Appendix A: Tacoma-Pierce County $PM_{2.5}$ Redesignation Request and Maintenance Plan Emissions Inventory Documentation

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Tacoma-Pierce County $PM_{2.5}$ Redesignation Request and Maintenance Plan Emission Inventory Documentation

1 Introduction

As part of developing a state implementation plan (SIP) revision, the Washington State Department of Ecology (Ecology) submitted an emission inventory (EI) preparation plan (IPP) and prepared an inventory of direct fine particles ($PM_{2.5}$) and their precursors. The precursors are nitrogen oxides (NO_X), sulfur dioxide (SO_2), volatile organic compounds (VOCs) and ammonia (NH_3). Ecology prepared nonattainment area winter day and annual inventories for the attainment year (2011), the final year of the maintenance plan (2026), and an interim year (2017).

The responsibility of the EI was a shared effort by Ecology, the Puget Sound Clean Air Agency (PSCAA), and the Puget Sound Regional Council. Ecology performed most of the calculations, ran the models, and wrote the documents while much of the specific information (i.e., sources of pollutants, survey data, etc.) needed for that task was provided by PSCAA. The Puget Sound Regional Council (PSRC) provided traffic and economic forecasting data.

This document provides documentation for the attainment year and projection year inventories per United States Environmental Protection Agency (EPA) inventory guidance.[1]

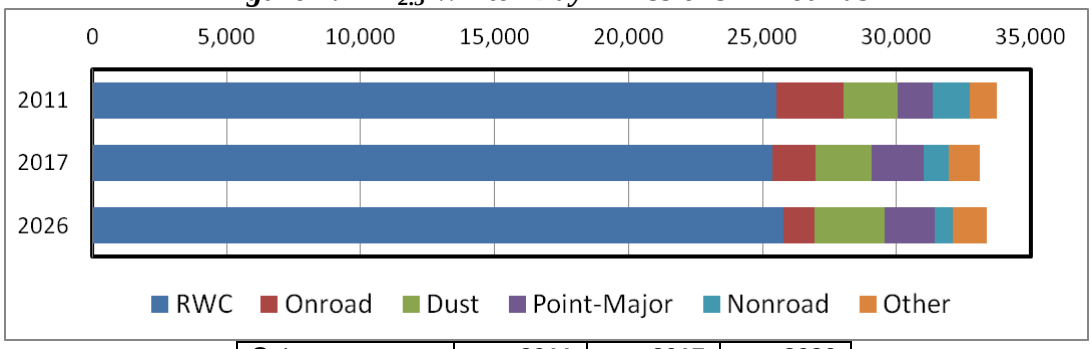
2 Emissions Summaries

Annual emissions and winter weekday emissions are presented here. Tables and charts are included. Tables show source types by major sector group. Sectors are abbreviated as PT - Point Sources, NP - Nonpoint Sources, NR - Nonroad Sources, OR - Onroad Sources. Abbreviations for each source are shown in the table below.

Table 1: Abbreviations Used in Emissions Summaries

Sector	Source Type	Abbreviation
PT1	Point Sources- Major	MAJOR
PT2	Point Sources – Minor	MINOR
NP	Architectural Coatings	ARCH
NP	Commercial Cooking	COOK
NP	Consumer & Commercial Solvents	SOLV
NP	Surface Coating	SURF
NP	Dust – Construction	DUST_CNST
NP	Dust - Paved Roads	DUST_PAV
NP	Dust – Coal Trains	DUST_RR
NP	Fertilizer Application	FERT
NP	Gas Cans	GAS_CANS
NP	Gas Stations	GAS_STN
NP	Livestock Waste	LIVE
NP	Residential Fuel, except Wood	FUEL
NP	Residential Fuel, Wood - Certified Stoves & Inserts	RWC-C
NP	Residential Fuel, Wood – Firelogs	RWC-LG
NP	Residential Fuel, Wood – Fireplaces	RWC-FP
NP	Residential Fuel, Wood - Pellet Stoves	RWC-PL
NP	Residential Fuel, Wood - Uncertified Stoves & Inserts	RWC-U
OR	Onroad	ONRD
NR	Locomotives	RR
NR	Marine - Harbor Craft	HARB
NR	Marine - Ocean-going Vessels	OCEAN
NR	Marine - Pleasure Craft	BOAT
NR	Nonroad - Commercial	COMM
NR	Nonroad - Construction	CNSTR
NR	Nonroad - Industrial	IND
NR	Nonroad - Lawn and Garden	LAWN
NR	Nonroad - Railroad Equipment	RAIL
NR	Port of Tacoma, non-Marine	PORT

Figure 1: $PM_{2.5}$ Winter Day Emissions in Pounds



Category	2011	2017	2026
RWC	25,519	25,355	25,788
Onroad	2,497	1,642	1,149
Dust	2,023	2,069	2,631
Point-Major	1,313	1,940	1,848
Nonroad	1,384	957	697
Other	1,025	1,136	1,266
TOTAL	***33,761***	***33,099***	***33,379***

Table 2: $PM_{2.5}$, SO_2, and NO_X Emissions, Winter Weekday, lbs

Gp	Source	PM2.5			SO2			NOx		
		2011	2017	2026	2011	2017	2026	2011	2017	2026
PT1	MAJOR	1,313	1,940	1,848	1,972	3,686	3,686	6,466	7,363	7,338
PT2	MINOR	0	55	55	0	258	258	0	303	314
NP	RWC-FP	5,477	5,410	5,311	93	92	90	603	596	585
NP	RWC-U	13,237	12,121	11,106	173	158	145	1,211	1,109	1,016
NP	RWC-C	6,421	7,418	8,927	160	187	227	883	1,035	1,260
NP	RWC-PL	60	73	93	6	8	10	75	91	116
NP	RWC-LG	325	333	350	0	0	0	88	90	95
NP	FUEL	49	53	58	687	738	813	3,810	4,093	4,506
NP	COOK	975	1,028	1,153	0	0	0	0	0	0
NP	DUST_CNST	596	654	678	0	0	0	0	0	0
NP	DUST_PAV	1,232	1,318	1,392	0	0	0	0	0	0
NP	DUST_RR	196	96	561	0	0	0	0	0	0
OR	ONRD	2,497	1,642	1,149	242	223	208	60,799	36,339	19,896
NR	COMM	75	62	48	3	2	3	1,041	791	660
NR	CNSTR	729	444	180	20	7	8	8,260	5,121	2,764
NR	IND	52	26	16	3	2	2	990	539	499
NR	LAWN	179	194	219	2	2	2	492	405	421
NR	RAIL	1	1	0	0	0	0	7	5	3
NR	RR	43	32	16	11	1	1	1,612	1,367	954
NR	PORT	118	132	143	1,188	1,500	1,958	2,497	2,752	2,675
NR	OCEAN	156	34	45	2,901	140	182	2,286	2,732	3,566
NR	HARB	31	31	30	1	1	1	879	817	741
NR	BOAT	0	0	0	0	0	0	7	7	6
	TOTAL	**33,761**	**33,099**	**33,379**	**7,463**	**7,004**	**7,594**	**92,006**	**65,555**	**47,414**

Table 3: VOC and NH_3 Emissions, Winter Weekday, lbs

		VOC			NH3		
Gp	**Source**	**2011**	**2017**	**2026**	**2011**	**2017**	**2026**
PT1	MAJOR	2,219	5,128	5,193	265	265	265
PT2	MINOR	266	2,076	2,527	0	0	1
NP	RWC-FP	4,386	4,333	4,254	418	413	405
NP	RWC-U	22,926	20,994	19,236	735	673	617
NP	RWC-C	5,076	5,914	7,155	359	420	510
NP	RWC-PL	1	1	1	6	7	9
NP	RWC-LG	452	464	487	0	0	0
NP	FUEL	217	234	257	766	823	906
NP	COOK	143	150	169	0	0	0
NP	ARCH	2,721	2,868	3,216	0	0	0
NP	SURF	4,765	5,023	5,633	0	0	0
NP	SOLV	12,179	12,837	14,397	0	0	0
NP	GAS_STN	1,105	1,172	1,383	0	0	0
NP	GAS_CANS	1,629	1,717	1,813	0	0	0
NP	FERT	0	0	0	3	3	3
NP	LIVE	0	0	0	0	0	0
OR	ONRD	33,198	20,303	11,977	973	746	645
NR	COMM	1,010	722	791	0	0	0
NR	CNSTR	1,161	881	731	0	0	0
NR	IND	175	64	51	0	0	0
NR	LAWN	3,913	3,928	4,458	0	0	0
NR	RAIL	1	1	1	0	0	0
NR	RR	91	66	42	0	0	0
NR	PORT	136	133	108	0	0	0
NR	OCEAN	72	91	119	0	0	0
NR	HARB	31	33	36	0	0	0
NR	BOAT	46	30	17	0	0	0
	TOTAL	**97,920**	**89,161**	**84,051**	**3,525**	**3,351**	**3,361**

Table 4: $PM_{2.5}$, SO_2, and NO_X Emissions, Annual, tons

		PM2.5			SO2			NOx		
Gp	**Source**	**2011**	**2017**	**2026**	**2011**	**2017**	**2026**	**2011**	**2017**	**2026**
PT1	MAJOR	240	354	337	360	673	673	1,180	1,344	1,339
PT2	MINOR	0	10	10	0	47	47	0	55	57
NP	RWC-FP	254	251	246	4	4	4	28	28	27
NP	RWC-U	613	561	514	8	7	7	56	51	47
NP	RWC-C	297	344	413	7	9	11	41	48	58
NP	RWC-PL	3	3	4	0	0	0	3	4	5
NP	RWC-LG	15	15	16	0	0	0	4	4	4
NP	FUEL	4	4	5	56	60	66	311	335	368
NP	COOK	181	191	214	0	0	0	0	0	0
NP	DUST_CNST	114	126	130	0	0	0	0	0	0
NP	DUST_PAV	209	224	237	0	0	0	0	0	0
NP	DUST_RR	20	11	63	0	0	0	0	0	0
OR	ONRD	359	229	150	44	40	37	10,697	6,377	3,458
NR	COMM	12	10	8	0	0	0	157	120	99
NR	CNSTR	140	85	34	4	1	1	1,582	981	529
NR	IND	11	5	3	1	0	0	204	114	108
NR	LAWN	48	51	56	1	1	1	226	165	166
NR	RAIL	0	0	0	0	0	0	1	1	0
NR	RR	8	6	3	2	0	0	294	249	174
NR	PORT	22	24	26	217	274	357	456	502	488
NR	OCEAN	28	6	8	529	25	33	417	499	651
NR	HARB	6	6	5	0	0	0	160	149	135
NR	BOAT	1	0	0	0	0	0	14	14	13
	TOTAL	**2,585**	**2,518**	**2,485**	**1,234**	**1,143**	**1,239**	**15,833**	**11,041**	**7,728**

Table 5: VOC and NH_3 Emissions, Annual, tons

		VOC			NH3		
Gp	**Source**	**2011**	**2017**	**2026**	**2011**	**2017**	**2026**
PT1	MAJOR	405	936	948	48	48	48
PT2	MINOR	49	379	461	0	0	0
NP	RWC-FP	203	201	197	19	19	19
NP	RWC-U	1,062	972	891	34	31	29
NP	RWC-C	235	274	331	17	19	24
NP	RWC-PL	0	0	0	0	0	0
NP	RWC-LG	21	21	23	0	0	0
NP	FUEL	18	19	21	63	67	74
NP	COOK	27	28	31	0	0	0
NP	ARCH	629	663	743	0	0	0
NP	SURF	760	801	898	0	0	0
NP	SOLV	2,265	2,388	2,678	0	0	0
NP	GAS_STN	216	229	255	0	0	0
NP	GAS_CANS	303	320	338	0	0	0
NP	FERT	0	0	0	8	8	8
NP	LIVE	0	0	0	0	0	0
OR	ONRD	5,058	3,114	1,938	184	142	123
NR	COMM	167	118	129	0	0	0
NR	CNSTR	223	169	140	0	0	0
NR	IND	35	13	11	0	0	0
NR	LAWN	918	765	852	0	0	0
NR	RAIL	0	0	0	0	0	0
NR	RR	17	12	8	0	0	0
NR	PORT	25	24	20	0	0	0
NR	OCEAN	13	17	22	0	0	0
NR	HARB	6	6	7	0	0	0
NR	BOAT	58	33	17	0	0	0
	TOTAL	**12,711**	**11,502**	**10,957**	**374**	**336**	**325**

3 Inventory Development

3.1 General Information

Ecology developed nonattainment area inventories of emissions for attainment year 2011 and projection years 2017 and 2026. The inventory includes annual and typical winter day emissions estimates of $PM_{2.5}$, $NO_{X,}$ SO_2, VOC, and NH_3.

A list of sources was developed using the 2011 National Emissions Inventory (NEI), local knowledge, and categories as defined in the 2005 Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations.[1] The list of sources is in Appendix A1 – National Emissions Inventory Source Categories. We used the guidance to select estimation methods and gathered information necessary to develop the attainment year and projection inventories.

Temporal Allocation

Past exceedances of the 24-hour $PM_{2.5}$ standard occurred primarily during cold days in the months of October through March. The design day temperature profile calculated for the SIP revision 2008 base year inventory was used for the maintenance plan inventories. The profile is representative of a cold, winter-like day. It was based on temperatures measured on days between January 1, 2006 and December 31, 2010 when daily fine particle concentrations exceeded 25 $\mu g/m^3$.

Figure 2: Design Day Temperature Profile

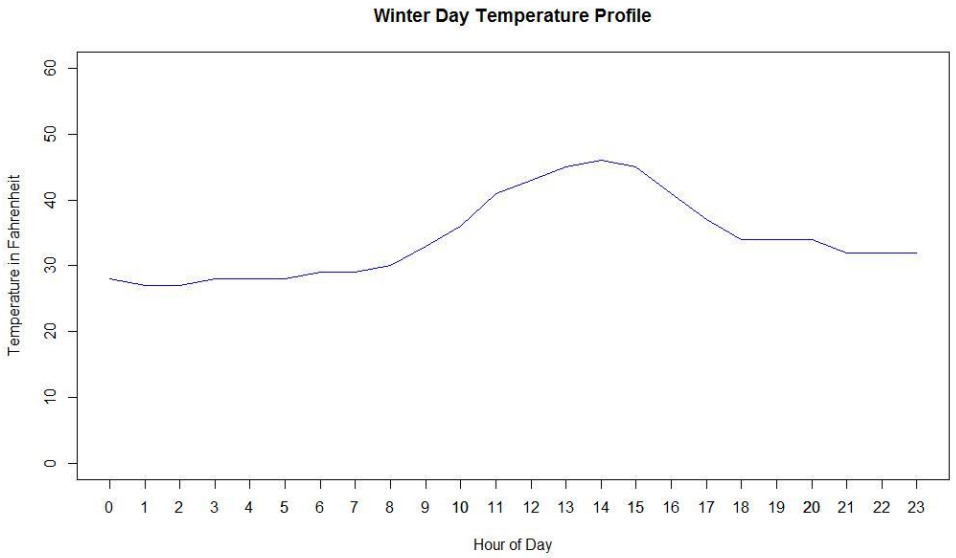


Table 6: Design Day Temperature Profile in Fahrenheit

Hour	0	1	2	3	4	5	6	7	8	9	10	11
Temperature	28	27	27	28	28	28	29	29	30	33	36	41
Hour	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Temperature	43	45	46	45	41	37	34	34	34	32	32	32

The temperature profile was used to calculate residential wood combustion, onroad mobile, and some nonroad mobile source emissions. For other sources, winter weekday emissions were calculated from annual emissions using temporal allocation profiles. Methods for each category are described beginning in Section 3.2.

Spatial Allocation

Emissions were calculated for the nonattainment area. For sources without specific coordinates where emissions were initially calculated at the county level, spatial surrogates were used to approximate both the location and magnitude of the emissions. Many of the surrogates are the same as or similar to the surrogates used in the Pacific Northwest's air quality prediction model, AIRPACT. Surrogates were allocated to the nonattainment area using GIS tools and scripts. Each emissions source was assigned to an appropriate surrogate.

Nonattainment Area emissions were estimated as:

$E_{NAA} = E_{County} * Surrogate_{NAA} / Surrogate_{County}$

Where E_{NAA} = emissions in the Nonattainment Area
E_{County} = emissions in county
$Surrogate_{NAA}$ = surrogate activity in the NAA
$Surrogate_{County}$ = surrogate activity in county.

Demographics, Employment, and Vehicle Miles Traveled Surrogates
Demographic, employment, road length, vehicle miles traveled (VMT), and vehicle population data are used in emissions calculations for several source categories. Vehicle population for 2011 was calculated as described in Section 3.6.2. PSRC provided the demographic, employment, VMT, and road length data for Pierce County and the Nonattainment Area.[2]

Table 7: Demographic, Employment, and Vehicle Statistics with Growth from 2011 Factors

Area	2011	2017		2026	
	Value	Value	Growth	Value	Growth
Population					
Pierce County	802,150	860,030	1.07	964,204	1.20
Pierce NAA	538,328	568,690	1.06	632,857	1.18
NAA/County ratio	0.67	0.66		0.66	
Households					
Pierce County	301,429	327,624	1.09	363,150	1.20
Pierce NAA	208,398	223,174	1.07	245,823	1.18
NAA/County ratio	0.69	0.68		0.68	
Total Employment					
Pierce County	316,777	351,060	1.11	395,106	1.25
Pierce NAA	209,798	230,101	1.10	260,043	1.24
NAA/County ratio	0.66	0.66		0.66	
Construction Employment					
Pierce County	19,101	20,827	1.09	21,528	1.13
Pierce NAA	11,862	12,352	1.04	12,966	1.09
NAA/County ratio	0.62	0.59		0.60	
Road Length in Miles					
Pierce County	3990.3	4083.7	1.02	4082	1.02
Pierce NAA	2,117	2,195	1.04	2,195	1.04
NAA/County ratio	0.53	0.54		0.54	
Vehicle Miles Traveled					
Pierce County	16,703,154	17,951,838	1.07	18,957,391	1.13
Pierce NAA	10,537,561	11,272,898	1.07	11,854,377	1.12
NAA/County ratio	0.63	0.63		0.63	
Vehicle Population					
Pierce County	645,639	685,561	1.06	745,445	1.15
Pierce NAA	407,316	430,853	1.06	466,158	1.14
NAA/County ratio	0.63	0.63		0.63	

Land Use and Land Cover Surrogates
Land use and land cover were used to spatially allocate county emissions from several source categories to the nonattainment area. The Environmental Protection Agency's Office of Information, Resources Management land use/cover data (LULC, published 1994), and the U.S. Geological Survey's National Land Cover Database (NLCD, published 1999) were used.

Table 8: Land Use and Land Cover in Acres

Land Use/Cover type	Source	Pierce Co.	NAA	NAA/County ratio
Confined Animal Feeding Operations	LULC code 23	205	0	0
Urban Land Use	NLCD codes 21-23	96,965	64,764	0.67
Agricultural Land Use	NLCD codes 81-84	29,841	5,331	0.18
Open Water	NLCD code 11	3,371	87,781	0.04

Inventory Tasks
To estimate emissions, four basic tasks were completed for each source category. The four tasks were: 1) estimate the activity level, 2) adjust/allocate the activity level (or emissions) temporally and spatially, 3) determine emission factors (rates) per the activity, and 4) estimate emissions. The tasks are described below for each source category. The summary of emissions estimates can be found in Section 2.

3.2 Point Sources

Industrial, commercial or institutional stationary sources which emit criteria and/or hazardous air pollutants are called point sources. Major point sources are those with the potential to emit 100 tons per year or more of any one criteria pollutant (carbon monoxide, volatile organic compounds, sulfur dioxide, nitrogen oxides, lead, and particulate matter) or a combination of criteria pollutants, and/or point sources with the potential to emit 10 tons per year or more of any single Hazardous Air Pollutant, or 25 tons per year or more of a combination of Hazardous Air Pollutants (Section 112, CAA). Facilities with a major source potential-to-emit are included in Title V Air Operating Permit (AOP) programs unless a facility voluntarily adopts federally enforceable permit limits that reduce their potential-to-emit below the criteria and HAPs thresholds.

For nonattainment areas, the federal Clean Air Act defines point sources as any stationary source having the potential to emit 100 tons per year of a criteria pollutant. There are eleven of these sources in the nonattainment area, discussed here as major point sources.

Simpson Tacoma Kraft (STK) is the only major point source in Ecology's jurisdiction. The ten other major point sources in the nonattainment area fall within the Puget Sound Clean Air Agency's (PSCAA) jurisdiction.

For a more thorough inventory, all sources registered with PSCAA that returned inventories were included, even if they were not major point sources. These sources are referred to as minor stationary sources and their emissions will be included in this section of the EI documentation. In summary Tables 1, 2, 3, 4, and 5 in the introduction section of this document they are listed separately under PT2 – Minor.

PSCAA registers sources that could potentially emit at least:

1) 2 tons of any single hazardous air pollutant;
2) 6 tons of total HAPs; and
3) 25 tons of carbon monoxide, nitrogen oxides, particulate matter, sulfur dioxides, or volatile organic compounds.

Sixteen of these sources submitted emission inventory reports to PSCAA and are reported here. The emissions reported by these sources may be less than the required reporting limits listed above.

Activity Level

Individual facility throughputs and production rates determine the activity level for each facility.

Spatial and Temporal Allocation

Point sources are located by county, address and coordinates. Throughput and emissions were assumed uniform throughout the year and 25% of the annual total was assigned to each season.

Emission Rates and Estimates

Emissions estimates for each facility are calculated using a variety of emissions estimation methods: continuous emissions monitors, stack test data, mass balance, best professional judgment, manufacturer's specifications, speciation profiles, EPA emission factors (e.g., AP-42), and/or other state, manufacturer, or research group emission factors. Methods are selected considering permit conditions, data availability, and resource constraints.

PSCAA Sources

For the 2011 inventory, Ecology utilized the 2011 emissions provided by PSCAA for the sources within their jurisdiction. One source, Graymont Western US Inc, changed their $PM_{2.5}$ emission calculation process which resulted in higher emission rates of $PM_{2.5}$ in 2012. Therefore, 2012 emissions were used for 2011 since the source felt that these were more accurate than the 2011 numbers.

There were seven sources that calculated only PM_{10} emissions for their facilities. In these cases, $PM_{2.5}$ was assumed to be equal to PM_{10}. These sources are: Carauster Mill Group Inc; Feed Commodities LLC; Frederickson Power; Simpson Lumber; Tucci & Sons Inc, McChord; Tucci & Sons Inc, Taylor Way; and US Oil & Refining.

In addition, PSCAA only requires sources to submit an emissions inventory if the source exceeds the thresholds for which a source would be required to obtain a registration with PSCAA. Those thresholds are listed above.

Since a facility is not required to submit an EI unless they are emitting above these amounts, even if there are no 2011 emissions reported for a facility in Table 9, that facility could still be emitting pollutants. Those emissions would be below the thresholds listed above but since there was no emissions inventory submitted, there is no way to know what the facility emitted that year. Therefore, if there is a zero in Table 9 for 2011, assume that the pollutant was unreported but may have emitted that pollutant at a level below the registration thresholds. Using zero emissions for these sources in the 2011 inventory is a conservative assumption because these sources were all given non-zero emissions for the future year inventories (see Table 9 below).

Ecology Sources

Data for Simpson Tacoma Kraft was taken from the facility's 2011 inventory. The facility calculated additional $PM_{2.5}$ emissions that are needed for the inventory but which they are not required by their permit to calculate.

2011 emissions are shown in Table 9: Point Source Emissions and Projections (tons per year).

Emissions Projections

The projection inventories were calculated using the five year max for Simpson Tacoma Kraft, unless the facility suggested an alternate projection based on expected facility changes.

For PSCAA sources, facility projections were determined by PSCAA engineers through consultation with the facility, engineering knowledge, or using the 10 year maximum emission for each pollutant.

Projection emissions are shown in Table 9.

Table 9: Point Source Emissions and Projections (tons per year)

Facility and Pollutant	2011 (tons)	2017 Projection (tons)	2026 Projection (tons)	Major?
Arclin Surfaces, LLC				***X***
VOC	11.55	34.64	75.16	
Boeing Commercial Airplane, Frederickson				***X***
NOX	0.00	15.12	12.98	
PM2.5	0.00	4.25	4.25	
SO2	0.00	0.16	0.16	
VOC	60.86	74.07	80.15	
Caraustar Mill Group Inc Tacoma Paperboard				
NOX	0.00	43.09	45.03	
PM2.5	0.00	2.16	2.16	
SO2	0.00	47.14	47.14	
Delta Prefinishing Corp				
VOC	5.96	7.10	7.69	
Feed Commodities LLC				
NOX	0.00	1.83	1.83	
PM2.5	0.00	5.00	5.00	
SO2	0.00	0.01	0.01	
VOC	0.00	126.81	126.81	
Frederickson Power LP				***X***
NOX	12.00	43.00	43.00	
PM2.5	9.60	38.10	38.10	
SO2	0.60	2.30	2.30	
VOC	4.50	17.70	17.70	
General Plastics Manufacturing Co				
VOC	1.32	2.63	3.29	
Georgia-Pacific Gypsum LLC				***X***
NOX	24.87	29.84	29.84	
PM2.5	25.95	31.13	31.13	
VOC	0.00	0.00	0.00	
Graymont Western US Inc				***X***
NOX	58.07	58.07	58.07	
PM2.5	80.26	80.26	80.26	
SO2	5.35	5.35	5.35	
VOC	2.61	2.61	2.61	
IDX - Seattle				
VOC	0.00	30.72	30.72	
James Hardie Building Products Inc				
VOC	5.59	11.18	22.36	
Jet Door LLC				
VOC	0.00	3.95	3.95	
Lianga Pacific Inc				
NH3	0.03	0.06	0.11	
VOC	33.37	109.71	176.45	
Milgard Manufacturing Inc				
VOC	0.00	0.00	0.00	
Parker Paint Manufacturing Co Inc Professional Paint				
VOC	0.00	2.25	3.94	

Facility and Pollutant	2011 (tons)	2017 Projection (tons)	2026 Projection (tons)	Major?
Professional Coatings Inc				***X***
VOC	58.94	117.89	117.89	
Puget Sound Energy, Frederickson				***X***
NOX	0.00	23.49	23.49	
PM2.5	0.00	1.43	1.43	
SO2	0.00	4.18	4.18	
VOC	0.00	0.28	0.28	
Rainier Richlite Co				
VOC	2.26	6.79	8.15	
Shore Terminals LLC				
VOC	0.00	33.75	33.75	
Sierra Pacific Industries				***X***
NOX	0.00	4.80	4.80	
PM2.5	0.00	16.00	16.00	
SO2	0.00	1.60	1.60	
VOC	0.00	241.00	241.00	
Simpson Lumber Company, LLC				***X***
NOX	6.42	12.10	9.64	
PM2.5	22.19	50.10	33.29	
SO2	0.07	0.10	0.11	
VOC	39.00	98.45	58.50	
Simpson Tacoma Kraft				***X***
NH3	6.00	6.00	6.00	
NOX	945.00	1013.00	1013.00	
PM2.5	89.40	106.80	106.80	
SO2	349.00	648.30	648.30	
VOC	77.00	104.00	104.00	
Tacoma Fixture Co Inc				
VOC	0.00	40.36	40.36	
Toray Composites America Inc				***X***
VOC	35.80	56.12	61.17	
Tucci & Sons Inc McChord				
NOX	0.00	4.48	4.48	
PM2.5	0.00	1.23	1.23	
Tucci & Sons Inc Taylor Way				
NOX	0.00	5.90	5.90	
PM2.5	0.00	1.62	1.62	
US Oil & Refining Co				***X***
NH3	42.35	42.45	42.45	
NOX	133.75	144.35	144.35	
PM2.5	12.30	26.07	26.07	
SO2	4.89	10.70	10.70	
VOC	114.69	189.20	189.20	
Westmark Products Inc				
VOC	0.00	3.62	3.62	

3.3 Minor Stationary Sources Inventoried as Point Sources

PSCAA inventoried minor stationary sources. Sources are required to report emissions from any criteria pollutant that equals or exceeds 25 tons per year.[3] Minor stationary sources may report emissions for less than this threshold. For more discussion on this refer to Section 3.2. All reported emissions of $PM_{2.5}$, NO_X, SO_2 , NH_3 and VOCs are included in this inventory (see Table 9).

Minor stationary source projections were performed in the same way that major source projections were calculated, please refer to 3.2 Point Sources, Emissions Projections.

3.4 Nonpoint Sources

Nonpoint sources include a variety of sources such as residential wood combustion, solvent usage, and road dust. Nonpoint source emissions are typically estimated by multiplying an activity level by an emission factor in mass per activity.

Emissions = Activity level x Emission Factor

Emissions estimation methods and data sources for each nonpoint source category are described in the sub-sections below.

3.4.1 Residential Wood Combustion

Residential wood combustion emissions were estimated using local survey data, EPA emission factors, local wood-burning device sales data, local change-out program statistics, and other local control program data.

Activity Level – Base Year 2008

The SIP revision base year 2008 inventory was the starting point for estimating 2011, 2017, and 2026 emissions. The 2008 inventory was updated to reflect a revised number of households estimate.[2] Residential wood combustion activity was estimated using data from a residential wood combustion survey of 1,015 households conducted in the central Puget Sound area in 2007 (NRC2007).[4, 5] This survey is the most recent and comprehensive survey conducted in the area, and it solicited complete information to conduct an inventory.

The survey was used to determine the percentage of households using wood burning devices and the annual amount of wood burned per device for fireplaces, woodstoves, inserts, and pellet stoves. Woodstoves and inserts were further broken out into three categories: certified catalytic, certified non-catalytic, and non-certified.

The survey included seven geographic groups. Three of the groups were used in this inventory: Pierce Co. Urban Growth Area (UGA), Pierce Co. Non-Urban Growth Area (NUGA), and King County (KING). The Pierce Co. Urban Growth area survey responses were used to derive most of the activity parameters for the Nonattainment Area (NAA). Parameters with low numbers of data points (e.g., fire logs burned in a certified insert) were estimated by combining geographic areas to get more data points. The split between catalytic and non-catalytic certified inserts and woodstoves was made using the professional judgment of air quality and industry staff.[6] Because it was useful in the calculations, the county attainment area (AA) is included in some of the tables below.

The survey gathered information on the amount of pellets, presto logs and cord wood burned. To calculate emissions using emission factors in lbs/ton burned, the weight of the wood burned was estimated. The weight of a cord of wood varies with moisture content and species type. The most common species reported in the survey were fir, alder, and maple. PSCAA estimated the bone dry (zero percent moisture) weight of a cord to be 2189 lbs. Pellets are sold in 40-lb sacks, and fire logs were estimated at 8 lbs per log.

Annual emissions for each wood burning device were calculated according to the following equation:

T/yr = (HH) x (usage fraction) x (T burned/device-yr) x (pollutant lbs /T) x (T/2000 lbs)

Where HH = number of households in the geographic area

T = tons

The numbers of households in each of the three geographic areas were estimated by the Puget Sound Regional Council (PSRC). The EPA data source is reference 9. All of the other parameter sources and values are described in the tables below.

Table 10: Woodstove Parameter Data Sources, Base Year 2008

Parameter	Fireplaces	Inserts	Woodstoves	Pellet stoves
Pierce NAA				
Own device (%)	UGA	UGA	UGA	UGA
Use device (%)	UGA	UGA+NUGA	UGA	UGA+NUGA+KING
Certified (% of devices used)	n/a	UGA+NUGA	UGA	n/a
Certified non-catalytic / catalytic split (%)	n/a	EPA	EPA	n/a
Cord wood burned	UGA	UGA+NUGA	UGA	n/a
Pellets burned	n/a	n/a	n/a	Entire survey
Fire logs burned	UGA	UGA+NUGA	UGA	n/a
Pierce AA				
Own device (%)	NUGA	NUGA	NUGA	NUGA
Use device (%)	NUGA	NUGA	NUGA	UGA+NUGA+KING
Certified (% of devices used)	n/a	NUGA	NUGA	n/a
Certified non-catalytic / catalytic split (%)	n/a	EPA	EPA	n/a
Cord wood burned	NUGA	NUGA	NUGA	n/a
Pellets burned	n/a	n/a	n/a	Entire Survey
Fire logs burned	NUGA	NUGA	NUGA	n/a

Table 11: Woodstove Parameter Values, Base Year 2008

Parameter	Fireplaces	Inserts	Woodstoves	Pellet stoves
Pierce NAA				
Own device (%)	16	7	16	2
Use device (%)	10.8	4.8	14.7	1.1
Certified (% of devices used)	n/a	70	36	n/a
Certified non-catalytic / catalytic split (%)	n/a	75 / 25	75 / 25	n/a
Cord wood burned (tons)	1.0	1.8	1.9	n/a
Pellets burned (tons)	n/a	n/a	n/a	0.7
Fire logs burned (tons)	0.01	0.03	0.01	n/a
Pierce AA				
Own device (%)	19	11	11	2
Use device (%)	10.0	9.3	8.0	1.1
Certified (% of devices used)	n/a	91	50	n/a
Certified non-catalytic / catalytic split (%)	n/a	87.5 /12.5	87.5 /12.5	n/a
Cord wood burned (tons)	0.9	2.0	1.1	n/a
Pellets burned (tons)	n/a	n/a	n/a	0.7
Fire logs burned (tons)	0.01	0.01	0.03	n/a

Activity Level – Attainment Year 2011, and Projection Years 2017 and 2026
Activity was projected to each of the three inventory years using number of households, annual woodstove sales data, professional judgment, and PSCAA's Nonattainment Area woodstove change-out program statistics. PSRC provided estimated households for the Nonattainment Area for 2011, 2017 and 2026.

The Department of Revenue tracks wood burning device sales. The county of sale and out-of-state sales are tracked.[7] Pierce County sales plus a proportional fraction of the out-of-state sales were used as the Pierce County total sales (see equation below). Total sales from 2009 to 2011 were used to calculate the number of new devices from the base year 2008 to 2011. For 2017 and 2026, total sales from 2006 to 2012 were used to calculate an average annual sales rate of 1,014 devices per year. The sales rate was multiplied by the number of years between the inventory year and the base year (i.e., inventory year – 2008) to calculate total new sales.

Total Pierce Sales Equation:

$$\text{Total Pierce Sales} = \text{Sales}_{PIERCE} + [\text{Sales}_{OUT} \times \text{Sales}_{PIERCE} / (\text{Sales}_{PIERCE} + \text{Sales}_{OTHER})]$$

Where Sales_{OUT} = Out of state sales to WA
Sales_{PIERCE} = Pierce County sales
Sales_{OTHER} = All Other Counties sales

The sales were split among the Nonattainment Area and the rest of the county according to the number of households in each area in the projection year. This was acceptable since the fraction of households using devices was about the same for each area in the base year.

Table 12: Solid Fuel Burning Device Sales, Number of Devices, 2006-2012

Area	2006	2007	2008	2009	2010	2011	2012	Average
All Other Counties	8,132	8,163	8,828	7,457	6,640	5,669	5,148	
Pierce County	874	1,164	994	909	1,022	730	786	
Out of State to WA	390	421	420	828	949	995	1,183	
Total	***9,396***	***9,748***	***10,242***	***9,194***	***8,611***	***7,394***	***7,117***	
Estimated Pierce portion of out of state sales to WA								
	38	53	43	90	127	114	157	
Sum of Pierce sales plus out of state sales to WA portion								
	912	1,217	1,037	999	1,149	844	943	1,104

Table 13: New Sales from 2009 to 2011, 2017, and 2026

Area	2009-2011	2009-2017	2009-2026
Pierce NAA	2,025	6,220	12,347
Pierce AA	966	2,907	5,907

The new sales were split into three groups for each of the three survey areas: catalytic inserts & woodstoves (10%), non-catalytic inserts & woodstoves (70%), and pellet stoves (20%), based on professional judgment.[8] The 2008 base year inventory was updated to reflect the catalytic vs. non-catalytic split. The inserts & woodstoves group was split among inserts and woodstoves based on the 2008 split of these device types for each area.

Other assumptions are listed below, based on professional judgment[8] and PSCAA's woodstove change-out program:

- 1/3 of woodstove and pellet stove sales are replacements of existing equipment
- 2/3 of woodstove and pellet stove sales are new installations
- 1/3 of insert sales are replacements of existing equipment
- 1/3 of insert sales are installed in existing open fireplaces
- 1/3 of insert sales are new installations
- 621 devices in the Nonattainment Area were changed from wood to gas/electric from 2008-2011. These were subtracted from uncertified devices for the 2011 attainment inventory.
- An estimated 849 devices in the Nonattainment Area were changed from wood to gas/electric from 2008-7/2/2013 (date of data acquisition for this inventory). Funding was secured to change out an additional 1,100 devices during 2014-2015. Based on change out statistics from 2008 - 2013, it was estimated that 41% or 455 of the 1,100 devices would be changed to gas/electric. Devices changed to gas/electric were subtracted from uncertified devices for the 2017 and 2026 projection inventories.
- Due to lack of information on fireplaces, assumed none of the new sales were fireplaces.
- All replacement devices were assumed to replace uncertified devices.

Table 14: Number of Devices Used and Tons Burned

Parameter	Pierce NAA		Pierce AA	
	Devices	**Tons**	**Devices**	**Tons**
Base Year 2008				
Fireplace	22,226	21,624	9,058	8,389
Fireplace inserts; non-EPA certified	2,915	5,337	769	1,553
Fireplace inserts; EPA certified; non-catalytic	5,213	9,546	5,764	11,647
Fireplace inserts; EPA certified; catalytic	1,738	3,182	1,921	3,882
Woodstove; non-EPA certified	19,287	36,942	3,623	3,966
Woodstove; EPA certified, non-catalytic	8,266	15,832	2,717	2,974
Woodstove; EPA certified, catalytic	2,755	5,277	906	991
Pellet Stove	2,200	1,613	986	723
Residential Firelog Total: All Combustor Types		1,051		387
Total	**64,600**	**100,404**	**25,745**	**34,513**
Attainment Year 2011				
Fireplace	22,092	21,493	8,927	21,493
Fireplace inserts; non-EPA certified	2,699	4,943	637	4,943
Fireplace inserts; EPA certified; non-catalytic	5,565	10,190	6,109	10,190
Fireplace inserts; EPA certified; catalytic	1,788	3,274	1,971	3,274
Woodstove; non-EPA certified	18,336	35,120	3,511	35,120
Woodstove; EPA certified, non-catalytic	9,358	17,924	3,016	17,924
Woodstove; EPA certified, catalytic	2,911	5,576	948	5,576
Pellet Stove	2,477	1,816	1,110	1,816
Residential Firelog Total: All Combustor Types		1,059		1,059
Total	**65,226**	**101,395**	**26,229**	**101,395**
Projection Year 2017				
Fireplace	21,823	21,232	8,645	8,006
Fireplace inserts; non-EPA certified	2,340	4,286	355	717
Fireplace inserts; EPA certified; non-catalytic	6,271	11,483	6,850	13,841
Fireplace inserts; EPA certified; catalytic	1,889	3,459	2,077	4,196
Woodstove; non-EPA certified	16,916	32,400	3,269	3,578
Woodstove; EPA certified, non-catalytic	11,549	22,121	3,658	4,003
Woodstove; EPA certified, catalytic	3,224	6,176	1,040	1,138
Pellet Stove	3,033	2,224	1,376	1,009
Residential Firelog Total: All Combustor Types		1,085		414
Total	**67,046**	**104,465**	**27,269**	**36,902**
Projection Year 2026				
Fireplace	21,425	20,844	8,220	7,613
* Fireplace inserts; non-EPA certified	1,942	3,557	0	0
* Fireplace inserts; EPA certified; non-catalytic	7,316	13,396	7,895	15,953
Fireplace inserts; EPA certified; catalytic	2,038	3,732	2,236	4,518
Woodstove; non-EPA certified	15,693	30,058	2,905	3,179
Woodstove; EPA certified, non-catalytic	14,791	28,331	4,623	5,060
Woodstove; EPA certified, catalytic	3,688	7,063	1,178	1,289
Pellet Stove	3,856	2,827	1,777	1,302
Residential Firelog Total: All Combustor Types		1,140		442
Total	**70,749**	**110,948**	**28,833**	**39,356**

* In 2026, the calculated projected devices and tons burned in the Attainment Area were -70 and -141, respectively. Since this cannot occur, the device and tons burned reductions were removed from the certified non-catalytic inserts instead.

Emission Factors

Emission factors were taken from EPA's emission factor manual, *AP42*, and their residential wood combustion tool.[9,10] Most of the factors in the tool are from *AP42*, the Mid-Atlantic Regional Air Management Association (MARAMA),or Environment Canada. Certified device PM2.5 factors were calculated using annual Washington State woodstove sales data to weigh emission factors in each standards class: pre-Phase I, Phase I, and Phase II. The average of pre-Phase I and Phase I factors were assumed for stoves and inserts sold during1990 - 1992, and Phase II factors were assumed for devices sold in 1993 and beyond. The last actual year of sales data (2012) was one of the lowest years for sales. It was used to project future year sales for calculating the emission factor, resulting in a conservative (high) estimate.

Table 15: Residential Wood-burning Device Sales, Washington State

Inventory Year	Sales Years	devices
All	1990-1992	36,567
2011	1993-2011	212,300
2017	1993-2017	256,700
2026	1993-2026	323,300

Table 16: Residential Wood Combustion Emission Factors in lbs/T Burned

	$PM_{2.5}$							
Device	Not Cert. or N/A	pre-Ph I	Ph I	Ph II	NOX	SO_2	VOC	NH_3
Fireplace	23.6				2.6	0.4	18.9	1.8
Inserts/Stoves, Not Cert	30.6				2.8	0.4	53	1.7
Inserts/Stoves, Cert, non-Cat.		25.8	20.0	14.6	2.28	0.4	12	0.9
Inserts/Stoves, Cert, Cat.		24.2	19.6	16.2	2	0.4	15	0.9
Pellet Stove	3.06				3.8	0.32	0.041	0.3
Residential Firelog: All	28.4				7.684	0	39.56	0

Table 17: Wtd. Average $PM_{2.5}$ Emission Factors for Certified Devices in lbs/T Burned

Year	non-Catalytic	Catalytic
2011	16.0	17.2
2017	15.6	16.9
2026	15.4	16.8

Temporal Allocation

Residential wood combustion emissions were calculated for the design day temperature profile using a temperature adjustment equation based on heating degree days with a base of 50 degrees (see Appendix A2 – Residential Wood Combustion Temperature Adjustment). The temperature adjustment eliminates the need for a monthly activity adjustment since the temperature adjustment assumes activity is directly related to temperature. The calculated daily emissions were adjusted to weekday activity using AIRPACT temporal allocation profile 407, which was calculated from the 2001 Washington State University woodstove survey.[11] The profile allocates 13.5 percent of activity to each weekday.

Spatial Allocation
Activity and emissions were calculated specifically for the Nonattainment Area.

3.4.2 **Paved Road Dust**

Dust emissions are generated as vehicles pass along paved roadways and disturb the layer of loose material on or near the road surface. This material contains particulate matter from soil, brake and tire wear, exhaust, and other substances. However, the paved road dust calculation excludes emissions from exhaust and brake and tire wear which are estimated as part of the onroad mobile sources emissions (see section 3.6). Paved road dust emissions were estimated using vehicle miles traveled (VMT) activity from the Washington State Dept. of Transportation (WSDOT) and the emission factor equation in AP-42.

Activity Level
Average daily VMT (ADVMT) based on the national Department of Transportation's Highway Performance Monitoring System (HPMS) was obtained from WSDOT. WSDOT makes estimates of county ADVMT by functional (roadway) classification from HPMS.[12] The HPMS classifications available in the WSDOT data were helpful in applying the AP-42 emission factor equation. Total Pierce County ADVMT from WSDOT was about 5% higher than the Puget Sound Regional Council's (PSRC) travel demand model VMT estimate. The travel demand model data was used to estimate onroad emissions, so there is a small inconsistency between the VMT used for the paved road dust estimate and the onroad emissions estimates.

Table 18: WSDOT 2011 Pierce County ADVMT

Road Class	Rural	Urban	Total
Interstate	339,293	3,232,487	3,571,780
Other Freeway Expressway	0	2,757,282	2,757,282
Principle Arterial	0	3,911,320	3,911,320
Minor Arterial	649,373	3,331,841	3,981,214
Major Collector	203,903	1,133,785	1,337,688
Minor Collector	46,567	0	46,567
Local Roadway	93,268	1,775,665	1,868,933
Total	***1,332,404***	***16,142,380***	***17,474,784***

Emission Factors and Temporal Allocation

Monthly $PM_{2.5}$ emission rates in grams per mile were calculated using equation 2 in EPA's *AP42*.[13, 14] Equation 2 estimates an emission rate for annual average conditions by incorporating a precipitation correction factor. Daily winter emissions were calculated assuming no rainfall, and therefore no precipitation adjustment (equation 2a).

$E_{ext} = [\ k\ (sL)^{0.91} \times (W)^{1.02}\ ]\ (1 - P/4N)$ equation (2)

$E_{DAILY} = [\ k\ (sL)^{0.91} \times (W)^{1.02}\ ]$ equation (2a)

where E_{ext} is the emission factor in g/VMT

k = g/VMT particle size multiplier (0.25 for $PM_{2.5}$)

sL = silt loading in g/m^2

W = mean vehicle weight (tons)

P = number of days with at least 0.01 inches of precipitation in the given month

N = number of days in the given month

EPA's *AP42* recommended values for average silt loading by average daily traffic (ADT) class were used. The HPMS facility types were classified into the ADT classes by dividing the number of statewide ADVMT by the roadway mileage. The classifications are shown in Table 19. Individual urban sampling areas are not shown in the table; however, with only minor exceptions, they each showed the same ADT classification as the urban average.

Table 19: WSDOT Statewide Estimated Average Daily Traffic, 2011

Rural	Interstate	Free/Expr	Prin Art	Min Art	Maj Coll	Min Coll	Local
Miles	467	645	1,335	1,910	8,432	6,453	40,817
ADVMT (in 1,000s)	12,531	4,873	6,172	5,867	10,690	3,185	3,260
Estimated ADT	26,815	7,551	4,623	3,072	1,268	494	80
ADT Class	> 10,000 limited access	5,000 - 10,000	500 - 5,000	500 - 5,000	500 - 5,000	< 500	< 500
silt loading (g/m^2)	0.015	0.06	0.2	0.2	0.2	0.6	0.6
Urban	**Interstate**	**Free/Expr**	**Prin Art**	**Min Art**	**Maj Coll**	**Min Coll**	**Local**
Miles	297	377	1,355	2,684	2,431	0	16,540
ADVMT (in 1,000s)	29,788	14,416	24,122	20,737	8,376	0	12,051
Estimated ADT	100,320	38,273	17,804	7,727	3,446	0	729
ADT Class	> 10,000 limited access	5,000 - 10,000	500 - 5,000	500 - 5,000	500 - 5,000	< 500	< 500
silt loading (g/m^2)	0.015	0.015	0.03	0.06	0.2	0.2	0.2

Mean vehicle weight by road class was calculated from a Federal Highway Administration report of in-use operating weights and VMT by vehicle type and road class.[15]

Table 20: Mean Vehicle Weight in Tons

Rural/Urban	Interstate	Free/Expr	Prin Art	Min Art	Maj Coll	Min Coll	Local
Rural	5.71	5.71	3.80	3.16	2.74	2.62	2.49
Urban	3.27	2.56	2.51	2.26	2.18	2.18	2.14

Days per month of precipitation greater than 0.01 inches in 2011 were obtained for SeaTac.

Table 21: Days with Greater than 0.01 Inches of Precipitation

Month	Days		Month	Days		Month	Days
01	20		05	16		09	8
02	15		06	13		10	18
03	25		07	8		11	16
04	23		08	2		12	13

Monthly and day-of-week ADVMT adjustments were provided by WSDOT.[16] Weekday adjustments are the average of Monday-Friday adjustments.

Table 22: WSDOT Monthly Adjustment Factors, 2008

Road Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rural Interstate	0.77	0.85	0.93	1.00	1.03	1.12	1.22	1.24	1.10	1.03	0.89	0.83
Other Rural Arterial	0.77	0.86	0.9	0.95	1.04	1.12	1.25	1.26	1.11	1.03	0.84	0.79
Other Rural	0.72	0.77	0.82	0.87	1.05	1.23	1.42	1.36	1.20	1.01	0.84	0.71
Urban Interstate	0.92	0.97	0.99	1.01	1.06	0.99	0.98	0.98	0.99	0.95	0.91	0.91
Other Urban Arterial	0.92	0.95	0.98	1.01	1.06	1.07	1.06	1.07	1.03	1.00	0.93	0.93

Table 23: WSDOT Day-of-Week Adjustment Factors, 2008

Road Type	Weekday
Rural Interstate	98.578
Other Rural Arterial	100.584
Other Rural	97.956
Urban Interstate	105.658
Other Urban Interstate	107.052

Monthly emissions were calculated using the equation below, with E from Equation 2 above. Annual emissions were calculated by summing all months. Daily emissions were calculated using the equation below, with E from Equation 2a above (no precipitation), the January monthly adjustment, and with D = 1.

V x T x D x E x (lb/454 g) x (T/2000 lbs) - monthly emissions
where V = ADVMT
T = monthly VMT adjustment factor
D = number of days in month, and
E = emission factor in g/VMT

Spatial Allocation

Emissions were allocated to the Nonattainment Area using VMT as the surrogate as described in Section 3.1. Each inventory year's link-level VMT were the surrogates (Table 7). The VMT was provided by PSRC and is described more fully in Section 3.6.

Projected Emissions
Emissions for the projection years were estimated by multiplying the WSDOT ADVMT by PSRC's county VMT growth factors (see Table 7) and using the emission factors calculated as described above.

3.4.3 **Petroleum Distribution**

Emissions from fuel service stations result from evaporation of gasoline and gasoline vapors during underground tank filling, underground tank breathing and emptying, and vehicle refueling. Losses from fuel trucks in transit are also included here.

Also included in this section are diesel refueling emissions. This category was estimated by the EPA and accepted by the Washington State Department of Ecology. The methodology behind the estimation will be included in the 2011 NEI Technical Support Document[17] which is currently in draft format.

The following information and data was taken from Ecology's 2011 Comprehensive Emissions Inventory and does not include the methodology for diesel refueling emissions.

Activity Level
Activity data for gasoline distribution is gallons of gasoline distributed. This data was taken from the 2011 Comprehensive emissions inventory prepared by Ecology. PSCAA did not report gallons of gasoline from service stations in Pierce County. Gallons of gasoline were determined using the equation below:

Annual gallons, county = *(County licensed vehicles/Total licensed vehicles in Washington) x Total Gallons Gasoline sold in State*

Table 24: Gallons of Gasoline Sold in Pierce County

Licensed Vehicles in Pierce County	Total Licensed Vehicles in WA	Gallons Gasoline Sold in WA	Gallons of Gas Sold, Pierce County
601,445	5,390, 474	2,601,564,000	290,270,885

Emission Factors

Refueling
To estimate the VOC emissions from refueling of gasoline, gasoline distributed in Pierce County were multiplied by a VOC emission factor. The emission factor is in pounds per 1000 gallons of gasoline, so the gallons of gasoline are shown reported as thousand gallons. Pierce County is one of the six remaining counties in Washington that require Stage II vapor recovery at gas stations. The EPA Mobile Vehicle Emission Simulator (MOVES) model was used to generate VOC emission factors for each season for Pierce County, taking into account local details including stage II vapor recovery requirements.

Diesel refueling emissions were added to the refueling category in Table 27.

Table 25: Pierce County VOC Refueling Emissions, Seasonal

Season	Thousand Gallons of Gas, Pierce County	Emission Factor (lb/1000 gal)	Emissions (lbs)	Emissions (tons)
Winter	65,818.45	.862	56,751.5	28.4
Spring	75,499.36	.827	62,472.8	31.2
Summer	77,530.82	.752	58,337.3	29.2
Fall	71,422.25	.652	46,551.5	23.3
		Totals	**224,113.1**	**112.1**

Underground Tank Filling, Breathing and Emptying, and Transit

Emission rates for underground tank filling, breathing and emptying, and transit losses were taken from documentation released by the EPA for gasoline distribution for the 2011 National Emissions Inventory (NEI). Emission factors for these categories do not vary by season.

Table 26: Pierce County VOC Gasoline Distribution Emissions, Annual

Category	Thousand Gallons of Gas, Pierce County	Emission Factor (lb/1000 gal)	Emissions (lbs)	Emissions (tons)
Underground Tank Filling	290,270.885	.3	87,081.3	43.5
Breathing and Emptying	290,270.885	1	290,270.9	145.1
Transit	290,270.885	.06	17,416.3	8.7

Temporal Allocation

As discussed above, MOVES output was generated by season. A temporal allocation was determined using the ratio of gallons used per season to what was used per year. The ratio for the winter season was approximately 23% in Pierce County. To temporally allocate the emissions, the annual emissions were multiplied by 23% and then divided by the amount of days in the season to determine winter weekday emissions for each category.

Table 27: 2011 Pierce County VOC Gasoline Distribution Emissions, Winter Weekday

Category	Annual Emission (lbs)	Temporal Allocation Factor	Winter Emissions (lbs)	Winter Weekday Emissions (lbs)
Refueling	250,772.6	.23	57,677.7	640.9
Underground Tank Filling	87,081.3	.23	20,028.7	222.5
Breathing and Emptying	290,270.9	.23	66,762.3	741.8
Transit	17,416.3	.23	4,005.7	44.5

Spatial Allocation

The nonattainment area population is 67% of the population of Pierce County, as listed in Table 7. In order to adjust the emissions to fit the area spatially, the winter weekday emissions of Pierce County were multiplied by 67%.

Table 28: 2011 Nonattainment Area Winter Weekday VOC Gasoline Distribution Emissions

Category	Winter Weekday Emissions (lbs)	County: NAA Ratio	NAA Winter Weekday Emissions (lbs)
Vehicle Refueling (including Diesel refueling)	640.9	.67	429.1
Underground Tank Filling	222.5	.67	146.9
Breathing and Emptying	741.8	.67	489.6
Transit	44.5	.67	29.4

Projections
Ecology projected emissions from this category using population growth provided by PSRC in Table 7. Projected growth for 2017 and 2026 was 1.06 and 1.18, respectively.

Table 29: Gasoline Distribution Nonattainment Area, Winter Weekday VOC Projected Emissions (lbs)

Category	2017 (Projected)	2026 (Projected)
Vehicle Refueling	455.1	537.1
Underground Tank Filling	158.0	186.5
Breathing_Emptying	526.8	621.7
Transit	31.6	37.3

3.4.4 **Fugitive Dust Emissions from Coal Trains**

Ecology is including information on coal dust generated by the transport of coal using trains. Currently, there are proposed increases to the export of coal from the Seattle region.

Emission Factor and Spatial Allocation
Ecology estimated the tonnage of $PM_{2.5}$ from railroad transport for 2011 and projections for 2017 and 2026. The calculations for the projected years assume all proposed coal exporting will occur as well as that expansions at Canadian facilities will allow more coal to be exported through the Seattle region. An equation from a study done of coal dust emissions in Canada[18] was used to determine a Total Suspended Particulate (TSP) emission factor. This equation includes a spatial component (SD) that allocates the emission factor to the Nonattainment Area.

TSP Emissions Factor (kg/27one)
= 0.1(0.62*D)*0.6 *(365-P)/365 *(SD/D)*(100-CE)/100*

Where:
D = total distance travelled by rail cars (km)
SD = rail segment length estimation for NAA (km)
P = number of days in the year with measureable precipitation (rain and snow)
CE = Control efficiency of any applied dust control measures (%)

The TSP emission factor was then converted to pounds per ton from kilograms per tonne. Please note that the control efficiency increases significantly in 2017 because of revised control strategies imposed by BNSF as of October 2011 in their Coal Loading Rule.[19]

Table 30: TSP Emission Factor for Annual Coal Train Fugitive Dust Emissions

Year	D	SD	P	CE	TSP EF (lb/ton)
2011	2414	40	177	21.25	.10803
2017	2414	40	156	85	.02288
2026	2414	40	156	85	.02288

A $PM_{2.5}$ to TSP ratio taken from US EPA AP-42[20] of .075, the amount of coal exported/projected to be escorted for the year, and the TSP emission factor are used to calculate the portion of the TSP emissions that are $PM_{2.5}$ using the following equation:

$PM_{2.5}$ Emissions (annual) =

*Tons of Coal Exported for year * TSP Emission factor * $PM_{2.5}$:TSP Ratio*

Table 31: Annual $PM_{2.5}$ Emissions from Coal Trains in tons

Year	Tons of Coal Exported/Projected for Export	Annual Tons of PM2.5
2011	4,863,661	19.70
2017	12,579,831	10.79
2026	73,206,881	62.80

The tons of coal exported in 2011 were available from the U.S. Energy Information Administration (EIA). The data is reported quarterly.

Projected year totals of coal exported include the addition of coal exports from a facility in Washington that is currently in the planning phases and plans to be fully operational by 2019,[21] as well as the continued exports from Canada that travel through the nonattainment area. The totals from the Canadian facilities also include anticipated expansions at those sites.[22,23,24]

Temporal Allocation

Winter weekday emissions were calculated for coal trains by recalculating the emissions for the winter period. Winter is typically December, January, and February for emissions inventory purposes. Data for these months is captured in both the first quarter (January, February, and March) and the fourth quarter (October, November December) in EIA data. 2011 coal exports for the winter season were calculated by dividing each of these quarters by three to get a monthly average for that quarter. The amount of coal exported during the winter season was obtained by summing two months of the first quarter with one month from the fourth quarter. The percentage of the coal that was exported in 2011 during the winter season was determined. The winter percentage for 2011 was then multiplied by the annual total of the estimates of coal to be shipped during 2017 and 2026 to estimate the amounts that would be shipped during the winter season in those years.

Another adjustment made to calculate the winter weekday was to use zero for the number of days of precipitation. This allows the final emissions to model the worst conditions expected in winter. The modified emission factor variables and resultant emission factor are listed in the table below.

Table 32: TSP Emission Factor for Winter Weekday Coal Train Fugitive Dust Emissions

Year	D	SD	P	CE	TSP EF (lb/ton)
2011	2414	40	0	21.25	.20974
2017	2414	40	0	85	.03995
2026	2414	40	0	85	.03995

PM2.5 Emissions were then calculated using the following equation to arrive at tons per winter season for 2011, 2017, and 2026.

$PM_{2.5}$ Emissions (winter) =

*Tons of Coal Exported for Winter season * TSP Emission factor * $PM_{2.5}$:TSP Ratio*

That number was then converted to winter weekday in pounds by multiplying the tons by the amount of lbs per ton, 2000, and dividing by the number of days in the winter season, 90.

Table 33: $PM_{2.5}$ Emissions from Coal Trains, Winter Weekday in pounds

Year	Winter Weekday Emissions (lbs)
2011	195.59
2017	96.36
2026	560.75

3.4.5 National Emissions Inventory Categories

Every 3 years, EPA develops a National Emissions Inventory (NEI). EPA estimates emissions for all nonpoint categories. State and local air agencies may either accept the EPA estimates or submit their own. The final NEI is a combination of state/local and EPA estimates. For the categories listed below, estimates from version 1 of the 2011 NEI[25] were used in the maintenance plan inventory.

Table 34: Other Nonpoint Source Categories and NEI Data Source

Category	NEI Source
Residential Distillate Oil and Natural Gas Combustion	Ecology
Construction Dust -Roads, Commercial/Industrial/Institutional	EPA
Commercial Cooking	EPA
Gas Cans	Ecology
Non-Industrial Commercial and Consumer Solvents	Ecology and EPA
Architectural Surface Coating	Ecology
Industrial Surface Coating	Ecology and EPA
Livestock	EPA
Fertilizer	Ecology

Temporal Allocation

Annual emissions were adjusted to winter (January) weekday activity using AIRPACT temporal allocation profiles for month and day of week. Several of the profiles came from EPA emissions modeling files.[26] The descriptions and category assignments are shown in the tables below.

Table 35: Temporal Profiles, Month and Weekday

Profile	Description	Source
Month		
262	Win=25.0%, Spr=25.0%, Sum=25.0%, Fal=25.0% (uniform)	EPA
485	Win=57.0%, Spr=22.5%, Sum=1.5%, Fal=19.2%	EPA
996	Win=3.7%, Spr=31.4%, Sum=28.1%, Fal=36.7%	EPA
998	Win=8.7%, Spr=47.1%, Sum=22.2%, Fal=22.1%	EPA
1500	Win=17.7%, Spr=25.5%, Sum=34.3%, Fal=22.6%	EPA from Gilliland NH3 profile
4002	Win=21.1%, Spr=25.1%, Sum=30.6%, Fal=23.1%	Architectural Coating 1996 Quarterly Business review revenue
4015	Win=20.7%, Spr=24.3%, Sum=30.6%, Fal=24.0%	EPA NONROAD2008 model for Construction Equipment (SEASON.DAT)
9008	Win=24.0%, Spr=26.3%, Sum=25.3%, Fal=24.4%	2008 WSDOT urban interstate traffic counters
Weekday		
6	Weekday average = 16.7%	EPA
7	Weekday average = 14.3% (uniform)	EPA
2004	Weekday average = 15.1%	2008 WSDOT urban interstate traffic counters

Table 36: Other Nonpoint Sources - Temporal Allocation, Month and Weekday

Category	Month	Day Type
Residential Distillate Oil and Natural Gas Combustion	485	7
Construction Dust - Roads, Commercial/Industrial/Institutional	4015	6
Commercial Cooking	262	6
Gas Cans - Spillage, Refilling	9008	2004
Gas Cans - Permeation, Evaporation	262	7
Non-Industrial Commercial and Consumer Solvents	262	7
Architectural Surface Coating	4002	7
Industrial Surface Coating	262	6
Livestock	1500	7
Fertilizer	996 & 998	7

Temporal Allocation – Additional Adjustments for Construction Dust

A further adjustment was made to construction dust to account for higher soil moisture values in the winter. The NEI dust equations contains a multiplier of 24/PE where PE is the 30-year average precipitation-evaporation value from Thornthwaite's PE Index. $PM_{2.5}$ concentrations in the Nonattainment Area greater than or equal to 25 ug/m^3 from 2001-2010 occurred during Oct-Feb with few exceptions. A variation of Thornwaite's precipitation-evaporation equation (below) was used to calculate PE by month using 10 years of temperature and precipitation data[27] from the Tacoma Narrows meteorological station. The calculated monthly PE values for Oct-Feb were normalized to produce a 12 month PE value representative of the winter (i.e., the high $PM_{2.5}$ values). The normal annual PE was divided by the winter PE to produce a moisture adjustment factor (60%).

PE Equation

$$PE = \sum^{12} 115\,[P/T\text{-}10]^{10/9}$$

where P is average monthly precipitation (inches) with 0.5 being the minimum value
T is average monthly temperature (degrees F) with 28.4 ° F being the minimum value used in the calculation.

Table 37: Tacoma Narrows Temperature (°F) and Precipitation (Inches), 1999-2008

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature	41.8	43	45.7	49.7	55.1	60.3	64.8	64.8	59.9	52.7	45.5	41.5	52.1
Precipitation	7.16	3.64	4.11	2.48	1.84	1.49	0.54	1.02	1.09	3.5	6.92	5.98	39.76

The calculated 60% adjustment was reasonable when compared to other information:

- PSCAA regulations specify no visible emissions
- Emissions Inventory Improvement Program estimation method applies 50% control to PM Nonattainment Areas
- Western Regional Air Partnership and AP42 attribute 10% - 74% control efficiency for watering depending on schedule and operation

Spatial Allocation

The county emissions in the NEI were allocated to the nonattainment area using spatial surrogates as described in Section 3.1. The surrogate for each category is shown below.

Table 38: Other Nonpoint Sources - Spatial Surrogates

Category	Surrogate
Residential Distillate Oil and Natural Gas Combustion	PSRC households
Construction Dust - Commercial/Industrial/Institutional	NLCD urban lands
Construction Dust -Roads	PSRC road miles
Commercial Cooking	PSRC Population
Gas Cans	PSRC population
Non-Industrial Commercial and Consumer Solvents	PSRC population
Architectural Surface Coating	PSRC population
Industrial Surface Coating, except Traffic Markings	PSRC population
Industrial Surface Coating - Traffic Markings	PSRC road miles
Livestock	LULC CAFOs
Fertilizer	NLDC agricultural lands

Projected Emissions
Nonpoint projections were made using county growth factors for source activity surrogates from PSRC as described in Section 3.1. Emissions were projected by multiplying the emissions from the attainment year by growth factors for the surrogate activity. The surrogate for each category is shown in Table 39: Other Nonpoint Sources - Projection Surrogates

$$Projected\ Emissions = Emissions_{attain.\ year} \times Projection\ year\ growth\ factor_{surrogate\ activity}$$

Table 39: Other Nonpoint Sources - Projection Surrogates

Category	Surrogate
Residential Distillate Oil and Natural Gas Combustion	PSRC households
Construction Dust - Roads, Commercial/Industrial/Institutional	PSRC construction employment
Commercial Cooking	PSRC Population
Gas Cans	PSRC population
Non-Industrial Commercial and Consumer Solvents	PSRC population
Architectural Surface Coating	PSRC population
Industrial Surface Coating, except Traffic Markings	PSRC population
Industrial Surface Coating - Traffic Markings	PSRC road miles
Livestock	Assumed constant
Fertilizer	Assumed constant

3.5 Nonroad Mobile Sources

Nonroad mobile sources include all off-road vehicles and equipment. Locomotives and marine vessels are also included in the nonroad category.

3.5.1 Nonroad Mobile, Except Locomotives, Marine, and Port Sources

The Nonroad Mobile category includes emissions estimates from gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG) fueled equipment. Emissions were estimated using EPA's NONROAD2008a model.[28] Equipment in six categories was inventoried:

- Lawn and Garden Equipment
- Recreational Marine Vessels
- Construction and Mining Equipment
- Commercial Equipment
- Railroad Maintenance Equipment
- Industrial Equipment

Temporal Allocation and Emission Rates
Emissions were generated for the four seasons using the seasonal temporal option in the NONROAD2008a model for 2011 base year and 2017 and 2026 projection years. The month of January, both weekday and weekend, was also chosen to represent a typical winter day scenario for each year as well (see Table 40). NONROAD2008a requires user input of seasonal meteorological and fuel parameters. The required fuel parameters are gasoline RVP and oxygen content; sulfur contents of gasoline, diesel (land and marine), and compressed natural gas (CNG) and liquefied petroleum gas (LPG); and presence of stage II vapor recovery requirements.

Table 40: NONROAD MODEL PARAMETERS

Year	Month or Season	Fuel RVP	O2 Wt. %	Gas Sulfur %	Diesel Sulfur %	Marine Diesel Sulfur %	CNG/ LPG Sulfur %	Min temp (°F)	Max temp (°F)	Avg Temp (°F)	EtOH blend mkt %	EtOH vol %
2011	January	14.7	3.5	0.003	0.0032	0.0236	0.003	26	47	36	100	10
2011	Win	14.7	3.5	0.003	0.0032	0.0236	0.003	34	46	42	100	10
2011	Spr	12.7	3.5	0.003	0.0032	0.0236	0.003	41	58	52	100	10
2011	Sum	10	3.5	0.003	0.0032	0.0236	0.003	53	74	67	100	10
2011	Fal	10	3.5	0.003	0.0032	0.0236	0.003	46	62	57	100	10
2017	Jan	14.7	3.5	0.0028	0.0011	0.0056	0.003	26	47	36	100	10
2017	Win	14.7	3.5	0.0028	0.0011	0.0056	0.003	34	46	42	100	10
2017	Spr	12.7	3.5	0.0028	0.0011	0.0056	0.003	41	58	52	100	10
2017	Sum	10	3.5	0.0028	0.0011	0.0056	0.003	53	74	67	100	10
2017	Fal	10	3.5	0.0028	0.0011	0.0056	0.003	46	62	57	100	10
2026	Jan	14.7	3.5	0.0028	0.0011	0.0055	0.003	26	47	36	100	10
2026	Win	14.7	3.5	0.0028	0.0011	0.0055	0.003	34	46	42	100	10
2026	Spr	12.7	3.5	0.0028	0.0011	0.0055	0.003	41	58	52	100	10
2026	Sum	10	3.5	0.0028	0.0011	0.0055	0.003	53	74	67	100	10
2026	Fal	10	3.5	0.0028	0.0011	0.0055	0.003	46	62	57	100	10

Activity Level and Spatial Allocation

The NONROAD model contains data on statewide equipment types and usage. The model utilizes spatial surrogates appropriate for each equipment type to disaggregate state activity levels to individual counties. The default surrogates were used for all equipment types except recreational marine vessels. The default spatial surrogate for recreational marine is water surface area. This method can overestimate recreational boat usage in certain counties due to the large areas of open water in a county's jurisdiction. A new allocation based on county boat registrations was substituted for the default. Registrations for 2011 were provided by the Washington Department of Licensing (Table 42).[29]

Emissions were allocated to the Nonattainment Area and modeling grids based on spatial surrogates (see Table 7 and Table 8).

Table 41: Spatial Allocations for Nonroad Sources

Category	**Surrogate**	**Source**
Recreational Marine Vessels	Land Use: open water	NLCD*
Railroad Maintenance Equipment	Active Railroad Track	WSDOT GIS files
Commercial Equipment	Land Use: Urban	NLCD
Construction and Mining Equipment	Land Use: Urban	NLCD
Industrial Equipment	Land Use: Urban	NLCD
Lawn and Garden Equipment	Land Use: Urban	NLCD

* National Land Cover Database[30]

Table 42: County Boat Registrations, 2011

County	**Registrations**
Pierce	25359

3.5.2 **Locomotives**

Emissions from Class I line haul and switch yard locomotives were estimated using EPA guidance and other information.[31] Two Class I railroads operate in Washington: Burlington Northern Santa Fe Railway (BNSF) and Union Pacific Railroad (UPRR). Amtrak was also included in this inventory. Class 2 and 3 railroad locomotive emissions were not inventoried. A special Northwest International Air Quality Environmental Science and Technology Consortium (NW-AIRQUEST; formerly Northwest Regional Technical Center) project conducted by the Oregon Department of Environmental Quality (ODEQ) found that emissions from Class 2 and 3 railroad locomotives were a small percentage of total locomotive emissions.[32,33]

*This section does not include fugitive dust from coal trains. Please refer to **3.4.4 Fugitive Dust from Coal Trains** for those emission calculations and emissions.*

Activity Level

Activity level is measured in gallons of diesel consumed by locomotives. BNSF Railway, UPRR and Amtrak provided county fuel use for line haul and switch yard locomotives for 2011.[34, 35, 36] Activity was projected to 2017 and 2026 using the Pierce County population projection factors (Table 7).

Coal dust emissions from the proposed Gateway Terminal coal export facility proposal in Whatcom County and from Canadian exports were estimated in Section 3.4.4. Increased rail traffic through the nonattainment area would increase diesel PM2.5 emissions. The increase is not estimated in this plan. The environmental effects of the Gateway Terminal are currently being studied through the State Environmental Policy Act and the National Environmental Policy Act processes.[37] More detailed emissions and effects of those emissions will be discussed in those environmental reviews. Without the terminal, projected locomotive PM2.5 emissions estimates are very small, 0.10% and 0.05% of the 2017 and 2026 daily inventories, respectively. Even a large increase in rail traffic would not significantly increase total daily PM2.5 emissions, nor cause the emissions to exceed the 2017 or 2026 emissions safety margin which is the difference between the maintenance year 2011 emissions and the projected year emissions.

Temporal and Spatial Adjustments

The activity information was obtained by county; therefore, no spatial adjustments were necessary at the county level. Emissions were allocated to the Nonattainment Area and using active railroad track GIS data from WSDOT as the spatial surrogate. The Nonattainment Area has 39% of the Pierce County line haul and passenger track. It has 100% of the yards.[38]

Locomotives were assumed to operate uniformly year-round per EPA guidance.[39]

Emission Rates

BNSF, UPRR and AMTRAK provided emissions estimates and emission factors for 2011, but were unable to project emissions into the future. 2017 and 2026 projection year emissions estimates, with the exception of SO_2 were calculated using EPA Guidance.[40] SO_2 emissions for 2017 and 2026 were estimated using the ratio between 2011 and each projection year emission factor and multiplying by the total SO_2 emissions from 2011 (see Table 43).

Table 43: Pierce County Locomotive Emission Factors in g/gal

Type	Pollutant	2011	2017	2026
Line Haul	VOC	7.7	4.6	2.5
Line Haul	NOx	149	114	69
Line Haul	SO2	1.88	0.09	0.09
Line Haul	PM2.5	4.4	2.9	1.5
Passenger	VOC	8.1	4.6	1.8
Passenger	NOx	167	112	64
Passenger	SO2	1.88	0.09	0.09
Passenger	PM2.5	4.5	2.8	1.2
Yard	VOC	14	11.8	7.6
Yard	NOx	235	206	144
Yard	SO2	1.88	0.09	0.09
Yard	PM2.5	5.3	4.5	3.1

3.5.3 **Marine and Port of Tacoma Sources**

Four types of marine and port sources were inventoried: ocean-going vessels, harbor vessels, cargo handling equipment, and port rail operations. Pleasure craft were also inventoried but were included in Section 3.5.1. The 2011 inventory prepared for the Puget Sound Maritime Air Forum by Starcrest Consulting Group, LLC (2011 PSEI) was the starting point for the inventories.[41] The PSEI is a bottom-up, activity-based emissions inventory.

Emissions Calculations for Projection Years 2017 and 2026
Emissions were calculated by projecting the 2011 inventory to each of the evaluation years. Emissions for pollutant "P" were calculated:

$E_{year} = E_{2011} \times A \times F$ Where E = Emissions,
A = Activity adjustment factor
F = Fuel/engine adjustment factor for pollutant

Activity level and emission rates are described in the 2011 PSEI report. The report addressed PM_{10}, $PM_{2.5}$, Nox, SO_2, CO, and VOC. Projections were made using local information and federal regulatory programs. The activity and fuel/engine adjustment factors are described in the *Activity Level* and *Emission Factors* sections below.

Activity Level
Activity was projected using one of two activity surrogates for each type of ship or port equipment: Port of Tacoma sector growth estimates,[42] or Pierce County population (Table 7). The sector growth estimates were given as growth between 2011and 2015 (22%) and between 2015 and 2020 (10%). The 10% growth rate between 2015 and 2020 was assumed to continue for the period 2020-2026. Sector growth was used to project activity for all sources except harbor craft. Harbor craft emissions were not readily available by type (e.g., ferry, tug, excursion). The 2008 base year inventory showed that emissions from ferries dominated the harbor craft inventory in the nonattainment area. Population was chosen to project harbor craft emissions since it was believed to be an appropriate surrogate for ferry activity.

Emission Factors

Ocean-going Vessels – Hotelling & Maneuvering

Changes in emission factors due to fuel changes were estimated. On March 26, 2010, the International Marine Organization officially designated waters off North American coasts as an Emission Control Area (ECA). New engine and fuel standards apply in ECAs. Fuel sulfur standards are:

- 10,000 ppm starting August 2012 (1.0%)
- 1,000 ppm starting January 2015 (0.1%)

In 2011, most ships used fuel with 2.7% sulfur content (2011 PSEI). Some ships switch to a low sulfur fuel (≤ 500 ppm) or use shore power at the Port of Tacoma. In 2011, the Port of Tacoma estimated that 97% of the fuel used contained 2.7% sulfur, and 3% contained 0.5% sulfur. Table 3.22 of the 2011 PSEI provided fuel correction factors for changing sulfur content from 2.7% to 0.5% and to 0.1%. The correction factors were used to estimate emission factor changes between 2011 and the projection years 2017 and 2026.

Harbor Craft

EPA's NONROAD2008 model was run for 2011, 2017, and 2026 for the largest gasoline and diesel powered boats. Emissions factors for harbor vessels were calculated and expressed as g/boat using the NONROAD model output. The ratios of the projection year to 2011 emission factors were calculated. The ratios were used as emission factor adjustments. The diesel fuel sulfur content for all years was set to 15 ppm, ultra-low sulfur diesel.

Cargo Handling Equipment

Emissions reductions are being made in cargo handling equipment, but the range of equipment and technologies make projections difficult. Cargo handling equipment is a small part of the inventory; therefore, no adjustments were made.

Port Rail

EPA provided adjustment factors for locomotives as part of their rule making activity for locomotives.[43] For 2017 and 2026, adjustment factors were calculated as the ratio of the EPA projection year emission factors to the attainment year 2011 emission factors.

Temporal and Spatial Allocation

Emissions were assumed to occur uniformly throughout the year.

All ocean-going vessel hotelling, cargo handling equipment, and port rail emissions were assumed to occur in the Nonattainment Area. Port of Tacoma, PSCAA, and Ecology staff assigned a fraction of the Pierce County ocean-going vessel maneuvering and harbor craft emissions to the Nonattainment Area when developing the 2008 attainment year inventory. The fractions were retained for this inventory.

Table 44: PSEI 2011 Pierce County Emissions (Tons), NAA Adjustment Factors, 2017 and 2026 Activity and Emission Rate Adjustment Factors

Category	Pierce County 2011 Emissions (PSEI) in Tons				Adjustments	
	PM2.5	Nox	SO2	VOC	Activity	NAA
Ocean-going vessels, maneuvering						
2011 Emissions	0.57	9.56	8.83	0.29		*0.17*
2017 Adjustment factors	*0.17*	*0.94*	*0.04*	*1.00*	*1.27*	*0.17*
2026 Adjustment factors	*0.17*	*0.94*	*0.04*	*1.00*	*1.66*	*0.17*
Ocean-going vessels, hotelling						
2011 Emissions	28	416	528	13		*1*
2017 Adjustment factors	*0.17*	*0.94*	*0.04*	*1.00*	*1.27*	*1*
2026 Adjustment factors	*0.17*	*0.94*	*0.04*	*1.00*	*1.66*	*1*
Harbor craft, diesel-powered						
2011 Emissions	28	801	0	26		*0.2*
2017 Adjustment factors	*0.94*	*0.87*	*1.00*	*1.00*	*1.07*	*0.2*
2026 Adjustment factors	*0.81*	*0.71*	*1.00*	*1.00*	*1.18*	*0.2*
Harbor craft, gasoline-powered						
2011 Emissions	0	1	0	1		*0.2*
2017 Adjustment factors	*1.00*	*0.93*	*0.98*	*1.00*	*1.07*	*0.2*
2026 Adjustment factors	*1.00*	*0.91*	*0.97*	*1.00*	*1.18*	*0.2*
Cargo handling equipment						
2011 Emissions	10	92	214	0		*1*
2017 Adjustment factors	*1.00*	*1.00*	*1.00*	*1.00*	*1.27*	*1*
2026 Adjustment factors	*1.00*	*1.00*	*1.00*	*1.00*	*1.66*	*1*
Port locomotives, switch yard						
2011 Emissions	7	230	1	17		*1*
2017 Adjustment factors	*0.85*	*0.88*	*1.00*	*0.84*	*1.27*	*1*
2026 Adjustment factors	*0.58*	*0.61*	*1.00*	*0.54*	*1.66*	*1*
Port locomotives, line haul						
2011 Emissions	5	134	1	7		*1*
2017 Adjustment factors	*0.66*	*0.77*	*0.06*	*0.60*	*1.27*	*1*
2026 Adjustment factors	*0.34*	*0.46*	*0.06*	*0.32*	*1.66*	*1*

Double-counting

There is potential for double-counting in this category since it overlaps with other nonroad sources. The sources are briefly discussed below.

Cargo handling equipment - This equipment is counted as industrial equipment in the NONROAD model, but the county allocations are based on manufacturing employment, which is not counted as port activity (Section 3.5.1). Therefore, emissions were not subtracted from the NONROAD model totals.

Port of Tacoma Rail - Three companies have rail operations in or near the Port of Tacoma: BNSF, UP, and Tacoma Rail. Emissions from BNSF and UP were counted under the locomotive category (Section 3.5.2). The 2011 PSEI did not contain sufficient detail to determine whether any emissions from BNSF or UP may have been double counted in this section.

3.6 Onroad Mobile Sources

Onroad mobile source emissions come from exhaust, evaporation, and brake and tire wear. EPA's Motor Vehicle Emission Simulator (MOVES) model was used with local and default data to calculate emissions.[44]

MOVES may be run to produce emissions (Inventory mode) or emission rates (Rates mode). The winter day inventory was run in rates mode, and the annual inventory in the simpler inventory mode.

This section describes the major components of the equations, data sources, and process used in the equations to develop the emissions estimates. The major components are VMT, vehicle population, and the MOVES data.

3.6.1 Vehicle Miles Traveled

Two sources of VMT were used. For the annual calculation, the WA Dept. of Transportation's (WSDOT) Pierce County estimate was used.[45] The winter day calculations relied on both the WSDOT Pierce County VMT and on VMT specifically allocated to the NAA provided by PSRC.

PSRC provided average weekday daily vehicle miles traveled (ADVMT) in the County and NAA for each evaluation year (2011, 2017, 2026). The WSDOT data was only available for 2011. PSRC's VMT data was used to calculate growth factors from 2011 (Table 7). The growth factors were used to project the 2011 WSDOT VMT to 2017 and 2026. The PSRC ratio of NAA to County VMT was used to allocate the WSDOT VMT to the NAA.

PSRC's VMT estimates were produced using their travel demand model. The model estimates VMT over individual roadway segments called *links* for five different time periods throughout the day. There are over 9,000 links in PSRC's travel demand model within the nonattainment area. The periods were AM (6am-9am), MD (9am-3pm), PM (3pm-6pm), EV (6pm-10pm), and NT (10pm-6am). The link data included congested speed and road type.

Each link was assigned to its nearest MOVES speed bin and MOVES road type: Rural Restricted, Rural Unrestricted, Urban Restricted, or Urban Unrestricted. Then the VMT was summed by speed bin and road type for each time period.

Emissions for each time period were calculated by multiplying the summed VMT by the average MOVES emission factor for the time period. Daily onroad emissions were calculated by adding the emissions from all 5 times periods.

3.6.2 **Vehicle Population**

Vehicle population is used to determine the amount of emissions from engine starts and extended idling. Vehicle population in the NAA was not available. Vehicles were allocated to the NAA using the NAA/County ratio of VMT (Table 7). The ratio was 0.63 for each year. County vehicle counts are described in Appendix B.

$$VehPop_{NAA} = VehPop_{County} \times (VMT_{NAA}/VMT_{County})$$

where $VehPop_{NAA}$ is the vehicle population in the Nonattainment area
$VehPop_{County}$ is the vehicle population in Pierce County
VMT_{NAA} is the VMT in the Nonattainment area
VMT_{County} is the VMT in Pierce County

3.6.3 **MOVES Modeling and Emissions Estimates**

MOVES version 2010b was used for the maintenance plan. MOVES includes a default database that includes emission relevant information for the entire United States. A combination of data from the default database (version 20100410) and data from local sources were used for the budget. The MOVES Technical Guidance for SIP inventories and the MOVES User's Guide were used in developing the local parameters.[46, 47]

MOVES may be run to produce emissions (Inventory model) or emission rates (Rates mode). The winter day inventory was run in rates mode, and the annual inventory in the simpler inventory mode.

Winter Daily Emissions

Winter day emission rates were run for Pierce County. MOVES was run in Rates mode at the county scale by hour for one weekday in January using the design day temperature profile. Emission rates were output by hour, road type, and emissions process.

The winter day calculation equation using output from MOVES' Rates mode is shown below:

$$E = (M \times Fgmi) + (V \times Fgpveh)$$

where E = emissions in g
M = VMT
V = vehicle population
Fgmi = emission factor in g/mi from MOVES
Fgpveh = emission factor in g/vehicle from MOVES

Annual Emissions

MOVES was run in Inventory mode at the county scale by hour for weekdays and weekend days for each of January, April, July, and October. Emissions were output by month.

Annual emissions were calculated according to the equation below:

$$E_{Annual} = \sum(E_{Month} \times 3)$$

Where E_{Annual} = annual emissions
E_{Month} = Emissions for each of 4 months, each representing a season: Jan = winter, Apr = spring, Jul = summer, Oct = fall.

MOVES inputs are described in Appendix B.

4 Quality Assurance and Quality Control

In order to provide data of sufficient quality for maintenance planning needs, the inventory process included quality assurance (QA) and quality control (QC) procedures. The procedures addressed data quality objectives of accuracy, completeness, comparability, and representativeness. Ecology used the following target goals for each objective:

- *Accuracy:* The inventory calculated and documented all estimates using acceptable methods. Individual source requirements and availability of data and resources affected estimation method selection.
- *Completeness:* Ecology addressed completeness by ensuring that the inventory included all applicable source categories, and verified that the inventory contained all the information required to estimate emissions.
- *Representativeness:* We calculated actual annual and peak $PM_{2.5}$ season daily emissions for each evaluation year. The inventory calculations used local data wherever possible.
- *Comparability:* Ecology compared data by source category to the prior 2008 base year inventory. We corrected or justified any discrepancies greater than 20%, involving sources that made up greater than 5% of either the 2008 or the 2011 annual inventories. We compared the projection inventories to the 2011 base year inventory. We investigated and either corrected or justified any discrepancies between the base year and given projection year if they:
    - were greater than the population increase percentage plus 10%, and
    - involved sources that made up greater than 5% of the 2011 or projection year daily inventories.

The tables below show the results of the comparability checks. Highlighted categories met the criteria for further investigation: Point Sources and Onroad Mobile Sources.

Point Sources increased substantially from 2011 through 2026 primarily due to the use of the ten year maximum for the projection of PSCAA sources. The ten year maximum was used because of the recent economic downturn. Ecology and PSCAA agreed that a ten year maximum would better characterize the future emissions from the facilities than a five year maximum which had been used previously for this nonattainment area.

Onroad mobile source emissions decreased substantially from 2011 through 2026 primarily due to fleet turnover.

Table 45: Base Year 2008 and Attainment Year 2011 Inventory Comparison

Category	2008 EI		2011 EI		Discrepancy
	lbs/day	%	lbs/day	%	2011 / 2008
Point Sources	979	3%	1,313	4%	1.341
Residential Wood	24,492	74%	25,519	76%	1.042
Residential non-	54	0%	49	0%	0.912
Commercial Cooking	727	2%	975	3%	1.341
Construction Dust	852	3%	596	2%	0.700
Paved Road Dust	1,284	4%	1,232	4%	0.960
Coal Train Dust			196	1%	
Onroad Mobile	3,041	9%	2,497	7%	0.821
Nonroad Other	1,079	3%	1,035	3%	0.960
Locomotives	55	0%	43	0%	0.783
Marine and Port	370	1%	306	1%	0.827
TOTAL	**32,933**		**33,761**		1.025

Table 46: Attainment Year 2011 and Projection Years Inventory Comparison

Category	2011 EI		2017 EI		2026 EI		Discrepancy	
	lbs/day	%	lbs/day	%	lbs/day	%	2017/2011	2026/2011
Point Sources	1,313	4%	1,995	6%	1,903	6%	1.519	1.449
Res. Wood Comb	25,519	76%	25,355	77%	25,788	77%	0.994	1.011
Res. non-Wood Fuel	49	0%	53	0%	58	0%	1.074	1.183
Comm. Cooking	975	3%	1,028	3%	1,153	3%	1.054	1.182
Construction Dust	596	2%	654	2%	678	2%	1.098	1.138
Paved Road Dust	1,232	4%	1,318	4%	1,392	4%	1.070	1.130
Coal Train Dust	196	1%	96	0%	561	2%	0.493	2.867
Onroad Mobile	2,497	7%	1,642	5%	1,149	3%	0.658	0.460
Nonroad Other	1,035	3%	726	2%	463	1%	0.702	0.447
Locomotives	43	0%	32	0%	16	0%	0.751	0.366
Marine and Port	306	1%	198	1%	218	1%	0.648	0.713
TOTAL	**33,761**		**33,099**		**33,379**		**0.980**	**0.989**

4.1 Quality Control Procedures

Ecology performed calculations as appropriate for the given estimation method. QC checks were an integral part of calculations. We performed calculations electronically wherever possible to minimize errors. We made hand calculations to verify electronic calculation equations. This final inventory report fully documents those calculations. During the development of the report we made comparisons to the 2008 inventory to catch any potential errors.

4.2 Quality Assurance Procedures

Several EI staff were involved in calculating the inventories. EI staff performed the reality/peer review and sample calculation checks on one another's work. We used several quality assurance checks to address the data quality objectives:

- reality/peer review checks,
- sample calculations,
- sensitivity analysis (emissions ranking), and
- range checks (see Comparability objective)

Appendix A1 – National Emissions Inventory Source Categories

Table 47: 2011 National Emissions Inventory (version 1), Pierce County*

		Tons/yr					Percent Total				
Sector	**Group**	**PM25**	**SO2**	**NOX**	**VOC**	**NH3**	**PM25**	**SO2**	**NOX**	**VOC**	**NH3**
Event	Managed Burns	82	6	8	234	16	2%	0%	0%	1%	1%
Nonpt	Comm. Cook	271			40		8%	0%	0%	0%	0%
Nonpt	Dust, Agric	15					0%	0%	0%	0%	0%
Nonpt	Dust, non-Res Cnstr	177					5%	0%	0%	0%	0%
Nonpt	Dust, Res Cnstr	10					0%	0%	0%	0%	0%
Nonpt	Dust, Road Cnstr	136					4%	0%	0%	0%	0%
Nonpt	Dust, Other	56					2%	0%	0%	0%	0%
Nonpt	Dust, PavRoads	332					9%	0%	0%	0%	0%
Nonpt	Dust,UnpvRoads	29					1%	0%	0%	0%	0%
Nonpt	Fertilizer	0				44	0%	0%	0%	0%	2%
Nonpt	Commercial	41	2	20	2	0	1%	0%	0%	0%	0%
Nonpt	ResFuel, DistOil	4	79	33	1	2	0%	7%	0%	0%	0%
Nonpt	ResFuel, Keros.	0	1	1	0	0	0%	0%	0%	0%	0%
Nonpt	ResFuel, LPG	0	0	48	2	0	0%	0%	0%	0%	0%
Nonpt	ResFuel, NGas	2	3	418	24	89	0%	0%	2%	0%	5%
Nonpt	ResFuel, Wood	1,471	24	162	1,660	83	41%	2%	1%	7%	4%
Nonpt	Livestock	0				1,016	0%	0%	0%	0%	53%
Nonpt	Misc	0	0	2	0		0%	0%	0%	0%	0%
Nonpt	Managed Burns	1		0	0		0%	0%	0%	0%	0%
Nonpt	OpenBurning	75	6	26	110		2%	0%	0%	0%	0%
Nonpt	BulkPlants	0			165		0%	0%	0%	1%	0%
Nonpt	GasCans	0			453		0%	0%	0%	2%	0%
Nonpt	GasStations	0			679		0%	0%	0%	3%	0%
Nonpt	GasStat, Stg2	0			130		0%	0%	0%	0%	0%
Nonpt	PetStoreTrans	0			109		0%	0%	0%	0%	0%
Nonpt	Ag Pesticides	0			15		0%	0%	0%	0%	0%
Nonpt	Asphalt Pav	0			235		0%	0%	0%	1%	0%
Nonpt	Dry Cleaning	0			3		0%	0%	0%	0%	0%
Nonpt	Graphic Arts	0			69		0%	0%	0%	0%	0%
Nonpt	Solv Con/Com	0			3,381		0%	0%	0%	14%	0%
Nonpt	SurfCoat, Arch	0			939		0%	0%	0%	4%	0%
Nonpt	SurfCoat, Indust	0			1,134		0%	0%	0%	5%	0%
Nonpt	Wastewater	0			8	2	0%	0%	0%	0%	0%
Nonrd	NR Model	350	10	3,659	3,844	5	10%	1%	18%	16%	0%
Nonpt	CMV	63	608	1,321	46	1	2%	50%	6%	0%	0%
Nonpt	Locomotives	18	5	616	32	0	0%	0%	3%	0%	0%
Onrod	Onroad	225	100	12,791	10,818	611	6%	8%	62%	44%	32%
Point	Airports	8	1	8	14		0%	0%	0%	0%	0%
Point	Point	205	365	1,379	416	48	6%	30%	7%	2%	3%
		3,572	**1,211**	**20,493**	**24,561**	**1,917**	**100%**	**100%**	**100%**	**100%**	**100%**

* Does not include wildfire or biogenic emissions. Highlighted categories were included in the inventory. Estimates for the peach-highlighted categories were taken directly from the NEI. Ecology made new calculations for the categories highlighted in blue, so the estimates in the table will not match those in the maintenance plan. Non-highlighted categories were not included in the inventories. They are expected to be small contributors to the total winter nonattainment area emissions.

Appendix A2 – Residential Wood Combustion Temperature Adjustment

The design day temperature profile calculated for the SIP revision 2008 base year inventory was used for the maintenance plan inventories. Residential wood combustion emissions were calculated for the design day temperature profile. The calculation is similar to the residential wood combustion temperature adjustment system used in the AIRPACT air quality forecasting model. Briefly, analysis of several $PM_{2.5}$ and meteorological monitoring sites throughout the region showed a strong linear relationship between ambient temperature and ambient fine particulate concentrations at temperatures below 50 degrees Fahrenheit.[48] This relationship was used to develop the temperature adjustment system. The adjustment system involves normalizing emissions to heating degree days (based on 50 degrees = HDD_{50}), and then multiplying the normalized value by the heating degree days for the design day. A more detailed description follows.

1) Calculate baseline HDD_{50}

Calculate annual HDD_{50} for woodstove survey period Sept. 2006 – Aug. 2007. This is the sum of the heating degree days for each day of the year. Daily min-max temperatures from the South L-Street meteorological site were used.

Annual $HDD_{50} = \sum_{i=1}^{365} 50 - Tavg_i$*), where Tavg = the daily average temperature (sum over all 365 days).*
If Tavg > 50, set the value of Tavg = 50.

= 1299

2) Calculate emissions as tons per HDD_{50}

Calculate annual county emissions (Tons/yr). Divide the annual emissions by the annual HDD_{50} calculated in step (1). The result is emissions expressed as tons per HDD_{50}. This can be viewed as emissions normalized to heating degree days.

Tons/HDD_{50} *= (Tons/yr) /* HDD_{50}*/yr)*

3) Calculate the design day HDD_{50}

The design day heating degree days are calculated as (50 – average temperature for the day). The average temperatures used in the calculation is the average of the maximum and minimum temperatures for the three design day temperature profiles.

Design Day HDD_{50} *= 50 –average temperature for the design day*
Design Day HDD_{50} *= 50 – (46 + 27)/2 = 14*

4) Calculate the design day emissions

Multiply the emissions in T/HDD_{50} by the design day HDD_{50} calculated in step (3). These are the final daily emissions.

Tons/day = Tons/HDD_{50} *x* HDD_{50}

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