# Port of Tacoma Source Apportionment Study

## Introduction

Section 302 (16) of the 2018 Supplemental Operating Budget directed Ecology to conduct a "multiyear study to distinguish the sources of emissions of the toxic air pollutant that poses the greatest cancer risk at the air monitoring station that is located closest to a port in the state with the highest volume of container traffic in domestic and foreign waterborne trade." To meet this requirement, Ecology designed a three-year monitoring study of fine particulate matter ($PM_{2.5}$) and its chemical components at Puget Sound Clean Air Agency's (PSCAA) Alexander Avenue monitoring site, adjacent to the Port of Tacoma.

A mathematical model called Positive Matrix Factorization (PMF) quantified sources of $PM_{2.5}$ at the monitoring site. PMF modeling decomposes a measured dataset into factors. A factor can be a single source, a source category, or multiple sources or source categories grouped together. PMF modeling identified the contributions of various source categories to concentrations of $PM_{2.5}$. This analysis also quantified $PM_{2.5}$ associated with diesel emissions relative to other sources of $PM_{2.5}$.

Technical details of PMF and its application to the 2018-2022 $PM_{2.5}$ Chemical Speciation Network dataset are described in the associated technical report.[1]

## $PM_{2.5}$ sources at the Port of Tacoma

PMF modeling identified 10 sources of $PM_{2.5}$. They included wood smoke, vehicles, fugitive dust (re-suspended dust), sea salt, fireworks, a mixture of unidentified urban sources, and PM2.5 associated with high concentrations of single components (sulfate-rich, nitrate-rich, iron-rich, and zinc-rich).

$PM_{2.5}$ associated with wood smoke contributed the most to the total $PM_{2.5}$ concentration, followed by the sulfate-rich and vehicles factors. (See Figure 1.) Annual averages of each factor were calculated to compare to the $PM_{2.5}$ annual National Ambient Air Quality Standard (NAAQS). All factors as well as their sum were below the $PM_{2.5}$ annual NAAQS.

[1] https://apps.ecology.wa.gov/publications/summarypages/2302075.html

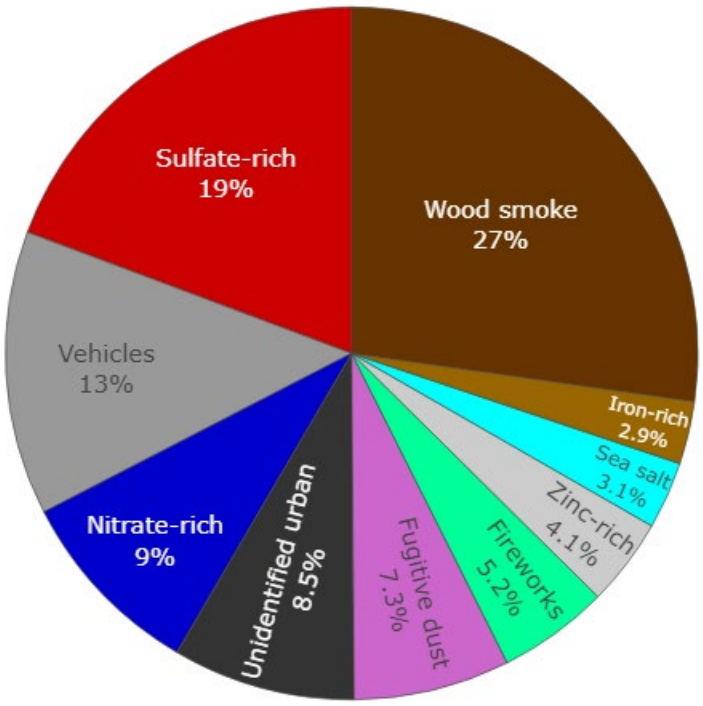


Figure 1. Average contribution of each factor identified by PMF to the total $PM_{2.5}$.

## $PM_{2.5}$ sources associated with diesel

Analysis identified components of diesel $PM_{2.5}$ in multiple PMF factors, including vehicles, zinc-rich, iron-rich, and unidentified urban. Together, these four factors comprised about 29% of the annual average $PM_{2.5}$ mass concentration. Figure 2 shows the monthly average contribution of the sum of the factors associated with diesel compared to the sum of the other factors identified.

$PM_{2.5}$ associated with diesel exhaust are generally enriched in components such as elemental carbon, calcium, copper, zinc, iron, and vanadium. However, many of these species commonly associated with diesel exhaust were not included in this PMF analysis due to low concentrations that did not rise above the noise of the data. The low concentrations of these species contributed to difficulties distinguishing and identifying distinct diesel $PM_{2.5}$ sources. Instead, PMF analysis identified multiple factors associated with common chemical components of diesel $PM_{2.5}$.

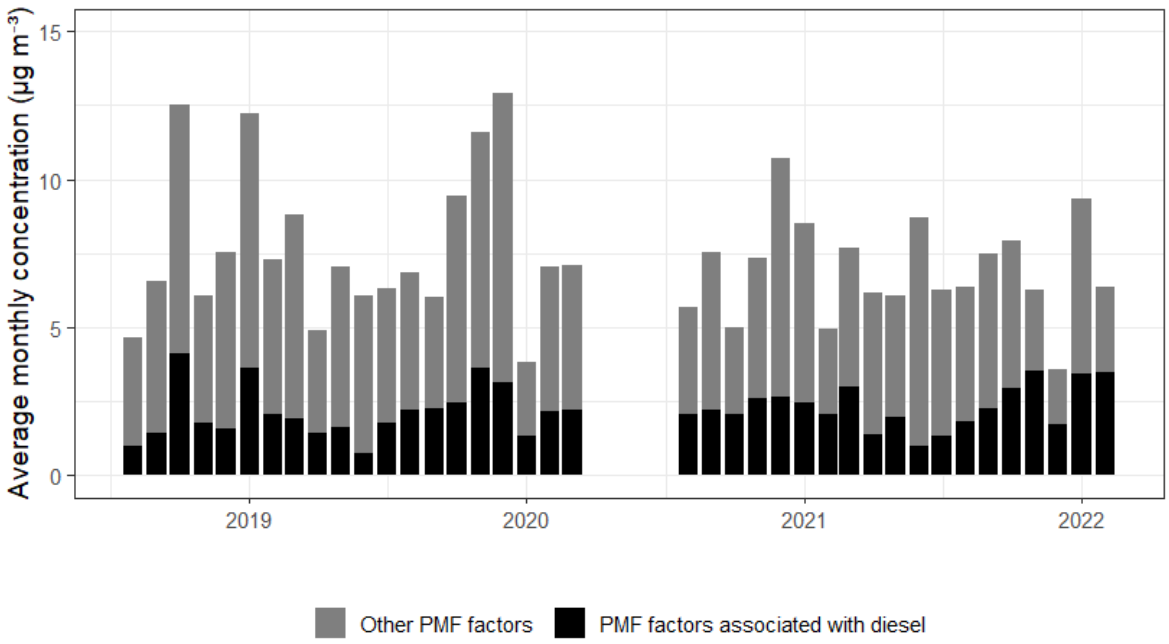


Figure 2. Average monthly concentrations of PMF factors grouped into PMF factors associated with diesel (black bars) and all other PMF factors (gray bars).

## Other findings

Average seasonal concentrations of each PMF factor were calculated to understand the effects of $PM_{2.5}$ factors at different times of the year. Many factors exhibited significant seasonal differences. $PM_{2.5}$ associated with wood smoke, vehicles, nitrate, and iron were significantly higher in the fall and winter months, while $PM_{2.5}$ associated with high concentrations of sulfate, fugitive dust, and fireworks were significantly higher during the spring and summer months.

Grouping factor concentrations by day of week determined significantly different weekend and weekday concentrations for $PM_{2.5}$ associated with fugitive dust, as well as high concentrations of iron. These differences between weekend and weekday concentrations indicate these factors are associated with local activities at the Port of Tacoma.

Days characterized by elevated $PM_{2.5}$ concentrations mosty occurred during wintertime and were associated with high contributions from $PM_{2.5}$ associated with wood smoke.

While it is difficult to substantiate a trend from a three-year dataset, our analysis identified a significant short-term increase for the vehicles factor.

# Conclusion

Pursuant to Section 302 (16) of the 2018 Supplemental Operating Budget, Ecology conducted a multiyear monitoring study of $PM_{2.5}$ and its chemical components at PSCAA's Alexander Avenue monitoring site adjacent to the Port of Tacoma. Analysis of measurements of these chemical components by PMF identified 10 $PM_{2.5}$ factors. These 10 factors included several that likely corresponded to specific source types – $PM_{2.5}$ associated with wood smoke, vehicles, fugitive dust, sea salt, fireworks, and urban emissions – along with factors that captured high concentrations of sulfate, nitrate, zinc, and iron, whose source was less clear or not unique. $PM_{2.5}$ associated with wood smoke was the highest contributing source to the measured $PM_{2.5}$ mass concentration; this factor exhibited a

significant seasonal pattern and contributed to days with high $PM_{2.5}$ concentrations that occurred during the wintertime.

Components of $PM_{2.5}$ associated with diesel were identified in multiple PMF factors, including $PM_{2.5}$ associated with vehicles, unidentified urban, and high concentrations of iron and zinc. However, this analysis was unable to identify a single unique $PM_{2.5}$ source associated with diesel.

# Appendix

# Publication information

This report is available on the Department of Ecology's website at https://apps.ecology.wa.gov/ecy/publications/SummaryPages/2302076html

Related Information: Technical Report: Port of Tacoma Source Apportionment Study[2]

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[2] https://apps.ecology.wa.gov/ecy/publications/SummaryPages/2302075html

[3] www.ecology.wa.gov/contact