Ozone

Ozone is a summertime air pollution problem in our area, and is not directly emitted by pollutant sources. Ozone forms when photochemical pollutants react with sunlight. These pollutants are called ozone precursors and include volatile organic compounds (VOC) and nitrogen oxides (NO_x). These precursors come from human-caused sources such as cars and trucks and industrial and commercial solvent use, as well as natural sources (biogenics).

Ozone levels in the Puget Sound area peak during the summer months, with the Washington Department of Ecology currently monitoring ozone levels from May through September. Highest ozone concentrations are observed in the Enumclaw and Pack Forest area (southeast of the Seattle and Tacoma urban areas) because of pollutant transport and the typical wind direction on hot summer days.

Despite reductions in ozone precursor emissions over the last decade, ozone concentrations have not decreased as significantly in the Puget Sound region. A recently-strengthened federal standard has threatening our attainment status for this pollutant. In addition, as discussed below, EPA has announced its intent to further strengthen it.

Health and Environmental Impacts

Upper atmosphere ozone protects the earth from harmful radiation, but ground-level ozone (often referred to as 'smog') is unhealthy. Exposure to ground-level ozone can cause reduced lung function, respiratory irritation, and can aggravate asthma symptoms.[i] Ozone exposure can also weaken the immune system.[ii] Even healthy individuals may experience respiratory symptoms on a high-ozone day.

In addition to human health effects, ground level ozone can also damage agricultural crops and forests, interfering with their ability to produce food and grow.[iii]

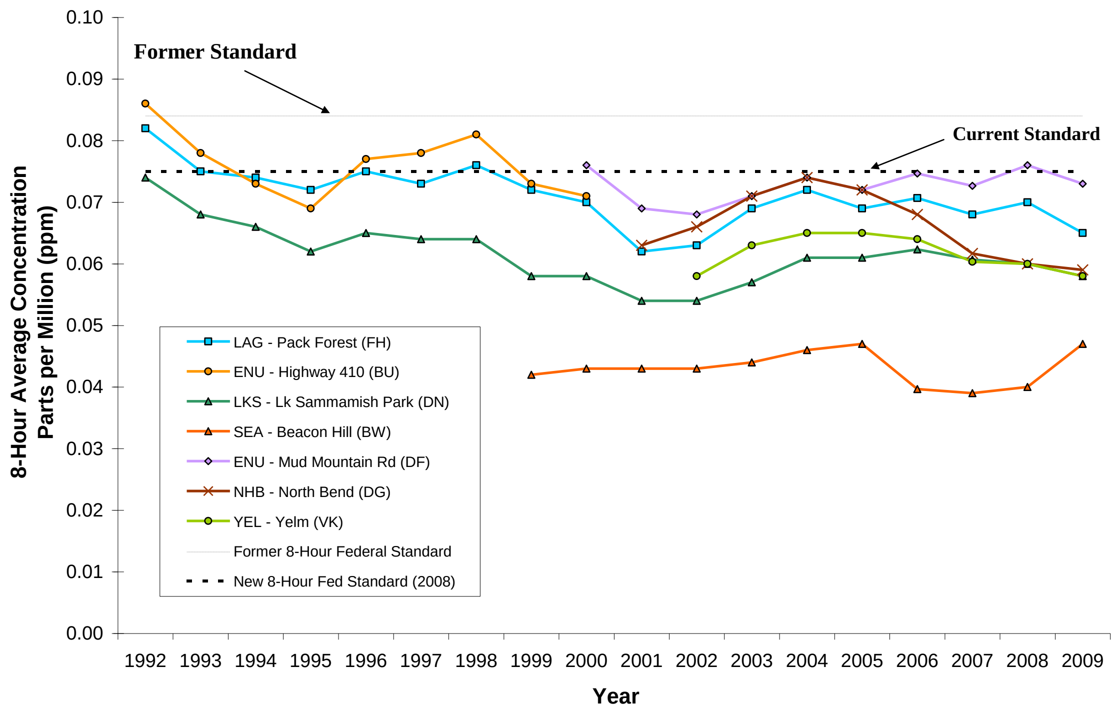
National Ambient Air Quality Standard and Attainment Status

The Environmental Protection Agency (EPA) sets and periodically updates a national ambient air quality standard (NAAQS) for ozone. The Puget Sound area has not violated the ozone standard since 1992 and was designated as "attainment" status for ozone in 1996.

EPA strengthened the 8-hour ozone standard in March 2008, from 0.08 parts per million (ppm) to 0.075 ppm. The EPA did not set the standard as low as the level recommended by the Clean Air Scientific Advisory Council (CASAC). The CASAC recommended a level no greater than 0.070 ppm in order to be protective of human health.

Based on our 2007-2009 data that are below the standard, it is highly unlikely that EPA will designate the Puget Sound area as "nonattainment" in the next round of nonattainment designations. However, EPA has announced its intent to further strengthen the 8-hour standard as soon as possible, to be consistent with the 2006 CASAC recommendation. If the 8-hour standard is set at 0.070 ppm, the Puget Sound area would likely violate that standard based on concentrations we typically see at the Enumclaw Mud Mountain monitor.

3-Year Average of the 4th Highest Daily Maximum 8-hour Annual Concentration vs. Standard



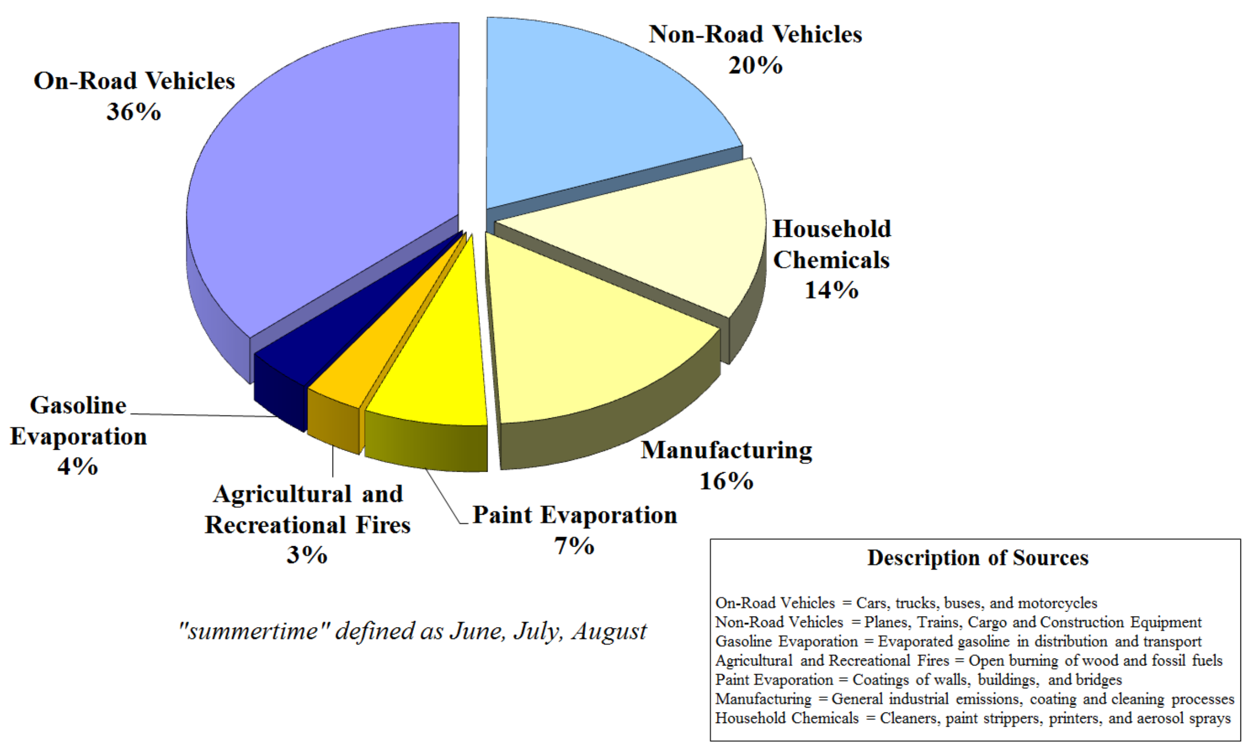
Sources

Emission sources do not directly emit ozone. Ozone forms when precursor pollutants, primarily complex nitrogen oxides and reactive volatile organic compounds, react with sunlight. Ozone formation depends on both precursor pollutants and meteorology.

The figure below presents sources from human activity (anthropogenic sources) that contribute most of the precursors that form ozone. Volatile organic compounds are presented because studies have repeatedly shown that reducing VOCs will reduce ozone concentrations at our peak locations. Summer months are shown because it's the main time of elevated ozone concentrations.

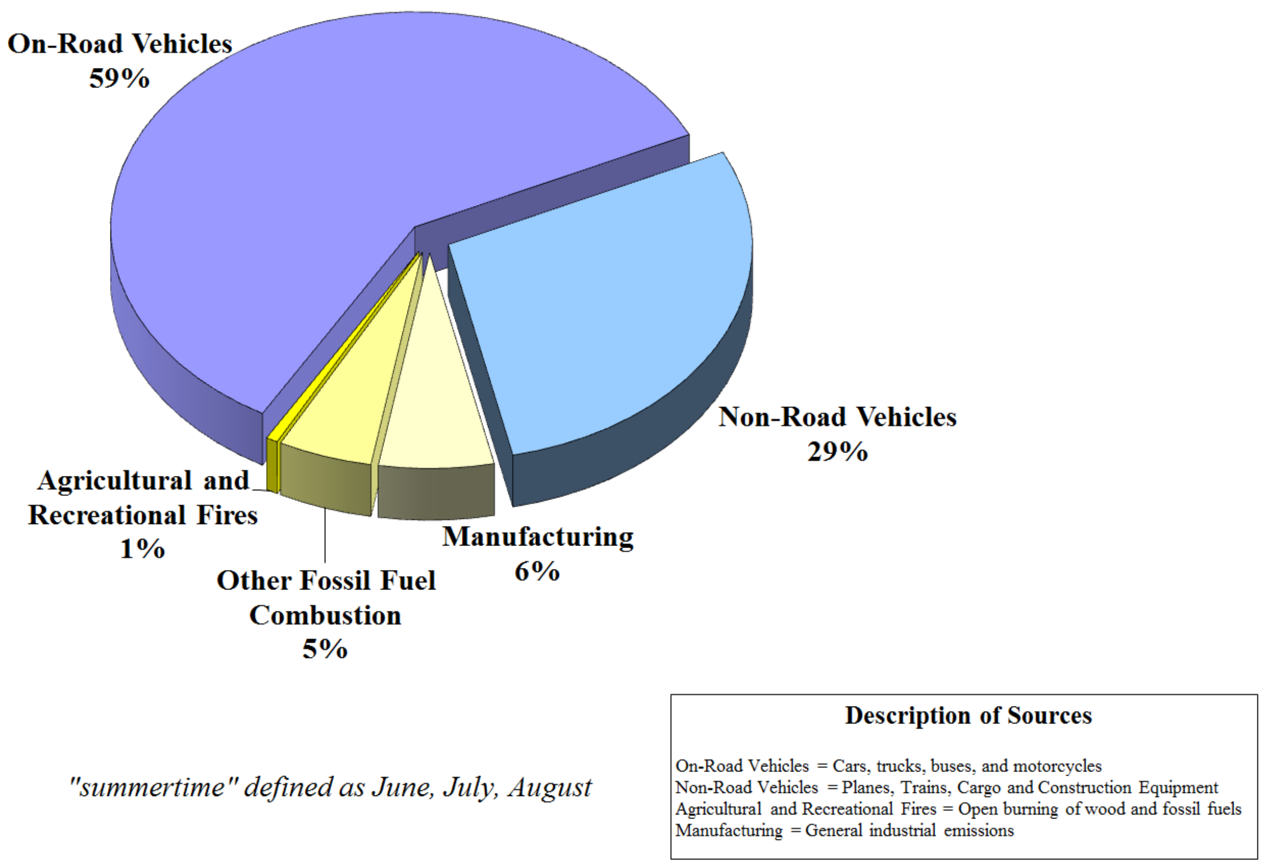
The pie chart indicates that onroad and nonroad vehicles combine to contribute more than 50% of VOC emissions during summer months. In addition to the anthropogenic sources shown below, natural (biogenic) sources such as trees also emit ozone precursors (primarily volatile organic compounds).

2005 Distribution of Summertime VOC Emissions



Like VOCs, sources of NO_x are mostly from vehicle engine combustion. In urban areas like Seattle, we are "VOC-limited". That is, ozone is mostly due to VOCs. However, NO_x is still a key ingredient to the recipe. The figure below shows the human sources that contribute to NO_x in our area.

2005 Distribution of Summertime NO_x Emissions



Ozone Precursor Emission Reduction Strategies

On-road gasoline vehicles (cars and trucks) are the greatest source of ozone precursors. EPA has regularly tightened tailpipe emissions standards since the late 1960's.[iv] Even though the number of vehicles on the road is increasing, on-road vehicles collectively are emitting significantly less than vehicles in previous years.

To supplement federal control strategies, the Agency evaluated, through a stakeholder process, local strategies to ensure maintaining ozone "attainment" status. Based on the technical information available, the stakeholder group recommended local control strategies to reduce ozone in the Puget Sound area.[v]

In addition to these strategies, the Agency partnered with stakeholders to encourage the adoption and implementation of stricter California motor vehicles standards in Washington. These standards, that are applicable to 2009 and later model year vehicles will also result in lower volatile organic compound mobile emissions.

Ozone Challenges

Emission inventories suggest that volatile organic compound and nitrogen oxide emissions will continue to decrease, despite increasing population and vehicle use. This reduction is mainly due to tighter federal volatile organic compound and nitrogen oxide controls for on-road and non-road mobile sources.

Unfortunately, these decreases in precursor pollutant emissions will likely not result in ozone concentrations that will comply with a tightening federal standard. Air dispersion modeling indicates that a large reduction in ozone precursors results in only small decreases in ozone concentrations.

EPA announced their intent, in October 2009, to potentially further strengthen the 8-hour ozone standard by August 2010.[vi] If this happens, our main challenge to meeting a more stringent standard will be ozone's relative insensitivity to precursor emission reductions. The Agency has already addressed the main VOC emission sources with its strategies described above.

There are very few emissions sources, besides fuels, that would provide great enough precursor emission reductions to result in monitored ozone levels below a more strict standard. Incorporating changes in our fuel mix with partners, including our local Washington fuel suppliers, would likely be the main strategy to meet a strengthened ozone standard

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[i] EPA AirNow. How Can Ground-Level Ozone Affect Your Health?; http://www.airnow.gov/index.cfm?action=static.ozone2#3.

[ii] EPA Airnow Smog Health Effects. http://wwww.epa.gov/airnow/health/smog1.html#3.

[iii] EPA Health and Environmental Effects of Ground Level Ozone. http://www.epa.gov/ttn/oarpg/naaqsfin/o3health.html.

[iv] For more information visit EPA's mobile source emissions milestones. http://www.epa.gov/otaq/invntory/overview/solutions/milestones.htm.

[v] Final Report of the Puget Sound Clean Air Agency CO/Ozone Stakeholders Group June 27, 2001. http://www.pscleanair.org/news/other/co_ozone_report.pdf.

[vi] EPA. October 2009. http://www.epa.gov/groundlevelozone/pdfs/O3_Reconsideration_FACT%20SHEET_091609.pdf.