2017 Comprehensive Emissions Inventory Quick Reference

This quick reference document summarizes the methods used to derive the Washington State 2017 Comprehensive Emissions Inventory, an Air Emissions Inventory product created by the Washington State Department of Ecology Air Quality Program. The main pollutants included in this Emissions Inventory (EI) are carbon monoxide, particulate matter, nitrogen oxides, sulfur dioxide, volatile organic compounds (VOCs), and ammonia. The EI data is not based on ambient air quality monitor observations used by the Environmental Protection Agency (EPA) to enforce the National Ambient Air Quality Standards, nor is it meant to account for greenhouse gases (e.g. carbon dioxide, methane, and CFCs are not part of the EI). Instead, the EI is a collection of annual emissions estimates that are calculated using publicly available information (e.g. population, permitted facilities, road activity, registered vehicles, etc.) and EPA models or emission factors usually documented in the Compilation of Air Pollutant Emission Factors (AP-42; e.g. from source test data, material balance studies, and engineering estimates). The EI is used for air quality State Implementation Plan (SIP) attainment/maintenance work, air quality forecasting, other air quality planning and rule efforts, public information, point source fee generation, and federal air quality reporting. Although Washington State developed most of the EI, some source category data was taken directly from the 2017 EPA National Emissions Inventory (NEI) v2. See the Technical Documentation and Summary Data in the Comprehensive Emissions Inventory section of the Air Emissions Inventory page for more details. Source Categories Included in the 2017 Comprehensive Emissions Inventory are listed below.

On-Road Mobile (ORM)  Industrial, Consumer, and Commercial Solvents (SOLV)
Non-Road Mobile (NRM)  Agricultural Burning (OB_AG)
Aircraft (AIR)  Point Sources (POINT)
Road Dust (ROADS)  Food and Kindred Products (FOOD)
Recreational Boats (BOAT)  Livestock (LIVE)
Commercial Marine Vessels (SHIP)  Fertilizer Application (FERT)
Locomotives (RR)  Agricultural Tilling and Harvesting (TILL_HARV)
Gasoline Storage/Transport/Stations (PETROL)  Prescribed (Silvicultural) Burning (OB_RX)
Industrial/Commercial/Institutional Fuel Use (F_ICI)  Wildfires (WF)
Residential Fuel Use (F_RES)  Residential Outdoor Burning (OB_RX)
Woodstoves, Fireplaces, and Inserts (RWC)  Natural Vegetation/Soils (NAT)
Construction (CONST)  Miscellaneous (MISC)

Emissions Source Category Descriptions:

On-Road Mobile (ORM) >> Emissions due to fuel combustion, fuel evaporation, brake wear, and tire wear from vehicles on public roadways are included in this category. EPA's Motor Vehicle Emission Simulator (MOVES) model version 2014b was used to calculate these emissions. Vehicle miles traveled, vehicle population, vehicle types, fuel types, emissions control programs, meteorological information, and other parameters were used as input to the MOVES model.

Non-Road Mobile (NRM) >> This category includes emissions from gasoline, diesel, compressed natural gas, and liquefied petroleum gas fueled equipment used in agriculture, lawn and garden, airports, logging, oil fields, construction and mining, recreation, commerce, railroad maintenance, and industry. Emissions were estimated using EPA's MOVES 2014b model, which has the NONROAD model embedded.
Aircraft (AIR) >> Emissions from aircraft landing and takeoff cycles are included in this category, but in-flight emissions are not included. Emissions were taken from the 2017 EPA NEI. EPA used the Federal Aviation Administration Emissions and Dispersion Modeling System for airports where detailed aircraft-specific activity data were available. Emissions from smaller airports were estimated using aircraft operations data and activity survey responses provided by the Federal Aviation Administration.

Road Dust (ROADS) >> Emissions generated as vehicles pass along roadways and disturb the layer of loose material on or near the road surface are included in this category. Brake and tire wear are not included here but are included in the On-Road Mobile source category. Emissions were estimated using vehicle miles traveled data, vehicle population, road types, precipitation, and EPA emission factors.

Recreational Boats (BOAT) >> Emissions from recreational marine vessels are included in this category. County boat registration and the average meteorological conditions by season were used as input to EPA's MOVES 2014b model, which has the NONROAD model embedded. Recreational Boats are separated from Non-Road Mobile for this EI.

Commercial Marine Vessels (SHIP) >> Emissions from ocean-going vessels and harbor vessels are included in this category. Estimates for coastal waterways, Puget Sound, and the Strait of Juan de Fuca were prepared by Starcrest Consulting Group, LLC and represent 2016. Emissions for the Columbia and Snake rivers were taken from the 2017 EPA NEI, discussed in the 2017 NEI Documentation.

Locomotives (RR) >> Emissions from Burlington Northern Santa Fe Railway, Union Pacific Railroad, and Amtrak are included in this category. Railroads provided 2017 county fuel use for line haul and switch yard locomotives, which was combined with EPA emission factors to calculate total emissions. Class II/III locomotives and additional rail yard emissions were obtained from EPA.

Gasoline Storage/Transport/Stations (PETROL) >> VOC emissions from bulk gasoline storage tanks, tank trucks, gasoline station underground tanks, and vehicle refueling are included in this category. EPA estimated this category using data from the Energy Information Administration, except for vehicle refueling which was estimated by Ecology using the MOVES 2014b model. Activity data and emission factors are discussed in the 2017 NEI Documentation.

Industrial/Commercial/Institutional Fuel Use (F_ICI) >> Emissions from industrial/commercial/institutional combustion of wood, natural gas, and other fuels were taken from the 2017 EPA NEI and included in this category. Total fuel consumption was estimated from the Energy Information Administration State Energy Data System and reported major facility fuel use was subtracted to avoid double counting with the Point Source category. State fuel use was allocated to counties using the County Business Patterns database of employment by industry.

Residential Fuel Use (F_RES) >> Emissions from heating homes with distillate oil, natural gas, and liquefied petroleum are included in this category. Each county’s fuel use was estimated using the 2017 Energy Information Administration State Energy Data System, the 2017 American Community Survey 5-Year Estimates, and EPA emission factors.

Woodstoves, Fireplaces, and Inserts (RWC) >> Emissions from woodstoves, fireplaces, fireplace inserts, and pellet stoves are included in this source category. EPA estimated RWC emissions based on the 2018
Commission on Environmental Cooperation (CEC) nationwide survey. EPA supplemented the CEC survey with information from the 2015 Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) and the state of Minnesota’s 2014/2015 residential wood survey. Ecology replaced some EPA assumptions about appliance fractions and burn rates with data from other surveys conducted by WSU, the National Research Center, and Kittitas county.

Construction (CONST) >> Dust generated during construction of non-residential, residential, and road developments were taken from the initial 2017 EPA NEI effort and modified to include county-level soil moisture parameters. Non-residential construction activity was based on County Business Patterns employment data. Residential construction activity was based on the area disturbed and volume of soil excavated, estimated using the US Census Bureau’s Building Permits Survey and Characteristics of New Housing reports. Road construction activity was based on the area disturbed, estimated using the 2014 Federal Highway Administration statistics. Moisture was estimated using regional soil moisture derived from Thornthwaite’s Precipitation-Evaporation Index and methodology from the California Air Resources Board.

Industrial, Consumer, and Commercial Solvents (SOLV) >> VOC and toxic gas emissions from solvents used in consumer, commercial, and industrial activities are included in this category: manufacturing, appliances, dry cleaning, metal and electrical coatings, architectural coating, wood finishing, graphic arts, degreasing, maintenance, machinery, motor vehicles and parts, paper, film, railroads, agrochemicals, personal care products, household products, aftermarket auto products, coatings, adhesives & sealants, insecticides, fungicides, rodenticides, etc. This category was estimated by EPA. Emission factors and activity data are discussed in the 2017 NEI Documentation.

Point Sources (POINT) >> Major industrial, commercial, or institutional stationary facilities are included in this category. This category includes landfills and some minor sources. Methods for estimating emissions across facilities may have included continuous emissions monitors, stack test data, mass balance, professional judgment, manufacturer specifications, scientific research, and emission factors from government, manufacturers, or research groups.

Food and Kindred Products (FOOD) >> Emissions from commercial cooking are included in this category and were taken directly from EPA. Restaurant data was derived from the 2018 Dun & Bradstreet Hoovers dataset. Emission factors and activity data are discussed in the 2017 NEI Documentation.

Livestock (LIVE) >> Dust and ammonia emissions from Concentrated Animal Feeding Operations (CAFOs) were included in this category. Emissions from livestock waste and dust from hooves were estimated by EPA using local cattle population data. Animal waste from livestock results in emissions of both NH₃ and VOCs. In addition, animal activity in the pens and feedlots results in dust emissions. VOC and PM10 emission factors were derived from the literature. Ammonia emission factors were taken from the Carnegie Mellon University Ammonia Model v.3.6.

Fertilizer Application (FERT) >> Ammonia emissions from croplands due to fertilizer usage are included in this category. Fertilizer usage was estimated using the Fertilizer Emissions Scenario Tool for CMAQ (FEST-C), which was run by EPA. Emission factors and activity data are discussed in the 2017 NEI Documentation.
Natural Vegetation and Soils (NAT) >> Biogenic emissions from vegetation and soils in this category were derived from the WSU AIRPACT simulations. Emissions were generated using the Weather Research and Forecasting (WRF) model and the Model of Emissions of Gases and Aerosols from Nature (MEGAN) v2.1.

Agricultural Tilling and Harvesting (TILL_HARV) >> Emissions of agricultural dust from tilling, preparation for planting, harvest machines, and loading/transport of crops in the field are all included in this category. Emissions of fugitive dust from agricultural tilling were based on crop-specific information from the USDA, WSDA, Midwest Research Institute, and WSU College of Agriculture. Harvesting emissions were based on the Western Regional Air Partnership Fugitive Dust Handbook plus crop-specific statistics produced by the USDA National Agricultural Statistics Service and the Washington State Department of Agriculture.

Agricultural Burning (OB_AG) >> This category includes emissions from agricultural burns of vegetative debris (e.g. for pest control or crop management). Agricultural burns are archived in the Department of Ecology agricultural burn permit database. Emissions estimates were based on agricultural permits issued in 2017. Additional burns reported by local clean air agencies and detected by satellites were also included.

Prescribed (Silvicultural) Burning (OB_RX) >> This category includes emissions from silvicultural burning of logging debris and forested areas (a.k.a. prescribed fires). Silvicultural burns in Washington are managed by the Department of Natural Resources, the US Forest Service, the Bureau of Indian Affairs, and private industry. Emissions estimates were based on silvicultural permits issued in 2017. Additional burns detected by satellites were also included.

Wildfires (WF) >> Wildfire emissions in this category were initially taken from the 2017 EPA Fire NEI effort, which used the BlueSky model. Wildfire locations were determined using Incident Command Summary Reports, the Hazard Mapping System, the Geospatial Multi-Agency Coordination group, the National Association of State Foresters (NASF) fire database, and the US Forest Service Activity Tracking System. Fuel moisture was estimated using the Wildland Fire Assessment System National Fuel Moisture Database. Fires that were excluded or misclassified by EPA as agricultural or prescribed burns were corrected by WA ECY and included in the wildfire category.

Residential Outdoor Burning (OB_RES) >> Emissions from the burning of yard waste (e.g. vegetative material such as branches, grass, or leaves), land clearing, and residential waste (e.g. trash and other solid waste) are included in this category. The yard waste burning activity method assumes that only rural households burn yard waste and that counties with more than 50% forest cover have households that generate twice the yard waste as other counties. The municipal waste burning activity method assumes that rural households burn 28% of their municipal solid waste. It is assumed that 4.5 lbs of waste are generated per person per day and that 80% of that waste is “burnable”. Emission factors are taken from the EPA.

Miscellaneous (MISC) >> Structure and motor vehicle fires, cremation, dental alloy production, bench scale reagents, fluorescent lamps, waste-water treatment plants, and other relatively minor sources of air emissions are included in the Miscellaneous source category. Details on the methods used to estimate emissions from these sources are available in the Technical Documentation hosted on the Comprehensive Emissions Inventory section of the Air Emissions Inventory page.

For more information, contact the Air Quality Program at (360) 407-6800 or airemissions@ecy.wa.gov.