions in the southwest area exclude the DuPont area, McChord Air Force Base, and Fort Lewis. These areas were excluded based largely on low PM_{2.5} emissions, low population density, low potential for growth, and meteorological information that the elevated levels at the violating monitor do not occur when winds are from the south and southwest. For more detail, see Appendix B, comments #3 and #4.

The omission of the far eastern edge of the CUGA was made largely based on topography and meteorology. The Bonney Lake, Orting, Sumner, and Auburn areas lie to the east of the Puyallup and White River valley, which runs north/south. While these areas may have substantial PM_{2.5} emissions, it is questionable that they would influence concentrations at the violating South L monitor. For additional detail, see Appendix B, comment #5.

Figure 25:



Factor 9: Level of Control of Emission Sources

In the late 1990s, the Agency evaluated, through a stakeholder process, local strategies to ensure maintaining PM_{2.5} "attainment" status and to meet our local health goal. Based on emissions inventory and extensive monitoring information, the stakeholder group recommended a broad suite of local control strategies to reduce PM_{2.5} in the Puget Sound area.³⁶

Strategies that are currently implemented include:

- *Enforcing winter burn bans*
This strategy involves education about the rules regarding temporary burn bans as well as encouraging Ecology to update the rules to reflect current burn ban triggers.
- *Encouraging cleaner winter burning and practices through partnerships*
This strategy involves exploring ways to implement an existing Seattle-King County Board of Health ordinance that requires removal of uncertified wood stoves when a home is sold as well as supporting the Puyallup Tribe in a wood stove change-out project.
- *Outdoor burning is prohibited in the urban growth area*
Violations require a response from fire departments and/or the Clean Air Agency.
- *National standards for on- and off-road diesel engines*
The 2007 Heavy-Duty Highway Engine Rule and the Clean Air Nonroad Diesel Rule cut diesel particulate matter, a subset of PM_{2.5} emissions, by an estimated 90% when fully implemented.
- *Diesel Solutions for trucks, rail and port activities*
The goal of the Diesel Solutions program and its associated Diesel Risk Reduction Plan is to bring all existing on-road and off-road engines to the emission standards of the 2007 highway diesel engines by 2020.
- *WA State clean vehicle and clean fuels programs*
The recently adopted clean vehicle and clean fuels regulation requires standards for particulate matter that complement the greenhouse gases emission reduction.
- *Industrial registration, notice of construction, and operating permit programs*
The Agency's registration and permitting programs ensure that levels of particulate matter from industrial sources will remain as they are or lower in the Tacoma area through offsets and required control technology.

The purpose of the Agency's work plan for wood stoves and fireplaces is to achieve sustainable improvements in wintertime air quality and to protect public health through the reduction of wood smoke pollution emissions. The work plan contains three focus areas: (1) regional efforts to reduce wood smoke, (2) localized efforts in areas known to be heavily affected by fireplace and wood stove use, and (3) targeted environmental justice efforts. Priority is given to areas that violate air quality standards for PM_{2.5} such as the south end of Tacoma. The Agency recently applied for and received \$175,000 in funding from the Washington State Department of Ecology to help replace uncertified wood stoves in the Tacoma and surrounding areas.

The Agency's 10-year objective of the wood smoke/fine particulate matter strategic plan is to meet or surpass the new federal PM_{2.5} standard and use the most cost-effective mix of tools and programs to reduce wood smoke emissions.

The purpose of the Agency's outdoor burning work plan is to begin phasing out land-clearing and residential burning in all four counties, including all of Pierce County. We plan to increase public awareness of the health risks associated with outdoor burning and the alternatives available. Although most or all outdoor burning occurs in areas at some distance from the violating monitor, certain weather patterns may allow particulate matter from outdoor burning to add to the ambient PM_{2.5} concentrations at the reference method monitors.

The purpose of the Agency's Diesel Solutions work plan is to reduce diesel engine emissions from school buses; public transit buses; municipal, county, state and private company fleets; locomotives; and marine and other diesel engines through retrofits and alternative energy sources, including biodiesel, ethanol, natural gas, and electricity. Diesel particulate matter is a subset of fine particulate matter, so any reductions will help the area meet the PM_{2.5} air quality standard. The work plan recognizes the co-benefits of reduction with criteria and toxic pollutants as well as climate change greenhouse gases. Our focus is on areas of highest, as well as sensitive population, exposure to diesel particulate matter emissions.

Appendix A

Table A-1: Pierce County Activity Levels, Emission Factors, and Key Assumptions from the Agency's Draft 2005 Emission Inventory³⁷

Source Category	Activity Levels	Emission Factors	Key Assumptions
Outdoor Open Burning			
Land Clearing Burning	264 permits, 672 acres cleared	23.4 lb PM2.5 per tons burned	95 tons burned per acres cleared
Yard Waste Burning	21,910 households burning	38 lb PM2.5 per tons burned	19.1% households burn yard waste, 875 lbs burned per household
Household Waste Burning	none	--	no garbage burned
Agricultural Burning	225 permits	3.7 to 15.8 lb PM2.5 per tons burned	2.4 to 10.4 tons burned per acre
Forest Wildfires and Managed Burning	24.34 acres wildfires, 158.5 acres managed burns	13.5 lbs PM2.5 per tons burned	95 tons burned per acres burning
Structure Burning	756,000 population	10.8 lbs per tons burned	2.3 fires per 1,000 persons, 1.15 tons burned per fire
Mobile Sources			
Non-road Diesel Engines	28.5 million gallons, 520.9 million hp-hrs	19.6 lbs PM2.5 per thousand gallons	Back-calculated from the 2005 EI (page 54 and table Appendix 2-4.1.3)
On-road Diesel Vehicles	536 million vehicle miles	130 to 785 mg PM2.5 per vehicle mile	MOBILE6.2 default distribution of vehicle types
On-road Gasoline Vehicles	5,524 million vehicle miles	14 to 114 mg per vehicle mile	MOBILE6.2 default distribution of vehicle types
Non-road Gasoline Engines	9,877 thousand gallons	16.2 lbs PM2.5 per thousand gallons	Back-calculated from the 2005 EI (page 54 and table Appendix 2-4.1.3)
Ocean-going Vessels	2,093 movements	52 lbs PM2.5 per movement	Back-calculated from Starcrest Maritime EI (page 236) for Port of Tacoma
Railroad Diesel Engines	3,328,000 line haul, 1,099,000 gallons switchyard	11.6 line haul, 13.8 switchyard lbs PM2.5 per 1,000 gal	Verbal data transfer
Harbor Vessels	124 vessel engines	0.30 to 0.72 g/kW-hr	Back-calculate using CO2 emissions in Pierce versus Region from Starcrest EI report pages 258,279, tables 4.2 and 4.16
On-road CNG and LPG Vehicles	6,060 million vehicle miles	7.6 lbs per million cubic feet of natural gas, 0.4 lb per 1,000 gal LPG	Washington State estimates apportioned by annual vmt
Airport Ground Support Diesel Engines	238,000 gallons burned, 4,351 thousand hp-hrs	1.4 lbs per 1,000 hp-hrs	McChord, Fort Lewis and other Pierce Co airports only
Aircraft	4,242 thousand gallons burned in land and takeoff (LTO), 138,833 LTOs	26 lbs PM2.5 per LTO	McChord, Fort Lewis and other Pierce Co airports only
Non-road LPG Engines	3,171 to 3,203 thousand gal, 29,916 1,000 hp-hrs	1.2 lbs per 1,000 gallons LPG burned	Back-calculated from regional totals, page 54 and table Appendix 2-4.1.6 show different activity levels
Recreational boats	3,293,000 gallons gasoline and 88,000 gal diesel	1.2 to 73.3 lbs PM2.5 per 1,000 gallons	Fuel consumed in the same county as the boat is registered or at least the crossover between counties cancel each other out, gallons per boat range from 70 to 908 gallons per year
Fireplaces and Woodstoves			
Wood Stove Wood Burning	32,856 to 44,737 tons wood burned	18.2 to 28.5 lbs per ton wood burned	8 hours per burn session, 5 lbs per hour burned, pages 81-82, tables 4-2.1.14 and 4.2-18 activity levels do not match
Fireplace Wood Burning	11, 066 tons wood burned	29.8 lbs per ton wood burned	4 hours per burn session, 6 lbs per hour burned
Fireplace/Woodstove Fire log Burning	3,872 to 6,358 tons fire logs burned	24.6 lbs per ton fire logs burned	fireplace: 4 hours per burn session, 1.5 lbs per hour burned; wood stove: 8 hours per burn session, two 6 lb fire logs burned per 8 hours; pages 81-82, tables 4-2.1.14 and 4-2.1.18 activity levels do not match
Pellet Stove Wood Burning	3,239 tons pellet wood burned	3.9 lbs per ton pellet wood burned	8 hours per burn session, 2 lbs per hour burned

Table A-1 (continued)

Other Source Categories			
Industrial Point Sources	2,205 million cf natural gas, 10,473,000 gal distillate oil, 56,000 gal residual oil, 10,000 gal propane, 25,397 tons coal, 145,436 tons wood burned by large sources	Not reported	Industries self report emissions
Natural Gas Burning	9,079 residential, 5,862 small commercial, 1,312,000 large commercial, 4,045 small industrial sources, 893 million cubic feet burned by large industrial sources	7.6 lbs per million cubic feet natural gas burned	Activity levels apportioned from state values by number of households, commercial and industrial employees
Boiler/Furnace Distillate Oil Burning	5,220,000 residential; 3,167,000 small commercial; 1,252,000 large commercial; 8,182,000 small industrial sources; and 9,221,000 gallons burned by large industrial sources	0.4 lb per 1,000 gal residential, 2 lb per 1,000 gal burned by commercial and industrial sources	Activity levels apportioned from state values by number of households, commercial and industrial employees
Propane Furnaces and Boilers	5,944,000 residential; 1,263,000 commercial and 1,891,000 gallons burned by small industrial sources	0.4 lb per 1,000 gal residential and commercial; 0.6 lb per 1,000 gal burned by industrial sources	Activity levels apportioned from state values by number of households, commercial and industrial employees

Appendix B

Comments and Responses on Tacoma Area Proposed PM_{2.5} Non-attainment Area

The Agency sought input from a variety of stakeholders on an initially proposed PM_{2.5} non-attainment area (Figure B-1). The boundary proposed in Figure B-1 was based on a preliminary review of EPA's nine required criteria, with the intent of beginning with a potentially larger-than-needed area to address all criteria. Informal, verbal comments (1-7 below) were sought and received from a variety of stakeholders, including:

- The City of Tacoma
- The Port of Tacoma
- Pierce County
- Tacoma-Pierce County Chamber of Commerce
- McChord Air Force Base
- Fort Lewis

Responses to these comments are provided below. Additionally, a written comment letter from the Tacoma-Pierce County Chamber of Commerce is included.

1. The Agency should considering excluding the Port of Tacoma and the tide flats area.

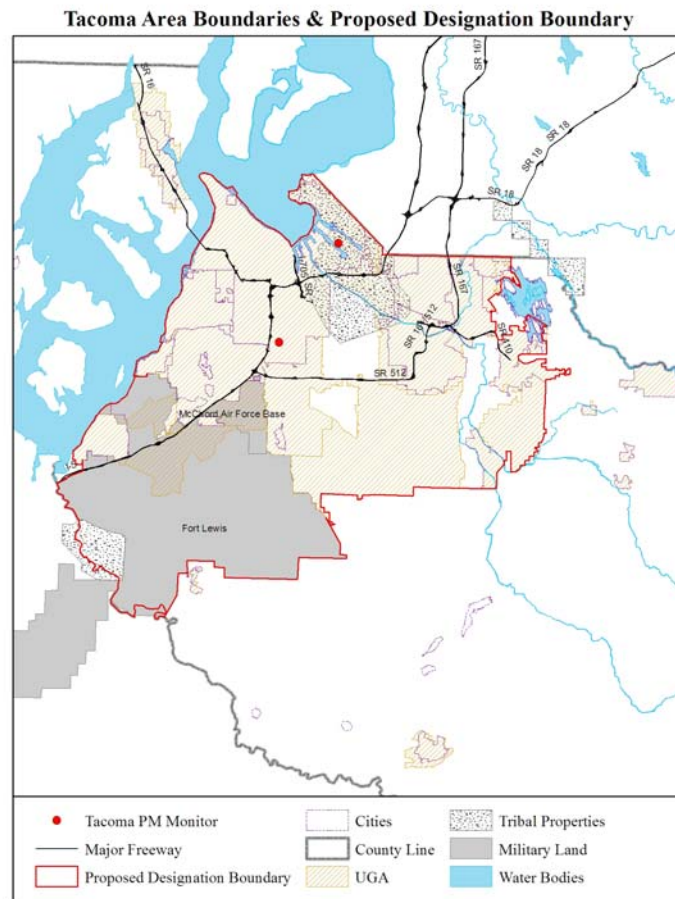
Fine particulate monitoring in the tide flats area consistently shows that the area experiences elevated PM_{2.5} levels. In 2006, the 3-year daily design value at the Tacoma Alexander site was 34 micrograms per cubic meter, just below the daily federal standard (concentrations from continuous methods).

The maritime PM_{2.5} emissions alone from the Port of Tacoma are estimated at 90 tons per year.³⁸ This estimate does not include off-terminal emissions, which contribute additional PM_{2.5}.

The Port of Tacoma projects a dramatic increase of its cargo handling capacity in the next two decades, with an estimated cargo growth factor of 4.8 from 1999 to 2015.³⁹ PM_{2.5} emissions in the tide flats area will likely increase due to this increased activity, including ship, cargo handling, rail, and truck activity. This clearly has the potential to impact not only the immediate port area, but also the larger area that connects the port with cargo destinations.

Based on factors 1, 2, 4, 5, and 8 (emissions, air quality, traffic and commuting patterns, growth, and jurisdictional boundaries), the Agency recommends that the Port of Tacoma tide flats area be included in the non-attainment designation area.

Figure B-1:



2. The Agency should consider expanding the boundary beyond the Pierce County boundary, northeast into King County.

The boundary between King and Pierce counties near Tacoma coincides with a topographical bluff, with the Tacoma tide flats at sea level and the King County border to the northeast at a higher level.

The Agency compared concentrations at two historic sites, Tacoma E 11th and Tacoma 54th NE. Tacoma E 11th sat in the Tacoma tide flats, at an elevation of 10 feet. Tacoma 54th NE was located on the bluff near the King County border, at an elevation of 420 feet. Both monitors measured light scattering from 1990 through 1992.⁴⁰ Concentrations at the lower tide flats monitor were consistently 1.5 times the concentrations observed on the bluff.

Based on criteria 2, 7, and 8 (air quality, geography, and jurisdictional boundaries), the Agency recommends that south King County not be included in the non-attainment area.

3. The Agency should consider not including the Fort Lewis base.

Based on emissions submitted to the Agency in 2006, Fort Lewis emitted only 5 tons of PM_{2.5}, less than 0.2% of the total PM_{2.5} included in the 2005 Pierce County inventory. Fort Lewis has no wood burning stoves on base. Their inventory shows 247 fireplaces in its housing area that are used occasionally.⁴¹ Figure 4 of this report shows very little wood burning for heat on base.

The population density in the majority of the base is very low (as shown in Figure 12 of this report), with a large portion of the base devoted to open training areas.

Puget Sound Regional Council's anticipated growth forecast analysis zones show very little growth in the majority of the Ft. Lewis base, as shown in Figures 14 through 17 of this report.

Wind rose information shows that highest concentrations of PM_{2.5} occur when winds are light and variable from the southeast, not the direction from Ft. Lewis (south and southwest).

Based on factors 1, 3, 5, and 6 (emissions, population density, expected growth, and meteorology), the Agency revises its initial recommendation and suggests that Fort Lewis not be included in the PM_{2.5} non-attainment area.

4. The Agency should consider not including the McChord base.

The McChord Air Force Base emits a negligible amount of PM_{2.5}, less than 1.5 tons in 2006 (see Appendix C, Talking Paper on McChord AFB's Fine Particulate Emissions). Additionally, the on-base housing units include only 11 wood burning fireplaces, and no wood stoves.⁴²

The population density in the majority of the base is low, and Puget Sound Regional Council's anticipated growth forecast analysis zones show very little growth on the McChord AFB (as shown in Figures 14 through 17 of this report).

Concentration wind roses show that highest concentrations of PM_{2.5} occur when winds are light and variable from the southeast, not the direction from the McChord AFB (south and southwest). Additionally, PM_{2.5} concentrations are typically lowest when flying activity for the base is highest (morning and early afternoon hours).

Based on further analysis of factors 1, 3, 5, and 6 (emissions, population density, expected growth, and meteorology), the Agency revises its initial recommendation and suggests that McChord AFB not be included in the PM_{2.5} non-attainment area.

5. The Agency should consider excluding the eastern and southern portions of the UGA.

The Agency examined the eastern edge of the UGA, the Bonney Lake and Orting areas. These areas could potentially have wood smoke emissions and elevated wintertime PM_{2.5} levels. However, this isn't known as the Agency does not maintain a monitor in that area. More importantly, based on

topography and meteorology, these areas may not impact the South L monitor. Based on a lack of information on air quality, and information on meteorology and topography that indicate they may not contribute, the Agency recommends excluding the far eastern edge of the comprehensive urban growth area from the non-attainment area. This edge is the area east of the valley that contains the White River, Stuck River, and Puyallup River.

The Agency examined the southern edge of the CUGA. Concentration wind roses (meteorology) indicate this area is directly upwind of the violating monitor at times when PM_{2.5} concentrations are highest. Additionally, according to PSRC forecasts, this area will likely experience growth in upcoming years (as shown in Figures 14 through 17 of this report). The southern edge of the CUGA encompasses an area large enough to encompass this upwind area. Cutting the area with smaller available jurisdictional boundaries, either the city of Tacoma or Highway 512, would not ensure that this upwind area is captured in the non-attainment area. Based on criteria 5, 6, and 8 (growth, meteorology, and jurisdictional boundaries), the Agency recommends including the southern extent of the CUGA in the non-attainment area.

6. The Agency should consider including only the immediate area around the violating monitor.

Given EPA's description of the required non-attainment area, the Agency is committed to creating a planning area that will enable them to effectively reduce emissions at the violating monitor. EPA requires that: *a nonattainment area must include not only the area that is violating the standard, but also nearby areas that contribute to the violation.*²¹

Based on the criteria of air quality alone, it is appropriate to include a larger area, as it is known that the Tacoma tide flats and areas on both sides of Interstate 5 experience elevated PM_{2.5} levels during winter months.

When other criteria such as wind direction, growth, and emissions are taken into account, it is clear that a planning area needs to be large enough to effectively reduce emissions and concentrations at the South L monitor. Based on criteria 1-9, the Agency recommends that the PM_{2.5} non-attainment area be larger than the immediate South End neighborhood.

7. The Agency should ensure that its recommendation is based on science.

While the Agency has informally sought feedback from several partners and stakeholders during this process, it has based its recommended area on EPA's nine required scientific and planning criteria. This effort is reflected in answers 1 through 6 above, as well as the description of these criteria in the report itself.

Appendix C

TALKING PAPER

ON

MCCHORD AFB'S PARTICULATE MATTER EMISSIONS

- McChord Air Force Base has a proud history of meeting and striving to exceed environmental standards.
- Our environmental flight regulates and records monthly particulate matter emissions less than PM 10 from the base boilers, which use natural gas and fuel oil.
 - In 2005, base boilers— McChord's primary emitter of particulate matter— produced 2753.4 lbs of particulate matter less than PM 10. In 2006, the base's total was 2600.15 lbs, and so far in 2007 (January to September), the total is 1651.49 lbs.
- McChord is not a key contributor to particulate matter from wood burning, as only 11 residences on base have fireplaces.
- Aircraft are exempt from regulations concerning particulate matter, yet the Air Force still strives to limit the impact of C-17s on the environment: like many Air Force aircraft, they use JP-8 aviation fuel (not diesel), and the C-17s boast cleaner engines than their predecessors at McChord, the C-141s.
- McChord established several initiatives to lower the amount of pollutants we emit into the atmosphere.
 - Although aerospace ground equipment (i.e. mobile generators, heating/ air conditioning carts, and maintenance stands) and other mobile sources are also exempt from regulations concerning particulate matter, we voluntarily converted them to cleaner-burning fuels. We converted our aerospace ground equipment from diesel to JP-8 jet fuel, and many motor vehicles from diesel to biodiesel, E85 fuel, and ultra-low sulfur diesel.
 - McChord has gone beyond the legal requirements in supporting the State Implementation Plan (SIP) for reducing air emissions from motor vehicles. Not only do we maintain our own state-approved vehicle emissions inspectors and keep our own fleet inspected, but for many years the base required all privately owned vehicles registered on base to comply with Washington emissions requirements even when those vehicles are registered in another state.
- As in years past, McChord will continue to meet environmental regulations and strive to create green practices which exceed these standards.
- *For questions on this paper, contact Capt Suzanne Ovel with 62nd Airlift Wing Public Affairs at (253) 982-5637.*

Appendix D

Comments from Tacoma-Pierce County Chamber



TACOMA-PIERCE COUNTY CHAMBER
POWER THROUGH
CONNECTIONS

October 19, 2007

Dennis McLerran
Executive Director
Puget Sound Clean Air Agency
1904 Third Ave., Ste. 105
Seattle, WA 98101

RECEIVED
OCT 22 2007
PUGET SOUND CLEAN
AIR AGENCY

RE: Implementation of Clean Air Act

Dear Mr. McLerran:

Our thanks to you again for your outreach efforts to our Chamber membership about your implementation planning for the Clean Air Act.

As a result of that presentation and further discussion, the Chamber submits for your consideration, as the agency develops its implementation plan, these points below.

In defining non-attainment areas, the Chamber supports:

- a. decisions based on scientific data (human health-based and/or environmentally-based criteria ((science-based guidelines)) for setting permissible levels) rather than popular sentiments
- b. areas not contributing pollutant by type or timing not to be included
- c. areas not out-of-attainment not included based on trend projections

Areas not contributing pollutant by type or timing not to be included:

If areas cannot be documented as contributing to the cause of non-attainment by contributing offending pollutants to exceed the federal standard based on scientific data, those areas should not be included in the non-attainment area boundaries. Non-attainment areas should be delineated by source so as to address the mitigation.

In our present case, the cause of the PM_{2.5} is wood smoke as supported by the data collected and as analyzed. In the question presented to us by PSCAA, McChord AFB should not be included in the non-attainment area as it is not documented to contribute to the exceedance of the federal standard. To do so would be unfair, would cause a burden on the base that might impair its development and could cause a mis-direction of its resources to wrongly address non-attainment issues. If popular sentiments believe

otherwise, it would be preferable to undertake a study on McChord to document any contributory sources without first placing it in a non-attainment area.

Areas not out-of-attainment not included based on trend projections:

If an area is not exceeding the allowable limits, it should not be included in a non-attainment area just because it might someday (sooner or later) exceed those limits. In our present case, the tideflats, as represented by the Alexander Ave. monitoring station, shows an upslope trend in PM2.5. While a straight line project might cause some to assume that the tideflats would inevitably violate the standards that are not a forgone conclusion. First, plotted lines in other areas show ups and downs in experiences. And, at the Alexander Ave. station, it shows a downward trend for four years and an upward trend for only the last two. Second, the community is acutely aware of those air quality trends and is earnestly debating the best and most effective programs to address the issue.

Decisions based on scientific data (human health-based and/or environmentally-based criteria ((science-based guidelines)) for setting permissible levels) rather than popular sentiments

The EPA clearly states that decisions are to be based on scientific data, a position the Chamber supports. The Chamber is aware of the perceptions some hold in the community that others are the cause of air pollution in their neighborhood, i.e. 78th & L Sts. Monitoring station and a wish by some to blame McChord AFB. The Chamber believes it is unfair to draw non-attainment boundaries not supported by scientific data just because some advocates wish those other area to be included.

Thank you for your consideration of these points.

Sincerely,


Gary D. Brackett, CCR
Manager, Business and Trade

End Notes:

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- ¹US Environmental Protection Agency (EPA). PM Standards – Review Completed in 2006. http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_2006.html.
- ²EPA. Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F. May 2002. <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060>
- ³US Environmental Protection Agency. Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper. EPA-452/R-05-005. June 2005. http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf.
- ⁴Miller et al. Long-term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women. The New England Journal of Medicine. February 1, 2007. <http://content.nejm.org/cgi/reprint/356/5/447.pdf>
- ⁵Pope et al. Lung Cancer, Cardiopulmonary Mortality, and Long –Term Exposure to Fine Particulate Air Pollution. Journal of the American Medical Association. 287: 1132-1141. March 6, 2002. <http://jama.ama-assn.org/cgi/reprint/287/9/1132>
- ⁶Dockery et al. An Association Between Air Pollution and Mortality in Six US Cities. New England Journal of Medicine. 1993. <http://content.nejm.org/cgi/content/full/329/24/1753>
- ⁷Kunzli et al. Ambient Air Pollution and Atherosclerosis in Los Angeles. Environmental Health Perspectives. Volume 113,2: 201-206. February 2005. <http://ehp.niehs.nih.gov/members/2004/7523/7523.pdf>.
- ⁸US Environmental Protection Agency. Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper. EPA-452/R-05-005. June 2005. http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20050630.pdf.
- ⁹Miller et al. Long-term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women. The New England Journal of Medicine. February 1, 2007. <http://content.nejm.org/cgi/reprint/356/5/447.pdf>
- ¹⁰Pope et al. Lung Cancer, Cardiopulmonary Mortality, and Long –Term Exposure to Fine Particulate Air Pollution. Journal of the American Medical Association. 287: 1132-1141. March 6, 2002. <http://jama.ama-assn.org/cgi/reprint/287/9/1132>
- ¹¹Dockery et al. An Association Between Air Pollution and Mortality in Six US Cities. New England Journal of Medicine. 1993. <http://content.nejm.org/cgi/content/full/329/24/1753>
- ¹²Kunzli et al. Ambient Air Pollution and Atherosclerosis in Los Angeles. Environmental Health Perspectives. Volume 113,2: 201-206. February 2005. <http://ehp.niehs.nih.gov/members/2004/7523/7523.pdf>.
- ¹³Respiratory health effects are listed on EPA’s Health and Environmental Effects of Particulate Matter Fact Sheet, dated July 17, 1997. <http://www.epa.gov/ttn/oarpg/naaqsfin/pmhealth.html>.
- ¹⁴Gauderman et al. The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age. The New England Journal of Medicine. Volume 351: 1057 – 1067. Number 11. September 9, 2004. <http://content.nejm.org/cgi/reprint/351/11/1057.pdf>
- ¹⁵Goss et al. Effect of Ambient Air Pollution on Pulmonary Exacerbations and Lung Function in Cystic Fibrosis. American Journal of Respiratory Critical Care Medicine. Volume 169: pp 816-821. January 12, 2004. <http://ajrccm.atsjournals.org/cgi/reprint/169/7/816>
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- ⁴² Discussion with Mike Grenko, 10/23/07. Mike Grenko, Environmental Management Flight Chief, McChord AFB, Mike.Grenko@McChord.af.mil.