Outlook

## SEPA Comments on Climate Resiliency Subelement - Part 1 of 2

**From** 350 Yakima Climate Action <350yakimaclimateaction@gmail.com>

**Date** Fri 11/13/2026 8:08 PM

**To** Martin, Trevor <Trevor.Martin@yakimawa.gov>; Ask Planning <Ask.Planning@yakimawa.gov>; Preston, Bill <Bill.Preston@yakimawa.gov>

**Cc** Ray Paolella <rlpaolella@gmail.com>; Felipe Rodriguez-Flores <feliperflores@gmail.com>; Bob Cox <3coxb1943@gmail.com>

9 attachments (24 MB)

SEPA Comments on Climate Resiliency Subelement.pdf; 2020 Washington Comprehensive Emissions Inventory.pdf; Landslide High Risk Info along Railroad Tracks.pdf; Yakima still collecting signatures on Terrace Heights annexation petition Gove.pdf; smart_growth_fixes_climate_adaptation_resilience.pdf; Overburdened Communities Highly Impacted by Air Pollution.pdf; East Yakima Environmental Justice Report 2025.pdf; YakimaAirWinterNitrate.pdf; WSDOT Multimodal Level of Service Standards_Aug2024.pdf;

Dear Mr. Preston and Mr. Martin,

Attached are 350 Yakima's comments regarding SEPA on the Climate Resiliency Subelement dated November 13, 2026, along with 9 of the attachments listed in it. Attachment #8, which is comprised of six (6) WA Department of Ecology Model Toxics Control Act Fact Sheets, will be sent in another email. Please look for Part 2 of 2.

Best regards,

350 YAKIMA CLIMATE ACTION
Coleen Anderson, President
Ray Paolella, Member

cc: Felipe Rodriguez Flores, Vice President
Bob Cox, Secretary

--

350 Yakima Climate Action acknowledges we live and work on the ancestral lands of the fourteen Confederated Tribes and Bands of the Yakama Nation. The people of the Yakama Nation inhabited more than 12 million acres across Adams, Benton, Chelan, Douglas, Franklin, Grant, Kittitas, Klickitat, and Yakima Counties. We thank the caretakers of this land who have lived here and continue to live here since time immemorial.

WSDOT Active Transportation Plan.pdf

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November 13, 2026

Bill Preston and Trevor Martin
Yakima City Planning Division
129 N. 2nd Street
Yakima, WA 98901

RE: Yakima Comprehensive Plan 2050 and State Environmental Policy Act (SEPA)

Dear SEPA Responsible Official and City Planning Manager:

Please accept these comments from 350 Yakima Climate Action on the SEPA Environmental Checklist and proposed Determination of Non-Significance pertaining to the GMA-required Climate Resiliency Subelement and the Transportation Element's required Multimodal and Active Transportation provisions since the transportation sector produces about half of all climate-warming greenhouse gas emissions in Washington State. Please include this letter and all the attachments in the official record for the Yakima Comprehensive Plan 2050 and compliance with the State Environmental Policy Act (SEPA).

**A. Growth Management Act (GMA) Requirements**

According to RCW 36.70A.070(9)(e), the City of Yakima must adopt a *Resiliency Subelement* as part of the City's GMA Comprehensive Plan Update. The Resiliency Subelement must:

- Avoid or substantially reduce the adverse impacts of climate change in human communities and ecological systems;
- Adopt goals, policies, and programs using the Best Available Science and scientifically credible climate projections and impact scenarios that moderate or avoid harm;
- Enhance the resiliency of natural and human systems, and enhance beneficial opportunities;
- Prioritize actions that benefit overburdened communities that will disproportionately suffer from compounding environmental impacts and will be most impacted by natural hazards due to climate change;
- Identify, protect, and enhance natural areas to foster resiliency to climate impacts, as well as areas of vital habitat for safe passage and species migration;
- Identify, protect, and enhance community resiliency to climate change impacts, including social, economic, and built environment factors, that support adaptation to climate impacts consistent with environmental justice; and
- Address natural hazards created or aggravated by climate change, including sea level rise, landslides, flooding, drought, heat, smoke, wildfire, and other effects of changes to temperature and precipitation patterns.



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We appreciate the City Planning Staff's and Planning Commission's efforts to comply with these new GMA requirements. However, the City's SEPA Environmental Checklist is inadequate and must be redone because it fails to address the foregoing 7 categories of climate change impacts and natural hazards created or aggravated by climate change that will affect developments allowed by the Comprehensive Plan.

**B. State Environmental Policy Act (SEPA) Requirements**

Under RCW Chapter 43.21C and WAC Chapter 197-11, the City of Yakima is required to conduct the SEPA process to analyze direct, indirect, and cumulative impacts of Comprehensive Plan Amendments on public safety, public health, the natural environment, and the built environment. SEPA documents must address probable impacts of future project actions allowed, authorized, or anticipated by the Comprehensive Plan Amendments. If the proposed Comprehensive Plan Amendments may have a probable significant adverse environmental impact, the SEPA Responsible Official must issue a Determination of Significance (DS), and an Environmental Impact Statement is required.

**C. SEPA Environmental Checklist Inadequate**

The SEPA Environmental Checklist (Sept. 24, 2026) does not provide sufficient information to complete environmental review of probable significant impacts of future project actions allowed, authorized, or anticipated by the Comprehensive Plan Amendments. The applicant has marked numerous environmental checklist questions as *"N/A"* without providing any explanation for why they do not apply to climate resiliency. SEPA instructions explicitly state that *"N/A"* should only be used *"when you can explain why it does not apply and not when the answer is unknown."*

The Environmental Checklist fails to mention the required *Resiliency Subelement*.

The Environmental Checklist fails to use Best Available Science, climate change projections, and impact scenarios to analyze climate change impacts and proposed resiliency goals, policies, and programs to avoid or substantially reduce harm to human and natural systems. Without first understanding the range and intensity of climate change impacts, the City will not be able to develop targeted policies, programs, and implementing measures to avoid or substantially reduce the harm from those impacts. Examples of implementation actions recommended by US EPA will be later in this letter.

The Environmental Checklist fails to discuss:

- Overburdened Communities -- RCW 36.70A.030(31)
- Environmental Justice -- RCW 36.70A.030(17)
- Highly Impacted Communities – RCW 19.405.020(22)
- Vulnerable Populations disproportionately impacted by environmental harms -- RCW 36.70A.030(52)
- Vital habitat for safe passage/species migration -- RCW 36.70A.070(9)(e)
- Best Available Science required by RCW 36.70A.070(9)(e)



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- **D. Significant Adverse Environmental Impacts – Comprehensive Plan 2050**

### 1. East Yakima Overburdened Community Highly Impacted by Air Pollution

The East Yakima Overburdened Community is delineated in the attached "East Yakima Community 2025 Environmental Justice Report" and "2025 Report: Overburdened Communities Highly Impacted by Air Pollution."

These reports were produced as a collaboration between the State Departments of Health and Ecology, and the reports contain Best Available Science and present scientifically credible climate projections and impact scenarios. Additional Best Available Science and climate impact scenarios are presented in the attached "Climate Action Plan for the City of Yakima (November 2023)" developed by the Sustainable Yakima Committee.

The East Yakima Overburdened Community has the highest estimated number of deaths per population associated with yearly PM 2.5 air pollution exposure in the entire State of Washington: 78 deaths per 100,000 population. The Lower Yakima Valley Overburdened Community Has the next highest estimated number of deaths per population associated with yearly PM 2.5 air pollution exposure: 56 deaths per 100,000 population.

The Environmental Checklist and Draft Comprehensive Plan 2050 contain no discussion of the very significant adverse climate change impacts in Overburdened Communities. The Environmental Checklist fails to address natural hazards created or aggravated by climate change and prioritizing actions that benefit communities that will disproportionately suffer from compounding environmental impacts in East Yakima as anticipated future development occurs.

### 2. Particulate Nitrate PM2.5 Air Pollution

According to the attached Washington Comprehensive Emissions Inventory and Yakima Air Wintertime Nitrate Study, high ammonia emissions from agricultural sources East of the City of Yakima lead to elevated atmospheric concentrations. When these ammonia precursor pollutants from agriculture mix with urban nitrogen oxide emissions from the combustion of fossil fuels by cars, trucks, and railroad locomotives, a chemical reaction occurs to form PM 2.5 particulate nitrate air pollution. This process is enhanced when the air is colder in winter, resulting in significant wintertime air pollution in Yakima. Yakima's particulate nitrate PM 2.5 pollution is unusual in Washington State and should be analyzed in detail for disproportionate impacts in the East Yakima Overburdened Community.

Diesel emissions are particularly harmful to human health. Seventy percent of cancers caused by airborne pollution come from diesel exhaust. It puts healthy people at risk for respiratory diseases and complicates health conditions for people with asthma, heart, and lung disease. https://ecology.wa.gov/air-climate/air-quality/vehicle-emissions. In warmer weather, these nitrogen oxides are baked with other pollutants to form ground-level ozone or smog. The



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Yakima Valley Trolleys emit unregulated diesel exhaust as they propose to travel along 6th Avenue past Davis and Stanton Academy High Schools and Garfield Elementary School, all within the East Yakima Overburdened Community.

### 3. Induced Growth and Future Development Anticipated by the Comprehensive Plan

The City's land capacity analysis shows the City has capacity for over 21,000 net new housing units, and the City seeks large-scale, mixed-use redevelopment in the East Yakima Overburdened Community and in the pending annexation of the adjacent Terrace Heights Urban Growth Area.[1] There is widespread historic soil and groundwater contamination in this area. Major anticipated projects allowed by the proposed Comprehensive Plan Amendments on hundreds of acres of land include redevelopment of the Boise-Cascade Mill and Old City Landfill/Interstate 82 Interchange properties near the Yakima River and East-West highway project crossing the Yakima River to connect to developable land in Terrace Heights. See, for example, the Boise Cascade Mill Site:

Future Site Characterization, Cleanup, And Re-Development



Boise Cascade Mill site, 2008, view to north (photo from Bing)

In April 2013, the City of Yakima contracted with an environmental consultant to collect additional data to further characterize contamination at the site. This additional data will help determine what types of cleanup actions will need to occur at the site in the future to allow for re-development.

[1] https://www.yakimaherald.com/news/local/government/yakima-still-collecting-signatures-on-terrace-heights-annexation-petition/article_47922d47-5a15-436d-ae6e-93d31447ad77.html



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Proposed plans for future re-development of the site include new retail space, commercial, light industrial, high density residential housing, and public venues with access provided by the proposed Yakima East-West Corridor roadway, including a freeway interchange on the site.[2]

### 4. Climate-Related Drought

Yakima heavily relies on water resources for agricultural activities and water supply for its residents. However, climate change has led to changes in the timing and intensity of increased precipitation, reducing snowpack in the mountains, altering the natural water flow regime, and affecting the availability of water during the dry season. This results in water scarcity, impacting agricultural productivity and the availability of drinking water. Drought is a serious hazard arising from climate change that could have profound deleterious impacts on the Yakima Valley economy as anticipated future development increases demand for water. Changes in temperature and precipitation patterns due to climate change can alter growing seasons and affect crop yields. Warmer temperatures and increased risks of pests and diseases can pose significant challenges to agricultural production.[3]

### 5. Active Transportation

The East Yakima Overburdened Community currently has inadequate access to green space and outdoor recreation on both sides of the Yakima and Naches River riparian corridors, including access to about 100 acres of public recreational lands at the rivers' confluence and William O. Douglas Hillclimb. The proposed multimodal level of service standards compromise public safety goals by allowing shared uses of City streets lanes by motor vehicles, pedestrians, and bicycles without prescribing dedicated space/separation for non-motorized active transportation. The public safety impacts of multimodal levels of service in the Transportation Element should be analyzed to consider spatial separation between active transportation and motorized vehicles. Future transportation projects listed in the comprehensive plan should be evaluated for dedicated, protected pedestrian, bicycle, and ADA facilities consistent with the attached Washington State Active Transportation Plan and WSDOT Multimodal Level of Service Guidance.[4]

The Yakima Greenway and William O. Douglas Trail that serve the residents of the East Yakima Overburdened Community should be completed and maintained to provide Vulnerable Populations with access to green space and outdoor recreation on both sides of the Yakima and Naches River riparian corridors, including access to about 100 acres of public recreational lands at the rivers' confluence and William O. Douglas Hillclimb. Safe pedestrian and bicycle connections to the City's Lower Cowiche Canyon/William O. Douglas Trail should be prioritized for recreational access and commuting by residents in East Yakima.

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[2] Source: https://apps.ecology.wa.gov/cleanupsearch/site/12095
[3] Climate Action Plan for the City of Yakima (Sustainable Yakima Committee, November 2023)
[4] https://wsdot.wa.gov/sites/default/files/2021-12/ATP-2020-and-Beyond.pdf; https://wsdot.wa.gov/sites/default/files/2024-08/MMLOS_guidance_Aug2024.pdf



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### 6. Natural Hazards Created or Aggravated by Climate Change

The Resiliency Subelement must have specific goals, policies, and programs to address natural hazards created or aggravated by climate change, including but not limited to, sea level rise, landslides, flooding, drought, heat, smoke, wildfire, and other effects of changes to temperature and precipitation patterns.

According to Department of Commerce Guidance, the City of Yakima can meet GMA's "*minimum requirements*" by including in the Comprehensive Plan "*at least one climate resilience policy for each climate-related hazard (e.g., sea level rise and drought) that is relevant to the jurisdiction*."[5]

The proposed plan does not address potential high-risk landslides where the City proposes to operate and maintain abandoned railroad tracks for public use in Selah Gap. The plan does not have a resilience policy for climate-related drought hazards arising from declining mountain snowpacks that alter the natural water flow regime that City residents and the agricultural economy rely on.

To equitably enhance resiliency to the adverse impacts of climate change in human communities and ecological systems, the Comprehensive Plan should address natural hazards created or aggravated by climate change, as recommended in the "*Climate Action Plan for the City of Yakima* (November 2023)" developed by the Sustainable Yakima Committee based on Best Available Science, together with Adaptation Strategies recommended by the U.S. Environmental Protection Agency, such as: Improve public education about the risks of developing in sensitive areas; planting trees to reduce urban heat island effect and provide shade; water conservation measures such as promoting xeriscaping vegetation in new developments instead of grass lawns; white roofs and light reflecting pavements; create a list of desired development elements in more-vulnerable areas, and encourage or require developers to implement a certain number of them.

## E. Determination of Significance

Due to probable, significant adverse climate impacts associated with anticipated development and identified future projects that will be allowed under Comprehensive Plan 2050, the SEPA Responsible Official is required to issue a Determination of Significance. 350 Yakima Climate Action respectfully requests that the City of Yakima withdraw the proposed DNS and prepare an Environmental Impact Statement for the proposed Comprehensive Plan Amendments. We request that this letter and attachments, together with prior comments and attachments submitted

[5] https://deptofcommerce.app.box.com/s/glw5yo8jvfsd40eoa4kdsx0fzde3s9ij



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on October 14 and 15, 2026 all be included in the public record for Comprehensive Plan 2050 and the associated SEPA process.

350 Yakima Climate Action appreciates the opportunity to comment on the SEPA Environmental Checklist and proposed DNS.

Thank you for your consideration,

/s/

Coleen Anderson, President
Raymond Paolella, Member
350 Yakima Climate Action

Attachments:

1. *2025 Report: Overburdened Communities Highly Impacted by Air Pollution* by Washington State Departments of Ecology and Health (December 2025, Ecology Publication 25-02-037): https://apps.ecology.wa.gov/publications/summarypages/2502037.html

2. *East Yakima Community 2025 Environmental Justice Report* (Washington State Departments of Ecology): https://apps.ecology.wa.gov/publications/parts/2502037part15.pdf

3. *Washington Comprehensive Emissions Inventory* (Updated 2024)

4. *The Yakima Air Wintertime Nitrate Study*, Laboratory for Atmospheric Research, Department of Civil & Environmental Engineering, Washington State University (2014)

5. *Smart Growth Fixes for Climate Adaptation and Resilience,* US EPA (2017)

6. Yakima Herald-Republic article on Terrace Heights Annexation (11/12/2026)

7. Landslide High Risk Info along Railroad Tracks

8. Six (6) WA Department of Ecology Model Toxics Control Act Fact Sheets

9. WSDOT Active Transportation Plan

10. WSDOT Multimodal Level of Service Standards



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# 2020 Washington Comprehensive Emissions Inventory

## Technical Support Document

Air Quality Program
Washington State Department of Ecology
Olympia, WA

**July 2023 (updated October 2024) | Publication #20-02-012**

DEPARTMENT OF
ECOLOGY
State of Washington



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## Publication Information

This document is available on the Department of Ecology's website at:
https://fortress.wa.gov/ecy/publications/summarypages/2002012.html

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- Northwest Regional Office, Bellevue 425-649-7000
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- Eastern Regional Office, Spokane 509-329-3400

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# List of Acronyms

| | |
|---|---|
| ADT | Average Daily Traffic |
| ADVMT | Average Daily Vehicle Miles Traveled |
| AIRPACT | Air Indicator Report for Public Awareness and Community Tracking |
| AOP | Air Operating Permit |
| AQPPS | Air Quality Program Permitting System |
| CAA | Clean Air Act |
| CAP | Criteria Air Pollutant |
| CDL | Cropland Data Layer |
| CRO | Central Regional Office |
| DNR | Department of Natural Resources |
| ECY | Washington State Department of Ecology |
| EF | Emission Factor |
| EI | Emissions Inventory |
| EPA | Environmental Protection Agency |
| ERO | Eastern Regional Office |
| GIS | Geographic Information Systems |
| HAP | Hazardous Air Pollutant |
| HMS | Hazard Mapping System |
| HPMS | Highway Performance Monitoring System |
| ICI | Industrial, Commercial, and Institutional |
| MOVES | Motor Vehicle Emission Simulator |
| NAAQS | National Ambient Air Quality Standards |
| NEC | Not Elsewhere Classified |
| NEI | National Emissions Inventory |
| OFM | Office of Financial Management |
| OHU | Occupied Housing Units |
| ORVR | Onboard Refueling Vapor Recovery |
| PE | Precipitation Effectiveness |



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| | |
|---|---|
| PM | Particulate Matter |
| POTW | Publicly Owned Treatment Works |
| SCC | Source Classification Code |
| SIP | State Implementation Plan |
| SMARTFIRE | Satellite Mapping Automatic Reanalysis Tool for Fire Incident Reconciliation |
| TPY | Tons Per Year |
| TRI | Toxics Release Inventory |
| ULSD | Ultra-Low Sulfur Diesel |
| UW | University of Washington |
| VMT | Vehicle Miles Traveled |
| VOC | Volatile Organic Compounds |
| VRS | Vapor Recovery System |
| WRAP | Western Regional Air Partnership |
| WRF | Weather Research and Forecasting Model |
| WSDOT | Washington State Department of Transportation |
| WSU | Washington State University |
| WWTP | Wastewater Treatment Plant |



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# 1 Introduction

## 1.1 Purpose and Background

This document describes the methods and data sources employed to estimate emissions for the 2020 Washington Comprehensive Emissions Inventory. The emissions inventory (EI) is based on indicators of activity (e.g. population, registered vehicles, land use area) and scientifically developed emission rates that are specific to a source category. The EI is *not* based on ambient air quality monitor observations used by EPA to enforce the National Ambient Air Quality Standards (NAAQS), nor does it account for air pollution that originated outside the state boundaries (e.g. wildfire smoke from other states/countries).

The comprehensive EI includes emissions from point sources (e.g. large facilities that report their emissions annually), area sources (e.g. residential, agricultural, and commercial activities), mobile sources (e.g. cars, trucks, trains, boats), biogenic sources (e.g. vegetation and soil microbes), and event-driven sources (e.g. wildfires and prescribed burning) of air pollution. The Department of Ecology uses the EI as part of the overall air quality management program. This includes supporting air quality modeling, State Implementation Plan (SIP) attainment/maintenance planning, other air quality planning and rule efforts, public information, point source fee generation, and to meet federal air quality reporting requirements. The Department of Ecology compiles a comprehensive EI for every third year, which relies on coordination with EPA National Emissions Inventory (NEI) process. The next comprehensive EI will be for base year 2023.

Discretion should be used when comparing results between different EI years. What appear to be emissions changes may instead reflect: (1) changes in emissions estimation models, methodologies, and /or emission rates, (2) sources and/or pollutants included in the inventory, and (3) correction of errors in prior inventories.

## 1.2 Pollutants and Emissions Sources

The EI includes estimates of relevant criteria air pollutants (CAPs) for all sources inventoried. The Clean Air Act (CAA) defines CAPs as carbon monoxide (CO), lead (Pb), Ozone ($O_3$), nitrogen oxides ($NO_X$), particulate matter (PM), and sulfur dioxide ($SO_2$). Lead emissions are calculated by EPA for aircraft that use leaded fuel, but lead is not included in this EI. Ozone is a secondary pollutant formed in the atmosphere and is not directly emitted. NOx and volatile organic compounds (VOCs) are ozone precursors and are included in this EI. PM is estimated for two size bins ($PM_{10}$ and $PM_{2.5}$), as specified in the NAAQS. Ammonia ($NH_3$) is technically not a CAP, but it is included in this EI because it is an important PM precursor and a Toxic Air Pollutant (TAP). Hazardous air pollutants (HAPs) are available from the NEI, as reported by Title V Major Sources and estimated from PM and VOC speciation profiles.

See Table 1-1 for information about the main pollutants included for each emissions category.



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## 1.3 Spatial and Temporal Resolution

Emissions were estimated for each county. Total annual emissions were estimated. If seasonal or other shorter timeframe estimates are required for a project, temporal profiles or other information may be used to adjust the inventories to the needed temporal scale.

**Table 1-1. Emissions Category Pollutant Checklist**

| Emissions Category | Abbr. | CO | $NH_3$ | NOx | $PM_{10}$ | $PM_{25}$ | $SO_2$ | VOC |
|---|---|---|---|---|---|---|---|---|
| Large point sources, usually with Title V AOP | POINT | X | X | X | X | X | X | X |
| Industrial/Commercial/Institutional fuel use | F_ICI | X | X | X | X | X | X | X |
| Residential non-wood fuel use (home heating) | F_RES | X | X | X | X | X | X | X |
| Residential wood combustion (home heating) | RWC | X | X | X | X | X | X | X |
| Residential open burning: yard waste, trash, land clearing | OB_RES | X | X | X | X | X | X | X |
| Agricultural open burning | OB_AG | X | X | X | X | X | X | X |
| Prescribed (Silvicultural) open burning | OB_RX | X | X | X | X | X | X | X |
| Wildfires | WF | X | X | X | X | X | X | X |
| Aircraft: military, commercial, general aviation | AIR | X | | X | X | X | X | X |
| Recreational boats | BOAT | X | X | X | X | X | X | X |
| Railroad (locomotives) | RR | X | X | X | X | X | X | X |
| Ships (commercial marine vessels) | SHIP | X | X | X | X | X | X | X |
| Nonroad mobile equipment and vehicles (NEC) | NRM | X | X | X | X | X | X | X |
| Onroad mobile sources | ORM | X | X | X | X | X | X | X |
| Industrial, commercial, and consumer solvent use | SOLV | | | | | | | X |
| Gasoline storage and transport | PETROL | | | | | | | X |
| Paved and unpaved road dust | ROADS | | | | X | X | | |
| Construction Dust | CONST | | | | X | X | | |
| Dust from agricultural tilling and harvesting | TILL_HARV | | | | X | X | | |
| Livestock | LIVE | | X | | X | X | | X |
| Fertilizer application | FERT | | X | | | | | |
| Food and kindred products | FOOD | X | | | X | X | | X |
| Natural emissions from soil and vegetation | NAT | X | | X | | | | X |
| Miscellaneous | MISC | X | X | X | X | X | X | X |

## 1.4 Emissions Calculated by EPA

In previous years, it was common for the Dept. of Ecology to estimate emissions for several non-point categories and submit them to EPA for inclusion in the NEI. Dept. of Ecology has typically used the same methods as EPA for calculations, but included updates to the input data assumptions for categories we calculate on our own. Recently, EPA has asked states to only submit new input data and allow EPA to make the emissions calculations. This ensures consistent methodology is used across the country and also allows for EPA to update methodology without need for States to recalculate and resubmit emissions. For the 2020 EI, emissions were calculated by EPA for many more categories than in previous years, but



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Ecology submitted the input data for categories as needed. However, there are a few categories that Ecology calculated themselves that differ from the EPA NEI, which are noted in Table 1-2 as "False" in the ECY/EPA Match column. The technical support documents, data, and emission factors for the 2020 NEI are all available from EPA.[1] There are also Nonpoint Emissions Methodology documents (NEMOs) that have more methodology details, which can be provided upon request.

**Table 1-2. Emissions Category Notes**

| Emissions Category | Abbr. | Final Calculation By | Ecology Activity Data | EPA/ECY Match |
|---|---|---|---|---|
| Large point sources, usually with Title V AOP | POINT | Ecology | N/A | True |
| Industrial/Commercial/Institutional fuel use [Industrial Wood] | F_ICI | Ecology | True | False |
| Industrial/Commercial/Institutional fuel use [all other] | F_ICI | EPA | True | True |
| Residential non-wood fuel use (home heating) | F_RES | EPA | False | True |
| Residential wood combustion (home heating) | RWC | EPA | True | True |
| Residential open burning [yard waste, trash] | OB_RES | EPA | True | True |
| Residential open burning [land clearing] | OB_RES | Ecology | True | True |
| Agricultural open burning | OB_AG | Ecology | True | True |
| Prescribed (Silvicultural) open burning | OB_RX | Ecology | True | True |
| Wildfires | WF | Ecology | True | True |
| Aircraft: military, commercial, general aviation | AIR | EPA | False | True |
| Recreational boats | BOAT | Ecology | True | False |
| Railroad (locomotives) [Line Haul] | RR | EPA | False | True |
| Railroad (locomotives) [Switch Yards] | RR | Ecology | True | True |
| Ships (commercial marine vessels) | SHIP | EPA | False | True |
| Nonroad mobile equipment and vehicles [NEC] | NRM | Ecology | False | False |
| Onroad mobile sources | ORM | Ecology | True | False |
| Industrial, commercial, and consumer solvent use | SOLV | EPA | False | True |
| Gasoline storage and transport [bulk operations] | PETROL | EPA | False | True |
| Gasoline storage and transport [vehicle refueling] | PETROL | Ecology | True | False |
| Paved and unpaved road dust [unpaved] | ROADS | Ecology | True | False |
| Paved and unpaved road dust [paved] | ROADS | EPA | True | True |
| Construction Dust | CONST | EPA | True | True |
| Dust from agricultural tilling and harvesting [Tilling] | TILL_HARV | EPA | True | True |
| Dust from agricultural tilling and harvesting [Harvesting] | TILL_HARV | Ecology | True | False |
| Livestock | LIVE | EPA | False | True |
| Fertilizer application | FERT | EPA | False | True |
| Food and kindred products | FOOD | EPA | False | True |
| Natural emissions from soil and vegetation | NAT | Ecology | N/A | False |
| Miscellaneous [Structure and Vehicle Fires] | MISC | Ecology | True | True |
| Miscellaneous [NEC] | MISC | EPA | False | True |



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# 2 Statistics Used Throughout the Inventory

## 2.1 County Demographics

Emissions estimation methods sometimes rely on surrogate parameters as indicators of activity. Population and occupied housing units (OHU) are two of the most common surrogates used. Estimates for 2020 below were obtained from the State Office of Financial Management (OFM).[2] The demographics are split into unincorporated and incorporated because rural/urban splits were not yet available for the 2020 Census.

**Table 2-1. Population and Occupied Housing Units**

| County | Incorp. Population | Unincorp. Population | Total Population | Incorp. OHU | Unincorp. OHU | Total OHU |
|---|---|---|---|---|---|---|
| Adams | 11,141 | 9,472 | 20,613 | 3,873 | 2,862 | 6,735 |
| Asotin | 8,365 | 13,920 | 22,285 | 3,795 | 6,239 | 10,034 |
| Benton | 170,317 | 36,556 | 206,873 | 67,266 | 12,810 | 80,076 |
| Chelan | 46,634 | 32,507 | 79,141 | 20,175 | 17,092 | 37,267 |
| Clallam | 31,319 | 45,836 | 77,155 | 15,343 | 22,587 | 37,930 |
| Clark | 270,263 | 233,048 | 503,311 | 110,468 | 84,568 | 195,036 |
| Columbia | 2,567 | 1,385 | 3,952 | 1,306 | 884 | 2,190 |
| Cowlitz | 62,391 | 48,339 | 110,730 | 26,229 | 19,195 | 45,424 |
| Douglas | 19,238 | 23,700 | 42,938 | 7,369 | 9,949 | 17,318 |
| Ferry | 992 | 6,186 | 7,178 | 531 | 3,528 | 4,059 |
| Franklin | 83,081 | 13,668 | 96,749 | 25,544 | 4,196 | 29,740 |
| Garfield | 1,389 | 897 | 2,286 | 713 | 481 | 1,194 |
| Grant | 54,136 | 44,987 | 99,123 | 20,948 | 17,687 | 38,635 |
| Grays Harbor | 46,643 | 28,993 | 75,636 | 23,137 | 12,921 | 36,058 |
| Island | 27,711 | 59,146 | 86,857 | 11,816 | 30,106 | 41,922 |
| Jefferson | 10,148 | 22,829 | 32,977 | 5,692 | 13,395 | 19,087 |
| King | 2,023,409 | 246,266 | 2,269,675 | 876,296 | 92,938 | 969,234 |
| Kitsap | 95,892 | 179,719 | 275,611 | 40,927 | 72,321 | 113,248 |
| Kittitas | 25,901 | 20,567 | 46,468 | 11,501 | 12,242 | 23,743 |
| Klickitat | 6,716 | 16,019 | 22,735 | 3,216 | 7,317 | 10,533 |
| Lewis | 32,688 | 49,461 | 82,149 | 13,665 | 21,747 | 35,412 |
| Lincoln | 5,586 | 5,290 | 10,876 | 2,611 | 3,121 | 5,732 |
| Mason | 10,371 | 55,355 | 65,726 | 3,887 | 29,382 | 33,269 |
| Okanogan | 16,161 | 25,943 | 42,104 | 7,405 | 14,315 | 21,720 |
| Pacific | 7,602 | 15,763 | 23,365 | 4,104 | 11,930 | 16,034 |
| Pend Oreille | 3,129 | 10,272 | 13,401 | 1,544 | 6,394 | 7,938 |
| Pierce | 490,882 | 430,248 | 921,130 | 203,036 | 156,453 | 359,489 |
| San Juan | 2,613 | 15,175 | 17,788 | 1,454 | 12,318 | 13,772 |
| Skagit | 76,917 | 52,606 | 129,523 | 31,492 | 24,252 | 55,744 |
| Skamania | 2,456 | 9,148 | 11,604 | 1,199 | 4,595 | 5,794 |
| Snohomish | 460,241 | 367,716 | 827,957 | 184,548 | 136,975 | 321,523 |
| Spokane | 380,815 | 158,524 | 539,339 | 162,826 | 61,193 | 224,019 |
| Stevens | 9,770 | 36,675 | 46,445 | 4,618 | 17,624 | 22,242 |
| Thurston | 149,937 | 144,856 | 294,793 | 63,854 | 57,584 | 121,438 |
| Wahkiakum | 560 | 3,862 | 4,422 | 308 | 1,881 | 2,189 |
| Walla Walla | 45,500 | 17,084 | 62,584 | 18,429 | 6,542 | 24,971 |
| Whatcom | 134,187 | 92,660 | 226,847 | 57,901 | 42,197 | 100,098 |
| Whitman | 42,044 | 5,929 | 47,973 | 18,168 | 2,754 | 20,922 |
| Yakima | 168,581 | 88,147 | 256,728 | 59,478 | 31,026 | 90,504 |
| State Total | 5,038,293 | 2,668,754 | 7,707,047 | 2,116,672 | 1,085,601 | 3,202,273 |



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# 3 Base Year 2020 Emissions Estimates

To estimate emissions, four sub-tasks were completed for each source category. The four tasks were: 1) estimate the activity level for 2020, 2) if necessary, adjust/allocate the activity level (or emissions) spatially to the county level, 3) determine emission rates per the activity, and 4) estimate emissions in tons per year (TPY). The tasks are described below for each source category. Emissions estimates are listed in Section 4.

## 3.1 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 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. Facilities that adopt these limits are called Synthetic Minor sources.

Local air agencies, Ecology regional offices, and Ecology's Industrial Section and Nuclear Waste Program (regulating authorities) regulate facilities in their jurisdictions according to state and local regulations and air operating permit programs. Emissions inventories are collected by Ecology annually from the facilities either directly or via the local air agency and EPA. All Title V sources (major) are included in the point source inventory.

EPA augments the point source data using a variety of sources including speciation profiles, the Toxics Release Inventory (TRI), airport reports, railyard estimates, landfill models, and other sources. Some of the augmented data was not accepted into Ecology's final inventory due to the possibility of double-counting emissions from sources. For instance, rail yards and airports were separated out of the EPA point source inventory. The final point source inventory is a combination of state, local, and federal estimates that represents a mutually exclusive list of point sources not represented in the other categories. The emissions for each individual point source in this category are available at:
https://ecology.wa.gov/Air-Climate/Air-quality/Air-quality-targets/Air-emissions-inventory

### 3.1.1 Activity Level

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

### 3.1.2 Spatial Allocation

Point sources are allocated to counties based on their address or geographic coordinates.

### 3.1.3 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.



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## 3.2 Onroad Mobile Sources

Onroad mobile source emissions are those generated by operating vehicles on public roadways. Emissions from fuel combustion and evaporation, and brake and tire wear were estimated. VOC emissions due to spillage and vapor displacement during refueling were calculated as part of the onroad methodology, but are included as part of the Gasoline Storage and Transport category (PETROL).

EPA's Motor Vehicle Emission Simulator (MOVES) model version 3.0 with database version 20220105 was used to calculate emissions. MOVES combines basic vehicle activity information with information about vehicle and fuel characteristics, emissions control programs, meteorological information, and other parameters to estimate emissions. The basic activity data are vehicle miles traveled (VMT) and vehicle population.

VMT, vehicle population, and a brief description of the MOVES input parameters are described below. The MOVES Technical Guidance for SIP inventories and the MOVES Overview were used in developing many of the inputs to MOVES.[3, 4] Detailed information about the MOVES input parameters is in a separate document.

Emissions were generated for the four seasons by choosing one month from the representative season to run – January for winter, April for spring, July for summer, and October for fall.

The MOVES3 default fleet includes no electric vehicles. MOVES3 allows users to input an appropriate fraction of electric vehicles. Ecology updated the fraction of electric vehicles as well as other vehicles based on the Washington State Department of Licensing registration data. It should be noted that there are no emission rates in MOVES3 for some vehicle types like electric motorcycles and electric motor homes. Emissions from those combinations are so small that can be negligible.

### 3.2.1 Vehicle Miles Traveled (VMT)

VMT are used in MOVES to calculate emissions while the vehicle is in motion or during short periods of idling. The source of county VMT data for 2020 used in this inventory was the Washington State Department of Transportation (WSDOT) under the national Department of Transportation's Highway Performance Monitoring System (HPMS).[5] HPMS is a system of traffic counts collected over several urban and rural sampling areas. WSDOT makes estimates of county VMT by roadway (functional) classification using the HPMS data (see Table 3-1 for rural roads and Table 3-2 for urban roads).

### 3.2.2 Vehicle Population

Vehicle population is used to calculate emissions while a vehicle is stationary. The emissions come from engine starts, extended idling, and some fuel evaporation processes. Vehicles are classified by age and type. There are thirteen vehicle types in MOVES within six broader categories: cars, motorcycles, light-duty trucks, heavy-duty single unit trucks, heavy-duty combination unit trucks, and buses.

Three sources were used to calculate vehicle population (see Table 3-3). The first was the Washington State Department of Licensing (DOL). DOL registers non-governmental vehicles annually.[6] Government vehicles have a one-time registration. DOL does not register public transit and school buses each year, so alternate sources of information were used. Transit and intercity bus data came from the MOVES default database. School bus information for 2020

was obtained from the Washington State Office of the Superintendent of Public Instruction (OSPI)..[7]

**Table 3-1. Average Daily VMT for Rural Roads**

*(All Values in Thousands)*

| County | Interstate | Other Freeway / Expressway | Other Principal Arterial | Minor Arterial | Major Collector | Minor Collector | Local |
|---|---|---|---|---|---|---|---|
| Adams | 592 | 478 | 0 | 0 | 151 | 42 | 89 |
| Asotin | 0 | 22 | 0 | 16 | 24 | 9 | 20 |
| Benton | 690 | 0 | 0 | 231 | 119 | 82 | 40 |
| Chelan | 0 | 238 | 339 | 235 | 163 | 38 | 57 |
| Clallam | 0 | 48 | 316 | 1 | 349 | 88 | 51 |
| Clark | 640 | 4 | 36 | 166 | 361 | 101 | 45 |
| Columbia | 0 | 0 | 74 | 0 | 56 | 9 | 30 |
| Cowlitz | 1,316 | 0 | 43 | 162 | 159 | 51 | 63 |
| Douglas | 0 | 148 | 178 | 45 | 74 | 30 | 101 |
| Ferry | 0 | 0 | 27 | 46 | 117 | 17 | 94 |
| Franklin | 0 | 533 | 0 | 0 | 208 | 55 | 55 |
| Garfield | 0 | 2 | 78 | 0 | 33 | 18 | 22 |
| Grant | 615 | 335 | 91 | 350 | 348 | 154 | 158 |
| Grays | 0 | 205 | 265 | 230 | 210 | 49 | 67 |
| Island | 0 | 18 | 358 | 128 | 105 | 100 | 33 |
| Jefferson | 0 | 140 | 300 | 113 | 88 | 88 | 57 |
| King | 1,117 | 295 | 325 | 485 | 480 | 293 | 54 |
| Kitsap | 0 | 157 | 228 | 63 | 255 | 54 | 25 |
| Kittitas | 2,176 | 0 | 169 | 5 | 165 | 77 | 99 |
| Klickitat | 0 | 28 | 252 | 69 | 180 | 27 | 82 |
| Lewis | 544 | 102 | 261 | 192 | 264 | 53 | 90 |
| Lincoln | 284 | 73 | 87 | 75 | 128 | 18 | 116 |
| Mason | 0 | 196 | 335 | 43 | 308 | 63 | 43 |
| Okanogan | 0 | 221 | 123 | 325 | 191 | 127 | 240 |
| Pacific | 0 | 15 | 178 | 168 | 167 | 24 | 56 |
| Pend | 0 | 45 | 71 | 111 | 44 | 27 | 63 |
| Pierce | 300 | 0 | 24 | 593 | 189 | 39 | 68 |
| San Juan | 0 | 0 | 0 | 0 | 88 | 41 | 17 |
| Skagit | 788 | 105 | 116 | 269 | 453 | 91 | 58 |
| Skamania | 0 | 19 | 164 | 42 | 61 | 22 | 41 |
| Snohomish | 609 | 101 | 278 | 506 | 311 | 149 | 64 |
| Spokane | 332 | 326 | 227 | 237 | 585 | 175 | 129 |
| Stevens | 0 | 142 | 273 | 100 | 258 | 68 | 189 |
| Thurston | 510 | 237 | 37 | 176 | 443 | 52 | 63 |
| Wahkiakum | 0 | 0 | 67 | 0 | 23 | 3 | 18 |
| Walla Walla | 0 | 135 | 223 | 112 | 135 | 28 | 41 |
| Whatcom | 346 | 18 | 76 | 179 | 657 | 127 | 65 |
| Whitman | 0 | 205 | 259 | 8 | 213 | 35 | 110 |
| Yakima | 731 | 27 | 188 | 157 | 623 | 150 | 249 |
| State Total | 11,589 | 4,616 | 6,067 | 5,635 | 8,787 | 2,674 | 2,963 |



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**Table 3-2. Average Daily VMT for Urban Roads**

*(All Values in Thousands)*

| County | Interstate | Other Freeway/ Express | Other Principal Arterial | Minor Arterial | Major Collector | Minor Collector | Local |
|---|---|---|---|---|---|---|---|
| Adams | 0 | 21 | 0 | 29 | 8 | 2 | 18 |
| Asotin | 0 | 6 | 42 | 85 | 26 | 0 | 20 |
| Benton | 567 | 580 | 601 | 616 | 320 | 25 | 317 |
| Chelan | 0 | 138 | 150 | 242 | 70 | 2 | 81 |
| Clallam | 0 | 60 | 263 | 80 | 123 | 20 | 82 |
| Clark | 1,799 | 1,133 | 1,241 | 1,007 | 393 | 33 | 689 |
| Columbia | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cowlitz | 562 | 84 | 263 | 283 | 112 | 2 | 148 |
| Douglas | 0 | 153 | 147 | 74 | 39 | 1 | 52 |
| Ferry | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Franklin | 392 | 187 | 153 | 164 | 71 | 2 | 131 |
| Garfield | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grant | 101 | 126 | 117 | 173 | 51 | 7 | 94 |
| Grays | 0 | 228 | 297 | 82 | 122 | 20 | 110 |
| Island | 0 | 0 | 156 | 148 | 47 | 8 | 54 |
| Jefferson | 0 | 0 | 54 | 0 | 53 | 0 | 32 |
| King | 11,193 | 4,298 | 7,991 | 6,190 | 2,736 | 87 | 3,824 |
| Kitsap | 0 | 1,528 | 642 | 708 | 294 | 23 | 405 |
| Kittitas | 101 | 3 | 82 | 65 | 33 | 8 | 25 |
| Klickitat | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lewis | 799 | 0 | 111 | 161 | 47 | 7 | 59 |
| Lincoln | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mason | 0 | 44 | 127 | 9 | 62 | 0 | 30 |
| Okanogan | 0 | 21 | 0 | 49 | 4 | 9 | 21 |
| Pacific | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pend Oreille | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pierce | 2,905 | 2,750 | 3,825 | 2,892 | 967 | 9 | 1,741 |
| San Juan | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skagit | 392 | 161 | 317 | 352 | 160 | 6 | 170 |
| Skamania | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Snohomish | 4,188 | 1,344 | 2,357 | 1,808 | 988 | 26 | 1,412 |
| Spokane | 1,904 | 285 | 2,669 | 1,298 | 410 | 37 | 821 |
| Stevens | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Thurston | 1,636 | 356 | 742 | 928 | 284 | 4 | 486 |
| Wahkiakum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Walla Walla | 0 | 169 | 118 | 140 | 48 | 1 | 59 |
| Whatcom | 714 | 6 | 377 | 565 | 347 | 16 | 265 |
| Whitman | 0 | 0 | 99 | 43 | 36 | 8 | 24 |
| Yakima | 552 | 286 | 748 | 647 | 268 | 22 | 303 |
| State Total | 27,805 | 13,967 | 23,689 | 18,840 | 8,120 | 385 | 11,470 |



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**Table 3-3. Vehicle Population, 2020**

| County | Motorcycles | Cars | Light Trucks | Buses | Single Unit Trucks | Combi-nation Unit Trucks | Total |
|---|---|---|---|---|---|---|---|
| Adams | 388 | 8,867 | 10,861 | 174 | 730 | 115 | 21,135 |
| Asotin | 840 | 9,409 | 11,526 | 46 | 941 | 127 | 22,889 |
| Benton | 6,654 | 87,253 | 106,879 | 535 | 7,879 | 1,156 | 210,356 |
| Chelan | 3,402 | 36,332 | 44,503 | 239 | 3,214 | 447 | 88,137 |
| Clallam | 2,710 | 34,830 | 42,664 | 207 | 3,659 | 432 | 84,502 |
| Clark | 13,554 | 204,193 | 250,121 | 1,162 | 17,300 | 2,807 | 489,137 |
| Columbia | 158 | 1,872 | 2,293 | 23 | 169 | 24 | 4,539 |
| Cowlitz | 3,964 | 51,099 | 62,593 | 485 | 4,427 | 621 | 123,189 |
| Douglas | 1,615 | 18,784 | 23,009 | 149 | 1,727 | 246 | 45,530 |
| Ferry | 258 | 3,486 | 4,270 | 46 | 361 | 44 | 8,465 |
| Franklin | 1,960 | 39,721 | 48,654 | 318 | 3,306 | 544 | 94,503 |
| Garfield | 58 | 1,058 | 1,296 | 19 | 101 | 13 | 2,545 |
| Grant | 2,834 | 43,111 | 52,807 | 427 | 3,927 | 563 | 103,669 |
| Grays Harbor | 2,415 | 32,816 | 40,197 | 266 | 3,046 | 420 | 79,160 |
| Island | 4,538 | 42,010 | 51,459 | 157 | 3,697 | 481 | 102,342 |
| Jefferson | 1,419 | 16,277 | 19,939 | 106 | 1,657 | 181 | 39,579 |
| King | 42,761 | 790,405 | 968,183 | 4,471 | 69,536 | 12,709 | 1,888,065 |
| Kitsap | 11,678 | 116,758 | 143,019 | 579 | 10,591 | 1,531 | 284,156 |
| Kittitas | 2,165 | 20,658 | 25,304 | 301 | 2,056 | 271 | 50,755 |
| Klickitat | 948 | 11,248 | 13,778 | 125 | 949 | 128 | 27,176 |
| Lewis | 3,191 | 41,628 | 50,990 | 347 | 3,416 | 451 | 100,023 |
| Lincoln | 446 | 5,489 | 6,723 | 133 | 525 | 62 | 13,378 |
| Mason | 3,099 | 32,691 | 40,043 | 235 | 3,089 | 369 | 79,526 |
| Okanogan | 1,320 | 18,704 | 22,911 | 170 | 1,711 | 243 | 45,059 |
| Pacific | 774 | 11,020 | 13,498 | 114 | 1,039 | 123 | 26,568 |
| Pend Oreille | 557 | 6,850 | 8,391 | 64 | 670 | 77 | 16,609 |
| Pierce | 27,006 | 344,047 | 421,429 | 2,106 | 31,386 | 5,064 | 831,038 |
| San Juan | 856 | 9,381 | 11,491 | 22 | 734 | 98 | 22,582 |
| Skagit | 5,201 | 60,961 | 74,673 | 452 | 5,595 | 734 | 147,616 |
| Skamania | 497 | 6,064 | 7,429 | 47 | 534 | 69 | 14,640 |
| Snohomish | 26,192 | 326,827 | 400,337 | 1,844 | 28,748 | 4,668 | 788,616 |
| Spokane | 16,782 | 209,536 | 256,664 | 1,207 | 19,425 | 2,938 | 506,552 |
| Stevens | 1,978 | 23,216 | 28,438 | 210 | 2,119 | 258 | 56,219 |
| Thurston | 10,738 | 126,632 | 155,115 | 797 | 11,094 | 1,636 | 306,012 |
| Wahkiakum | 146 | 2,254 | 2,761 | 20 | 203 | 24 | 5,408 |
| Walla Walla | 2,105 | 24,468 | 29,971 | 176 | 2,323 | 351 | 59,394 |
| Whatcom | 7,143 | 96,322 | 117,986 | 522 | 9,804 | 1,282 | 233,059 |
| Whitman | 1,010 | 14,861 | 18,203 | 183 | 1,670 | 284 | 36,211 |
| Yakima | 5,406 | 110,813 | 135,737 | 712 | 9,517 | 1,452 | 263,637 |
| State Total | 218,766 | 3,041,951 | 3,726,145 | 19,196 | 272,875 | 43,043 | 7,321,976 |



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### 3.2.3 MOVES Input Parameters

MOVES includes a default database that summarizes emissions relevant information for all counties in the United States. Default data may be replaced by local data to improve the estimates. Ecology developed local data for many of the parameters in MOVES.

Input parameters were developed that were characteristic of local conditions for each county and month. Some of the parameters presented here required local data. For others, EPA guidance recommended that local data be used. The parameters are shown in the table below. Note that Pierce County is known to have a transit bus system that uses Compressed Natural Gas, which was updated in the MOVES parameters. Also, Clark County fuel parameters were changed to use Oregon's fuel formulation.

**Table 3-4. MOVES Model Parameters**

| MOVES Table | Parameter | Data Source | References |
|---|---|---|---|
| sourcetypeyear, avft | Vehicle population | DOL, OSPI, FTA | 6, 7, 8 |
| hpmsvtypeyear | VMT | WSDOT and MOVES | 5, 8 |
| hourvmtfraction, dayvmtfraction, monthvmtfraction | Temporal allocation to month, day, and hour | WSDOT and MOVES | 9 |
| moves3_levs_wa | California Emissions Standards | MOVES | 10 |
| fuelsupply, fuelformulation, fuelusagefraction | Fuel parameters | MOVES | N/A |
| zonemonthhour | Hourly temperatures and relative humidity | MOVES | N/A |
| roadtypedistribution | Road type distribution | WSDOT and MOVES | 5, 8 |
| sourcetypeagedistribution | Vehicle age distribution | DOL, OSPI, FTA | 6, 7, 8 |
| avgspeeddistribution | Speeds | MOVES Default | N/A |
| refuelingfactors | Vehicle refueling | MOVES Default | N/A |

### 3.2.4 Road Dust

Dust emissions are generated as vehicles pass along 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 road dust calculation excludes emissions from exhaust and brake and tire wear, which are estimated as part of the onroad mobile sources emissions. Road dust is not calculated by MOVES, but the calculations do use VMT inputs as the basis. Paved road VMT was obtained from a WSDOT HPMS report for 2020, which included rural/urban and functional road class categories, shown in the tables above. Note that the HPMS Average Daily VMT (ADVMT) estimate includes travel over both paved and unpaved roads; however, they are not distinguished from one another. A slight



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overestimation of ADVMT does occur when using HPMS ADVMT as the paved road activity level. The overestimation is not significant, though, since unpaved ADVMT is only estimated to be 0.5% of the entire ADVMT. Unpaved road VMT was pulled forward from the 2017 Comprehensive EI (see Table 3-5). Both paved and unpaved VMT was submitted to EPA for calculations, which are explained in detail in the EPA NEI TSD[1]. However, Ecology made an error in the VMT submittal to EPA and had to correct the emissions estimates which are not reflected in the NEI.

**Table 3-5. ADVMT on Unpaved Roads – Total of County and City Jurisdictions**

| County | VMT |
|---|---|
| Adams | 35,827 |
| Asotin | 6,599 |
| Benton | 12,410 |
| Chelan | 6,523 |
| Clallam | 806 |
| Clark | 1,049 |
| Columbia | 15,577 |
| Cowlitz | 281 |
| Douglas | 73,826 |
| Ferry | 19,040 |
| Franklin | 35,518 |
| Garfield | 18,463 |
| Grant | 62,617 |
| Grays Harbor | 3,733 |
| Island | 169 |
| Jefferson | 4,670 |
| King | 55,866 |
| Kitsap | 3,619 |
| Kittitas | 4,254 |
| Klickitat | 16,153 |
| Lewis | 2,173 |
| Lincoln | 49,632 |
| Mason | 2,969 |
| Okanogan | 30,731 |
| Pacific | 3,938 |
| Pend Oreille | 21,194 |
| Pierce | 3,270 |
| San Juan | 1,454 |
| Skagit | 2,821 |
| Skamania | 1,400 |
| Snohomish | 1,750 |
| Spokane | 108,113 |
| Stevens | 44,644 |
| Thurston | 4,813 |
| Wahkiakum | 743 |
| Walla Walla | 13,043 |
| Whatcom | 5,048 |



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| County | VMT |
|---|---|
| Whitman | 51,997 |
| Yakima | 58,457 |
| State Total | 785,189 |

### 3.3 Construction Dust

Construction dust was estimated by the EPA Nonpoint Methods Advisory Committee (NOMAD) for road construction, residential construction, and nonresidential construction. Construction dust emissions are based on the total amount of soil disturbed. Additionally, each of the three categories had emissions corrected using silt content and soil moisture parameters. EPA used the National Cooperative Soil Survey to develop county-level silt content values and Ecology provided soil moisture parameters derived from 22 airport weather stations across the state.

#### 3.3.1 Activity Level

Road construction activity was estimated by EPA using the Federal Highway Administration's Highway Statistics for New Construction, Relocation, Added Capacity, Major Widening, and Minor Widening. These categories were also differentiated according to the road type. The State expenditure data were then converted to new miles of road constructed using $/mile conversions obtained from the Florida Department of Transportation (FLDOT) Cost Per Mile model for 2020. A conversion of $9.6 million/mile is applied to the urban interstate expenditures and a conversion of $4.8 million/mile is applied to the rural interstate expenditures. For expenditures on other urban arterial and collectors, a conversion factor of $4.8 million/mile is applied. For expenditures on other rural arterial and collectors, a conversion factor of $2.6 million/mile is applied. The new miles of road constructed are used to estimate the acreage disturbed due to road construction. The total area disturbed in each state is calculated by converting the new miles of road constructed to acres using an acres disturbed/mile conversion factor for each road type which ranges from 6.6 to 11.4 acres disturbed per mile of constructed road.

Residential construction activity was estimated by EPA using acres of surface soil disturbed and volume of soil removed for basements. Surface soil disturbed was estimated using the 2020 *New Privately Owned Housing Units Started by Purpose and Design*.[11] dataset from the US Census Bureau. The amount of soil removed were assumed to be ¼ acre, 1/3 acre, and ½ acre for 1-unit, 2-unit, and apartment structures, respectively. To calculate basement soil removal, the 2020 table of *Characteristics of New Single-Family Houses Completed, Foundation* [12] was used by EPA to estimate the percentage of 1 unit structures that have a basement (on the regional level). The county level estimate of number of 1-unit starts was multiplied by the percent of 1 unit houses in the region that have a basement to get the number of basements in a county. Basement volume was calculated by assuming a 2000 square foot house has a basement dug to a depth of 8 feet (making 16,000 $ft^3$ per basement). An additional 10% is added for peripheral dirt bringing the total to 17,600 $ft^3$ (651.85 $yd^3$) per basement.

Non-residential construction activity was estimated by EPA using acres disturbed and were estimated by multiplying the value of non-residential construction put in place (obtained from the US Census Bureau) by the number of acres disturbed per million dollars. EPA used a factor of 0.84 acres/$1 million to convert from dollars to acres disturbed.



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### 3.3.2 Spatial Allocation

Building permits were used by EPA to allocate the state-level acres disturbed by road construction to the county level. A ratio of the number of building starts in each county to the total number of building starts in each state was applied to the state-level acres disturbed to estimate the total number of acres disturbed by road construction in each county.

Residential construction activity data was already at the county level, so no spatial adjustment was needed.

The national value of non-residential construction put in place was allocated to counties using county-level non-residential construction employment data obtained from the US Census Bureau.

### 3.3.3 Emission Rates

Initial $PM_{10}$ emissions from construction of roads were calculated by EPA using an emission factor of 0.42 tons/acre-month. This emission factor represents the large amount of dirt moved during the construction of roadways, reflecting the high level of cut and fill activity that occurs at road construction sites. The duration of construction activity for road construction is assumed to be 12 months.

Initial $PM_{10}$ emissions from construction of residential structures were calculated using emission factors that ranged from 0.032 tons PM10/acre-month (1-unit structures without basements) to 0.11 tons PM10/acre-month (apartments). The duration of construction activity for houses was assumed to be 6 months and the duration of construction for apartments was assumed to be 12 months.

Initial $PM_{10}$ emissions from construction of non-residential buildings were calculated by EPA using an emission factor of 0.19 tons/acre-month. The duration of construction activity for non-residential construction is assumed to be 11 months.

Regional variances in construction emissions were corrected using soil moisture level and silt content. To account for the silt content, the $PM_{10}$ emissions are weighted using average silt content for each county. EPA used the National Cooperative Soil Survey Microsoft Access Soil Characterization Database to develop county-level, average silt content values for surface soil. To account for the soil moisture level, the $PM_{10}$ emissions were weighted using a county-specific 30-year average precipitation-effectiveness (PE) value calculated by Ecology. Table 3-6 shows the PE Index values submitted by Ecology.

### 3.3.4 Emissions Estimates

The equation for $PM_{10}$ emissions corrected for soil moisture and silt content is:

$$Corrected\ E_{PM10} = Initial\ \mathrm{E}_{PM10} \times \frac{24}{PE} \times \frac{S}{9\%}$$

where:

Corrected $E_{PM10}$ = $PM_{10}$ emissions corrected for soil moisture and silt content,
PE = precipitation-evaporation value for each county,
S = % dry silt content in soil for area being inventoried.

Once $PM_{10}$ adjustments were made, $PM_{2.5}$ emissions were set to 10% of $PM_{10}$.



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**Table 3-6. Precipitation Effectiveness Index Values**

| County | PE-Index |
|---|---|
| Adams | 17.6 |
| Asotin | 28.2 |
| Benton | 14.5 |
| Chelan | 18.9 |
| Clallam | 87.5 |
| Clark | 92.5 |
| Columbia | 41.5 |
| Cowlitz | 99.7 |
| Douglas | 18.9 |
| Ferry | 41.7 |
| Franklin | 14.5 |
| Garfield | 28.2 |
| Grant | 17.6 |
| Grays Harbor | 182.9 |
| Island | 96.5 |
| Jefferson | 87.5 |
| King | 113.2 |
| Kitsap | 159.5 |
| Kittitas | 20.2 |
| Klickitat | 37.6 |
| Lewis | 99.7 |
| Lincoln | 17.6 |
| Mason | 216.4 |
| Okanogan | 41.7 |
| Pacific | 182.9 |
| Pend Oreille | 41.7 |
| Pierce | 113.2 |
| San Juan | 22.3 |
| Skagit | 96.5 |
| Skamania | 92.5 |
| Snohomish | 96.5 |
| Spokane | 48.4 |
| Stevens | 41.7 |
| Thurston | 142.5 |
| Wahkiakum | 99.7 |
| Walla Walla | 41.5 |
| Whatcom | 87.7 |
| Whitman | 60.3 |
| Yakima | 18.0 |



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### 3.4 Nonroad Mobile Vehicles and Equipment (NEC)

Nonroad mobile emissions estimates account for exhaust from nonroad mobile vehicles and equipment that combust fuel. However, nonroad mobile emissions for commercial ships, seaport support equipment, locomotives, and aircraft are estimated separately and thus not included here. Each nonroad sector includes multiple equipment types and horsepower classes. The sectors included in Ecology's nonroad mobile category and corresponding examples are listed in the table below. Note that recreational marine vessels are discussed here but their emissions are listed separately in the BOAT category.

**Table 3-7. Sectors Included in Ecology's Nonroad Mobile Category**

| Sector | Examples |
|---|---|
| Agricultural Equipment | Tractors, Combines, Tillers, etc. |
| Airport Support Equipment | Ground Support, Servicing Aircraft |
| Commercial Equipment | Pumps, Compressors, Welders, etc. |
| Construction Equipment | Crushers, Pavers, Backhoes, etc. |
| Industrial Equipment | Forklifts, Scrubbers, Tractors, etc. |
| Lawn and Garden Equipment | Chainsaws, Blowers, Lawn Mowers, etc. |
| Logging Equipment | Chainsaws, Shredders, etc. |
| Oil Field Equipment | Pumps, Tanks, Pipelines, etc. |
| Pleasure Craft | Pleasure Craft, Personal Boats |
| Railroad Maintenance Equipment | Railway Maintenance Equipment |
| Recreational Equipment | Snowmobiles, ATVs, Golf Carts, etc. |
| Underground Mining Equipment | Trucks, Loaders, Shovels, etc. |

EPA's Motor Vehicle Emission Simulator (MOVES) model version 3.0 with database version 20220105 was used to estimate nonroad emissions. MOVES combines basic nonroad activity information with information about equipment, vehicle and fuel characteristics, emissions control programs, meteorological information, and other parameters to estimate emissions.

#### 3.4.1 MOVES Input Parameters

MOVES includes a default database that summarizes emissions-relevant information for all counties in the United States. Default data may be replaced by local data to improve the estimates. Default data was used for all parameters except the recreational marine vessel spatial surrogate. Note that despite using the same defaults as EPA, and EPA using the updated spatial surrogates, Ecology values do not exactly match EPA NEI since Ecology simulated seasons.

The default surrogate for recreational marine vessels is water surface area. Water surface area can overestimate recreational boat usage in counties with large areas of open water (e.g., Clallam). Spatial allocation from state to county was not based on defaults (water area) and



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instead based on county boat registrations. Boat registrations for 2017 were provided by the Washington Department of Licensing[13], shown in Table 3-8.

### 3.4.2 Emission Rates

Emissions were generated by the model for the four seasons by choosing one month from the representative season to run – January for winter, April for spring, July for summer, and October for fall.

**Table 3-8. Boats Registered**

| County | Inboard | Outboard |
|---|---|---|
| Adams | 15 | 436 |
| Asotin | 23 | 812 |
| Benton | 402 | 6,696 |
| Chelan | 339 | 3,869 |
| Clallam | 655 | 2,748 |
| Clark | 809 | 11,119 |
| Columbia | 5 | 142 |
| Cowlitz | 310 | 4,235 |
| Douglas | 105 | 1,985 |
| Ferry | 29 | 353 |
| Franklin | 111 | 2,469 |
| Garfield | 4 | 94 |
| Grant | 172 | 4,288 |
| Grays Harbor | 198 | 2,219 |
| Island | 1,127 | 4,196 |
| Jefferson | 853 | 1,647 |
| King | 10,090 | 34,574 |
| Kitsap | 2,621 | 7,412 |
| Kittitas | 121 | 1,473 |
| Klickitat | 53 | 593 |
| Lewis | 221 | 2,290 |
| Lincoln | 102 | 980 |
| Mason | 539 | 3,768 |
| Okanogan | 85 | 1,464 |
| Pacific | 166 | 800 |
| Pend Oreille | 30 | 998 |
| Pierce | 3,433 | 19,238 |
| San Juan | 1,168 | 1,385 |
| Skagit | 1,844 | 5,165 |
| Skamania | 35 | 398 |
| Snohomish | 4,112 | 19,291 |
| Spokane | 661 | 14,215 |
| Stevens | 198 | 3,124 |
| Thurston | 1,328 | 7,141 |
| Wahkiakum | 63 | 346 |
| Walla Walla | 71 | 1,447 |
| Whatcom | 2,200 | 5,515 |



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| County | Inboard | Outboard |
|---|---|---|
| Whitman | 37 | 920 |
| Yakima | 245 | 4,628 |
| State Total | 34,580 | 184,473 |

### 3.5 Locomotives

Emissions from Class I line-haul and switch yard locomotives were estimated using EPA guidance and information from the railroads. U.S. Class I railroads are line-haul freight railroads with operating revenue in excess of $250 million or more after applying the revenue deflator formula which adjusts for inflation using the Railroad Freight Price Index relative to 1991 ($900.0 million in 2020).[14, 15, 16, 17, 18] The Class I railroads that operate in Washington are Burlington Northern Santa Fe Railway (BNSF) and Union Pacific Railroad (UP). Amtrak passenger train emissions were also included in this inventory. Note that EPA estimated Class I, 2 and 3 line-haul locomotive emissions as part of the 2020 NEI, which was accepted by Ecology. Ecology calculated switch yard locomotive emissions.

#### 3.5.1 Activity Level

Activity level is measured in gallons of diesel consumed by locomotives. BNSF provided 2020 fuel use for switch yard locomotives by location, summarized in Table 3-9.[19] Amtrak and UP have switch yards in King and Pierce County, but did not provide fuel use data. Ecology used EPA's switch yard locomotive fuel estimates for King and Pierce counties, which included all three railroads.

**Table 3-9. BNSF Switch Yard Locomotives Fuel Consumption (gallons)**

| County | Fuel Consumption (gallons) |
|---|---|
| Benton | 4870 |
| Chelan | 13840 |
| Clark | 195,020 |
| Cowlitz | 35,590 |
| Franklin | 723,330 |
| Grant | 1230 |
| King | 1,156,246 |
| Klickitat | 4390 |
| Lewis | 23,040 |
| Lincoln | 2880 |
| Pierce | 1,099,596 |
| Skagit | 1,980 |
| Skamania | 1400 |
| Snohomish | 195,910 |
| Spokane | 438,150 |
| Stevens | 2,270 |
| Walla Walla | 2,260 |
| Whatcom | 18,380 |
| Yakima | 185,250 |
| ***State Total*** | ***4,105,632*** |



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### 3.5.2 Emission Rates

Emission factors (shown in Table 3-10) were taken from EPA documentation..[20]

**Table 3-10. Switch Yard Locomotives Emission Factors (grams per gallon of fuel consumed)**

| Pollutant | Emission Factor (g/gal) |
|---|---|
| Volatile Organic Compounds | 12.97662 |
| Carbon Monoxide | 27.816 |
| Nitrogen Oxides | 199.83548 |
| $PM_{2.5}$ | 5.0870182 |
| $PM_{10}$ | 5.2443486 |
| Sulfur Dioxide | 0.0939 |
| Ammonia | 0.0833 |

### 3.5.3 Emissions Estimates

For switch yard locomotives emissions calculated with emission factors, the equation used was:

TPY = (fuel use in gallon) x (emission factor in g/gal of fuel) x 1.1E-6 tons/gram



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## 3.6 Silvicultural Burning (Prescribed Burning)

Silvicultural burning, also discussed as prescribed burning, includes rangeland burns, logging debris burns and forest health burns. It does not include land clearing nor agricultural burns. Silvicultural burning is done by the Department of Natural Resources (DNR), Department of Fish & Wildlife (WDFW), U.S. Forest Service (USFS), Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS), and private industry.

### 3.6.1 Activity Level and Emission Rates

Prescribed burns are conducted either as pile burns, understory burns, or broadcast burns. Activity for pile burns is reported as tons of material burned while understory and broadcast burns are reported as "acres burned" and have a corresponding fuel loading (tons/acre) from which tons of material burned is calculated. Emissions for silvicultural burns were calculated using historical emission factors that were applied to the tonnage burned.

The amount and type of material burned was primarily obtained from the DNR completed burns database. Burn permits were not available for prescribed burns done by the BIA. Furthermore, the DNR completed burns database was incomplete and contained errors, for which some gap-filling was done based on DNR planned burn database and HMS satellite hot-spot detects. Some prescribed burn location data was also obtained from EPA, based on HMS satellite detected hot-spots, Forest Service Activity Tracking System (FACTS) database, and the USFWS database. The HMS locations and prescribed burn data from EPA was spatiotemporally cross-checked against the DNR data to avoid double-counting. All HMS and EPA data added to the prescribed burn database were assumed to be 100 tons (the maximum burn size allowed without a DNR permit).

**Table 3-11. Silvicultural Burning Emission Factors (pounds per ton consumed)**

| Pollutant | EF |
|---|---|
| $PM_{10}$ | 15.5 |
| $PM_{2.5}$ | 13.5 |
| CO | 76 |
| $NO_X$ | 4 |
| VOC | 19 |
| SO2 | 0.1 |

### 3.6.2 Spatial Adjustments

No spatial adjustments were necessary. All burns were identified either by their coordinates or by county and Public Land Survey System (PLSS) legal description (i.e. section-township-range).

### 3.6.3 Emissions Estimates

Prescribed burn emissions were calculated assuming 100% combustion completeness:

TPY = (tons burned) x (pollutant lb/T) x (1 T/2000 lb)



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**Table 3-12. Silvicultural Burning Activity**

| County | Forest Burns (Tons) | Rangeland Burns (Tons) |
|---|---|---|
| Adams | | 400 |
| Asotin | 100 | |
| Benton | | 2,000 |
| Chelan | 2,824 | |
| Clallam | 16,654 | |
| Clark | 1,893 | |
| Columbia | 319 | |
| Cowlitz | 5,879 | |
| Douglas | 1,898 | 300 |
| Ferry | 43,138 | |
| Franklin | | 100 |
| Garfield | | |
| Grant | | 600 |
| Grays Harbor | 23,917 | |
| Island | 130 | |
| Jefferson | 11,207 | |
| King | 756 | |
| Kitsap | | |
| Kittitas | 1,320 | 1,000 |
| Klickitat | 30,259 | 200 |
| Lewis | 17,878 | |
| Lincoln | 700 | 200 |
| Mason | 3,750 | |
| Okanogan | 9,654 | |
| Pacific | 6,571 | |
| Pend Oreille | 14,173 | |
| Pierce | 9,010 | |
| San Juan | 216 | |
| Skagit | 15,601 | |
| Skamania | 3,775 | |
| Snohomish | 6,956 | |
| Spokane | 11,498 | |
| Stevens | 41,481 | |
| Thurston | 1,130 | |
| Wahkiakum | 811 | |
| Walla Walla | | 600 |
| Whatcom | 12,924 | |
| Whitman | | 100 |
| Yakima | 15,941 | 900 |
| State Total | 312,363 | 6,400 |



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## 3.7 Wildfires

Wildfire emissions were initially estimated for the 2020 EPA NEI by an EPA contractor. The Satellite Mapping Automatic Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) v2 was used to estimate fire location and size, while the BlueSky Pipeline modeling framework was used to estimate the resultant emissions. The EPA effort used SMARTFIRE v2 to combine fire locations reported by the following sources: Incident Command Summary (ICS-209) reports, the National Oceanic and Atmospheric Administration (NOAA) Hazard Mapping System (HMS), the National Wildfire Coordinating Group (NWCG) National Incident Feature Service (NIFS), the US Fish and Wildlife Service (USFWS) prescribed burn database, and the Department of Interior (DOI) Integrated Reporting of Wildland Fire Information (IRWIN) database. All fire locations detected by HMS that were within the boundaries of the USDA Cropland Data Layer (CDL) were classified as agricultural burns, except for pasture land. All remaining fire locations detected by HMS were classified as wildfire if they occurred between July 6 and September 20 and there was no other information available.

### 3.7.1 Activity Level

Ecology reviewed the EPA's wildfire and prescribed fire emissions estimates and found many errors with fire type, location, and size. Some of these errors occurred presumably due to complications with SMARTFIRE, which was not developed to handle many sources of input. Other errors occurred because EPA removed data sources: HMS fire locations were removed if snow was on the ground, the National Interagency Fire Center (NIFC) perimeters were not used, and all HMS fire locations were moved to agricultural fire if they occurred on cropland. The EPA wildfire emissions data was corrected after crosschecking against InciWeb reports, the WildCAD online system, DNR prescribed burn reports, HMS fire locations, and perimeters from NIFC. The county level estimate of wildfire area burned is shown in Table 3-13. Washington's largest wildfires in 2020 are shown in Table 3-14.

### 3.7.2 Spatial Adjustments

No spatial adjustments were necessary. All fire locations were identified by their coordinates.

### 3.7.3 Emissions Estimates

The BlueSky modeling framework incorporates a variety of modeling components to determine emissions. This effort simulated emissions in BlueSky using the following model pathway: the Fuel Characteristic Classification System (FCCS) v3 to determine fuel loading, the Consume v5 model to estimate the percentage of fuels consumed, and the Fire Emission Production Simulator (FEPS) v2 to estimate total emissions by pollutant type. EPA used the BlueSky default fuel moisture settings, so emissions scale linearly with area burned for each fuel type. The EPA BlueSky emissions were used for kept locations and to derive emission factors (lbs/acre burned by fuel type) to be used for additional fire locations. Fire locations that weren't in the original EPA dataset were assigned a representative fuel type for the region of interest, so that emissions could be calculated.



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**Table 3-13. Wildfire Area Burned by County (acres)**

| County | Area Burned |
|---|---|
| Adams | 801 |
| Asotin | 57 |
| Benton | 5,419 |
| Chelan | 14,230 |
| Clallam | 91 |
| Clark | 274 |
| Columbia | 501 |
| Cowlitz | 102 |
| Douglas | 231,514 |
| Ferry | 21,679 |
| Franklin | 23,010 |
| Garfield | 0 |
| Grant | 9,636 |
| Grays Harbor | 6 |
| Island | 0 |
| Jefferson | 29 |
| King | 132 |
| Kitsap | 3 |
| Kittitas | 19,298 |
| Klickitat | 488 |
| Lewis | 35 |
| Lincoln | 125,884 |
| Mason | 13 |
| Okanogan | 223,489 |
| Pacific | 3 |
| Pend Oreille | 168 |
| Pierce | 1,840 |
| San Juan | 1 |
| Skagit | 15 |
| Skamania | 24,209 |
| Snohomish | 5,716 |
| Spokane | 1,298 |
| Stevens | 559 |
| Thurston | 645 |
| Wahkiakum | 2 |
| Walla Walla | 394 |
| Whatcom | 106 |
| Whitman | 34,822 |
| Yakima | 96,707 |
| State Total | 843,177 |



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**Table 3-14. Largest Wildfires in Washington**

| Fire Name | Area Burned (Acres) | Counties |
|---|---|---|
| Anglin | 1,992 | Okanogan |
| Apple Acres | 5,752 | Chelan |
| Babb-Malden | 15,269 | Spokane, Whitman |
| Beverly Burke | 920 | Grant |
| Big Hollow | 24,995 | Skamania |
| Chief Timothy | 1,400 | Whitman |
| Chikamin | 2,151 | Chelan |
| Cold Springs | 189,923 | Okanogan |
| Colockum | 2,967 | Chelan |
| Customs Road | 2,208 | Ferry |
| Downey Creek | 3,166 | Snohomish |
| Evans Canyon | 75,817 | Kittitas, Yakima |
| Green | 1,480 | Okanogan |
| Greenhouse | 5,320 | Okanogan |
| Inchelium Highway | 7,120 | Ferry |
| Kahlotus | 22,000 | Franklin |
| Kewa Field | 11,797 | Ferry |
| Konnowac | 1,083 | Yakima |
| Lower Coyote Creek | 2,582 | Okanogan |
| Manning Rd. | 2,685 | Whitman |
| North Brownstown 2 | 884 | Yakima |
| North Brownstown 3 | 5,981 | Yakima |
| Palmer | 17,988 | Okanogan |
| Paterson | 1,460 | Benton |
| Pearl Hill | 223,730 | Douglas |
| Road 11 | 9,330 | Douglas |
| Saddle Mountain | 8,063 | Grant |
| Taylor Pond | 24,892 | Yakima |
| Tule Road | 702 | Yakima |
| Whitney | 127,430 | Lincoln |



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## 3.8 Agricultural Burning

Agricultural burning in Washington is defined as "the burning of vegetative debris from an agricultural operation necessary for disease or pest control, necessary for crop propagation and/or crop rotation, or where identified as a best management practice by the agricultural burning practices and research task force established in RCW [Revised Code of Washington] 70.94.650 or other authoritative source on agricultural practices." [21] All agricultural burning in Washington requires a permit by law, but compliance is not 100%. In addition to the agricultural burn permits obtained, satellite-detected hot-spot data for agricultural land was obtained from NOAA HMS. The burn data for agricultural land from HMS was spatiotemporally cross-checked against the permit data for redundancy. Duplicate HMS locations from the same date and location were removed. It is noted here that in Chelan, Douglas, Kittitas, Klickitat, and Okanogan Counties some orchards are removed but not replanted and thus do not qualify for agricultural burning permits. Emissions from these tear-outs are not consistently included in the inventory due to lack of permits and dependence on satellite detection.

### 3.8.1 Activity Level

The activity level for agricultural burning is the amount of residue consumed. The general equation and sources of each parameter are described below.

tons consumed = acres burned x fuel loading (tons/acre) x combustion completeness
or
tons consumed = tons burned x combustion completeness factor

**Acres or Tons Burned**

*Department of Ecology Central and Eastern Regional Offices (CRO, ERO)*

The Department of Ecology maintains the Air Quality Program Permit System (AQPPS) database. The permits include crop type, general location (legal description), and permit issue date. Pile burn permits include the amount of material burned in tons while field burn permits include acreage and fuel loading estimates.[22] Permits issued in 2020 were selected for this inventory.

*Yakima Regional Clean Air Agency (YRCAA) Permits*

AQPPS does not contain information for counties outside of Ecology air jurisdiction. Permit information was obtained for Yakima County from YRCAA, but fuel type and location were not included, so general crop-type emission factors were used.

*Satellite-Detected Hot-Spots*

Satellite hot spot detects from NOAA HMS that were added to the agricultural burning data were assumed to be a 120-acre burn (EPA default). The 2020 Washington State Department of Agriculture Land Use GIS data was used to determine crop type for locations acquired from HMS.

**Fuel Loading**

The overall average loading factor for wheat field burns was 4.2 tons/acre. This is comparable to the 4 tons/acre average found in a special study performed by Air Sciences Incorporated.[23] Air Sciences Incorporated performed a field study funded by Ecology, the Washington Association of Wheat Growers, and the US EPA-Region 10 to measure emissions and develop emission rates for wheat stubble field burning. The loading factor was 0.7 tons/acre higher than the wheat field loading factor of 3.2 tons/acre in AP42 (adjusted for fuel consumption).



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The agricultural burn permit database included a loading factor for each field burn. For burns detected by satellite, the default fuel loading of 1.9 tons/acre was used, except for corn (4.2 tons/acre). Overall average fuel loading and combustion completeness for field burns is shown in the table below for the following crop groups: barley; beans; corn; fallow land; hay, grass, pasture and Conservation Reserve Program (CRP) land; potatoes, wheat (including triticale), and all other field crops.

**Table 3-15. Average Fuel Loading for Agricultural Field Burns**

| Crop Group | Fuel Loading (Tons/Acre) | Combustion Completeness |
|---|---|---|
| Barley | 3.1 | 85% |
| Beans | 1.8 | 85% |
| Corn | 3.7 | 75% |
| Fallow | 1.9 | 75% |
| Hay, Grass, Pasture, CRP | 2.2 | 85% |
| Other | 2.5 | 85% |
| Potatoes | 1.9 | 85% |
| Wheat | 4.2 | 85% |

All field and pile burns were summed together to generate the total tons of agricultural residue burned in 2020, shown in Table 3-16. Note that Yakima permit data did not include crop type or location, so they were grouped in the "Other" category.

### 3.8.2 Emission Rates

Emission rates were taken from EPA's AP42 (VOC, CO, $NO_X$), a San Joaquin Valley study ($NO_X$)[24], the Air Sciences Incorporated report ($PM_{10}$, $PM_{2.5}$, $CH_4$)[23], and the 2014 NEI Agricultural Burning Emission Factors spreadsheet (NH3)[25]. Emission rates for NH3 are based on the NOx/NH3 emissions ratio in the 2002 NEI and the NOx emissions rate from McCarty et al. (2011)[26].

### 3.8.3 Emissions Estimates

Emissions estimates were calculated with the equation below.

TPY = (tons consumed) x (pollutant lb/T) x (1 T/2000 lb)



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**Table 3-16. Agricultural Residue Burned (tons)**

| County | Wheat | Corn | Tree Plantations, Orchards, & Vineyards | Grass, Hay, Pasture, CRP, and Fallow | Other or Unknown |
|---|---|---|---|---|---|
| Adams | 3,423 | 2,688 | 1,313 | 4,480 | 2,257 |
| Asotin | | | | | 35 |
| Benton | 1,824 | 4,536 | 912 | 5,244 | 2,964 |
| Chelan | 228 | | 8,190 | | |
| Clallam | | | | 228 | |
| Columbia | 92,061 | 137 | 6 | 12,547 | 1,170 |
| Douglas | 228 | | 12,763 | 1,716 | 15 |
| Franklin | 5,470 | 4,091 | 9,040 | 4,885 | 2,471 |
| Garfield | 25,670 | | | 1,405 | 355 |
| Grant | 7,303 | 7,622 | 18,615 | 7,997 | 5,438 |
| Grays Harbor | | 1,008 | | | |
| Island | | | | 684 | |
| King | | 1,512 | | 228 | 228 |
| Kittitas | | | 4 | 1,596 | 1,410 |
| Klickitat | 684 | | 6,734 | 1,824 | 481 |
| Lewis | | 1,008 | | 228 | |
| Lincoln | 2,533 | | 4 | 1,433 | 100 |
| Okanogan | | | 7,217 | 912 | |
| Pend Oreille | | | | 249 | |
| San Juan | | | | 456 | |
| Snohomish | | 504 | | | |
| Spokane | 684 | | | 1,140 | 1,140 |
| Stevens | | | | 474 | 20 |
| Thurston | | | | 1,140 | |
| Walla Walla | 104,229 | 504 | 5,272 | 3,179 | 16,001 |
| Whatcom | | 1,008 | | 456 | 228 |
| Whitman | 72,690 | | | 4,683 | 2,841 |
| Yakima | 4,560 | 10,584 | 456 | 23,940 | 26,043 |
| **State Total** | **321,586** | **35,201** | **70,526** | **81,123** | **63,196** |



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**Table 3-17. Agricultural Burn Emission Factors (pounds per ton of material consumed)**

| Crop | Burn Season | CO | $NO_X$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC | $NH_3$ |
|---|---|---|---|---|---|---|---|---|
| Barley | spring | 67 | 5.1 | 6.8 | 6.8 | 0.1 | 5.3 | 12.52 |
| Barley | fall | 117 | 5.1 | 12.3 | 12.3 | 0.1 | 12 | 12.52 |
| Wheat and triticale | spring | 67 | 4.3 | 6.8 | 6.8 | 0.9 | 5.3 | 33.73 |
| Wheat and triticale | fall | 117 | 4.3 | 12.3 | 12.3 | 0.9 | 12 | 33.73 |
| Corn | all | 108 | 3.3 | 13.8 | 13.2 | 0.4 | 12 | 19.32 |
| CRP, grass, pasture | all | 101 | 4.5 | 15.7 | 15 | 0.6 | 15 | 12.52 |
| Hay - Alfalfa | all | 106 | 4.5 | 44.3 | 42.2 | 0.6 | 28 | 12.52 |
| Hay - Other | all | 139 | 4.5 | 31.5 | 30 | 0.6 | 17 | 12.52 |
| Apple | all | 42 | 5.2 | 3.9 | 3.7 | 0.1 | 3 | 12.52 |
| Apricot | all | 49 | 5.2 | 5.9 | 5.6 | 0.1 | 6 | 12.52 |
| Cherry | all | 44 | 5.2 | 7.9 | 7.4 | 0.1 | 8 | 12.52 |
| Mixed fruit trees | all | 42 | 5.2 | 3.9 | 3.7 | 0.1 | 3 | 12.52 |
| Peach | all | 42 | 5.2 | 5.9 | 5.6 | 0.1 | 4 | 12.52 |
| Pear | all | 57 | 5.2 | 8.8 | 8.3 | 0.1 | 7 | 12.52 |
| Berries | all | 117 | 5.2 | 20.7 | 19.7 | 0.1 | 18 | 12.52 |
| Beans, legumes, lentils | all | 186 | 5.2 | 42.3 | 40.3 | 0.1 | 36 | 39.76 |
| Peas | all | 147 | 5.2 | 30.5 | 29.1 | 0.1 | 29 | 12.52 |
| Potatoes | all | 117 | 4.5 | 20.7 | 19.7 | 0.6 | 18 | 12.52 |
| Vineyards | all | 117 | 5.2 | 20.7 | 19.7 | 0.1 | 18 | 12.52 |
| Other Crops | all | 117 | 5.2 | 20.7 | 19.7 | 0.1 | 18 | 12.52 |
| Limbs & Brush | all | 140 | 4.3 | 16.3 | 14.5 | 0.1 | 19 | 12.52 |
| Willow | all | 140 | 5.2 | 16.3 | 14.5 | 0.1 | 19 | 12.52 |



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### 3.9 Municipal Solid Waste Burning

Municipal Solid Waste Burning is outdoor burning of household waste. The EPA calculated this category.

#### 3.9.1 Activity Level

The measure of activity for residential trash burning is the amount of material burned. The EPA method assumes that 0.42 tons of waste are generated per person per year and that 0.354 tons of that waste is combustible or "burnable". This assumes that a person burning RHW in their yard is more likely to be a non-recycler than an avid recycler. Open burning of trash is generally not practiced in urban areas, so only the rural population in each county is assumed to practice open burning. The EPA default assumes that 24% of the rural population burns trash. Trash burning is illegal in Washington, but compliance is not 100%. Ecology asked EPA to consider that municipal waste burning is banned, but 25% of the original emissions is still assumed to occur.

The amount of residential trash burned was estimated using the following equation:

Rural Population x 0.354 (tons/person/year) x 28% x 25%.

#### 3.9.2 Emission Rates

Emissions factors for open burning of municipal solid waste are listed in the table below. The emissions factors for CO, NOX, PM, SO2, and VOC are from AP-42[27] and the EPA report *Evaluation of Emissions from the Open Burning of Household Waste in Barrels*[28]. Emission factors were applied to the combustible waste burned.

#### 3.9.3 Emissions Estimates

Emissions estimates were calculated with the equations below.

TPY = (tons burned) x (pollutant lb/T) x (1 T/2000 lb)

**Table 3-18. Emission Rates in Pounds Per Ton of Combustible Material Burned**

| Pollutant Name | Pollutant Code | Emission Rate (lbs/ton) |
|---|---|---|
| Carbon Monoxide | CO | 100.7 |
| Nitrogen Oxides | NOX | 7.1 |
| PM10 | PM10-PRI | 38 |
| PM2.5 | PM25-PRI | 34.8 |
| Sulfur Oxides | SO2 | 1.18 |
| VOC | VOC | 7.409 |

### 3.10 Publicly Owned Treatment Works (POTW)

Emissions from publicly owned wastewater treatment plants (WWTPs) are included in the POTW category. POTWs are distinct and separate from industrial wastewater treatment.

#### 3.10.1 Activity Level

Activity for POTWs is measured in gallons of wastewater treated, which was obtained from the Permit and Reporting Information System (PARIS).[29] Discharge Monitoring Reports (DMRs) [30]. Reports for 2020 were selected from Municipal National Pollutant Discharge Elimination System Individual Permits (NPDES IP), Municipal to ground State Waste Discharge Permits (SWDP), and Reclaimed Water Individual Permits. The amount of wastewater treated at POTWs is shown in Table 3-19.

#### 3.10.2 Emission Rates

An ammonia emission factor of 0.169 pounds per million gallons was obtained from a report to EPA,.[31] while the VOC emission factor of 0.85 pounds per million gallons was based on a study from a California-based Technical Advisory Committee (Tri-TAC).[32]

#### 3.10.3 Spatial Allocation

WWTPs were allocated to counties based on their geographical coordinates.

#### 3.10.4 Emissions Estimates

Annual emissions for each county were calculated according to the following equation:

TPY = (million gallons treated) x (pollutant lb/million gallons) x (1 T/2000 lb)



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**Table 3-19. Public Wastewater Treatment Plant Throughput (millions of gallons)**

| County | Wastewater Treated |
|---|---|
| Adams | 816 |
| Asotin | 312 |
| Benton | 12,359 |
| Chelan | 1,615 |
| Clallam | 1,390 |
| Clark | 11,512 |
| Columbia | 87 |
| Cowlitz | 3,888 |
| Douglas | 632 |
| Ferry | 36 |
| Franklin | 3,947 |
| Garfield | 49 |
| Grant | 2,001 |
| Grays Harbor | 2,706 |
| Island | 134 |
| Jefferson | 380 |
| King | 65,950 |
| Kitsap | 4,031 |
| Kittitas | 2,532 |
| Klickitat | 316 |
| Lewis | 2,240 |
| Lincoln | 199 |
| Mason | 884 |
| Okanogan | 442 |
| Pacific | 717 |
| Pend Oreille | 213 |
| Pierce | 17,832 |
| San Juan | 150 |
| Skagit | 3,068 |
| Skamania | 89 |
| Snohomish | 21,784 |
| Spokane | 16,826 |
| Stevens | 667 |
| Thurston | 5,086 |
| Wahkiakum | 33 |
| Walla Walla | 2,089 |
| Whatcom | 6,460 |
| Whitman | 1,361 |
| Yakima | 4,696 |
| State Total | 199,530 |



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### 3.11 Residential Wood Combustion

Residential wood combustion (RWC) consists of home heating and recreational use of wood-burning equipment. Emissions from woodstoves, fireplaces, fireplace inserts, pellet stoves, indoor furnaces, and outdoor hydronic heaters are included. Other outdoor wood burning devices, such as fire pits, are part of the residential outdoor burning category for the 2020 EI.

#### 3.11.1 Activity Level

The measure of activity for residential wood combustion is the amount of wood burned. 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 with data from other surveys conducted by WSU, the National Research Center, and Kittitas County. Specifically, Ecology replaced appliance fractions of woodstoves and fireplace inserts for predominantly urban counties (King, Pierce, Snohomish, Spokane, Clark, Yakima, Thurston, Kitsap, Benton, and Whatcom) and replaced burn rates of woodstoves and fireplace inserts for all counties. Ecology also replaced the estimate of occupied housing units with OFM 2020 demographic data.

EPA originally had Ecology's values for appliance fractions as their defaults (pulled forward from 2017), so Ecology did not submit new appliance fractions. However, EPA later replaced the appliance fraction defaults, rendering the EPA NEI values unusable for Ecology. Ecology subsequently calculated emissions for this Comprehensive EI, which significantly lowered emissions relative to EPA NEI. Note that despite using the same appliance fractions and burn rates used in 2017, EPA changed many other assumptions that caused dramatic increases in emissions estimates relative to 2017: wood density factors increased by more than 25% and some pollutant emission factors for certified devices increased by 33% to 67%.

The residential wood combustion activity data replaced by Ecology was taken from the three residential wood combustion surveys previously used for our state. The first Washington survey was conducted by Washington State University in 2001 (WSU2001).[33] It divided the state into regions and compiled results for each region. The WSU survey had 749 completed surveys for WA. The second Washington survey was conducted by the National Research Center in 2007 (NRC2007).[34, 35] It covered seven geographic areas in the central Puget Sound region and consisted of 1,015 completed surveys. The third Washington survey was conducted by the Kittitas County Health Department in 2014 and 2015. It covered Kittitas County and consisted of 1174 responses. The surveys solicited complete information to conduct an inventory. The Washington survey areas are listed in Table 3-20. The Washington surveys were used for each county group as shown in Table 3-21.

The EPA and Washington surveys were 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. For woodstoves and fireplace inserts, EPA used distribution profiles based on a combination of data from RECS and Minnesota surveys such that 31% of devices in western states are uncertified, 41% are certified noncatalytic, and 28% are certified catalytic. For central heaters, EPA used distribution profiles based on the CEC survey such that 1% are indoor pellet boilers, 3% are indoor pellet furnaces, 23% are indoor cordwood boilers, 37% are indoor cordwood furnaces, and 36% are outdoor cordwood boilers. The percentage of occupied households using wood burning devices are shown in Table 3-22.



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**Table 3-20: Surveys and Survey Groups**

| Survey | Survey Group | Geographic Area |
|---|---|---|
| Kit2014-15 | Ellensburg and other areas | Kittitas County occupied housing unit weighted average |
| NRC2007 | PS_King | King County total |
| NRC2007 | PS_Kitsap | Kitsap County total |
| NRC2007 | PS_PieN | Pierce County Non-Urban Growth Area |
| NRC2007 | PS_PieU | Pierce County Urban Growth Area |
| NRC2007 | PS_SnoD | Snohomish County - Darrington |
| NRC2007 | PS_SnoM | Snohomish County - Marysville, Lake Stevens, North Everett |
| NRC2007 | PS_SnoO | Snohomish County - All other areas |
| WSU2001 | Eastern WA_Range | Adams, Asotin, Benton, Franklin, Garfield, Grant, Lincoln, Whitman Counties |
| WSU2001 | Eastern WA Forested | Chelan, Columbia, Douglas, Ferry, Kittitas, Klickitat, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Yakima |

**Table 3-21. County to Survey Assignments**

| County(ies) | Survey Group |
|---|---|
| Kittitas | Kittitas |
| King | PS_King |
| Kitsap | PS_Kitsap |
| Pierce | PS_Pierce = Household weighted average of PS_PieN and PS_PieU |
| Snohomish | PS_Snohomish = Household weighted average of PS_SnoD, PS_SnoM, and PS_SnoO |
| Adams, Asotin, Benton, Franklin, Garfield, Grant, Lincoln, Whitman | EWA_Range |
| Chelan, Columbia, Douglas, Ferry, Klickitat, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Yakima | EWA Forested |
| Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, Lewis, Mason, Pacific, San Juan, Skagit, Skamania, Thurston, Wahkiakum, Whatcom | PS_KitPieSno = Household weighted average of all the PS survey areas except King Co.* |

To calculate emissions using emission factors in lb/ton burned, the weight of the wood burned was estimated. Pellets are sold in 40-lb sacks, and fire logs were estimated at 8 lb per log. The amount of wood burned per device is shown in Table 3-23. The weight of a cord of wood varies with moisture content and species type. EPA calculated the weight of wood burned using wood density factors (e.g. for hardwood and pine) from the US Forest Service [36], which varied from



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2268 to 2992 pounds per cord for counties in Washington, a significant increase from previous years.



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**Table 3-22. Device Usage (Percent of Occupied Housing Units)**

| County | Fireplaces | Woodstoves | Fireplace Inserts | Central Heaters | Pellet Stoves | Wax Logs |
|---|---|---|---|---|---|---|
| Adams | 3.8% | 11.1% | 5.3% | 1.4% | 3% | 0% |
| Asotin | 7.4% | 7.8% | 4.3% | 1% | 2.5% | 0% |
| Benton | 3.9% | 5% | 3% | 1% | 2.4% | 0% |
| Chelan | 6% | 16.7% | 7.6% | 3.5% | 3% | 0% |
| Clallam | 7.7% | 15.5% | 9.2% | 2.3% | 3.2% | 0% |
| Clark | 10.3% | 12.3% | 8.1% | 1.5% | 2.5% | 0% |
| Columbia | 4.7% | 15.9% | 8.0% | 2.3% | 3.5% | 0% |
| Cowlitz | 9.5% | 14.4% | 9% | 2.3% | 2.9% | 0% |
| Douglas | 3.3% | 13.6% | 6.4% | 2% | 2.8% | 0% |
| Ferry | 6.5% | 25.9% | 9.6% | 6.8% | 4.5% | 0% |
| Franklin | 4.8% | 9.1% | 5.2% | 1% | 2.6% | 0% |
| Garfield | 3.6% | 20.1% | 7.5% | 3.6% | 4.6% | 0% |
| Grant | 2.9% | 11.9% | 6.1% | 1.4% | 2.6% | 0% |
| Grays Harbor | 9.5% | 15% | 8.8% | 2.5% | 3.2% | 0% |
| Island | 5.3% | 12.6% | 6.4% | 1.7% | 3.6% | 0% |
| Jefferson | 9.3% | 18.8% | 10.4% | 3.3% | 3.9% | 0% |
| King | 11.1% | 5.9% | 5.9% | 1% | 1.8% | 1.9% |
| Kitsap | 8.5% | 15.3% | 12.9% | 1.2% | 2.6% | 0% |
| Kittitas | 6.4% | 14.8% | 5.9% | 3.4% | 3.1% | 0% |
| Klickitat | 5.6% | 14.2% | 6.8% | 2.1% | 3.7% | 0% |
| Lewis | 9.5% | 17.3% | 9.5% | 3.2% | 3.5% | 0% |
| Lincoln | 4.2% | 18.5% | 6.1% | 3.6% | 4.7% | 0% |
| Mason | 9.1% | 19.1% | 10% | 3.5% | 4% | 0% |
| Okanogan | 5.2% | 20.4% | 8.4% | 4.1% | 4.1% | 0% |
| Pacific | 6.3% | 17.8% | 9.1% | 2.9% | 3.7% | 0% |
| Pend Oreille | 8.8% | 25% | 10.5% | 6.7% | 4.2% | 0% |
| Pierce | 10.7% | 11.2% | 6.7% | 1.3% | 2.3% | 1.2% |
| San Juan | 4.3% | 18.6% | 7.6% | 2.8% | 5.1% | 0% |
| Skagit | 12.5% | 10.9% | 6.2% | 1.9% | 3.1% | 0% |
| Skamania | 10.1% | 25.1% | 10% | 7.6% | 4.3% | 0% |
| Snohomish | 12.2% | 12.4% | 8% | 1.4% | 2.4% | 0% |
| Spokane | 7.6% | 11.5% | 5.2% | 1.7% | 2.5% | 0% |
| Stevens | 8.4% | 20.8% | 8.1% | 5.3% | 4.1% | 0% |
| Thurston | 10.7% | 12.3% | 8.1% | 1.3% | 2.7% | 0% |
| Wahkiakum | 8.2% | 23% | 10.5% | 4.6% | 4.8% | 0% |
| Walla Walla | 5.4% | 8.4% | 4.5% | 1% | 2.7% | 0% |
| Whatcom | 10.2% | 12.3% | 8.1% | 2.5% | 2.7% | 0% |
| Whitman | 3.6% | 7.4% | 3.3% | 1.1% | 2.1% | 0% |
| Yakima | 6.7% | 11.5% | 5.2% | 1.3% | 2.8% | 0% |



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**Table 3-23. Amount of Wood Burned Per Device**

| County | Fireplaces (Cords) | Woodstoves (Cords) | Fireplace Inserts (Cords) | Central Heaters (Cords) | Pellet Stoves (Tons) | Wax Logs (Tons) |
|---|---|---|---|---|---|---|
| Adams | 0.42 | 1.40 | 1.30 | 2.61 | 0.40 | 0.78 |
| Asotin | 0.36 | 1.40 | 1.30 | 2.57 | 0.34 | 0.78 |
| Benton | 0.36 | 1.40 | 1.30 | 2.57 | 0.36 | 0.78 |
| Chelan | 0.34 | 2.70 | 1.70 | 3.02 | 1.27 | 0.78 |
| Clallam | 0.35 | 2.03 | 1.98 | 2.82 | 0.90 | 0.78 |
| Clark | 0.27 | 2.03 | 1.98 | 2.43 | 0.87 | 0.78 |
| Columbia | 0.39 | 2.70 | 1.70 | 2.77 | 0.64 | 0.78 |
| Cowlitz | 0.32 | 2.03 | 1.98 | 2.82 | 1.05 | 0.78 |
| Douglas | 0.38 | 2.70 | 1.70 | 2.78 | 0.58 | 0.78 |
| Ferry | 0.41 | 2.70 | 1.70 | 3.11 | 1.76 | 0.78 |
| Franklin | 0.38 | 1.40 | 1.30 | 2.59 | 0.34 | 0.78 |
| Garfield | 0.47 | 1.40 | 1.30 | 2.78 | 0.73 | 0.78 |
| Grant | 0.41 | 1.40 | 1.30 | 2.69 | 0.47 | 0.78 |
| Grays Harbor | 0.35 | 2.03 | 1.98 | 2.78 | 0.94 | 0.78 |
| Island | 0.37 | 2.03 | 1.98 | 2.51 | 0.53 | 0.78 |
| Jefferson | 0.37 | 2.03 | 1.98 | 2.86 | 1.11 | 0.78 |
| King | 0.23 | 1.31 | 1.35 | 1.92 | 0.91 | 0.78 |
| Kitsap | 0.29 | 1.94 | 1.57 | 2.39 | 0.65 | 0.78 |
| Kittitas | 0.36 | 2.00 | 2.10 | 2.94 | 1.05 | 0.78 |
| Klickitat | 0.41 | 2.70 | 1.70 | 2.64 | 0.56 | 0.78 |
| Lewis | 0.36 | 2.03 | 1.98 | 2.87 | 1.18 | 0.78 |
| Lincoln | 0.47 | 1.40 | 1.30 | 2.79 | 0.66 | 0.78 |
| Mason | 0.38 | 2.03 | 1.98 | 2.84 | 1.12 | 0.78 |
| Okanogan | 0.41 | 2.70 | 1.70 | 2.90 | 1.06 | 0.78 |
| Pacific | 0.39 | 2.03 | 1.98 | 2.83 | 0.93 | 0.78 |
| Pend Oreille | 0.37 | 2.70 | 1.70 | 3.15 | 2.04 | 0.78 |
| Pierce | 0.28 | 1.42 | 1.70 | 2.58 | 0.77 | 0.78 |
| San Juan | 0.47 | 2.03 | 1.98 | 2.61 | 0.56 | 0.78 |
| Skagit | 0.35 | 2.03 | 1.98 | 2.65 | 0.65 | 0.78 |
| Skamania | 0.38 | 2.03 | 1.98 | 3.14 | 2.30 | 0.78 |
| Snohomish | 0.29 | 2.86 | 2.29 | 2.61 | 0.74 | 0.78 |
| Spokane | 0.32 | 2.70 | 1.70 | 2.75 | 0.67 | 0.78 |
| Stevens | 0.38 | 2.70 | 1.70 | 3.04 | 1.45 | 0.78 |
| Thurston | 0.31 | 2.03 | 1.98 | 2.52 | 0.64 | 0.78 |
| Wahkiakum | 0.42 | 2.03 | 1.98 | 2.86 | 1.18 | 0.78 |
| Walla Walla | 0.38 | 2.70 | 1.70 | 2.52 | 0.32 | 0.78 |
| Whatcom | 0.32 | 2.03 | 1.98 | 2.89 | 1.00 | 0.78 |
| Whitman | 0.37 | 1.40 | 1.30 | 2.58 | 0.42 | 0.78 |
| Yakima | 0.36 | 2.70 | 1.70 | 2.60 | 0.49 | 0.78 |



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**Table 3-24. Tons of Wood Burned for Home Heating**

| County | Fireplaces | Woodstoves | Fireplace Inserts | Central Heaters | Pellet Stoves | Wax Logs | TOTAL |
|---|---|---|---|---|---|---|---|
| Adams | 107 | 1,047 | 464 | 246 | 81 | 0 | 1,945 |
| Asotin | 267 | 1,096 | 561 | 258 | 85 | 0 | 2,267 |
| Benton | 1,124 | 5,605 | 3,123 | 2,058 | 692 | 0 | 12,602 |
| Chelan | 760 | 16,804 | 4,815 | 3,939 | 1,420 | 0 | 27,738 |
| Clallam | 1,022 | 11,935 | 6,909 | 2,460 | 1,092 | 0 | 23,419 |
| Clark | 5,424 | 48,699 | 31,280 | 7,109 | 4,242 | 0 | 96,753 |
| Columbia | 40 | 940 | 298 | 140 | 49 | 0 | 1,467 |
| Cowlitz | 1,381 | 13,278 | 8,095 | 2,946 | 1,383 | 0 | 27,083 |
| Douglas | 217 | 6,359 | 1,884 | 963 | 281 | 0 | 9,705 |
| Ferry | 108 | 2,838 | 662 | 858 | 321 | 0 | 4,789 |
| Franklin | 542 | 3,789 | 2,010 | 770 | 263 | 0 | 7,375 |
| Garfield | 20 | 336 | 116 | 119 | 40 | 0 | 632 |
| Grant | 459 | 6,437 | 3,064 | 1,455 | 472 | 0 | 11,887 |
| Grays Harbor | 1,199 | 10,980 | 6,283 | 2,506 | 1,085 | 0 | 22,052 |
| Island | 822 | 10,723 | 5,312 | 1,789 | 800 | 0 | 19,446 |
| Jefferson | 657 | 7,284 | 3,930 | 1,801 | 826 | 0 | 14,499 |
| King | 24,745 | 74,912 | 77,199 | 18,609 | 15,876 | 14,364 | 225,706 |
| Kitsap | 2,792 | 33,614 | 22,936 | 3,248 | 1,914 | 0 | 64,504 |
| Kittitas | 547 | 7,028 | 2,942 | 2,373 | 773 | 0 | 13,663 |
| Klickitat | 242 | 4,038 | 1,218 | 584 | 218 | 0 | 6,300 |
| Lewis | 1,211 | 12,436 | 6,661 | 3,252 | 1,463 | 0 | 25,023 |
| Lincoln | 113 | 1,485 | 455 | 576 | 178 | 0 | 2,806 |
| Mason | 1,150 | 12,899 | 6,587 | 3,307 | 1,490 | 0 | 25,434 |
| Okanogan | 463 | 11,963 | 3,102 | 2,583 | 944 | 0 | 19,055 |
| Pacific | 394 | 5,794 | 2,889 | 1,316 | 552 | 0 | 10,944 |
| Pend Oreille | 258 | 5,358 | 1,417 | 1,675 | 680 | 0 | 9,389 |
| Pierce | 10,770 | 57,173 | 40,946 | 12,057 | 6,367 | 3,365 | 130,678 |
| San Juan | 278 | 5,200 | 2,072 | 1,006 | 393 | 0 | 8,951 |
| Skagit | 2,439 | 12,334 | 6,843 | 2,807 | 1,123 | 0 | 25,546 |
| Skamania | 222 | 2,952 | 1,147 | 1,383 | 573 | 0 | 6,278 |
| Snohomish | 11,375 | 114,025 | 58,903 | 11,748 | 5,710 | 0 | 201,762 |
| Spokane | 5,448 | 69,558 | 19,803 | 10,473 | 3,752 | 0 | 109,035 |
| Stevens | 710 | 12,491 | 3,063 | 3,584 | 1,322 | 0 | 21,170 |
| Thurston | 4,028 | 30,322 | 19,476 | 3,978 | 2,098 | 0 | 59,903 |
| Wahkiakum | 75 | 1,022 | 455 | 288 | 124 | 0 | 1,964 |
| Walla Walla | 512 | 5,663 | 1,910 | 629 | 216 | 0 | 8,931 |
| Whatcom | 3,267 | 24,993 | 16,054 | 7,232 | 2,703 | 0 | 54,249 |
| Whitman | 279 | 2,168 | 898 | 594 | 185 | 0 | 4,122 |
| Yakima | 2,183 | 28,101 | 8,001 | 3,059 | 1,242 | 0 | 42,586 |
| State Total | 87,655 | 683,681 | 383,783 | 125,780 | 63,029 | 17,729 | 1,361,657 |



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### 3.11.2 Emission Rates

Emissions factors for RWC (see Table 3-25) come primarily from AP-42 [37] and Houck and Eagle (2006) [38], but also from Houck et al. (2001) [39]. Emissions factors for wax fire logs are from Li and Rosenthal (2006) [40]. Additional emission factors are taken from Aurell et al. (2012) [41]. Note that EPA significantly changed the emission factors used for certified woodstoves and certified fireplace inserts, which now use the AP-42 values. Note that the new factors for PM are 67% larger than the factors used in previous EIs. Emission factor values from the 2017 EI are shown in parentheses for comparison in Table 3-25.

### 3.11.3 Spatial Allocation

Spatial allocation was not necessary since occupied housing units were available by county.

### 3.11.4 Emissions Estimates

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

TPY = (OHU) x (usage fraction) x (T burned/device-yr) x (pollutant lb/T) x (T/2000 lb)
where OHU= number of occupied housing units in the county

**Table 3-25. Pollutant Emission Factors in Pounds Per Ton Burned**

| Pollutant | Fireplaces | Certified Catalytic Inserts & Woodstoves | Certified Non-Catalytic Inserts & Woodstoves | Uncertified Inserts & Woodstoves | Pellet Stoves | Wax Logs |
|---|---|---|---|---|---|---|
| Ammonia | 1.8 | 0.67 | 0.67 | 1.7 | 0.3 | |
| Carbon Monoxide | 149 | 92.3 | 122.6 | 230.8 | 15.9 | 125.1 |
| Nitrogen Oxides | 2.6 | 2 (1.49) | 1.69 | 2.8 | 3.8 | 7.7 |
| Primary PM10 | 23.6 | 16.2 (9.72) | 14.6 (8.76) | 30.6 | 3.06 | 29.3 |
| Primary PM2.5 | 23.6 | 16.2 (9.72) | 14.6 (8.76) | 30.6 | 3.06 | 28.4 |
| Sulfur Dioxide | 0.4 | 0.4 (0.3) | 0.4 (0.3) | 0.4 | 0.32 | |
| VOCs | 18.9 | 15 (11.2) | 12 (8.88) | 53 | 2.20 | 39.6 |



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### 3.12 Industrial and Commercial/Institutional (ICI) Fuel Use

Industrial and Commercial/Institutional (ICI) fuel combustion sources include emissions from boilers, engines, and other combustion sources from the industrial, commercial, and institutional sectors that are *not* reported as large point sources. This category includes emissions from combustion of coal, distillate fuel oil, residual fuel oil, kerosene, liquefied petroleum gas (LPG), natural gas, and wood.

The calculations for estimating emissions from the ICI sectors include estimating the total fuel consumption by sector in each state, using data from the Energy Information Administration (EIA) State Energy Data System (SEDS). Total fuel consumption is adjusted to account for fuel consumed by mobile sources in each sector and fuel used as an input to industrial processes but is not combusted. Washington submitted state-level fuel consumption data from point sources in these sectors to EPA, using information from the WEIRS database and as reported by local clean air agencies. The state-level point source fuel consumption was subtracted from the total fuel consumption to estimate the fuel consumption from nonpoint sources, and EPA calculated the subsequent emissions. An adjustment was made to the nonpoint estimate of industrial wood combustion, since it was unreasonably high. After consultation with a senior Ecology engineer, and consistent with the previous EI, it was decided to estimate nonpoint industrial wood combustion at 25% of the total point source value. However, that value was not submitted to EPA in time for inclusion in the NEI.

#### 3.12.1 Activity Level

The activity data for this source category is total fuel consumption in the industrial and commercial/institutional sectors. The default data for this category are obtained from the total 2020 state-level fuel consumption in each sector from EIA SEDS [42] for all fuel types except distillate. Distillate fuel consumption is taken from EIA's Form 821 data [43], which reports distillate sales by state and sector for 2020. Note that EPA makes small adjustments to some of the SEDS data.

**Table 3-26. State Industrial and Commercial/Institutional Fuel Use**

| Sector | Fuel | Units | State | Point | Nonpoint |
|---|---|---|---|---|---|
| Commercial | Coal | Tons | 0 | 0 | 0 |
| Commercial | Distillate | Thousand Gallons | 526 | 106 | 420 |
| Commercial | Kerosene | Thousand Gallons | 168 | 0 | 168 |
| Commercial | LPG | Thousand Gallons | 48,459 | 147 | 48,312 |
| Commercial | Natural Gas | Million Cubic Feet | 55,548 | 1,175 | 54,373 |
| Commercial | Residual | Thousand Gallons | 0 | 0 | 0 |
| Commercial | Wood | Million BTU | 4,520,000 | 0 | 4,520,000 |
| Industrial | Coal | Tons | 81,100 | 61,380 | 19,720 |
| Industrial | Distillate | Thousand Gallons | 15,594 | 107 | 15,487 |



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| Sector | Fuel | Units | State | Point | Nonpoint |
|---|---|---|---|---|---|
| Industrial | Kerosene | Thousand Gallons | 0 | 0 | 0 |
| Industrial | LPG | Thousand Gallons | 28,903 | 546 | 28,357 |
| Industrial | Natural Gas | Million Cubic Feet | 74,263 | 36,153 | 38,110 |
| Industrial | Residual | Thousand Gallons | 0 | 2,460,637 | 0 |
| Industrial | Wood | Million BTU | 64,453,000 | 13,383,698 | 3,346,925 |



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### 3.12.2 Spatial Allocation

The estimated state-level nonpoint source activity data in each state is distributed to the county level based on employment in the industrial or commercial sector from the Census Bureau's County Business Patterns.[44]. The adjusted nonpoint fuel consumption in each state is distributed to the county based on the proportion of employment in each county in each sector to the total employment at the state level in each sector.

### 3.12.3 Emission Rates and Emissions

Emissions were calculated as:

$$E = A \times EF$$

where A is the amount of fuel used, and EF is the emission rate in lbs/unit. The emission factors are discussed in the Section 25 of the 2020 NEI EPA TSD.



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### 3.13 Agricultural Harvesting Operations

The Western Regional Air Partnership (WRAP) published a handbook for calculating dust emissions which includes harvesting operations. Harvesting emissions are generated by three different operations: crop handling by the harvest machine, loading of the harvested crop into trailers or trucks, and transport by trailers or trucks in the field. Emissions from these operations are in the form of solid particulates composed mainly of raw plant material and soil dust that is entrained into the air..[45] The WRAP Handbook recommended the methodology and emission rates used by the California Air Resources Board (CARB). Note that emissions for this category have not been adjusted since 2017, due to lack of updated activity data.

#### 3.13.1 Activity Level and Spatial Adjustments

Acres harvested by crop type are the measure of activity. Every 5 years an extensive national census is made. The USDA National Agricultural Statistics Service (NASS) published the USDA/WSDA crop data and Census data on-line for query and download [46]. Statistics from the 2017 census were obtained for several major crop and fruit types. "Acres Harvested" statistics were used for most crops, except for fruit statistics that are reported as "Acres Bearing". The data included individual county acreage estimates for several crop types, but individual county acreage was considered confidential in some instances. State totals were used to evenly apportion remaining crop acreage to individual counties when county estimates were withheld.

Harvested acreage by county is shown in Table 3-27, with similar crop types grouped as follows:

**Beans & Peas**: Dry Beans, Lima Beans, Snap Beans, Lentils, Dry Peas, Green Peas
**Fruit**: Apples, Apricots, Berries, Cherries, Grapes, Nectarines, Peaches, Pears, Plums
**Grains**: Barley, Canola, Corn, Wheat
**Hay & Haylage**: Alfalfa Hay, Hay, Alfalfa Haylage, Haylage
**Potatoes**: Potatoes
**Other Crops:** Hops, Oats, Onions

**Table 3-27. Area of Crops Harvested (Acres)**

| County | Beans & Peas | Fruit | Grains | Hay & Haylage | Potatoes | Other Crops |
|---|---|---|---|---|---|---|
| Adams | 11,460 | 4,435 | 280,403 | 9,141 | 21,780 | 1,279 |
| Asotin | 2 | 305 | 26,751 | 5,229 | 0 | 119 |
| Benton | 12,207 | 41,294 | 143,454 | 11,204 | 42,046 | 25,289 |
| Chelan | 505 | 20,293 | 305 | 2,220 | 2 | 1 |
| Clallam | 2,066 | 276 | 5,648 | 4,647 | 9 | 126 |
| Clark | 1,882 | 1,302 | 796 | 16,190 | 10 | 122 |
| Columbia | 15,205 | 169 | 71,399 | 3,361 | 384 | 119 |
| Cowlitz | 471 | 1,540 | 5,588 | 4,206 | 384 | 119 |
| Douglas | 1,723 | 11,495 | 165,733 | 5,331 | 1 | 119 |
| Ferry | 506 | 55 | 4,640 | 9,995 | 384 | 1 |
| Franklin | 8,974 | 16,584 | 96,359 | 84,585 | 29,983 | 3,757 |
| Garfield | 207 | 95 | 101,972 | 1,960 | 0 | 119 |
| Grant | 41,327 | 66,532 | 219,903 | 138,569 | 47,052 | 7,230 |
| Grays Harbor | 2,323 | 553 | 4,395 | 10,173 | 6 | 1 |
| Island | 8 | 528 | 5,083 | 5,532 | 3 | 4 |
| Jefferson | 1 | 116 | 1 | 3,103 | 2 | 2 |
| King | 1,974 | 469 | 1,764 | 8,519 | 20 | 42 |
| Kitsap | 11 | 102 | 4 | 8,110 | 11 | 6 |
| Kittitas | 2,563 | 1,001 | 2,925 | 41,195 | 384 | 44 |
| Klickitat | 2,460 | 2,700 | 57,092 | 36,587 | 4 | 10 |
| Lewis | 852 | 543 | 6,718 | 38,359 | 2 | 107 |
| Lincoln | 3,366 | 1,138 | 364,578 | 26,610 | 384 | 287 |
| Mason | 4 | 1,002 | 89 | 8,409 | 2 | 1 |
| Okanogan | 218 | 19,408 | 12,267 | 30,485 | 6 | 217 |
| Pacific | 142 | 1,285 | 0 | 6,698 | 3 | 1 |
| Pend Oreille | 0 | 60 | 0 | 16,155 | 0 | 0 |
| Pierce | 435 | 535 | 5,021 | 5,751 | 5 | 9 |
| San Juan | 1,854 | 251 | 4,909 | 3,994 | 5 | 2 |
| Skagit | 2,525 | 2,446 | 16,813 | 17,668 | 9,896 | 10 |
| Skamania | 141 | 321 | 0 | 974 | 384 | 0 |
| Snohomish | 40 | 833 | 6,021 | 11,686 | 979 | 74 |
| Spokane | 41,351 | 503 | 155,112 | 62,233 | 384 | 1,165 |
| Stevens | 1,946 | 249 | 5,429 | 39,985 | 384 | 395 |
| Thurston | 11 | 1,246 | 311 | 15,038 | 13 | 15 |
| Wahkiakum | 1 | 1,419 | 0 | 4,078 | 1 | 1 |
| Walla Walla | 24,538 | 14,498 | 205,165 | 17,261 | 10,223 | 1,647 |
| Whatcom | 1,877 | 11,953 | 13,005 | 36,486 | 1,635 | 130 |
| Whitman | 181,807 | 1,034 | 573,641 | 20,502 | 1 | 120 |
| Yakima | 74 | 90,393 | 75,075 | 45,948 | 1,027 | 29,161 |
| State Total | 367,055 | 318,964 | 2,638,369 | 818,177 | 167,801 | 71,849 |



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### 3.13.2 Emission Rates

Emission rates were adapted from the WRAP Handbook. The handbook assumed that $PM_{2.5}$ was 15% of the $PM_{10}$. No control measures were assumed.

**Table 3-28. Agricultural Harvesting Emission Rates (lb/acre)**

| Crop | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|
| Apples | 0.08 | 0.012 |
| Apricots | 0.08 | 0.012 |
| Barley | 5.80 | 0.870 |
| Beans, other | 1.68 | 0.252 |
| Beans, snap | 0.17 | 0.026 |
| Berries | 0.08 | 0.012 |
| Canola | 5.80 | 0.870 |
| Cherries | 0.08 | 0.012 |
| Corn for grain | 1.68 | 0.252 |
| Corn for silage | 0.17 | 0.026 |
| Corn, sweet | 0.08 | 0.012 |
| Grapes | 0.17 | 0.026 |
| Hay, alfalfa | 0.17 | 0.026 |
| Hay, other | 1.68 | 0.252 |
| Haylage (silage) | 0.17 | 0.026 |
| Hops | 5.80 | 0.870 |
| Lentils | 1.68 | 0.252 |
| Nectarines | 0.08 | 0.012 |
| Oats | 5.80 | 0.870 |
| Onions | 1.68 | 0.252 |
| Onions, green | 0.08 | 0.012 |
| Peaches | 0.08 | 0.012 |
| Pears | 0.08 | 0.012 |
| Peas | 0.17 | 0.026 |
| Plums | 0.08 | 0.012 |
| Potatoes | 1.68 | 0.252 |
| Wheat | 5.80 | 0.870 |

### 3.13.3 Emissions Estimates

Annual county emissions estimates of agricultural harvesting were calculated by multiplying the emission rates by the number of harvested acres by crop type.

TPY = (acres) x (lb pollutant/acre) x (1 T/2000 lb)



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### 3.14 Agricultural Tilling

Fugitive dust emissions from agricultural tilling include the airborne soil particulate emissions produced during the preparation of agricultural lands for planting. Fugitive dust emissions from agricultural tilling were estimated for PM10 and PM2.5. EPA calculated emissions after Ecology submitted the acres tilled by crop type and the number of passes per crop type by tilling practice type. Note that in contrast to EPA defaults, Ecology assumes that no tilling passes are made on land marked as no-till.

#### 3.14.1 Activity Level

Acres tilled by crop type are the measure of activity. The total number of acres of farmland for crop types by county was obtained from the WSDA 2020 Agricultural Land Use GIS Data[47]. Winter wheat and spring wheat were obtained from the USDA 2020 Census of Agriculture, provided by EPA and supplemented with the WSDA land use data for spring wheat in counties where USDA had no data. All farmland data was aggregated to the following crop types: barley, beans and peas, canola, corn, fallow, alfalfa hay, hay/grass/silage (non-alfalfa), oat, pasture, peas, potato, rye, sorghum, soybean, sunflower, beets, winter wheat, and spring wheat. All hay and seed categories were aggregated to their respective crop types where possible (e.g. alfalfa hay and alfalfa seed are treated as "alfalfa"). Only wheat fallow and tilled fallow were included for "fallow" crop type. Acres tilled by county for crop type groups are shown in Table 3-29.

#### 3.14.2 Emissions Rates

The emission rates for agricultural tilling are based on the number of tilling passes made per year and the silt content of the soil. The number of tilling passes by crop type and farming practice (e.g. conservation or conventional land use) were taken from the Midwest Research Institute [48] and revised based on information from the WSU College of Agriculture [49]. All pastureland is assumed to be no-till. The fraction of acres farmed that are conventional, no-till, or in conservation were obtained from the 2017 USDA Census of Agriculture.

The following equation was used to determine the emission rates from agricultural tilling [50] [51].

$$\text{Emissions Rate (lbs/acre)} = c \times k \times s^{0.6} \times p$$

where:
- $c$ = constant of 4.8 lbs/acre-pass
- $k$ = dimensionless particle size multiplier ($PM_{10}$=0.21; $PM_{2.5}$=0.042)
- $s$ = percent silt content of surface soil, defined as the mass fraction of particles smaller than 50 µm diameter found in surface soil
- $p$ = number of tilling passes in a year

Silt content by county was based on the National Cooperative Soil Survey data [52].



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**Table 3-29. Area of Farmland Tilled (Acres)**

| County | Beans & Peas | Grains | Hay | Potatoes | Fallow | Pasture | Other Crops |
|---|---|---|---|---|---|---|---|
| Adams | 14,929 | 306,878 | 19,458 | 22,377 | 258,983 | 7,032 | 236 |
| Asotin | 373 | 26,754 | 5,585 | 0 | 23,523 | 14,020 | 0 |
| Benton | 11,500 | 136,423 | 9,360 | 29,449 | 99,774 | 15,328 | 1,857 |
| Chelan | 0 | 11 | 850 | 0 | 3,825 | 1,674 | 0 |
| Clallam | 0 | 605 | 4,564 | 0 | 351 | 4,466 | 0 |
| Clark | 0 | 891 | 13,280 | 0 | 1,340 | 14,279 | 0 |
| Columbia | 22,757 | 114,345 | 2,607 | 0 | 27,659 | 16,289 | 0 |
| Cowlitz | 0 | 626 | 2,458 | 1 | 286 | 2,208 | 0 |
| Douglas | 323 | 166,182 | 2,271 | 14 | 175,668 | 4,624 | 128 |
| Ferry | 0 | 422 | 6,122 | 0 | 2,034 | 8,116 | 0 |
| Franklin | 6,137 | 107,618 | 53,666 | 42,068 | 61,817 | 11,984 | 120 |
| Garfield | 793 | 93,707 | 2,369 | 0 | 56,467 | 33,583 | 0 |
| Grant | 46,169 | 224,104 | 119,20 | 43,691 | 109,374 | 22,871 | 400 |
| Grays Harbor | 47 | 3,201 | 10,365 | 3 | 377 | 8,805 | 0 |
| Island | 62 | 817 | 6,478 | 26 | 515 | 3,737 | 0 |
| Jefferson | 0 | 8 | 2,032 | 0 | 159 | 2,407 | 0 |
| King | 0 | 1,455 | 6,504 | 0 | 2,033 | 16,577 | 0 |
| Kitsap | 0 | 7 | 9,085 | 0 | 69 | 1,609 | 0 |
| Kittitas | 626 | 1,970 | 5,211 | 180 | 2,943 | 30,249 | 654 |
| Klickitat | 803 | 51,605 | 40,843 | 1,178 | 28,992 | 12,445 | 0 |
| Lewis | 0 | 2,204 | 33,395 | 0 | 2,653 | 26,369 | 0 |
| Lincoln | 6,872 | 393,897 | 22,433 | 3,254 | 250,644 | 34,090 | 492 |
| Mason | 0 | 40 | 1,910 | 0 | 65 | 2,404 | 0 |
| Okanogan | 0 | 11,787 | 23,603 | 4 | 19,090 | 37,148 | 0 |
| Pacific | 0 | 0 | 3,405 | 0 | 623 | 4,579 | 0 |
| Pend Oreille | 0 | 39 | 11,049 | 0 | 2,252 | 8,488 | 0 |
| Pierce | 89 | 189 | 5,350 | 0 | 1,292 | 14,841 | 0 |
| San Juan | 0 | 191 | 4,435 | 0 | 165 | 4,977 | 0 |
| Skagit | 2,028 | 16,441 | 18,309 | 9,674 | 2,207 | 11,523 | 0 |
| Skamania | 0 | 0 | 733 | 0 | 254 | 1,425 | 0 |
| Snohomish | 0 | 7,670 | 13,419 | 416 | 1,618 | 15,318 | 2 |
| Spokane | 16,008 | 173,681 | 57,528 | 331 | 27,339 | 11,884 | 1,001 |
| Stevens | 0 | 6,531 | 49,961 | 378 | 7,646 | 29,949 | 298 |
| Thurston | 36 | 162 | 9,896 | 1 | 691 | 17,337 | 1 |
| Wahkiakum | 0 | 0 | 2,552 | 0 | 410 | 4,099 | 0 |
| Walla Walla | 19,833 | 217,104 | 12,317 | 14,354 | 123,477 | 16,158 | 11 |
| Whatcom | 0 | 15,760 | 32,673 | 2,999 | 1,375 | 6,898 | 0 |
| Whitman | 71,409 | 607,042 | 20,923 | 0 | 161,580 | 45,974 | 78 |
| Yakima | 179 | 67,884 | 40,655 | 255 | 29,411 | 44,505 | 34 |
| ***State Total*** | ***220,972*** | ***2,758,245*** | ***686,862*** | ***170,653*** | ***1,488,981*** | ***570,269*** | ***5,312*** |



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**Table 3-30. Farming Practices and Silt Content**

| County | No-Till | Conservation | Conventional | Silt Content |
|---|---|---|---|---|
| Adams | 4% | 53% | 42% | 62% |
| Asotin | 75% | 20% | 5% | 63% |
| Benton | 40% | 44% | 16% | 43% |
| Chelan | 75% | 14% | 11% | 36% |
| Clallam | 30% | 15% | 56% | 41% |
| Clark | 16% | 9% | 75% | 52% |
| Columbia | 43% | 53% | 4% | 74% |
| Cowlitz | 3% | 0% | 97% | 38% |
| Douglas | 23% | 29% | 49% | 48% |
| Ferry | 17% | 4% | 79% | 52% |
| Franklin | 9% | 49% | 43% | 40% |
| Garfield | 63% | 31% | 6% | 67% |
| Grant | 7% | 32% | 61% | 48% |
| Grays Harbor | 3% | 38% | 59% | 49% |
| Island | 20% | 12% | 68% | 32% |
| Jefferson | 67% | 6% | 28% | 22% |
| King | 10% | 33% | 57% | 36% |
| Kitsap | 25% | 52% | 23% | 29% |
| Kittitas | 13% | 29% | 58% | 41% |
| Klickitat | 46% | 28% | 26% | 41% |
| Lewis | 14% | 6% | 80% | 49% |
| Lincoln | 27% | 45% | 28% | 64% |
| Mason | 57% | 4% | 40% | 37% |
| Okanogan | 60% | 11% | 29% | 44% |
| Pacific | 6% | 5% | 89% | 34% |
| Pend Oreille | 5% | 41% | 54% | 45% |
| Pierce | 8% | 13% | 79% | 24% |
| San Juan | 28% | 38% | 34% | 40% |
| Skagit | 3% | 3% | 94% | 31% |
| Skamania | 25% | 29% | 46% | 33% |
| Snohomish | 22% | 8% | 70% | 36% |
| Spokane | 44% | 39% | 17% | 52% |
| Stevens | 8% | 17% | 76% | 47% |
| Thurston | 11% | 22% | 67% | 42% |
| Wahkiakum | 0% | 43% | 57% | 58% |
| Walla Walla | 43% | 41% | 16% | 69% |
| Whatcom | 7% | 8% | 85% | 51% |
| Whitman | 20% | 65% | 15% | 66% |
| Yakima | 29% | 26% | 45% | 33% |



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**Table 3-31. Tilling Passes for Field Crops**

| Crop | Conservation Use | Conventional Use |
|---|---|---|
| Alfalfa | 3 | 3 |
| Barley | 3 | 5 |
| Beans & Peas | 3 | 3 |
| Canola | 3 | 3 |
| Corn | 2 | 6 |
| Cover | 1 | 1 |
| Fallow | 1 | 4 |
| Hay | 1 | 1 |
| Oats | 3 | 5 |
| Potatoes | 3 | 3 |
| Rye | 3 | 5 |
| Sorghum | 1 | 6 |
| Soybeans | 1 | 6 |
| Spring Wheat | 1 | 2 |
| Sugar beets | 3 | 3 |
| Sunflower | 3 | 3 |
| Winter Wheat | 2 | 4 |

### 3.14.3 Emissions Estimates

Annual county emissions estimates of agricultural tilling were calculated using the equation below.

TPY = (acres tilled) x (number of passes) x (lb pollutant/acre) x (1 T/2000 lb)



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### 3.15 Land clearing

Emissions from land clearing burning were estimated. Land clearing is the burning of land debris, like trees, stumps, shrubbery, or other natural vegetation from projects that clear the land surface.

#### 3.15.1 Activity Level

Land clearing emissions are based on 2020 land clearing burn permits issued by the Department of Ecology in counties under Ecology jurisdiction (Adams, Asotin, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, San Juan, Stevens, Walla Walla, and Whitman). Each land clearing permit indicates the total amount of brush that is burned at a location, in tons. For each of these 18 counties, Ecology summed the total tons burned, then calculated tons per capita using unincorporated population totals. Using the average tons per capita, Ecology estimated the tons burned in counties outside Ecology jurisdiction based on their unincorporated populations. Land clearing is illegal in King, Kitsap, Pierce, Snohomish, and Spokane counties, so emissions were assumed to be zero there.

#### 3.15.2 Emission Rates

Land clearing emissions were assumed to be due to the burning of trees and brush. Thus, Ecology used emission rates for the agricultural burning crop type "Limbs and Brush", shown in Table 3-17, for all land clearing emissions.

#### 3.15.3 Emissions Estimates

Annual county emissions estimates were calculated by multiplying emission rates by the number of tons burned, scaled by a combustion completeness factor of 85%.

TPY = (# tons) x (85% combustion completeness) x (emission rate in lb/T) x (1 T/2000 lb)



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**Table 3-32. Land clearing tons burned by county**

| County | Tons cleared |
|---|---|
| Adams | 16.5 |
| Asotin | 100.0 |
| Benton | 262.7 |
| Chelan | 517.0 |
| Clallam | 329.4 |
| Clark | 1674.8 |
| Columbia | 0.0 |
| Cowlitz | 347.4 |
| Douglas | 301.5 |
| Ferry | 10.0 |
| Franklin | 98.2 |
| Garfield | 6.4 |
| Grant | 545.0 |
| Grays Harbor | 208.4 |
| Island | 425.0 |
| Jefferson | 164.1 |
| King | 0.0 |
| Kitsap | 0.0 |
| Kittitas | 127.5 |
| Klickitat | 47.5 |
| Lewis | 355.4 |
| Lincoln | 50.0 |
| Mason | 397.8 |
| Okanogan | 65.0 |
| Pacific | 113.3 |
| Pend Oreille | 213.5 |
| Pierce | 0.0 |
| San Juan | 109.1 |
| Skagit | 378.0 |
| Skamania | 65.7 |
| Snohomish | 0.0 |
| Spokane | 0.0 |
| Stevens | 8.5 |
| Thurston | 1041.0 |
| Wahkiakum | 27.8 |
| Walla Walla | 122.8 |
| Whatcom | 665.9 |
| Whitman | 42.6 |
| Yakima | 633.5 |
| State Total | 9,471.3 |



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### 3.16 Structure & Vehicle Fires

Emissions from accidental structure and vehicle fires were estimated. Structure fires resulting from unintentional actions, arson, or natural events were included. Vehicle fires included any commercial or private vehicles authorized for use on public roads. Fire emissions were estimated using methods in the Emission Inventory Improvement Program (EIIP).[53, 54]

#### 3.16.1 Activity Level

National structure and vehicle fire records are maintained by the Department of Homeland Security US Fire Administration. Records are kept on the National Fire Incident Reporting System (NFIRS).[55] Structure and vehicle fire data was taken from the NFIRS database by county for 2020. All counties reported 2020 data.

#### 3.16.2 Emission Rates

The EIIP provided loading and emission factors.[53,54] The loading factor was 1.15 tons consumed per structure fire and 0.25 tons consumed per vehicle fire. Emission factors are shown below. $PM_{10}$ and $PM_{2.5}$ were estimated from total PM factors using California size fractions for unplanned structure fires (profile 137).[56]

**Table 3-33. Structure and Vehicle Fire Emission Factors (pounds per Ton consumed)**

| Pollutant | Pollutant Code | Structure Fire EF | Vehicle Fire EF |
|---|---|---|---|
| CO | CO | 60 | 125 |
| $NO_X$ | $NO_X$ | 1.4 | 4 |
| $PM_{10}$ | $PM_{10}$ | 10.6 | 98 |
| $PM_{2.5}$ | $PM_{2.5}$ | 9.9 | 91 |
| VOC | VOC | 11 | 32 |
| Acrolein | 107028 | 4.41 | N/A |
| Formaldehyde | 50000 | 1.02 | N/A |
| Hydrochloric acid | 7647010 | 15.11 | N/A |
| Hydrogen cyanide | 74908 | 35.49 | N/A |

#### 3.16.3 Emissions Estimates

Annual county emissions estimates were calculated by multiplying the emission rates by the number of fires and loading per fire.

TPY = (#fires) x (Loading Factor) x (emission rate in lb/T) x (1 T/2000 lb)



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**Table 3-34. Structure and Vehicle Fire Counts**

| County | Structure Fires | Vehicle Fires |
|---|---|---|
| Adams | 5 | 6 |
| Asotin | 27 | 12 |
| Benton | 207 | 120 |
| Chelan | 101 | 48 |
| Clallam | 99 | 41 |
| Clark | 356 | 187 |
| Columbia | 4 | 3 |
| Cowlitz | 127 | 74 |
| Douglas | 31 | 32 |
| Ferry | 4 | 0 |
| Franklin | 79 | 59 |
| Garfield | 8 | 2 |
| Grant | 156 | 88 |
| Grays Harbor | 192 | 60 |
| Island | 101 | 30 |
| Jefferson | 46 | 25 |
| King | 1875 | 779 |
| Kitsap | 177 | 97 |
| Kittitas | 69 | 46 |
| Klickitat | 23 | 19 |
| Lewis | 154 | 66 |
| Lincoln | 4 | 4 |
| Mason | 109 | 48 |
| Okanogan | 70 | 44 |
| Pacific | 37 | 6 |
| Pend Oreille | 22 | 7 |
| Pierce | 845 | 434 |
| San Juan | 24 | 9 |
| Skagit | 156 | 70 |
| Skamania | 6 | 6 |
| Snohomish | 509 | 218 |
| Spokane | 520 | 236 |
| Stevens | 84 | 30 |
| Thurston | 318 | 117 |
| Wahkiakum | 6 | 1 |
| Walla Walla | 69 | 32 |
| Whatcom | 260 | 93 |
| Whitman | 46 | 8 |
| Yakima | 446 | 221 |
| State Total | 7,372 | 3,378 |



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### 3.17 Natural/Biogenic

Emissions from natural/biogenic activity of trees, shrubs, and soil were estimated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) v2.1[57]. Monthly MEGAN results were obtained from the AIRPACT-5 framework at Washington State University for 2020. It should be noted that MEGAN does not include detailed information about agricultural vegetation in Washington.

#### 3.17.1 Activity Level

MEGAN is a process-based model that uses landcover (e.g. plant functional type and leaf area index) and meteorology to estimate emissions from soil and vegetation. Meteorological information was obtained from the UW WRF 4-km forecasts. Plant activity is determined within the model by using a leaf age model, a canopy environment model, soil moisture algorithms, CO2 algorithms, and light and temperature algorithms. The different plant functional types are shown in the table below.

**Table 3-35. MEGAN Functional Plant Types**

| Class # | Plant Type |
|---|---|
| 1 | Needleleaf Evergreen Temperate Tree |
| 2 | Needleleaf Evergreen Boreal Tree |
| 3 | Needleleaf Deciduous Boreal Tree |
| 4 | Broadleaf Evergreen Tropical Tree |
| 5 | Broadleaf Evergreen Temperate Tree |
| 6 | Broadleaf Deciduous Tropical Tree |
| 7 | Broadleaf Deciduous Temperate Tree |
| 8 | Broadleaf Deciduous Boreal Tree |
| 9 | Broadleaf Evergreen Temperate Shrub |
| 10 | Broadleaf Deciduous Temperate Shrub |
| 11 | Broadleaf Deciduous Boreal Shrub |
| 12 | Arctic C3 Grass |
| 13 | Cool C3 Grass |
| 14 | Warm C4 Grass |
| 15 | Crop |

#### 3.17.2 Emission Rates

The MEGAN model estimates emissions of individual VOCs, NO, and CO. The VOCs reported include isoprene, methanol, ethanol, acetaldehyde, acetone, alpha-pinene, beta-pinene, t-beta-ocimene, limonene, ethene, and propene, terpenoids, monoterpenes and sesquiterpenes. The emission factors for each pollutant by plant class # are shown in the table below. AIRPACT groups many of these VOCs together and they were added together to get a total VOC estimate.



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**Table 3-36. MEGAN v2.1 Biogenic Emission Factors by Class Number (µg/m²/hr)**

| Compound | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Isoprene | 600 | 3000 | 1 | 7000 | 10000 | 7000 | 10000 | 11000 | 2000 | 4000 | 4000 | 1600 | 800 | 200 | 1 |
| Myrcene | 70 | 70 | 60 | 80 | 30 | 80 | 30 | 30 | 30 | 50 | 30 | 0.3 | 0.3 | 0.3 | 0.3 |
| Sabinene | 70 | 70 | 40 | 80 | 50 | 80 | 50 | 50 | 50 | 70 | 50 | 0.7 | 0.7 | 0.7 | 0.7 |
| Limonene | 100 | 100 | 130 | 80 | 80 | 80 | 80 | 80 | 60 | 100 | 60 | 0.7 | 0.7 | 0.7 | 0.7 |
| 3-Carene | 160 | 160 | 80 | 40 | 30 | 40 | 30 | 30 | 30 | 100 | 30 | 0.3 | 0.3 | 0.3 | 0.3 |
| t-β-Ocimene | 70 | 70 | 60 | 150 | 120 | 150 | 120 | 120 | 90 | 150 | 90 | 2 | 2 | 2 | 2 |
| β-Pinene | 300 | 300 | 200 | 120 | 130 | 120 | 130 | 130 | 100 | 150 | 100 | 1.5 | 1.5 | 1.5 | 1.5 |
| α-Pinene | 500 | 500 | 510 | 600 | 400 | 600 | 400 | 400 | 200 | 300 | 200 | 2 | 2 | 2 | 2 |
| Other Monoterpenes | 180 | 180 | 170 | 150 | 150 | 150 | 150 | 150 | 110 | 200 | 110 | 5 | 5 | 5 | 5 |
| α-Farnesene | 40 | 40 | 40 | 60 | 40 | 60 | 40 | 40 | 40 | 40 | 40 | 3 | 3 | 3 | 4 |
| β-Caryophyllene | 80 | 80 | 80 | 60 | 40 | 60 | 40 | 40 | 50 | 50 | 50 | 1 | 1 | 1 | 4 |
| Other Sesquiterpenes | 120 | 120 | 120 | 120 | 100 | 120 | 100 | 100 | 100 | 100 | 100 | 2 | 2 | 2 | 2 |
| 232-MBO | 700 | 60 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Methanol | 900 | 900 | 900 | 500 | 900 | 500 | 900 | 900 | 900 | 900 | 900 | 500 | 500 | 500 | 900 |
| Acetone | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 80 | 80 | 80 | 80 |
| CO | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| Bidirectional VOC | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 80 | 80 | 80 | 80 |
| Stress VOC | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| Other VOC | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 |

### 3.17.3 Emissions Estimates

Annual county emissions estimates were calculated by adding the monthly MEGAN emissions estimates for 2020. Emissions estimates of VOCs, NO, and CO came directly from the process described above.



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### 3.18 Emissions Calculated by EPA

The Dept. of Ecology acquired CAP emission estimates from EPA for several source types, as calculated in the 2020 NEI using EPA defaults and methodology, listed in Table 3-37. The technical support document for the 2020 NEI provides more information about each source type calculated by EPA[1].

**Table 3-37. Emissions Source Types Calculated by EPA using Defaults**

| ECY SCC Category | ECY SCC Group | Description |
|---|---|---|
| F_RES | F_RES | Residential non-Wood Fuel |
| AIR | AIR | Aircraft: military, commercial, general aviation |
| SHIP | SHIP | Commercial Marine Vessels |
| RR | RR | Locomotives [line-haul; not switch yards] |
| FOOD | FOOD | Food and Kindred Products |
| SOLV | SURFC | Surface coating |
| SOLV | DEGR | Degreasing |
| SOLV | DRY | Dry cleaning |
| SOLV | GRAPH | Graphic arts |
| SOLV | COCM-S | Consumer and commercial solvents |
| SOLV | ASPHLT | Asphalt |
| SOLV | AGR_PEST | Agricultural Pesticides |
| PETROL | PPS | Petroleum gas cans and bulk plants |
| PETROL | GASSTN | Gas stations [storage tank filling and breathing; not vehicle refueling] |
| PETROL | AV-GAS | Aviation gas storage and transport |
| PETROL | PPT | Petroleum truck transport |
| MISC | COMPOST | Composting |
| FERT | FERT | Fertilizer Application |
| LIVE | LIVE_SILAGE | Agricultural Silage Livestock Feed |
| LIVE | LIVE_B | Livestock Waste - Beef |
| LIVE | LIVE_O | Livestock Waste - Other |
| LIVE | LIVE_D | Livestock Waste - Dairy |
| LIVE | LIVE_DUST | Livestock Dust from Hooves |
| MISC | GRILL_RES | Residential outdoor charcoal grilling |
| MISC | OTH_COMBUST | Other Combustion |



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# 4 Emissions Summaries

Annual emissions summaries are presented below for criteria pollutants and ammonia. More detailed information (e.g. sub-categories or by SCC) can also be generated upon request. Abbreviations used are listed in Table 1-1.

**Table 4-1. Statewide Emissions in Tons per Year**

| Category | CO | NH3 | NOX | PM10 | PM2.5 | SO2 | VOC |
|---|---|---|---|---|---|---|---|
| AIR | 9,699 | | 1,691 | 233 | 200 | 202 | 1,232 |
| BOAT | 29,365 | 5 | 2,731 | 85 | 79 | 2 | 5,340 |
| CONST | | | | 54,100 | 5,539 | | |
| F_ICI | 7,028 | 109 | 8,119 | 2,334 | 1,938 | 441 | 473 |
| F_RES | 1,999 | 887 | 5,003 | 56 | 48 | 32 | 275 |
| FERT | | 15,661 | | | | | |
| FOOD | 2,156 | | | 5,630 | 5,230 | | 773 |
| LIVE | | 31,227 | | 11,754 | 2,408 | | 9,820 |
| MISC | 2,229 | 195 | 55 | 456 | 376 | 5 | 1,512 |
| NAT | 44,219 | | 2,680 | | | | 214,163 |
| NRM | 224,050 | 37 | 16,615 | 1,881 | 1,785 | 18 | 16,395 |
| OB_AG | 22,335 | 6,007 | 1,080 | 3,225 | 3,135 | 151 | 2,710 |
| OB_RES | 12,658 | 197 | 292 | 2,237 | 2,187 | 44 | 1,557 |
| OB_RX | 12,113 | 1,995 | 638 | 2,470 | 2,152 | 16 | 3,028 |
| ORM | 330,309 | 1,817 | 60,029 | 3,911 | 1,769 | 175 | 27,675 |
| PETROL | | | | | | | 11,009 |
| POINT | 28,763 | 506 | 26,025 | 3,970 | 3,323 | 7,483 | 9,025 |
| ROADS | | | | 54,899 | 7,181 | | |
| RR | 2,862 | 9 | 13,629 | 352 | 342 | 10 | 575 |
| RWC | 124,009 | 870 | 1,911 | 17,446 | 17,438 | 378 | 21,060 |
| SHIP | 1,691 | 3 | 13,549 | 280 | 266 | 256 | 534 |
| SOLV | | | | | | | 69,076 |
| TILL_HARV | | | | 76,422 | 14,895 | | |
| WF | 512,337 | 8,426 | 7,866 | 52,901 | 44,832 | 4,118 | 121,121 |
| Total | 1,367,822 | 67,950 | 161,914 | 294,642 | 115,122 | 13,329 | 517,353 |

**Table 4-2. Annual Statewide Emissions Source Percentages by Pollutant**

| Category | CO | NH3 | NOX | PM10 | PM2.5 | SO2 | VOC |
|---|---|---|---|---|---|---|---|
| AIR | 0.71% | | 1.04% | 0.08% | 0.17% | 1.51% | 0.24% |
| BOAT | 2.15% | 0.01% | 1.69% | 0.03% | 0.07% | 0.02% | 1.03% |
| CONST | | | | 18.36% | 4.81% | | |
| F_ICI | 0.51% | 0.16% | 5.01% | 0.79% | 1.68% | 3.31% | 0.09% |
| F_RES | 0.15% | 1.31% | 3.09% | 0.02% | 0.04% | 0.24% | 0.05% |
| FERT | 0.00% | 23.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| FOOD | 0.16% | | | 1.91% | 4.54% | | 0.15% |
| LIVE | | 45.96% | | 3.99% | 2.09% | | 1.90% |
| MISC | 0.16% | 0.29% | 0.03% | 0.15% | 0.33% | 0.04% | 0.29% |
| NAT | 3.23% | | 1.66% | | | | 41.40% |
| NRM | 16.38% | 0.05% | 10.26 % | 0.64% | 1.55% | 0.13% | 3.17% |
| OB_AG | 1.63% | 8.84% | 0.67% | 1.09% | 2.72% | 1.13% | 0.52% |
| OB_RES | 0.93% | 0.29% | 0.18% | 0.76% | 1.90% | 0.33% | 0.30% |
| OB_RX | 0.89% | 2.94% | 0.39% | 0.84% | 1.87% | 0.12% | 0.59% |
| ORM | 24.15% | 2.67% | 37.07 % | 1.33% | 1.54% | 1.31% | 5.35% |
| PETROL | | | | | | | 2.13% |
| POINT | 2.10% | 0.74% | 16.07 % | 1.35% | 2.89% | 56.14% | 1.74% |
| ROADS | | | | 18.63% | 6.24% | | |
| RR | 0.21% | 0.01% | 8.42% | 0.12% | 0.30% | 0.08% | 0.11% |
| RWC | 9.07% | 1.28% | 1.18% | 5.92% | 15.15 % | 2.83% | 4.07% |
| SHIP | 0.12% | 0.00% | 8.37% | 0.10% | 0.23% | 1.92% | 0.10% |
| SOLV | | | | | | | 13.35% |
| TILL_HARV | | | | 25.94% | 12.94 % | | |
| WF | 37.46% | 12.40% | 4.86% | 17.95% | 38.94 % | 30.89% | 23.41% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% |



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## Table 4-3. County $PM_{10}$ Emissions Estimates in Tons per Year

| County | OB_AG | AIR | FOOD | SHIP | TILL_HARV | CONST | ROADS | F_ICI | POINT | LIVE | RR | MISC | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 111 | 3 | 11 | | 12,522 | 87 | 1,373 | 5 | | 469 | 28 | 1 | 40 | 0 | 26 | 0 | 7 | 29 | 3 | 19 |
| Asotin | 0 | 0 | 11 | 0 | 316 | 73 | 363 | 4 | | 233 | 0 | 2 | 6 | 0 | 10 | 0 | 6 | 30 | 1 | 3 |
| Benton | 134 | 2 | 138 | 1 | 2,952 | 7,911 | 573 | 59 | 5 | 392 | 28 | 12 | 53 | 2 | 116 | 0 | 48 | 129 | 16 | 134 |
| Chelan | 24 | 1 | 64 | | 25 | 987 | 660 | 28 | | 7 | 7 | 5 | 19 | 2 | 47 | 0 | 32 | 395 | 22 | 1,785 |
| Clallam | 2 | 4 | 53 | 41 | 68 | 139 | 309 | 14 | 24 | 72 | 0 | 6 | 15 | 1 | 45 | 0 | 38 | 355 | 129 | 78 |
| Clark | | 4 | 294 | 8 | 143 | 2,868 | 643 | 132 | 60 | 294 | 20 | 30 | 79 | 4 | 209 | 2 | 156 | 1,236 | 15 | 17 |
| Columbia | 456 | 0 | 1 | 0 | 1,668 | 24 | 761 | 1 | | 71 | 0 | 0 | 33 | 0 | 4 | 0 | 2 | 19 | 2 | 92 |
| Cowlitz | | 2 | 71 | 11 | 72 | 716 | 327 | 35 | 396 | 205 | 19 | 7 | 17 | 2 | 81 | 0 | 44 | 423 | 46 | 68 |
| Douglas | 44 | 3 | 21 | | 6,009 | 502 | 3,599 | 7 | 23 | 115 | 1 | 3 | 25 | 1 | 23 | 0 | 14 | 126 | 17 | 2,928 |
| Ferry | | 0 | 3 | | 158 | 469 | 1,973 | 1 | | 75 | 1 | 0 | 13 | 0 | 8 | 0 | 6 | 71 | 334 | 3,270 |
| Franklin | 176 | 6 | 40 | 1 | 4,428 | 2,199 | 1,293 | 23 | | 623 | 22 | 5 | 40 | 1 | 41 | 0 | 21 | 106 | 1 | 953 |
| Garfield | 88 | | 1 | 0 | 1,138 | 2 | 892 | 0 | | 98 | 0 | 0 | 11 | 0 | 4 | 0 | 2 | 9 | | |
| Grant | 301 | 13 | 49 | | 10,110 | 1,014 | 2,311 | 22 | 23 | 2,405 | 6 | 6 | 69 | 2 | 63 | 0 | 36 | 174 | 5 | 149 |
| Grays Harbor | 5 | 1 | 47 | 7 | 147 | 38 | 575 | 14 | 244 | 66 | 1 | 6 | 15 | 1 | 50 | 0 | 37 | 330 | 185 | 4 |
| Island | 5 | 7 | 45 | 12 | 87 | 148 | 154 | 10 | 4 | 71 | 0 | 6 | 14 | 2 | 33 | 1 | 47 | 304 | 1 | |
| Jefferson | | 4 | 23 | 14 | 12 | 82 | 467 | 6 | 47 | 22 | 0 | 3 | 13 | 1 | 23 | 0 | 23 | 225 | 87 | 22 |
| King | 11 | 66 | 2,199 | 60 | 117 | 12,588 | 5,640 | 935 | 87 | 280 | 22 | 120 | 471 | 18 | 1,037 | 25 | 461 | 2,652 | 6 | 113 |
| Kitsap | | 6 | 166 | 36 | 100 | 254 | 585 | 43 | 15 | 13 | 0 | 17 | 47 | 4 | 121 | 3 | 86 | 825 | | 3 |
| Kittitas | 25 | 4 | 38 | | 193 | 770 | 487 | 10 | | 287 | 3 | 4 | 18 | 1 | 66 | 0 | 20 | 197 | 18 | 657 |
| Klickitat | 34 | 2 | 9 | 1 | 1,241 | 77 | 1,133 | 4 | 226 | 227 | 37 | 2 | 18 | 0 | 16 | 0 | 12 | 83 | 236 | 73 |
| Lewis | 7 | 6 | 59 | | 310 | 430 | 496 | 19 | 568 | 316 | 14 | 6 | 17 | 1 | 63 | 0 | 46 | 396 | 139 | 15 |
| Lincoln | 29 | 2 | 8 | | 10,022 | 483 | 2,170 | 2 | | 124 | 15 | 1 | 52 | 0 | 18 | 0 | 8 | 40 | 7 | 2,350 |
| Mason | | 6 | 35 | 0 | 22 | 104 | 418 | 8 | 33 | 15 | 1 | 5 | 10 | 2 | 31 | 0 | 44 | 396 | 29 | 5 |
| Okanogan | 30 | 7 | 18 | | 389 | 469 | 2,335 | 7 | | 513 | 1 | 3 | 13 | 1 | 33 | 0 | 28 | 275 | 75 | 8,081 |
| Pacific | | 0 | 16 | 5 | 78 | 29 | 428 | 5 | 16 | 56 | 0 | 2 | 6 | 0 | 13 | 0 | 17 | 172 | 51 | 1 |
| Pend Oreille | 4 | 0 | 6 | | 148 | 120 | 2,276 | 2 | 4 | 41 | 1 | 1 | 10 | 0 | 9 | 0 | 12 | 145 | 110 | 77 |
| Pierce | | 11 | 551 | 21 | 75 | 2,149 | 1,079 | 217 | 325 | 133 | 20 | 55 | 184 | 9 | 467 | 5 | 222 | 1,559 | 70 | 232 |
| San Juan | 3 | 11 | 14 | 16 | 61 | 121 | 99 | 4 | | 22 | 0 | 2 | 7 | 1 | 4 | 0 | 18 | 143 | 2 | 0 |
| Skagit | | 6 | 93 | 15 | 638 | 836 | 568 | 43 | 469 | 247 | 5 | 9 | 30 | 3 | 86 | 1 | 55 | 407 | 121 | 8 |
| Skamania | | | 3 | 0 | 27 | 17 | 220 | 2 | | 8 | 16 | 1 | 10 | 0 | 9 | 0 | 9 | 102 | 29 | 20,732 |
| Snohomish | 3 | 23 | 589 | 9 | 259 | 2,405 | 1,388 | 293 | 15 | 241 | 13 | 45 | 150 | 9 | 388 | 5 | 214 | 2,555 | 54 | 4,821 |
| Spokane | 23 | 10 | 357 | | 2,644 | 7,964 | 7,673 | 150 | 139 | 330 | 33 | 33 | 98 | 5 | 282 | 4 | 133 | 1,146 | 89 | 126 |
| Stevens | 6 | 1 | 17 | | 889 | 294 | 4,279 | 7 | 171 | 236 | 2 | 3 | 16 | 1 | 26 | 0 | 29 | 311 | 321 | 82 |
| Thurston | 8 | 5 | 193 | 1 | 95 | 834 | 738 | 55 | 0 | 198 | 12 | 19 | 44 | 3 | 154 | 1 | 110 | 759 | 9 | 258 |
| Wahkiakum | | | 1 | 6 | 68 | 23 | 94 | 1 | | 63 | 0 | 0 | 1 | 0 | 3 | 0 | 4 | 33 | 6 | 1 |
| Walla Walla | 682 | 2 | 40 | 0 | 4,482 | 1,023 | 398 | 19 | 122 | 328 | 8 | 4 | 41 | 1 | 32 | 0 | 17 | 113 | 5 | 7 |
| Whatcom | 10 | 5 | 178 | 13 | 754 | 2,104 | 705 | 73 | 883 | 642 | 6 | 14 | 46 | 3 | 107 | 2 | 87 | 655 | 100 | 58 |
| Whitman | 359 | 4 | 23 | 0 | 11,906 | 74 | 2,616 | 11 | 16 | 239 | 5 | 2 | 80 | 0 | 25 | 0 | 12 | 56 | 1 | 618 |
| Yakima | 646 | 4 | 148 | | 2,048 | 3,672 | 2,802 | 63 | 55 | 1,977 | 5 | 17 | 54 | 2 | 137 | 1 | 75 | 465 | 131 | 5,062 |
| State Total | 3,225 | 233 | 5,630 | 280 | 76,422 | 54,100 | 54,899 | 2,334 | 3,970 | 11,754 | 352 | 456 | 1,881 | 85 | 3,911 | 56 | 2,237 | 17,446 | 2,470 | 52,901 |

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## Table 4-4. County $PM_{2.5}$ Emissions Estimates in Tons per Year

| County | OB_AG | AIR | FOOD | SHIP | TILL_HARV | CONST | ROADS | F_ICI | POINT | LIVE | RR | MISC | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 106 | 2 | 10 | | 2,464 | 9 | 145 | 4 | | 95 | 27 | 1 | 39 | 0 | 16 | 0 | 6 | 29 | 3 | 16 |
| Asotin | 0 | 0 | 10 | 0 | 59 | 7 | 40 | 3 | | 48 | 0 | 1 | 6 | 0 | 5 | 0 | 6 | 30 | 1 | 3 |
| Benton | 128 | 2 | 128 | 1 | 570 | 791 | 80 | 49 | 2 | 81 | 28 | 10 | 51 | 2 | 54 | 0 | 47 | 129 | 14 | 114 |
| Chelan | 22 | 1 | 59 | | 5 | 99 | 101 | 23 | | 2 | 7 | 4 | 18 | 1 | 23 | 0 | 31 | 395 | 19 | 1,512 |
| Clallam | 1 | 4 | 49 | 38 | 13 | 16 | 70 | 12 | 14 | 15 | 0 | 5 | 14 | 1 | 22 | 0 | 37 | 355 | 112 | 66 |
| Clark | | 4 | 273 | 7 | 28 | 290 | 151 | 109 | 58 | 60 | 19 | 24 | 75 | 4 | 96 | 2 | 152 | 1,236 | 13 | 15 |
| Columbia | 452 | 0 | 1 | 0 | 323 | 3 | 80 | 1 | | 14 | 0 | 0 | 31 | 0 | 2 | 0 | 2 | 19 | 2 | 78 |
| Cowlitz | | 1 | 66 | 10 | 14 | 83 | 79 | 29 | 355 | 42 | 19 | 6 | 16 | 1 | 44 | 0 | 43 | 423 | 40 | 58 |
| Douglas | 42 | 3 | 20 | | 1,178 | 50 | 372 | 5 | 7 | 24 | 1 | 2 | 24 | 1 | 10 | 0 | 14 | 126 | 15 | 2,481 |
| Ferry | | 0 | 2 | | 31 | 58 | 213 | 1 | | 15 | 1 | 0 | 12 | 0 | 4 | 0 | 6 | 71 | 291 | 2,771 |
| Franklin | 169 | 5 | 37 | 1 | 873 | 224 | 139 | 19 | | 127 | 21 | 4 | 38 | 1 | 19 | 0 | 20 | 106 | 1 | 808 |
| Garfield | 87 | | 1 | 0 | 213 | 0 | 92 | 0 | | 20 | 0 | 0 | 10 | 0 | 2 | 0 | 2 | 9 | | |
| Grant | 289 | 12 | 46 | | 1,995 | 104 | 253 | 18 | 22 | 497 | 6 | 5 | 66 | 1 | 34 | 0 | 34 | 174 | 4 | 126 |
| Grays Harbor | 5 | 0 | 44 | 6 | 29 | 4 | 106 | 11 | 212 | 14 | 1 | 5 | 14 | 1 | 24 | 0 | 36 | 330 | 161 | 4 |
| Island | 4 | 7 | 41 | 11 | 17 | 16 | 37 | 9 | 3 | 15 | 0 | 5 | 13 | 2 | 16 | 1 | 45 | 304 | 1 | |
| Jefferson | | 3 | 21 | 13 | 2 | 10 | 76 | 5 | 5 | 4 | 0 | 2 | 12 | 1 | 12 | 0 | 22 | 225 | 76 | 18 |
| King | 11 | 59 | 2,042 | 57 | 23 | 1,274 | 858 | 782 | 72 | 58 | 22 | 99 | 444 | 17 | 413 | 22 | 458 | 2,645 | 5 | 96 |
| Kitsap | | 5 | 155 | 35 | 20 | 26 | 115 | 36 | 2 | 3 | 0 | 14 | 44 | 4 | 53 | 3 | 84 | 825 | | 2 |
| Kittitas | 24 | 3 | 35 | | 37 | 80 | 77 | 8 | | 60 | 3 | 3 | 17 | 1 | 41 | 0 | 19 | 197 | 16 | 557 |
| Klickitat | 32 | 2 | 9 | 1 | 239 | 8 | 131 | 4 | 83 | 47 | 36 | 1 | 17 | 0 | 9 | 0 | 11 | 83 | 206 | 62 |
| Lewis | 6 | 5 | 55 | | 60 | 47 | 100 | 16 | 496 | 57 | 13 | 5 | 16 | 1 | 35 | 0 | 44 | 396 | 121 | 13 |
| Lincoln | 28 | 1 | 7 | | 1,951 | 48 | 227 | 1 | | 25 | 14 | 1 | 50 | 0 | 11 | 0 | 8 | 40 | 6 | 1,992 |
| Mason | | 5 | 32 | 0 | 4 | 13 | 75 | 7 | 20 | 3 | 1 | 4 | 9 | 1 | 16 | 0 | 42 | 396 | 25 | 5 |
| Okanogan | 28 | 6 | 16 | | 76 | 50 | 275 | 6 | | 107 | 1 | 3 | 12 | 1 | 19 | 0 | 27 | 275 | 65 | 6,848 |
| Pacific | | 0 | 15 | 5 | 15 | 3 | 67 | 4 | 9 | 12 | 0 | 1 | 5 | 0 | 7 | 0 | 17 | 172 | 44 | 1 |
| Pend Oreille | 4 | 0 | 5 | | 29 | 14 | 244 | 1 | 3 | 9 | 1 | 1 | 9 | 0 | 6 | 0 | 11 | 145 | 96 | 66 |
| Pierce | | 9 | 512 | 19 | 14 | 231 | 240 | 181 | 270 | 25 | 19 | 45 | 174 | 8 | 193 | 4 | 220 | 1,558 | 61 | 196 |
| San Juan | 3 | 10 | 13 | 16 | 11 | 13 | 13 | 4 | | 4 | 0 | 1 | 7 | 1 | 2 | 0 | 18 | 143 | 1 | 0 |
| Skagit | | 5 | 86 | 14 | 125 | 89 | 113 | 36 | 444 | 51 | 5 | 7 | 28 | 3 | 43 | 1 | 53 | 407 | 105 | 6 |
| Skamania | | | 3 | 0 | 5 | 2 | 38 | 2 | | 1 | 16 | 1 | 9 | 0 | 5 | 0 | 9 | 102 | 25 | 17,570 |
| Snohomish | 2 | 19 | 548 | 9 | 51 | 250 | 329 | 239 | | 48 | 12 | 37 | 141 | 9 | 172 | 4 | 211 | 2,555 | 47 | 4,085 |
| Spokane | 22 | 8 | 331 | | 504 | 799 | 844 | 125 | 111 | 68 | 32 | 27 | 93 | 5 | 126 | 4 | 131 | 1,146 | 78 | 106 |
| Stevens | 6 | 1 | 16 | | 176 | 34 | 470 | 6 | 127 | 49 | 2 | 3 | 15 | 1 | 16 | 0 | 28 | 311 | 280 | 69 |
| Thurston | 7 | 4 | 179 | 1 | 18 | 88 | 136 | 46 | 0 | 37 | 11 | 15 | 42 | 3 | 70 | 1 | 107 | 759 | 8 | 219 |
| Wahkiakum | | | 1 | 6 | 14 | 3 | 15 | 0 | | 13 | 0 | 0 | 1 | 0 | 2 | 0 | 4 | 33 | 5 | 1 |
| Walla Walla | 672 | 2 | 37 | 0 | 867 | 103 | 48 | 16 | 115 | 68 | 8 | 3 | 39 | 0 | 16 | 0 | 16 | 113 | 4 | 6 |
| Whatcom | 10 | 4 | 166 | 13 | 150 | 220 | 133 | 60 | 870 | 133 | 6 | 12 | 43 | 3 | 51 | 1 | 84 | 655 | 87 | 49 |
| Whitman | 357 | 4 | 21 | 0 | 2,291 | 7 | 278 | 9 | 7 | 49 | 5 | 2 | 77 | 0 | 13 | 0 | 12 | 56 | 1 | 524 |
| Yakima | 616 | 4 | 137 | | 401 | 373 | 320 | 52 | 12 | 408 | 4 | 14 | 52 | 2 | 65 | 1 | 72 | 465 | 114 | 4,290 |
| State Total | 3,135 | 200 | 5,230 | 266 | 14,895 | 5,539 | 7,181 | 1,938 | 3,323 | 2,408 | 342 | 376 | 1,785 | 79 | 1,769 | 48 | 2,187 | 17,438 | 2,152 | 44,832 |

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## Table 4-5. County $SO_2$ Emissions Estimates in Tons per Year

| County | OB_AG | AIR | SHIP | F_ICI | POINT | RR | MISC | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 3 | 0 | | 1 | | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 2 |
| Asotin | 0 | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Benton | 3 | 0 | 0 | 11 | 1 | 1 | 0 | 0 | 0 | 5 | 0 | 1 | 3 | 0 | 14 |
| Chelan | 0 | 0 | | 6 | | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 10 | 0 | 117 |
| Clallam | 0 | 1 | 57 | 3 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 9 | 1 | 5 |
| Clark | | 1 | 10 | 27 | 7 | 1 | 0 | 1 | 0 | 9 | 2 | 3 | 25 | 0 | 2 |
| Columbia | 38 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Cowlitz | | 1 | 16 | 8 | 724 | 1 | 0 | 0 | 0 | 4 | 0 | 1 | 11 | 0 | 4 |
| Douglas | 1 | 1 | | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 298 |
| Ferry | | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 254 |
| Franklin | 5 | 6 | 0 | 5 | | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 97 |
| Garfield | 10 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Grant | 7 | 9 | | 5 | 7 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 4 | 0 | 14 |
| Grays Harbor | 0 | 0 | 4 | 3 | 72 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 8 | 1 | 0 |
| Island | 0 | 10 | 14 | 2 | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 7 | 0 | |
| Jefferson | | 1 | 16 | 1 | 81 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 1 | 1 |
| King | 0 | 124 | 43 | 154 | 129 | 1 | 1 | 5 | 1 | 46 | 12 | 8 | 50 | 0 | 7 |
| Kitsap | | 1 | 26 | 7 | | 0 | 0 | 0 | 0 | 5 | 1 | 2 | 17 | | 0 |
| Kittitas | 1 | 1 | | 2 | | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 5 | 0 | 64 |
| Klickitat | 1 | 1 | 0 | 1 | 21 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 2 | 6 |
| Lewis | 0 | 2 | | 4 | 1,701 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 10 | 1 | 1 |
| Lincoln | 1 | 0 | | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 238 |
| Mason | | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 10 | 0 | 0 |
| Okanogan | 0 | 4 | | 1 | | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 7 | 0 | 735 |
| Pacific | | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 0 |
| Pend Oreille | 0 | 0 | | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 5 |
| Pierce | | 2 | 35 | 40 | 258 | 1 | 1 | 2 | 0 | 20 | 3 | 4 | 30 | 0 | 17 |
| San Juan | 0 | 6 | 5 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Skagit | | 1 | 11 | 10 | 433 | 0 | 0 | 0 | 0 | 4 | 1 | 1 | 10 | 1 | 1 |
| Skamania | | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1,350 |
| Snohomish | 0 | 6 | 3 | 71 | 11 | 0 | 0 | 2 | 0 | 17 | 4 | 4 | 51 | 0 | 314 |
| Spokane | 1 | 12 | | 26 | 33 | 1 | 0 | 1 | 0 | 12 | 3 | 3 | 23 | 1 | 10 |
| Stevens | 0 | 0 | | 2 | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 9 | 2 | 6 |
| Thurston | 0 | 1 | 1 | 9 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 2 | 15 | 0 | 17 |
| Wahkiakum | | | 6 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Walla Walla | 42 | 1 | 0 | 4 | 1,099 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 1 |
| Whatcom | 0 | 2 | 8 | 16 | 2,869 | 0 | 0 | 0 | 0 | 5 | 1 | 2 | 13 | 1 | 4 |
| Whitman | 29 | 1 | 0 | 3 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 60 |
| Yakima | 9 | 2 | | 13 | 2 | 0 | 0 | 1 | 0 | 6 | 1 | 2 | 9 | 1 | 466 |
| State Total | 151 | 202 | 256 | 441 | 7,483 | 10 | 5 | 18 | 2 | 175 | 32 | 44 | 378 | 16 | 4,118 |

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## Table 4-6. County NOx Emissions Estimates in Tons per Year

| County | OB_AG | AIR | SHIP | F_ICI | POINT | RR | MISC | NAT | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 26 | 2 | | 19 | | 1,091 | 0 | 92 | 534 | 3 | 694 | 7 | 1 | 3 | 1 | 4 |
| Asotin | 0 | 0 | 2 | 14 | | 0 | 0 | 40 | 68 | 6 | 146 | 22 | 1 | 3 | 0 | 1 |
| Benton | 27 | 2 | 42 | 204 | 144 | 1,115 | 1 | 104 | 554 | 61 | 1,827 | 58 | 6 | 15 | 4 | 32 |
| Chelan | 19 | 1 | | 98 | | 256 | 1 | 90 | 155 | 40 | 821 | 4 | 5 | 37 | 6 | 184 |
| Clallam | 0 | 6 | 2,566 | 48 | 68 | 0 | 1 | 35 | 95 | 47 | 767 | 13 | 5 | 34 | 33 | 8 |
| Clark | | 4 | 342 | 467 | 142 | 769 | 4 | 37 | 653 | 108 | 3,149 | 265 | 21 | 139 | 4 | 3 |
| Columbia | 195 | 0 | 5 | 3 | | 6 | 0 | 39 | 226 | 1 | 87 | 1 | 0 | 2 | 1 | 14 |
| Cowlitz | | 4 | 507 | 129 | 3,447 | 759 | 1 | 42 | 142 | 41 | 1,658 | 14 | 6 | 41 | 12 | 7 |
| Douglas | 32 | 8 | | 23 | 8 | 54 | 0 | 71 | 314 | 18 | 472 | 2 | 2 | 12 | 4 | 692 |
| Ferry | | 0 | | 5 | | 31 | 0 | 110 | 56 | 4 | 170 | 2 | 1 | 6 | 86 | 484 |
| Franklin | 50 | 54 | 21 | 83 | | 849 | 1 | 78 | 486 | 21 | 817 | 35 | 3 | 10 | 0 | 224 |
| Garfield | 50 | | 6 | 1 | | 0 | 0 | 37 | 138 | 1 | 78 | 1 | 0 | 1 | | |
| Grant | 91 | 88 | | 79 | 55 | 243 | 1 | 151 | 862 | 35 | 1,329 | 5 | 6 | 16 | 1 | 33 |
| Grays Harbor | 1 | 0 | 273 | 49 | 321 | 34 | 1 | 57 | 103 | 23 | 857 | 26 | 5 | 32 | 48 | 0 |
| Island | 1 | 102 | 738 | 36 | 11 | 0 | 1 | 5 | 100 | 77 | 531 | 81 | 7 | 30 | 0 | |
| Jefferson | | 3 | 859 | 22 | 555 | 0 | 0 | 34 | 91 | 49 | 462 | 24 | 3 | 21 | 22 | 2 |
| King | 3 | 1,040 | 2,645 | 3,168 | 1,822 | 861 | 14 | 60 | 3,492 | 672 | 12,979 | 1,810 | 53 | 344 | 2 | 12 |
| Kitsap | | 9 | 1,759 | 146 | | 12 | 2 | 12 | 331 | 165 | 1,781 | 177 | 11 | 91 | | 0 |
| Kittitas | 6 | 4 | | 33 | | 113 | 0 | 80 | 156 | 15 | 1,635 | 37 | 3 | 18 | 5 | 146 |
| Klickitat | 21 | 7 | 51 | 16 | 91 | 1,458 | 0 | 104 | 167 | 6 | 335 | 11 | 2 | 8 | 61 | 12 |
| Lewis | 2 | 11 | | 69 | 6,295 | 530 | 1 | 81 | 141 | 25 | 1,301 | 19 | 7 | 38 | 36 | 2 |
| Lincoln | 8 | 1 | | 6 | | 562 | 0 | 102 | 680 | 11 | 425 | 8 | 1 | 3 | 2 | 552 |
| Mason | | 55 | 9 | 28 | 57 | 25 | 1 | 33 | 69 | 48 | 602 | 20 | 7 | 38 | 8 | 1 |
| Okanogan | 18 | 33 | | 25 | | 50 | 0 | 191 | 130 | 13 | 732 | 6 | 4 | 26 | 19 | 1,590 |
| Pacific | | 5 | 200 | 17 | 62 | 0 | 0 | 24 | 34 | 13 | 277 | 6 | 2 | 16 | 13 | 0 |
| Pend Oreille | 0 | 0 | | 6 | 14 | 36 | 0 | 62 | 53 | 8 | 207 | 2 | 2 | 13 | 28 | 10 |
| Pierce | | 10 | 952 | 751 | 1,293 | 763 | 7 | 53 | 1,381 | 277 | 6,188 | 534 | 26 | 185 | 18 | 29 |
| San Juan | 1 | 55 | 637 | 16 | | 0 | 0 | 4 | 44 | 61 | 85 | 13 | 3 | 14 | 0 | 0 |
| Skagit | | 5 | 610 | 156 | 4,158 | 187 | 1 | 40 | 255 | 115 | 1,590 | 131 | 8 | 39 | 31 | 1 |
| Skamania | | | 17 | 7 | | 632 | 0 | 48 | 39 | 4 | 185 | 5 | 1 | 9 | 8 | 2,113 |
| Snohomish | 1 | 39 | 381 | 1,075 | 141 | 494 | 5 | 51 | 1,104 | 308 | 5,619 | 599 | 26 | 281 | 14 | 492 |
| Spokane | 6 | 94 | | 513 | 912 | 1,297 | 4 | 106 | 962 | 121 | 4,057 | 464 | 17 | 128 | 23 | 19 |
| Stevens | 1 | 1 | | 27 | 467 | 62 | 0 | 155 | 144 | 29 | 597 | 24 | 4 | 28 | 83 | 12 |
| Thurston | 2 | 11 | 34 | 186 | 6 | 455 | 2 | 33 | 352 | 105 | 2,383 | 187 | 15 | 84 | 2 | 28 |
| Wahkiakum | | | 353 | 2 | | 0 | 0 | 8 | 7 | 5 | 56 | 1 | 1 | 3 | 2 | 0 |
| Walla Walla | 244 | 3 | 17 | 67 | 1,056 | 314 | 0 | 73 | 489 | 13 | 569 | 41 | 2 | 11 | 1 | 2 |
| Whatcom | 3 | 13 | 507 | 261 | 4,848 | 234 | 2 | 42 | 389 | 134 | 1,726 | 217 | 12 | 74 | 26 | 6 |
| Whitman | 148 | 4 | 18 | 40 | 22 | 162 | 0 | 98 | 1,054 | 8 | 438 | 28 | 2 | 5 | 0 | 135 |
| Yakima | 126 | 15 | | 224 | 32 | 174 | 2 | 197 | 566 | 41 | 2,400 | 103 | 11 | 51 | 34 | 1,016 |
| State Total | 1,080 | 1,691 | 13,549 | 8,119 | 26,025 | 13,629 | 55 | 2,680 | 16,615 | 2,731 | 60,029 | 5,003 | 292 | 1,911 | 638 | 7,866 |

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## Table 4-7. County VOC Emissions Estimates in Tons per Year

| County | OB_AG | AIR | FOOD | SHIP | F_ICI | POINT | LIVE | RR | MISC | NAT | PETROL | SOLV | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 89 | 5 | 1 | | 1 | | 336 | 44 | 1 | 2,092 | 107 | 1,019 | 79 | 11 | 139 | 0 | 4 | 33 | 4 | 40 |
| Asotin | 0 | 0 | 1 | 0 | 1 | | 47 | 0 | 1 | 1,194 | 11 | 187 | 43 | 21 | 97 | 1 | 5 | 34 | 1 | 7 |
| Benton | 103 | 4 | 19 | 1 | 12 | 9 | 271 | 45 | 69 | 2,835 | 370 | 2,693 | 292 | 177 | 832 | 3 | 34 | 156 | 19 | 282 |
| Chelan | 20 | 2 | 9 | | 6 | | 4 | 11 | 62 | 9,139 | 109 | 1,062 | 260 | 104 | 412 | 0 | 22 | 456 | 27 | 4,251 |
| Clallam | 1 | 8 | 7 | 115 | 3 | 61 | 25 | 0 | 3 | 5,681 | 114 | 579 | 208 | 82 | 411 | 1 | 25 | 416 | 158 | 185 |
| Clark | | 7 | 41 | 13 | 27 | 69 | 148 | 33 | 15 | 3,584 | 187 | 3,822 | 677 | 296 | 1,637 | 15 | 115 | 1,531 | 18 | 39 |
| Columbia | 410 | 0 | 0 | 0 | 0 | | 24 | 0 | 0 | 2,380 | 8 | 65 | 709 | 4 | 31 | 0 | 1 | 23 | 3 | 210 |
| Cowlitz | | 4 | 10 | 20 | 8 | 650 | 40 | 31 | 4 | 5,642 | 114 | 981 | 212 | 113 | 603 | 1 | 29 | 492 | 56 | 162 |
| Douglas | 35 | 10 | 3 | | 1 | 3 | 37 | 2 | 1 | 2,157 | 52 | 483 | 85 | 52 | 219 | 0 | 10 | 150 | 21 | 6,181 |
| Ferry | | 0 | 0 | | 0 | | 26 | 1 | 0 | 11,523 | 14 | 66 | 391 | 9 | 66 | 0 | 3 | 81 | 410 | 7,490 |
| Franklin | 133 | 38 | 5 | 1 | 5 | | 692 | 38 | 63 | 2,009 | 761 | 1,876 | 119 | 64 | 386 | 2 | 14 | 122 | 1 | 2,014 |
| Garfield | 71 | | 0 | 0 | 0 | | 31 | 0 | 0 | 1,306 | 6 | 44 | 34 | 2 | 22 | 0 | 1 | 10 | | |
| Grant | 237 | 50 | 7 | | 5 | 24 | 1,356 | 10 | 3 | 4,365 | 392 | 3,057 | 254 | 112 | 525 | 0 | 22 | 202 | 6 | 318 |
| Grays Harbor | 5 | 1 | 6 | 10 | 3 | 161 | 66 | 2 | 4 | 8,948 | 68 | 592 | 236 | 60 | 391 | 1 | 23 | 383 | 227 | 10 |
| Island | 4 | 51 | 6 | 30 | 2 | 36 | 24 | 0 | 2 | 560 | 47 | 611 | 136 | 128 | 352 | 4 | 30 | 359 | 1 | |
| Jefferson | | 6 | 3 | 34 | 1 | 80 | 9 | 0 | 1 | 5,859 | 93 | 252 | 172 | 59 | 207 | 1 | 14 | 260 | 106 | 52 |
| King | 10 | 720 | 297 | 103 | 184 | 614 | 246 | 39 | 917 | 7,845 | 2,534 | 18,218 | 4,523 | 1,073 | 5,651 | 102 | 354 | 3,202 | 7 | 269 |
| Kitsap | | 12 | 23 | 64 | 8 | 93 | 7 | 1 | 67 | 1,734 | 359 | 1,946 | 435 | 239 | 1,031 | 9 | 58 | 1,030 | | 6 |
| Kittitas | 21 | 7 | 5 | | 2 | | 104 | 5 | 2 | 6,271 | 163 | 466 | 222 | 40 | 353 | 2 | 13 | 223 | 22 | 1,407 |
| Klickitat | 30 | 5 | 1 | 2 | 1 | 237 | 99 | 59 | 60 | 7,793 | 69 | 222 | 225 | 16 | 146 | 1 | 6 | 98 | 289 | 166 |
| Lewis | 6 | 12 | 8 | | 4 | 442 | 283 | 22 | 3 | 10,921 | 155 | 674 | 190 | 62 | 490 | 1 | 27 | 457 | 170 | 36 |
| Lincoln | 22 | 3 | 1 | | 0 | | 56 | 23 | 0 | 2,979 | 78 | 254 | 128 | 27 | 108 | 0 | 4 | 44 | 9 | 4,969 |
| Mason | | 29 | 5 | 0 | 2 | 144 | 5 | 1 | 2 | 4,729 | 98 | 466 | 134 | 106 | 342 | 1 | 27 | 457 | 36 | 13 |
| Okanogan | 24 | 22 | 2 | | 1 | | 131 | 2 | 2 | 16,743 | 307 | 633 | 113 | 39 | 297 | 0 | 15 | 319 | 92 | 17,710 |
| Pacific | | 2 | 2 | 6 | 1 | 63 | 52 | 0 | 1 | 4,144 | 22 | 169 | 111 | 23 | 128 | 0 | 11 | 200 | 62 | 2 |
| Pend Oreille | 3 | 0 | 1 | | 0 | 66 | 14 | 2 | 0 | 8,220 | 15 | 109 | 264 | 26 | 99 | 0 | 7 | 164 | 135 | 181 |
| Pierce | | 19 | 77 | 44 | 44 | 773 | 68 | 33 | 28 | 6,429 | 1,589 | 6,863 | 1,531 | 553 | 2,985 | 30 | 165 | 1,908 | 86 | 542 |
| San Juan | 3 | 32 | 2 | 21 | 1 | | 10 | 0 | 1 | 438 | 80 | 122 | 93 | 58 | 91 | 1 | 11 | 167 | 2 | 1 |
| Skagit | | 10 | 13 | 22 | 9 | 1,862 | 398 | 8 | 5 | 5,301 | 158 | 1,333 | 329 | 167 | 679 | 7 | 37 | 466 | 148 | 18 |
| Skamania | | | 0 | 1 | 0 | | 3 | 26 | 0 | 7,279 | 13 | 108 | 296 | 11 | 79 | 0 | 5 | 112 | 36 | 49,443 |
| Snohomish | 2 | 44 | 81 | 14 | 63 | 370 | 367 | 21 | 25 | 7,177 | 673 | 6,306 | 1,437 | 568 | 2,688 | 33 | 153 | 3,170 | 66 | 11,494 |
| Spokane | 19 | 72 | 50 | | 30 | 195 | 125 | 55 | 78 | 5,769 | 780 | 4,225 | 759 | 371 | 2,082 | 26 | 91 | 1,424 | 109 | 288 |
| Stevens | 4 | 1 | 2 | | 2 | 257 | 96 | 3 | 2 | 13,000 | 45 | 365 | 183 | 83 | 318 | 1 | 15 | 353 | 394 | 188 |
| Thurston | 7 | 10 | 27 | 1 | 11 | 229 | 204 | 19 | 9 | 3,790 | 246 | 2,265 | 358 | 206 | 1,123 | 10 | 78 | 934 | 11 | 612 |
| Wahkiakum | | | 0 | 14 | 0 | | 18 | 0 | 0 | 1,371 | 4 | 39 | 6 | 10 | 26 | 0 | 2 | 38 | 8 | 2 |
| Walla Walla | 616 | 7 | 6 | 1 | 4 | 243 | 119 | 13 | 2 | 2,668 | 59 | 1,377 | 188 | 38 | 284 | 2 | 11 | 135 | 6 | 15 |
| Whatcom | 9 | 14 | 25 | 18 | 15 | 1,705 | 1,174 | 10 | 8 | 5,282 | 383 | 1,842 | 429 | 183 | 914 | 11 | 59 | 807 | 123 | 139 |
| Whitman | 330 | 11 | 3 | 1 | 2 | 30 | 63 | 8 | 1 | 2,313 | 286 | 536 | 141 | 24 | 172 | 2 | 7 | 64 | 1 | 1,327 |
| Yakima | 496 | 15 | 21 | | 13 | 608 | 3,042 | 8 | 68 | 12,693 | 441 | 3,151 | 395 | 122 | 1,258 | 6 | 48 | 578 | 160 | 11,053 |
| State Total | 2,710 | 1,232 | 773 | 534 | 473 | 9,025 | 9,820 | 575 | 1,512 | 214,163 | 11,009 | 69,076 | 16,395 | 5,340 | 27,675 | 275 | 1,557 | 21,060 | 3,028 | 121,121 |

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## Table 4-8. County CO Emissions Estimates in Tons per Year

| County | OB_AG | AIR | FOOD | SHIP | F_ICI | POINT | RR | MISC | NAT | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 595 | 135 | 4 | | 15 | | 239 | 4 | 1,183 | 846 | 53 | 3,202 | 3 | 31 | 198 | 15 | 167 |
| Asotin | 2 | 0 | 4 | 0 | 12 | | 0 | 8 | 411 | 494 | 98 | 894 | 9 | 38 | 209 | 4 | 30 |
| Benton | 648 | 116 | 53 | 6 | 177 | 20 | 243 | 58 | 1,155 | 4,105 | 858 | 9,755 | 24 | 277 | 930 | 76 | 1,177 |
| Chelan | 175 | 56 | 24 | | 83 | | 53 | 25 | 1,499 | 2,388 | 522 | 4,730 | 2 | 181 | 2,719 | 107 | 18,091 |
| Clallam | 10 | 160 | 20 | 285 | 42 | 30 | 0 | 28 | 873 | 2,246 | 471 | 4,415 | 4 | 207 | 2,476 | 633 | 788 |
| Clark | | 207 | 113 | 41 | 394 | 188 | 162 | 146 | 596 | 10,451 | 1,460 | 17,676 | 110 | 922 | 9,010 | 72 | 162 |
| Columbia | 4,058 | 1 | 0 | 1 | 3 | | 1 | 2 | 603 | 1,857 | 17 | 414 | 0 | 10 | 135 | 12 | 888 |
| Cowlitz | | 68 | 27 | 60 | 103 | 2,422 | 164 | 35 | 997 | 2,312 | 556 | 7,874 | 6 | 240 | 2,938 | 223 | 689 |
| Douglas | 316 | 125 | 8 | | 20 | 3 | 12 | 12 | 841 | 944 | 251 | 2,669 | 1 | 81 | 888 | 84 | 25,796 |
| Ferry | | 14 | 1 | | 4 | | 4 | 2 | 1,932 | 984 | 47 | 872 | 0 | 27 | 483 | 1,639 | 31,686 |
| Franklin | 934 | 215 | 15 | 3 | 68 | | 173 | 23 | 975 | 1,624 | 307 | 4,698 | 15 | 115 | 734 | 4 | 8,409 |
| Garfield | 819 | | 0 | 1 | 1 | | 0 | 1 | 463 | 247 | 12 | 337 | 0 | 8 | 62 | | |
| Grant | 1,690 | 410 | 19 | | 65 | 97 | 49 | 26 | 1,875 | 2,644 | 529 | 6,914 | 2 | 185 | 1,202 | 23 | 1,332 |
| Grays Harbor | 41 | 25 | 18 | 38 | 41 | 547 | 4 | 29 | 1,308 | 2,163 | 300 | 4,820 | 9 | 195 | 2,291 | 909 | 42 |
| Island | 29 | 161 | 17 | 80 | 31 | 5 | 0 | 32 | 97 | 2,163 | 751 | 3,297 | 26 | 249 | 2,131 | 5 | |
| Jefferson | | 164 | 9 | 93 | 18 | 673 | 0 | 13 | 963 | 1,223 | 395 | 2,481 | 7 | 120 | 1,555 | 426 | 221 |
| King | 82 | 3,148 | 833 | 352 | 2,855 | 1,612 | 176 | 593 | 1,328 | 80,935 | 6,382 | 71,299 | 737 | 2,815 | 18,443 | 29 | 1,147 |
| Kitsap | | 286 | 64 | 223 | 133 | | 2 | 85 | 290 | 6,862 | 1,480 | 11,034 | 66 | 477 | 6,033 | | 26 |
| Kittitas | 135 | 194 | 15 | | 29 | | 25 | 17 | 1,163 | 1,564 | 197 | 6,205 | 13 | 105 | 1,341 | 88 | 5,886 |
| Klickitat | 248 | 62 | 4 | 8 | 13 | 159 | 321 | 8 | 1,424 | 1,071 | 80 | 1,688 | 4 | 55 | 583 | 1,157 | 702 |
| Lewis | 51 | 227 | 23 | | 58 | 3,560 | 113 | 27 | 1,942 | 1,998 | 314 | 6,298 | 7 | 228 | 2,733 | 679 | 154 |
| Lincoln | 157 | 79 | 3 | | 5 | | 120 | 4 | 1,360 | 1,183 | 136 | 1,812 | 3 | 36 | 266 | 34 | 20,741 |
| Mason | | 169 | 14 | 1 | 24 | 53 | 3 | 22 | 810 | 1,496 | 559 | 3,660 | 7 | 225 | 2,730 | 143 | 54 |
| Okanogan | 192 | 240 | 7 | | 22 | | 6 | 16 | 2,766 | 1,108 | 187 | 3,800 | 2 | 129 | 1,899 | 367 | 74,384 |
| Pacific | | 7 | 6 | 31 | 13 | 22 | 0 | 8 | 597 | 877 | 131 | 1,526 | 2 | 91 | 1,189 | 250 | 9 |
| Pend Oreille | 11 | 8 | 2 | | 5 | 2 | 5 | 5 | 1,372 | 850 | 121 | 1,121 | 1 | 61 | 986 | 539 | 769 |
| Pierce | | 507 | 213 | 105 | 657 | 1,819 | 156 | 269 | 1,088 | 24,673 | 3,020 | 35,496 | 217 | 1,323 | 11,147 | 342 | 2,299 |
| San Juan | 20 | 313 | 5 | 97 | 13 | | 0 | 8 | 76 | 1,169 | 442 | 696 | 4 | 93 | 994 | 8 | 4 |
| Skagit | | 272 | 36 | 83 | 128 | 1,729 | 41 | 44 | 932 | 3,642 | 1,035 | 8,499 | 51 | 301 | 2,814 | 593 | 77 |
| Skamania | | | 1 | 2 | 5 | | 139 | 4 | 1,380 | 886 | 54 | 929 | 2 | 43 | 677 | 143 | 210,463 |
| Snohomish | 20 | 1,044 | 226 | 55 | 853 | 112 | 104 | 226 | 1,196 | 23,957 | 3,192 | 30,892 | 241 | 1,236 | 18,638 | 264 | 48,926 |
| Spokane | 119 | 444 | 139 | | 454 | 212 | 273 | 161 | 1,432 | 12,607 | 1,775 | 23,634 | 192 | 743 | 8,363 | 437 | 1,217 |
| Stevens | 23 | 32 | 7 | | 22 | 640 | 9 | 16 | 2,514 | 1,189 | 403 | 3,376 | 9 | 132 | 2,118 | 1,576 | 794 |
| Thurston | 49 | 191 | 75 | 5 | 168 | 3 | 96 | 92 | 621 | 5,723 | 1,134 | 13,317 | 74 | 633 | 5,522 | 43 | 2,600 |
| Wahkiakum | | | 0 | 42 | 2 | | 0 | 2 | 204 | 98 | 55 | 284 | 0 | 18 | 226 | 31 | 7 |
| Walla Walla | 5,628 | 105 | 15 | 3 | 56 | 661 | 62 | 20 | 958 | 1,827 | 182 | 3,231 | 17 | 94 | 802 | 23 | 64 |
| Whatcom | 72 | 161 | 69 | 72 | 216 | 14,128 | 51 | 71 | 888 | 6,465 | 1,162 | 9,879 | 83 | 479 | 4,763 | 491 | 590 |
| Whitman | 3,278 | 173 | 9 | 3 | 33 | 55 | 23 | 11 | 1,500 | 1,631 | 113 | 2,288 | 11 | 61 | 387 | 4 | 5,552 |
| Yakima | 2,933 | 180 | 57 | | 188 | 15 | 32 | 78 | 2,609 | 5,548 | 585 | 14,298 | 41 | 396 | 3,392 | 640 | 46,394 |
| State Total | 22,335 | 9,699 | 2,156 | 1,691 | 7,028 | 28,763 | 2,862 | 2,229 | 44,219 | 224,050 | 29,365 | 330,309 | 1,999 | 12,658 | 124,009 | 12,113 | 512,337 |

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## Table 4-9. County $NH_3$ Emissions Estimates in Tons per Year

| County | OB_AG | SHIP | FERT | F_ICI | POINT | LIVE | RR | MISC | NRM | BOAT | ORM | F_RES | OB_RES | RWC | OB_RX | WF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | 118 | | 1,007 | 0 | | 1,281 | 1 | 0 | 1 | 0 | 20 | 1 | 0 | 1 | 3 | 3 |
| Asotin | 0 | 0 | 164 | 0 | | 219 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 2 | 1 | 0 |
| Benton | 106 | 0 | 804 | 3 | 38 | 898 | 1 | 9 | 1 | 0 | 52 | 11 | 4 | 7 | 13 | 20 |
| Chelan | 47 | | 264 | 1 | | 19 | 0 | 9 | 0 | 0 | 24 | 1 | 5 | 18 | 18 | 296 |
| Clallam | 1 | 0 | 136 | 1 | 1 | 99 | 0 | 0 | 0 | 0 | 21 | 1 | 4 | 17 | 104 | 13 |
| Clark | | 0 | 217 | 7 | 6 | 578 | 1 | 1 | 2 | 0 | 93 | 52 | 19 | 64 | 12 | 3 |
| Columbia | 1,392 | 0 | 284 | 0 | | 105 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 2 | 15 |
| Cowlitz | | 0 | 212 | 2 | 134 | 189 | 1 | 0 | 0 | 0 | 45 | 2 | 5 | 20 | 37 | 11 |
| Douglas | 80 | | 584 | 0 | 8 | 151 | 0 | 0 | 0 | 0 | 14 | 0 | 2 | 6 | 14 | 430 |
| Ferry | | | 138 | 0 | | 104 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 3 | 270 | 521 |
| Franklin | 195 | 0 | 733 | 1 | | 2,297 | 1 | 9 | 1 | 0 | 25 | 7 | 2 | 5 | 1 | 140 |
| Garfield | 377 | 0 | 284 | 0 | | 122 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | | |
| Grant | 332 | | 1,342 | 1 | 5 | 4,546 | 0 | 0 | 1 | 0 | 37 | 1 | 5 | 8 | 4 | 22 |
| Grays Harbor | 7 | 0 | 263 | 1 | 26 | 196 | 0 | 0 | 0 | 0 | 26 | 3 | 3 | 16 | 150 | 1 |
| Island | 4 | 0 | 14 | 0 | 0 | 96 | 0 | 0 | 0 | 0 | 14 | 5 | 5 | 15 | 1 | |
| Jefferson | | 0 | 105 | 0 | 25 | 36 | 0 | 0 | 0 | 0 | 13 | 0 | 2 | 11 | 70 | 4 |
| King | 13 | 1 | 305 | 39 | 6 | 758 | 1 | 125 | 10 | 1 | 439 | 344 | 34 | 132 | 5 | 19 |
| Kitsap | | 0 | 100 | 2 | | 50 | 0 | 9 | 1 | 0 | 55 | 25 | 6 | 42 | | 0 |
| Kittitas | 16 | | 564 | 0 | | 371 | 0 | 0 | 0 | 0 | 41 | 4 | 2 | 9 | 15 | 98 |
| Klickitat | 57 | 0 | 385 | 0 | 6 | 353 | 1 | 8 | 0 | 0 | 9 | 2 | 1 | 4 | 191 | 12 |
| Lewis | 9 | | 357 | 1 | 36 | 1,182 | 0 | 0 | 0 | 0 | 36 | 2 | 4 | 19 | 112 | 3 |
| Lincoln | 44 | | 849 | 0 | | 209 | 0 | 0 | 1 | 0 | 11 | 1 | 1 | 2 | 6 | 346 |
| Mason | | 0 | 123 | 0 | | 25 | 0 | 0 | 0 | 0 | 17 | 2 | 5 | 19 | 23 | 1 |
| Okanogan | 43 | | 526 | 0 | | 476 | 0 | 0 | 0 | 0 | 20 | 0 | 2 | 13 | 60 | 1,232 |
| Pacific | | 0 | 127 | 0 | | 152 | 0 | 0 | 0 | 0 | 8 | 0 | 2 | 8 | 41 | 0 |
| Pend Oreille | 1 | | 98 | 0 | 1 | 52 | 0 | 0 | 0 | 0 | 5 | 0 | 2 | 7 | 89 | 13 |
| Pierce | | 0 | 244 | 10 | 106 | 475 | 0 | 2 | 4 | 0 | 197 | 100 | 16 | 80 | 56 | 38 |
| San Juan | 2 | 0 | 34 | 0 | | 56 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 7 | 1 | 0 |
| Skagit | | 0 | 271 | 2 | 16 | 1,059 | 0 | 0 | 1 | 0 | 47 | 20 | 5 | 20 | 98 | 1 |
| Skamania | | 0 | 148 | 0 | | 28 | 0 | 0 | 0 | 0 | 5 | 1 | 1 | 5 | 24 | 3,439 |
| Snohomish | 4 | 0 | 305 | 17 | 2 | 1,135 | 0 | 2 | 3 | 0 | 171 | 107 | 15 | 131 | 44 | 800 |
| Spokane | 22 | | 730 | 7 | 11 | 481 | 1 | 10 | 2 | 0 | 118 | 92 | 9 | 59 | 72 | 20 |
| Stevens | 3 | | 327 | 0 | | 350 | 0 | 0 | 0 | 0 | 15 | 3 | 2 | 14 | 260 | 13 |
| Thurston | 6 | 0 | 203 | 2 | | 960 | 0 | 0 | 1 | 0 | 74 | 32 | 12 | 40 | 7 | 43 |
| Wahkiakum | | 0 | 56 | 0 | | 72 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 5 | 0 |
| Walla Walla | 1,627 | 0 | 719 | 1 | 39 | 451 | 0 | 0 | 1 | 0 | 16 | 8 | 2 | 6 | 4 | 1 |
| Whatcom | 11 | 0 | 355 | 4 | 39 | 2,708 | 0 | 1 | 1 | 0 | 49 | 32 | 9 | 34 | 81 | 10 |
| Whitman | 1,082 | 0 | 1,367 | 1 | | 291 | 0 | 0 | 2 | 0 | 13 | 5 | 1 | 3 | 1 | 92 |
| Yakima | 407 | | 917 | 3 | | 8,597 | 0 | 9 | 1 | 0 | 68 | 18 | 8 | 24 | 105 | 769 |
| State Total | 6,007 | 3 | 15,661 | 109 | 506 | 31,227 | 9 | 195 | 37 | 5 | 1,817 | 887 | 197 | 870 | 1,995 | 8,426 |

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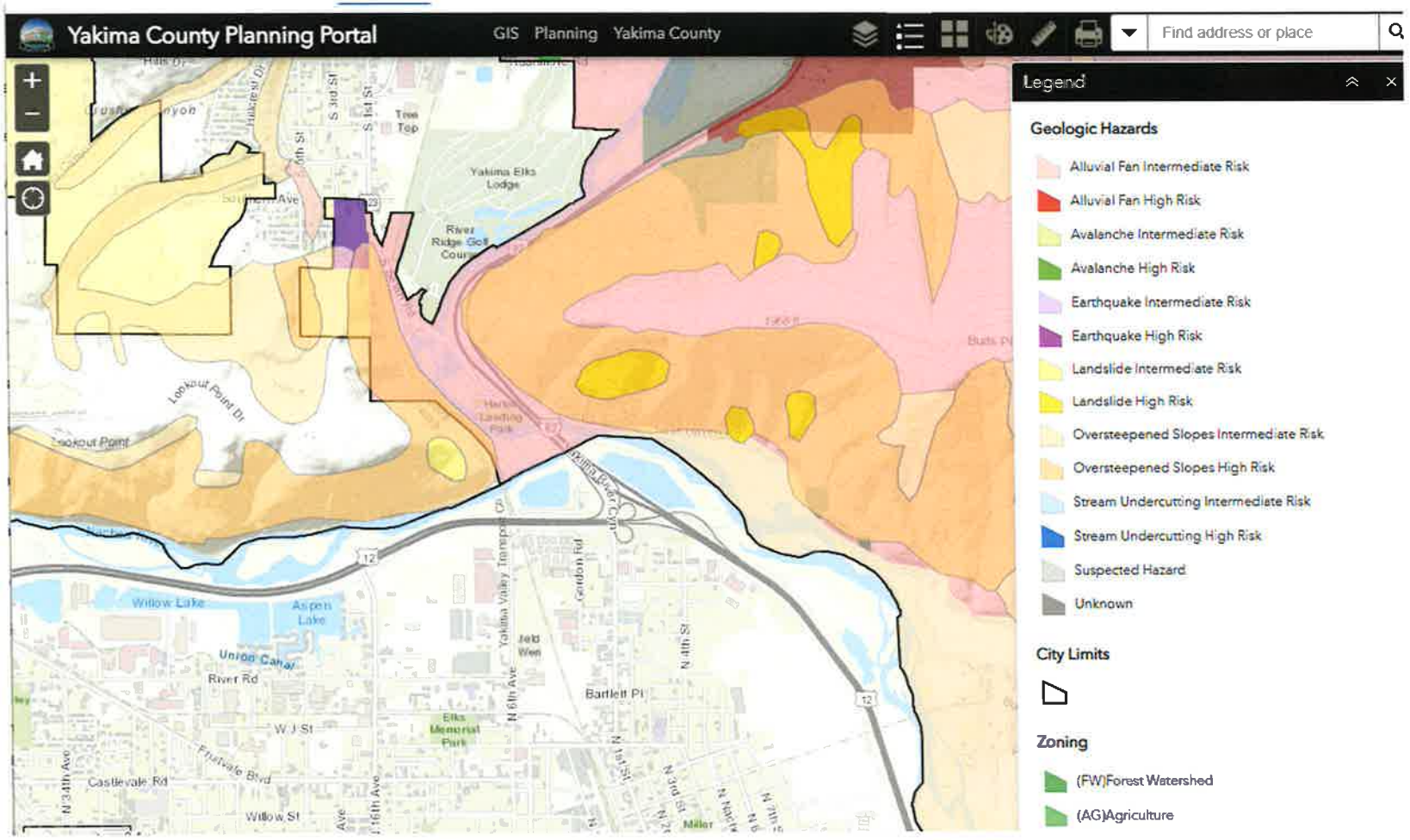
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# Landslide High Risk Info along Trolley Route




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# Yakima still collecting signatures on Terrace Heights annexation petition

OLIVIA PALMER Yakima Herald-Republic
Nov 12, 2026





The tower at the old Del Monte fruit processing plant is seen over commercial property Tuesday, Nov. 10, 2026, in Yakima, Wash. A petition would annex commercial property in Terrace Heights into the city of Yakima.

Evan Abell / Yakima Herald-Republic

Earlier this year, Yakima city officials got the green light to start collecting signatures for an annexation petition in Terrace Heights. The process is still in its early stages — but as conversations with local property owners continue, leaders are considering what the change could mean for economic development, fire and police capacity if it goes through.

Compared to a proposed annexation map from two years ago, this one is smaller and would take in fewer homes.



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In 2024, Terrace Heights property owners Byron Borton, Larry Hull and Nicholas Temple submitted individual petitions for annexation. The original map spanned around 900 acres, with an estimated 1,500 people, and included Sun Country Estates, Pacific Northwest University of Health Sciences, Riverside Christian School, Yakima Sportsman State Park and an area along Keys Road where a new Amazon warehouse was being built. The City Council approved a smaller map that excluded Sun Country Estates after residents said they did not want to be brought into Yakima.

The earlier petition expired after the city failed to collect enough property-owner signatures to reach at least 60% of the area's assessed value.

In April, Hull submitted a new notice of intent to begin annexation. The map for that proposal is around 300 acres and has about 50 residential property owners, City Planning Manager Trevor Martin said. The area is primarily zoned for commercial and light industrial, and includes Pacific Northwest University of Health Sciences, the former Del Monte fruit processing plant and the industrial area along Keys Road. Sun Country Estates is not included.

"One of the big differences, I think, between this one and that last one is there's been a little more talk amongst the commercial property owners in this area," Martin said. "There's been a lot more general talks, conversations, and buy-in because it's a smaller area."

Martin said potential economic development opportunities were one driver for the petition.



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Terrace Heights is part of Yakima's urban growth area, which refers to the boundaries within which the city can expand. The city's urban development zoning can allow for higher density or more mixed uses compared to the county's rules. A 2024 annexation study by FCS Group also indicated that building out the commercial portion of the annexation map could generate more than 2,000 jobs, Martin added.

Assistant City Manager Gary Ballew acknowledged that the physical barrier of the Yakima River could present challenges that haven't been as much of a consideration for expansion in other directions.

"If you look at Yakima, you have downtown and you have our centralized core. We've grown almost entirely to the west, and not to the east," Ballew said. "As you provide services, you want to kind of balance around your core, so any geographical boundary like a river or ridge line can provide difficulties in jumping across that, and once you do, then it would look a little bit more like how the West Valley is looking: you have a single developer who's developing a small portion of property, and then they say, 'Yeah, I want to bring this into the city.'"

## What would change?

The city has until March to collect signatures representative of 60% of the area's assessed value. If it reaches that threshold, it will hold public hearings on the petition to decide whether or not to finalize the annexation. If it doesn't, the petition will expire. The city is at around 30%, City Manager Vicki Baker said in a City Council update on Tuesday.



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Ballew said city leaders have been meeting with property owners to answer their questions.

"The thing to remember is it is driven by the property owners, so it's a two-step process to get to," he said. "Sixty percent of the assessed value has to say 'Yes, we would like to be in the city,' and then there's a process that the city has to say, 'Yes, we want you.' And so both kind of have this veto authority over the whole thing."

Martin estimated the annexation would bring in around $250,000 in additional property tax revenue if approved, although the exact number is still uncertain. Property owners would still pay countywide taxes, but would no longer pay the county roads property tax of $1.18 per $1,000 assessed value. Negotiations are still taking place to determine whether property owners would continue to pay a $1.29 per $1,000 rate for service from the East Valley Fire District.

The city's property tax rate is $1.79 per $1,000 of assessed value, Ballew said.

Businesses in the area would also switch to the city of Yakima's sales tax rate of 8.6%, which is 0.4% higher than the county rate and includes a 0.3% tax for transit.

The area is currently served by the Terrace Heights Sewer District for sewer service, and Yakima County for water and roads. If the annexation went through, that wouldn't change — at least in the near term — although it could lay the groundwork for city water and



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sewer connections years down the road if new development takes place. The area's flood control district wouldn't change either, but the public safety and fire organizations in charge of the area would.

## Fire

Terrace Heights is currently served by the East Valley Fire District.

Fire Chief Ray Lamoureux has been vocal about concerns around potential impacts on service levels if that changed.

It takes two to four minutes for a crew at the Fire District's Terrace Heights station to reach the proposed annexation area. By comparison, the closest station in Yakima — Station 95 — is six to seven minutes away, and the second closest — Station 91 — is seven to eight minutes away. Fire grows exponentially, roughly doubling in size by the minute, Lamoureux said.

"If there's a rescue situation, if you're in the house and we can get there in three minutes versus six minutes, those three minutes could mean the difference between getting out safely and not," he said.

The Yakima stations are on the other side of a bridge from Terrace Heights — something Lamoureux believes could be an issue if the bridge ever had to be closed to commercial vehicles. He said he's also uncertain about the Yakima Fire Department's ability to take on additional capacity given recent financial strains. Last year, the city's Fire Station 92 in the West Valley faced a threat of closure due to



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budget cuts. Although the station is funded in the proposed 2027 budget, Lamoureux said he believes there's "no financial wiggle room for the city to be able to add firefighters at a fire station."

"I don't want to see the Terrace Heights community go backwards as far as their level of service," Lamoureux said.

Yakima Fire Department Deputy Chief Jonathan Hood said the department is fairly confident it could get 10 people to the area within 10 minutes. Annually, the department responds to about 10,000 calls for service per year. Including the proposed portion of Terrace Heights in its coverage area would add an estimated 100 calls or so.

The impact on the number of calls would be relatively small. The main consideration, Hood said, would be getting crews to the area in a timely manner.

"I think citywide we'd be able to absorb that amount no matter what area we're looking to annex, and I think we're going to respond to that area if it's in the city or if we have an automatic aid agreement or a mutual aid agreement or whatever with East Valley, no matter what happens," Hood said. He added that the fire department is just one piece in the puzzle, and it will work under the direction of the rest of the city, city manager and council as the process continues.

The exact timeline for a potential transfer of service would depend on yet-to-be-answered questions regarding the continued collection of the Fire District 4 levy. The levy expires at the end of 2031,



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Lamoureux said. If the district continues to collect the tax from property owners in the area for those years, he said it would likely be the one providing the services to that area.

## Law enforcement

If annexed, the portion of Terrace Heights on the new map would also transfer from the Yakima County Sheriff's Office to the Yakima Police Department. Sheriff Bob Udell told the Yakima Herald-Republic in an email that the impact on capacity would likely be negligible for his office.

For the police department, it could be more noticeable.

Yakima Police Chief Shawn Boyle said an estimated 90 to 100 crimes are reported per year in the annex area. In initial discussions, he requested one additional patrol officer per shift to help manage the extra workload if the annexation is approved — something he said would be especially important after losing a dozen budgeted positions last year due to budget cuts.

The request would mean at least six additional police officers on staff, likely costing the city more than $1 million.

"I see the need for the expansion for the economic growth of the city," Boyle said. "We're evaluating the capacity it's going to put on our police officers because, like I said, we just reduced our force by 12 commissioned police this year."



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Staff writer



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