# 2. Emission Inventory

### 2.1 Source Data

In the 1999 Statewide Emission Inventory project, the Department calculated county total emissions by source classification code (SCC) for point, area, and non-road mobile sources in Multnomah, Washington, and Clackamas counties. Data for these sources included temporal patterns where available. Major stationary point source data included actual or estimated stack parameters (i.e., release height, release velocity, release temperature), as well as seasonal and diurnal adjustments. Area, non-road mobile, and major stationary source emissions for Columbia, Yamhill, and Clark (WA) counties were taken from the 1999 NEI prepared by US EPA.

Portland's Metropolitan Regional Government Organization (METRO) provided on-road emission estimates for Multnomah, Washington, and Clackamas counties, as well as Clark County, Washington, developed using the EMME/2 travel demand model and US EPA's MOBILE 6.2 emission factor model. These included annual emission rates by roadway link for freeway and primary arterials, and by traffic analysis zone for secondary roads. A link is a series of roads or streets that a vehicle takes to get from one location to another. A transportation analysis zone is a geographic area where trips begin or end. METRO also provided temporal profiles.

On-road emissions for the small portions of Columbia and Yamhill counties that fall in the modeling domain were taken from US EPA's 1996 NTI, because this portion of the 1999 NEI was not yet released at the time of this study. These included annual emission rates for gasoline and diesel fueled vehicles by county.

Table 2.1 summarizes the agency or database providing emissions estimates for each county and emission source type. The processing of these data for model input is discussed below.

**Table 2.1 Data sources for 1999 PATA emissions estimates, by county and emission source category.**

| County | On-Road Mobile | Non-Road Mobile | Major Stationary Sources | Area Sources |
|---|---|---|---|---|
| **Multnomah** | METRO | ODEQ | ODEQ | ODEQ |
| **Clackamas** | METRO | ODEQ | ODEQ | ODEQ |
| **Washington** | METRO | ODEQ | ODEQ | ODEQ |
| **Columbia** | 1996 NTI | 1999 NEI | 1999 NEI | 1999 NEI |
| **Yamhill** | 1996 NTI | 1999 NEI | 1999 NEI | 1999 NEI |
| **Clark (WA)** | METRO | 1999 NEI | 1999 NEI | 1999 NEI |

## 2.2 Spatial and Temporal Allocation

### 2.2.1 General Description

In order to provide sufficient spatial resolution in emissions to support the block group resolution of the model receptors in Multnomah, Clackamas, and Washington Counties, all area and non-road emissions, other than marine vessels, railway yards, and aircraft were allocated to 1-km by 1-km grid cells in the inner portion of the domain. In the remainder of the modeling domain, these emission categories were allocated to 2-km by 2-km grid cells (see Figure 4.1).

Commercial marine vessel (CMV) emissions were allocated to 59 special areas, or polygons developed to represent shipping routes along the Columbia and Willamette Rivers. This process involved creating a set of vertices for each of the polygons using the TOPO computer software program. These points with their respective latitude and longitude were imported into ARCVIEW GIS 3.1. The areas were then created by connecting the points with lines to form polygons. Commercial shipping polygons were created along the Multnomah County border with the Columbia River and up the Willamette River to the Steel Bridge. Recreational marine vessels (RMV) were similarly allocated to 118 special polygons (including the 59 CMV polygons) developed in the same manner to represent the areas of recreational boating, but extending farther upriver to the Clackamas County border with Marion County.

Using the same method described above for marine vessels, railway yards and airports were allocated to special polygons developed by creating vertices in the TOPO program and then polygons, in ARCVIEW GIS 3.1. These polygons represent the actual locations and extent of the facilities.

METRO provided emissions from freeways and primary arterials for each of 1,095 two-way roadway links. These links were represented with special polygons. Emissions for secondary roadways were reported by traffic analysis zone. The boundaries of these zones were used to specify 1,194 special polygons.

On-road mobile source emissions in the small parts of Yamhill and Columbia Counties that fall within the modeling domain were allocated to the same grid cells as the area sources.

### 2.2.2 Dry Cleaners

Although dry cleaner emissions are typically characterized as area sources in modeling studies, location parameters were gathered for the 170 individual dry cleaning establishments in the modeling domain so that they could be characterized as point sources. Oregon waste reporting laws yield exact locations for dry cleaners. Each was modeled as a volume source with an effective release height of 1.5 m. These values were derived based on the assumption of fugitive emissions (non-stack) from a one-story building of 1,000 sq. feet.

### 2.2.3 Area Sources

Area source emissions were spatially allocated from the county total to model grid cells using spatial surrogates based on land use and population. This allocation followed the methods applied in the 1996 NATA national-scale assessment. First, each category of sources based on source classification code was assigned to a spatial surrogate. For example, industrial fuel combustion sources were assigned to industrial land use, and consumer product solvent use was assigned to population. Then, the emissions for the SCC were distributed among the county's grid cells in the same proportions as the corresponding surrogate.

Residential population patterns were derived from the 2000 US Census. Land use patterns were derived from the 21 categories in the USGS National Land Cover Dataset. However, this dataset aggregates several land use categories that were reported separately in the 1990 USGS Land Use and Land Cover data used for the 1996 NATA national-scale assessment. For example, commercial, industrial, and transportation land uses are combined into a single category in the 2000 dataset, but comprise all or part of six different land use categories in the 1990 dataset. Therefore, in order to maintain the level of detail in spatial allocation used in the NATA national-scale assessment, the Department subdivided the 2000 commercial-industrial-transportation category into three separate land use categories on the basis of the 1990 dataset proportions.

For area sources each model grid cell was modeled as an area source with an effective emission height of 5.0-m. For residential wood-smoke, an important area source pollutant in Portland, these values were derived based on the assumption of a typical vertical dimension of a buoyant release associated with residential combustion of wood from a one-story building.

### 2.2.4 Non-road Mobile Sources: Commercial and Recreational Marine Vessels

Emissions from commercial marine vessels (CMV) and recreational marine vessels (RMV) were spatially allocated to polygons representing shipping and boating routes on the Columbia and Willamette Rivers as described above. The CMV emissions were temporally allocated in a uniform matter. Recreational Marine Vessle emissions were temporally allocated according to patterns provided by data in the 1999 Boating in Oregon report completed by the Oregon State Marine Board, showing heavier use during the summer months. Both types of emissions were modeled as area sources with an effective emission height of 0.0-m.

### 2.2.5 Non-road Mobile Sources: Railroads

Railroad line haul emissions were spatially allocated to model grid cells according to railroad miles derived from the US Census Topologically Integrated Geographic Encoding and Referencing (TIGER®/Line) files. Railroad yard emissions were allocated to ten specific locations designated by the polygons as described above. Both yard and line haul emissions were modeled as area sources.

### 2.2.6 Non-road Mobile Sources: Aircraft

Aircraft emissions were spatially allocated to the locations of the seven airports within the modeling domain, and temporally allocated according to profiles provided by the Port of Portland based on landing and takeoff records. Each airport was modeled as a volume source based on the size of airport. With the exception of commercial aircraft at Portland International Airport (PDX), all emissions were modeled with an effective release height of 1.5 m, based on a typical wingspan for general aviation aircraft of 10 m. Portland Airport commercial aircraft emissions were modeled in three operating modes: taxi, takeoff, and climb out/approach - with release height to reflect the mode and size of larger aircraft with average wingspan of 50 m and tail height of 15 m.

### 2.2.7 Non-road Mobile Sources: Construction Equipment

County total construction equipment emissions were estimated with US EPA's NON-ROAD model. The NON-ROAD model allocates emissions from construction equipment to counties based on expenditures for construction activity in each county. To maintain consistency for this study, construction equipment emissions were then allocated from county totals to model grid cells according to spatial and temporal surrogates of estimated expenditures on construction equipment activity for buildings and roadways.

METRO provided a building permits database containing building construction expenditures by date, location, and structure type throughout the modeling domain. The Department assumed that 20% of building construction cost was associated with diesel equipment activity, primarily for site preparation. Building construction expenditures derived from building permits do not include the costs of installing associated utilities and private roads, even though these activities typically rely heavily on diesel equipment. Therefore, an additional 25% of building costs for residences and 15% of costs for other buildings were attributed to diesel activity.

State, county and local transportation agencies provided data about their expenditures on road construction and maintenance during the modeling period. All expenditures for roadway construction and maintenance were attributed to diesel equipment activity. These same data were also used to temporally allocate the emissions to seasons: December through February, March through May, June through August and September through November. Once the construction equipment emissions were allocated to grid cells, each grid cell was modeled as an area source with an effective release height of 2.0 meters.

### 2.2.8 Other Non-road Mobile Sources

All other non-road mobile source categories were spatially allocated from county totals to the grid cells using surrogates of land use and population following the method used in the 1996 NATA national-scale assessment, as described in 2.2.2.3., and modeled as area sources with an effective release height of 2.0 m.

### 2.2.9 On-road Mobile Sources

On-road mobile source emissions for Multnomah, Clackamas, Washington, and Clark Counties were allocated to either special polygons developed to represent roadway links (freeways and primary arterials) or traffic analysis zones (secondary and local roadways). The spatial allocations were provided by METRO from their travel demand model, EMME/2. METRO also included a temporal profile. On-road mobile source emissions for Yamhill and Columbia Counties were allocated to the same grid cells as the area sources. The spatial surrogates were adapted from the NATA national-scale assessment, and consisted of a combination of roadway miles and population. The same temporal profile provided by METRO for the other four counties was used for these as well. All on-road mobile emissions were modeled as area sources with an effective release height of 2.0 m, to account for buoyant plume rise and turbulent mixing from the vehicle wake.

## 2.3 Quality Assurance/Quality Control

DEQ staff reviewed and corrected inventory methodology and data based on preliminary Community Multi-Scale Air Quality (CMAQ) dispersion model runs. Initial modeling showed questionable results for several non-road categories, as well as residential wood combustion, commercial marine vessels, nickel emissions from industrial fossil fuel consumption, and aircraft emissions.

### 2.3.1 Non-road Categories

Suspect data from non-road categories included particulate matter (PM) emissions from diesel construction equipment, and benzene and 1, 3- butadiene emissions from light commercial, and lawn and garden equipment. Emissions for these categories were generated by the EPA Draft 2000 NON-ROAD model. During the PATA review process, this model was refined to correct a PM error and include more accurate estimates of national equipment populations, and improved allocation methods and factors. In consultation with EPA and ICF, the Department decided to use the refined version of the NON-ROAD model for PATA.

Before conducting the new model runs, DEQ staff reviewed input parameters, making corrections to fuel properties and temperature data. The output from the 2002 model showed reduced PM emissions from diesel construction equipment, but supported the initial results for light commercial and lawn and garden equipment.

### 2.3.2 Residential Wood Combustion

CMAQ modeling showed the Residential Wood Combustion (RWC) category to be problematic for emissions in POM, benzene, and acetaldehyde. The emission factor for acetaldehyde had an EPA rating of E (poor) and was based on a single test; as such these acetaldehyde emissions were dropped from the inventory. OMNI Environmental Consulting provided more up to date benzene emission factors to DEQ. The new benzene emission factors encompassed two additional RWC woodstove types, fireplaces and non-catalytic woodstoves. Further checking of emission factors revealed errors in the POM emission factors and in a specific 16-PAH emission factor. Both were corrected.

DEQ staff also reviewed wood burning activity data for accuracy and determined that some data for conventional woodstoves had been overlooked. Although the revised emission factors reduced total pollutant emissions for the category, the combination of the additional benzene emission factors and the added activity data offset the reductions.

#### 2.3.3 Commercial Marine Vessels

The Department initiated quality assurance on commercial marine vessel emissions because the modeled values of arsenic seemed too high. This led DEQ staff to determine that there had been an error during the calculation of these emissions. This not only affected the arsenic emissions but all other CMV pollutants as well. New calculations led to large reductions in CMV emissions and more reasonable outputs.

#### 2.3.4 Nickel Emissions from Industrial Fossil Fuel Consumption

After the initial modeling was completed, there was some concern about the accuracy of estimated nickel concentrations south of Highway 26 in Washington County. The levels were driven by emissions from area source fossil fuel use (distillate, residual, and natural gas) in the industrial and commercial/institutional sectors.

The Department investigated both the activities and the emission factors for accuracy. State level fuel use was taken from the 1999 State Energy Data Report and apportioned to each county using a ratio of employees--taken from the 1999 Oregon Labor Market Information System (OLMIS). The emission factors for the distillate and residual fuel were from the 1999 NEI, and the natural gas emission factor was taken from the FIRE 6.23 system, classified for residential heating devices. The assumption is that the natural gas being used residentially is the same as that being used for heating purposes in the industrial and commercial/institutional sectors. Therefore if nickel was emitted in one locale then it should also be emitted in the other.

While the total industrial emissions in Washington County are less than those in Multnomah County, they are spread over 58% less area. This gives Washington County the highest industrial emissions density of the three counties. It was determined that the nickel concentrations in southeastern Washington County were located correctly.

#### 2.3.5 Aircraft

The initial modeling results led to a question about the validity of the PAH emission factors for the piston engine aircraft type. Through investigation of the emissions estimates, the Department determined that there was an error in calculation of PAH emissions from piston aircraft. The emissions had incorrectly been factored from the VOC total. Emissions were corrected in accordance with EPA guidance (Documentation for the Draft 1999 Base Year Aircraft, CMV, and Locomotive NEI for Criteria and Hazardous Air Pollutants), which derives PAH from PM10 emissions, based on speciation factors. This change lowered the total PAH from piston aircraft 33% over the air taxi and general aviation categories at each airport.

The Department also received a new study by the US Air Force. The study developed new emission factors for ten toxic air pollutants, many of which were included in this assessment.  Upon review by the DEQ, these new emission factors were used to recalculate emissions.