2014 National Emissions Inventory, Version 1 Technical Support Document

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Acronyms and Chemical Notations

AERR	Air Emissions Reporting Rule
APU	Auxiliary power unit
BEIS	Biogenics Emissions Inventory System
C1	Category 1 (commercial marine vessels)
C2	Category 2 (commercial marine vessels)
C3	Category 3 (commercial marine vessels)
CAMD	Clean Air Markets Division (of EPA Office of Air and Radiation)
CAP	Criteria Air Pollutant
CBM	Coal bed methane
CDL	Cropland Data Layer
CEC	North American Commission for Environmental Cooperation
CEM	Continuous Emissions Monitoring
CENRAP	Central Regional Air Planning Association
CERR	Consolidated Emissions Reporting Rule
CFR	Code of Federal Regulations
CH_4	Methane
CHIEF	Clearinghouse for Inventories and Emissions Factors
CMU	Carnegie Mellon University
CMV	Commercial marine vessels
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CSV	Comma Separated Variable
dNBR	Differenced normalized burned ratio
E10	10% ethanol gasoline
EDMS	Emissions and Dispersion Modeling System
EF	emission factor
EGU	Electric Generating Utility
EIS	Emission Inventory System
EAF	Electric arc furnace
EF	Emission factor
EI	Emissions Inventory
EIA	Energy Information Administration
EMFAC	Emission FACtor (model) – for California
EPA	Environmental Protection Agency
ERG	Eastern Research Group
ERTAC	Eastern Regional Technical Advisory Committee
FAA	Federal Aviation Administration
FACTS	Forest Service Activity Tracking System
FCCS	Fuel Characteristic Classification System
FETS	Fire Emissions Tracking System
FWS	United States Fish and Wildlife Service
FRS	Facility Registry System

GHG	Greenhouse gas
GIS	Geographic information systems
GPA	Geographic phase-in area
GSE	Ground support equipment
HAP	Hazardous Air Pollutant
HCl	Hydrogen chloride (hydrochloric acid)
Hg	Mercury
HMS	Hazard Mapping System
ICR	Information collection request
I/M	Inspection and maintenance
IPM	Integrated Planning Model
KMZ	Keyhole Markup Language, zipped (used for displaying data in Google Earth
LRTAP	Long-range Transboundary Air Pollution
LTO	Landing and takeoff
LPG	Liquified Petroleum Gas
MARAMA	Mid-Atlantic Regional Air Management Association
MATS	Mercury and Air Toxics Standards
MCIP	Meteorology-Chemistry Interface Processor
MMT	Manure management train
MOBILE6	Mobile Source Emission Factor Model, version 6
MODIS	Moderate Resolution Imaging Spectroradiometer
MOVES	Motor Vehicle Emissions Simulator
MW	Megawatts
MWC	Municipal waste combustors
NAA	Nonattainment area
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NARAP	North American Regional Action Plan
NASF	National Association of State Foresters
NASS	USDA National Agriculture Statistical Service
NATA	National Air Toxics Assessment
NCD	National County Database
NEEDS	National Electric Energy Data System (database)
NEI	National Emissions Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NFEI	National Fire Emissions Inventory
NG	Natural gas
NH_3	Ammonia
NMIM	National Mobile Inventory Model
NO	Nitrous oxide
NO_2	Nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_X	Nitrogen oxides
O_3	Ozone
OAQPS	Office of Air Quality Standards and Planning (of EPA)
OEI	Office of Environmental Information (of EPA)

ORIS	Office of Regulatory Information Systems
OTAQ	Office of Transportation and Air Quality (of EPA)
PADD	Petroleum Administration for Defense Districts
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PCB	Polychlorinated biphenyl
PM	Particulate matter
PM25-CON	Condensable $PM_{2.5}$
PM25-FIL	Filterable $PM_{2.5}$
PM25-PRI	Primary $PM_{2.5}$ (condensable plus filterable)
$PM_{2.5}$	Particulate matter 2.5 microns or less in diameter
PM_{10}	Particular matter 10 microns or less in diameter
PM10-FIL	Filterable PM_{10}
PM10-PRI	Primary PM_{10}
POM	Polycyclic organic matter
POTW	Publicly Owned Treatment Works
PSC	Program system code (in EIS)
RFG	Reformulated gasoline
RPD	Rate per distance
RPP	Rate per profile
RPV	Rate per vehicle
RVP	Reid Vapor Pressure
Rx	Prescribed (fire)
SCC	Source classification code
SEDS	State Energy Data System
SFv1	SMARTFIRE version 1
SFv2	SMARTFIRE version 2
S/L/T	State, local, and tribal (agencies)
SMARTFIRE	Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SO_4	Sulfate
TAF	Terminal Area Forecasts
TEISS	Tribal Emissions Inventory Software Solution
TRI	Toxics Release Inventory
UNEP	United Nations Environment Programme
USDA	United States Department of Agriculture
VMT	Vehicle miles traveled
VOC	Volatile organic compounds
USFS	United States Forest Service
WebFIRE	Factor Information Retrieval System
WFU	Wildland fire use
WLF	Wildland fire
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecasting Model

1 Introduction

1.1 What data are included in the 2014 NEI, Version 1?

The 2014 National Emissions Inventory (NEI), version 1, hereafter referred to as the "2014 NEI," is a national compilation of criteria air pollutant (CAP) and hazardous air pollutant (HAP) emissions. These data are collected from state, local, and tribal (S/L/T) air agencies and the Environmental Protection Agency (EPA) emissions programs including the Toxics Release Inventory (TRI), the Acid Rain Program, and Maximum Achievable Control Technology (MACT) standards development. The 2014 v1 is synonymous with "2014 NEI" until the next version of the NEI is released, which is currently scheduled for the fall of 2017. The NEI program develops datasets, blends data from these multiple sources, and performs data processing steps that further enhance, quality assure, and augment the compiled data.

The emissions data in the NEI are compiled at different levels of granularity, depending on the data category. For point sources (in general, large facilities), emissions are inventoried at a process-level within a facility. For nonpoint sources (typically smaller, yet pervasive sources) and mobile sources (both onroad and nonroad), emissions are given as county totals. For marine vessel and railroad in-transit sources, emissions are given at the sub-county polygon shape-level. For wildfires and prescribed burning, the data are compiled as day-specific, coordinate-specific (similar to point) events in the "event" portion of the inventory, and these emission estimates are further stratified by smoldering and flaming components.

The pollutants included in the NEI are the pollutants associated with the National Ambient Air Quality Standards (NAAQS), known as CAPs, as well as HAPs associated with EPA's Air Toxics Program. The CAPs have ambient concentration limits or are precursors for pollutants with such limits from the NAAQS program. These pollutants include lead (Pb), carbon monoxide (CO), nitrogen oxides (NO_X), volatile organic compounds (VOCs), sulfur dioxide (SO_2), particulate matter 10 microns or less (PM_{10}), particulate matter 2.5 microns or less ($PM_{2.5}$), and ammonia (NH_3), which is technically not a CAP, but an important PM precursor. The HAP pollutants include the 187 remaining HAP pollutants (methyl ethyl ketone was removed) from the original 188 listed in Section 112(b) of the 1990 Clean Air Act Amendments[1]. There are many different types of HAPs. For example, some are acid gases such as hydrochloric acid (HCl); others are heavy metals such as mercury (Hg), nickel and cadmium; and others are organic compounds such as benzene, formaldehyde, and acetaldehyde. Greenhouse gases (GHGs) are included in the NEI for fires and mobile sources only.

1.2 What is included in this documentation?

This technical support document (TSD) provides a central reference for the 2014 NEI. The primary purpose of this document is to explain the sources of information included in the inventory. This includes showing the sources of data and types of sources that are used for each data category, and then providing more information about the EPA-created components of the data.After the introductory material included in this section, Section 2 explains the source categories and/or sectors that we use for summarizing the 2014 NEI and for organizing this document, and it provides an overview of the contents of the inventory and a summary of mercury emissions. Section 3 provides an overview of point sources. Section 4 provides information about nonpoint sources, including descriptions by source category or sector of the EPA emission estimates and tools. Sections 5 and 6

[1] The current list of HAPs is available at http://www.epa.gov/ttn/atw/188polls.html.

provide documentation for the nonroad mobile and onroad mobile data categories, respectively. Fires (wild and prescribed burning) are described in Section 7, and biogenic emissions are described in Section 8.

1.3 Where can I obtain the 2014 NEI data?

The 2014 NEI data are available in several different ways listed below. Data are available to the reporting agencies and EPA staff via the Emission Inventory System (EIS).

1.3.1 Emission Inventory System Gateway

https://www.epa.gov/air-emissions-inventories/emission-inventory-system-eis-gateway

The EIS Gateway is available to all EPA staff, EIS data submitters (i.e., the S/L/T air agency staff), Regional Planning Organization staff that support state, local and tribal agencies, and contractors working for the EPA on emissions related work. The EIS reports functions can be used to obtain raw input datasets and create summary files from these datasets as well as the 2014 NEI and older versions of the NEI such as 2011 and 2008. The 2014 NEI in the EIS is called "2014 NEI FINAL V1." Note that if you run facility-, unit- or process-level reports in the EIS, you will get the 2014 NEI emissions, but the facility inventory, which is dynamic in the EIS, will reflect more current information. For example, if an Agency ID has been changed since the time we ran the reports for the public website (October 2016), then that new Agency ID will be in the Facility Inventory or a Facility Configuration report in the EIS but not in the report on the public website nor the Facility Emissions Summary reports run on the "2014 NEI FINAL V1" in the EIS. Use the link provided above for more information about how to obtain an account and to access the gateway itself.

1.3.2 NEI main webpage

Next, data from the EIS are exported for public release on the NEI main webpage.

https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

There are two pages related to the 2014 NEI on the NEI main page website: "2014 NEI Data" and "2014 NEI Documentation." The 2014 NEI Data page includes the most recent **publicly**-available version of the 2014 NEI; this will be 2014 v1 until at least the fall of 2017, at which time, the data will reflect version 2 of the 2014 NEI. The 2014 NEI Documentation page includes the 2014 NEI plan and schedules, all publicly-available supporting materials by inventory data category (e.g., point, nonpoint, onroad mobile, nonroad mobile, events), and this TSD.

The 2014 NEI Data page includes a query tool that allows for summaries by EIS Sector (see Section 2.4) or the more traditional Tier 1 summary level (CAPs only) used in the EPA Trends Report. Summaries from the 2014 NEI Data site include national-, state-, and county-level emissions for CAPs, HAPs and GHGs. You can choose which states, EIS Sectors, Tiers, and pollutants to include in custom-generated reports to download Comma Separated Value (CSV) files to import into Microsoft® Excel®, Access®, or other spreadsheet or database tools. Biogenic emissions and tribal data (but not tribal onroad emissions) are also available from this tool. Tribal summaries are also posted under the "Additional Summary Data" section of this page.

The source classification codes (SCC) data files section of the webpage provides detailed data files for point, nonpoint, onroad and nonroad data categories via a pull down menu. These detailed CSV files (provided in zip files) contain emissions at the process level. Due to their size, all but the nonpoint data are broken out into EPA regions. Facility-level by pollutant and events by pollutant summaries are also available. These CSV files must be "linked" (as opposed to imported) in order to open them with Microsoft® Access®.

The 2014 NEI Documentation page includes links to the NEI TSD and supporting materials referenced in this TSD. This page is a working page, meaning that content is updated as new products are developed.

1.3.3 Air Emissions and "Where you live"

Main: https://www.epa.gov/air-emissions-inventories/air-emissions-sources
Where you live: https://www3.epa.gov/air/emissions/where.htm

NOTE: Please review table legends which provide the NEI year and version when using the data from these sites.

The Air Emissions website provides emissions of CAPs except for NH_3 using point-and-click maps and bar charts to provide access to summary and detailed emissions data. The maps, charts, and underlying data (in CSV format) can be saved from the website and used in documents or spreadsheets.

In addition, the "Where you live" feature of the Air Emissions website allows users to select states and EIS sectors (see Section 2.1) to create KMZ files used by Google Earth. You must have Google Earth installed on your computer to open the files. You can customize the maps to select the facility types of interest (e.g., airport, steel mill, petroleum refinery, pulp and paper plant), and all other facility types will go into an "Other" category on the maps. The resulting maps allow you to click on the icons for each facility to get a chart of emissions associated with each facility for all criteria pollutants.

1.3.4 Modeling files

https://www.epa.gov/air-emissions-modeling

The modeling files are provided in formats that can be read by the Sparse Matrix Operator Kernel Emissions (SMOKE, https://www.cmascenter.org/smoke/). These files are also CSV formats that can be read by other systems, such as databases. The modeling files provide the process-level emissions apportioned to release points, and the release parameters for the release points. Release parameters include stack height, stack exit diameter, exit temperature, exit velocity and flow rate. The EPA may make changes to the NEI modeling files prior to use. The 2014 modeling platform will be based on the 2014 NEI and is under development; it is expected to be posted in early 2017. Any changes between the NEI and modeling platform data will be described in an accompanying TSD for the 2014 Emissions Modeling Platform, which would also be posted at the above website.

While the 2014 NEI-based emissions modeling platform files are not yet available, SMOKE flat files by data category are available for download at: ftp://ftp.epa.gov/EmisInventory/2014/flat_files/. These flat files are the emissions for the 2014 NEI and can be input into SMOKE for processing for air quality modeling. However, for onroad and nonroad mobile sources, we use more finely resolved data for air quality modeling. The data files for nonroad mobile emissions use monthly emissions values. For onroad mobile sources, the emissions are computed hourly based on gridded meteorological data and emission factors. Therefore, these aggregated annual onroad and nonroad modeling files should not be used directly for modeling.

For point and nonpoint sources, the modeling files have the sources split into smaller source groupings (modeling sectors) for emissions modeling because emissions processing methods vary between these source groupings.

1.4 Why is the NEI created?

The NEI is created to provide the EPA, federal, state, local and tribal decision makers, and the national and international public the best and most complete estimates of CAP and HAP emissions. While the EPA is not directly obligated to create the NEI, the Clean Air Act authorizes the EPA Administrator to implement data collection efforts needed to properly administer the NAAQS program. Therefore, the Office of Air Quality Planning and Standards (OAQPS) maintains the NEI program in support of the NAAQS. Furthermore, the Clean Air Act requires states to submit emissions to the EPA as part of their State Implementation Plans (SIPs) that describe how they will attain the NAAQS. The NEI is used as a starting point for many SIP inventory development efforts and for states to obtain emissions from other states needed for their modeled attainment demonstrations.

While the NAAQS program is the basis on which the EPA collects CAP emissions from the S/L/T air agencies, it does not require collection of HAP emissions. For this reason, the HAP reporting requirements are voluntary. Nevertheless, the HAP emissions are an essential part of the NEI program. These emissions estimates allow EPA to assess progress in meeting HAP reduction goals described in the Clean Air Act amendments of 1990. These reductions seek to reduce the negative impacts to people of HAP emissions in the environment, and the NEI allows the EPA to assess how much emissions have been reduced since 1990.

1.5 How is the NEI created?

The NEI is created based on both regulatory and technical components. The Air Emissions Reporting Rule (AERR) is the regulation that requires states to submit CAP emissions, and provides the framework for voluntary submission of HAP emissions. The 2008 NEI was the first inventory compiled using the AERR, rather than its predecessor, the Consolidated Emissions Reporting Rule (CERR). The 2014 NEI is the third AERR-based inventory, and improvements in the 2014 NEI process reflect lessons learned by the S/L/T air agencies and EPA from the prior NEI efforts. The AERR requires agencies to report all sources of emissions, except fires and biogenic sources. Reporting of open fire sources, such as wildfires, is encouraged, but not required. Sources are divided into large groups called “data categories”: stationary sources are “point” or “nonpoint” (county totals) and mobile sources are either onroad (cars and trucks driven on roads) or nonroad (locomotives, aircraft, marine, off-road vehicles and nonroad equipment such as lawn and garden equipment).

The AERR has emissions thresholds above which states must report stationary emissions as “point” sources, with the remainder of the stationary emissions reported as “nonpoint” sources.

The AERR changed the way these reporting thresholds work, as compared to the CERR, by changing these thresholds to “potential to emit” thresholds rather than actual emissions thresholds. In both the CERR and the AERR, the emissions that are reported are actual emissions, despite that the criteria for which sources to report is now based on potential emissions. The AERR requires emissions reporting every year, with additional requirements every third year in the form of lower point source emissions thresholds, and 2014 is one of these third-year inventories.

Table 1-1 provides the potential-to-emit reporting thresholds that applied for the 2014 NEI cycle. “Type B” is the terminology in the rule that represents the lower emissions thresholds required for point sources in the triennial years. The reporting thresholds are sources with potential to emit of 100 tons/year or more for most criteria pollutants, with the exceptions of CO (1000 tons/year), and, updated in the 2014 AERR, Pb (0.5 tons/year, actual). As shown in the table, special requirements apply to nonattainment area (NAA) sources, where even lower thresholds apply. The relevant ozone (O_3), CO, and PM_{10} nonattainment areas that applied during the year that the S/L/T agencies submitted their data for the 2014 NEI are available athttps://www.epa.gov/green-book.

While not applicable to the 2014 NEI, the AERR thresholds have been further revised to reflect 70 tons/year for PM_{10}, $PM_{2.5}$, and PM precursors for sources within PM_{10} and $PM_{2.5}$ nonattainment areas.

Table 1-1: Point source reporting thresholds (potential to emit) for CAPs in the AERR for the year 2014 NEI

Pollutant		2014 NEI thresholds: potential to emit (tons/yr)	
		Everywhere (Type B sources)	NAA sources[1]
1	SO_2	≥ 100	≥ 100
2	VOC	≥ 100	O_3 (moderate) ≥ 100
3	VOC		O_3 (serious) ≥ 50
4	VOC		O_3 (severe) ≥ 25
5	VOC		O_3 (extreme) ≥ 10
6	NO_X	≥ 100	≥ 100
7	CO	≥ 1000	O_3 (all areas) ≥ 100
8	CO		CO (all areas) ≥ 100
9	Pb	≥ 0.5 (actual)	≥ 0.5 (actual)
10	PM_{10}	≥ 100	PM_{10} (moderate) ≥ 100
11	PM_{10}		PM_{10} (serious) ≥ 70
12	$PM_{2.5}$	≥ 100	≥ 100
13	NH_3	≥ 100	≥ 100

[1] NAA = Nonattainment Area. Special point source reporting thresholds apply for certain pollutants by type of nonattainment area. The pollutants by nonattainment area are: Ozone: VOC, NO_X, CO; CO: CO; PM_{10}: PM_{10}

Based on the AERR requirements, S/L/T air agencies submit emissions or model inputs of point, nonpoint, onroad mobile, nonroad mobile, and fires emissions sources. With the exception of California, reporting agencies were required to submit model inputs for onroad and nonroad mobile sources instead of emissions. For the 2014 NEI, all these emissions and inputs were required to be submitted to the EPA per the AERR by December 31, 2015 (with an extension given through January 15, 2016). Once the initial reporting NEI period closed, the EPA provided feedback on data quality such as suspected outliers and missing data by comparing to previously established emissions ranges and past inventories. In addition, the EPA augmented the S/L/T data using various sources of data and augmentation procedures. This documentation provides a detailed account of EPA's quality assurance and augmentation methods.

1.6 Who are the target audiences for the 2014 NEI?

The comprehensive nature of the NEI allows for many uses and, therefore, its target audiences include EPA staff and policy makers, the U.S. public, other federal and S/L/T decision makers, and other countries. Table 1-2 below lists the major current uses of the NEI and the plans for use of the 2014 NEI in those efforts. These uses include those by the EPA in support of the NAAQS, Air Toxics, and other programs as well as uses by other federal and regional agencies and for international needs. In addition to this list, the NEI is used to respond to Congressional inquiries, provide data that supports university research, and allow environmental groups to understand sources of air pollution.

Table 1-2: Examples of major current uses of the NEI

Audience	Purposes
U.S. Public	Learn about sources of air emissions
EPA – NAAQS	Regulatory Impact Analysis – benefits estimates using air quality modeling

Audience	Purposes
	NAAQS Implementations, including State Implementation Plans (SIPs)
	Monitoring Rules
	Final NAAQS designations
	NAAQS Policy Assessments
	Integrated Science Assessments
	Transport Rule air quality modeling (e.g., Clean Air Interstate Rule, Cross-State Air Pollution Rule)
EPA – Air toxics	National Air Toxics Assessment (NATA)
	Mercury and Air Toxics Standard – mercury risk assessment and Regulatory Impact Assessment
	National Monitoring Programs Annual Report
	Toxicity Weighted emission trends for the Government Performance and Reporting Act (GPRA)
	Residual Risk and Technology Review – starting point for inventory development
EPA – other	NEI Reports – analysis of emissions inventory data
	Report on the Environment
	Air Emissions website for providing graphical access to CAP emissions for state maps and Google Earth views of facility total emissions
	Department of Transportation, national transportation sector summaries of CAPs
	Black Carbon Report to Congress
Other federal or regional agencies	Modeling in support of Regional Haze SIPs and other air quality issues
International	United Nations Environment Programme (UNEP) – global and North American Assessments
	The Organization for Economic Co-operation and Development (OECD) - environmental data and indicators report
	UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) - emission reporting requirements, air quality modeling, and science assessments
	Community Emissions Data System (CEDS) - science network for earth system, climate, and atmospheric modeling
	Commission for Environmental Cooperation (CEC) - North American emissions inventory improvement and reduction policies
	U.S. and Canada Air Quality Reports
	Arctic Contaminants Action Program (ACAP) - national environmental and emission reduction strategy for the Arctic Region
Other outside parties	Researchers and graduate students

1.7 What are appropriate uses of the 2014 NEI and what are the caveats about the data?

As shown in the preceding section, the NEI provides a readily-available comprehensive inventory of both CAP and HAP emissions to meet a variety of user needs. Although the accuracy of individual emissions estimates will vary from facility-to-facility or county-to-county, the NEI largely meets the needs of these users in the aggregate. Some NEI users may wish to evaluate and revise the emission estimates for specific pollutants from specific source types for either the entire U.S. or for smaller geographical areas to meet their needs. Regulatory uses of the NEI by the EPA, such as for interstate transport, always include a public review and comment period. Large-scale assessment uses, such as the NATA study, also provide review periods and can serve as an effective screening tool for identifying potential risks.

One of the primary goals of the NEI is to provide the best assessment of current emissions levels using the data, tools and methods currently available. For significant emissions sectors of key pollutants, the available data, tools and methods typically evolve over time in response to identified deficiencies and the need to understand the costs and benefits of proposed emissions reductions. As these method improvements have been made, there have not been consistent efforts to revise previous NEI year estimates to use the same methods as the current year. Therefore, care must be taken when reviewing different NEI year publications as a time series with the goal of determining the trend or difference in emissions from year to year. An example of such a method change in the 2008 NEI v3 and 2011 NEI is the use of the Motor Vehicle Emissions Simulator (MOVES) model[2] for the onroad data category. Previous NEI years had used the Mobile Source Emission Factor Model, version 6 (MOBILE6)[3] and earlier versions of the MOBILE model for this data category. The 2011 NEI (2011v2) also used an older version of MOVES (2014) that has been updated in the current 2014 NEI (MOVES2014a). The new version of MOVES also calculates nonroad equipment emissions, adding VOCs and toxics, updating the gasoline fuels used for nonroad equipment to be consistent with those used for onroad vehicles. These most recent changes in MOVES lead to a small increase in nonroad NO_X emissions in some locations, introducing additional uncertainty when comparing 2014 NEI to past inventories.

Other significant emissions sectors have also had improvements and, therefore, trends are also impacted by inconsistent methods. Examples include paved and unpaved road PM emissions, ammonia fertilizer and animal waste emissions, oil and gas production, residential wood combustion, solvents, industrial and commercial/institutional fuel combustion and commercial marine vessel emissions.

Users should take caution in using the emissions data for filterable and condensable components of particulate matter (PM10-FIL, PM2.5-FIL and PM-CON), which is not complete and should not be used at any aggregated level. These data are provided for users who wish to better understand the components of the primary PM species, where they are available, in the disaggregated, process-specific emissions reports. Where not reported by S/L/T agencies, the EPA augments these components (see Section 2.2.4). However, not all sources are covered by this routine, and in mobile source and fire models, only the primary particulate species are estimated. Thus, users interested in PM emissions should use the primary species of particulate matter (PM10-PRI and PM25-PRI), described in this document simply as PM_{10} and $PM_{2.5}$.

1.8 Outstanding Issues in the 2014 NEI

As with every recent triennial NEI, the 2014 NEI will be updated with improvements that will be included in version 2, expected to be released in the fall of 2017. Many of the issues that will lead to updates for 2014 v2 NEI have already been identified, and additional items could be added as S/L/Ts and other stakeholders review the 2014 NEI. We expect that most point and events data category updates will be provided directly by S/L/T air agencies and limited newer activity data. The EPA plans to update mobile input data including vehicle distribution and activity. For the nonpoint data category (Section 4), there are numerous updates in development that will be incorporated in 2014 v2 NEI. These nonpoint data category updates include, but are not limited to:

- Updated emission factors for Residential Wood Combustion, Industrial and Commercial/Institutional Boilers and Engines and Oil and Gas Exploration and Production
- Some HAPs augmented for oil and gas in the Uinta basin used emission factor ratios applied to state-supplied VOC emission estimates based on speciation profiles which have since been updated. The updated speciation data will be used in v2.
- Revised activity data for Mercury sources, Oil and Gas, Road Dust, Commercial Cooking, Stage I Gasoline Distribution, Agricultural Pesticides and Residential Heating
- New category for Composting

[2] See http://www.epa.gov/otaq/models/moves/index.htm
[3] See http://www.epa.gov/otaq/m6.htm

- Revisions based on addressing 2014 v1 NEI comments from S/L/Ts and others.

Not every identified issue in the 2014 v1 NEI will be resolved for the 2014 v2 NEI. We will discuss each outstanding issue within the following sections of this document and whether these issues are likely to be updated in the 2014 v2 NEI, or simply identified as items that need additional resources for later NEI inventories such as year 2017.

2 2014 NEI contents overview

2.1 What are EIS sectors and what list was used for this document?

First used for the 2008 NEI, EIS Sectors continue to be used for the 2014 NEI. The sectors were developed to better group emissions for both CAP and HAP summary purposes. The sectors are based simply on grouping the emissions by the emissions process based on the SCC to the EIS sector. In building this list, we gave consideration not only to the types of emissions sources our data users most frequently ask for, but also to the need to have a relatively concise list in which all sectors have a significant amount of emissions of at least one pollutant. The SCC-EIS Sector cross-walk used for the summaries provided in this document is available in the comma-separated values (CSV) file "source_classification_codes (9).csv" that can be imported into a Microsoft® Excel ® spreadsheet. No changes were made to the SCC-mapping or sectors used for the 2014 NEI except where SCCs were retired or new SCCs were added. Users of the NEI are free to obtain the SCC-level data. SCCs and their associated sectors are available from the SCC Search Page.

Some of the sectors include the nomenclature "NEC," which stands for "not elsewhere classified." This simply means that those emissions processes were not appropriate to include in another EIS sector and their emissions were too small individually to include as its own EIS sector.

Since the 2008 NEI, the inventory has been compiled using five major categories that are also data categories in the EIS: point, nonpoint, onroad, nonroad and events. The event category is used to compile day-specific data from prescribed burning and wildfires. While events could be other intermittent releases such as chemical spills and structure fires, prescribed burning and wildfires have been a focus of the NEI creation effort and are the only emission sources contained in the event data category.

Table 2-1 shows the EIS sectors or source category component of the EIS sector in the left most column. EIS data categories -Point, Nonpoint, Onroad, Nonroad, and Events- that have emissions in these sectors/source categories are also reflected. This table also identifies in the rightmost column the section number of this document that provides more information about that EIS sector or source category **if the EPA was involved in creating emissions for that component of the NEI**. Many Industrial Processes-related EIS sectors do not have detailed sector-specific documentation because the emissions are comprised almost exclusively from S/L/T point and/or nonpoint submittals. As discussed in the next section, the EPA had little, if any, input to these sectors other than augmenting HAPs or tagging out unexpected data.

As Table 2-1 illustrates, many EIS sectors include emissions from more than one EIS data category because the EIS sectors are compiled based on the type of emissions sources rather than the data category. Note that the EIS sector "Mobile – Aircraft" is part of the point and nonpoint data categories and "Mobile – Commercial Marine Vessels" and "Mobile – Locomotives" is part of the nonpoint data category. We include biogenics emissions, "Biogenics - Vegetation and Soil," in the nonpoint data category in the EIS; however, we document biogenics in its own Section (8). NEI users who aggregate emissions by EIS data category rather than EIS sector should be aware that these changes will give differences from historical summaries of "nonpoint" and "nonroad" data unless care is taken to assign those emissions to the historical grouping.

Table 2-1: EIS sectors/source categories with EIS data category emissions reflected, and where provided, document sections

Component **EIS Sector or EIS Sector: Source Category Name**	**Point**	**Nonpoint**	**Onroad**	**Nonroad**	**Event**	**Document Section(s)**
Agriculture - Crops & Livestock Dust		☑				4.3
Agriculture - Fertilizer Application		☑				4.4
Agriculture - Livestock Waste	☑	☑				4.5
Biogenics - Vegetation and Soil		☑				8
Bulk Gasoline Terminals	☑	☑				4.6
Commercial Cooking		☑				4.7
Dust - Construction Dust	☑	☑				4.8
Dust - Paved Road Dust		☑				4.9
Dust - Unpaved Road Dust		☑				4.10
Fires - Agricultural Field Burning		☑				4.11
Fires - Prescribed Burning					☑	7
Fires - Wildfires					☑	7
Fuel Comb - Comm/Institutional - Biomass	☑	☑				4.12
Fuel Comb - Comm/Institutional - Coal	☑	☑				4.12
Fuel Comb - Comm/Institutional - Natural Gas	☑	☑				4.12
Fuel Comb - Comm/Institutional - Oil	☑	☑				4.12
Fuel Comb - Comm/Institutional - Other	☑	☑				4.12
Fuel Comb - Electric Generation - Biomass	☑					3.4
Fuel Comb - Electric Generation - Coal	☑					3.4
Fuel Comb - Electric Generation - Natural Gas	☑					3.4
Fuel Comb - Electric Generation - Oil	☑					3.4
Fuel Comb - Electric Generation - Other	☑					3.4
Fuel Comb - Industrial Boilers, ICEs - Biomass	☑	☑				4.12
Fuel Comb - Industrial Boilers, ICEs - Coal	☑	☑				4.12
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	☑	☑				4.12
Fuel Comb - Industrial Boilers, ICEs - Oil	☑	☑				4.12
Fuel Comb - Industrial Boilers, ICEs - Other	☑	☑				4.12
Fuel Comb - Residential - Natural Gas		☑				4.13
Fuel Comb - Residential - Oil		☑				4.13
Fuel Comb - Residential - Other		☑				4.13
Fuel Comb - Residential - Wood		☑				4.14
Gas Stations	☑	☑				4.6
Industrial Processes - Cement Manufacturing	☑					
Industrial Processes - Chemical Manufacturing	☑	☑				
Industrial Processes - Ferrous Metals	☑					
Industrial Processes - Mining	☑	☑				4.15
Industrial Processes - NEC	☑	☑				

Component **EIS Sector or EIS Sector: Source Category Name**	**Point**	**Nonpoint**	**Onroad**	**Nonroad**	**Event**	**Document Section(s)**
Industrial Processes - Non-ferrous Metals	☑	☑				
Industrial Processes - Oil & Gas Production	☑	☑				4.16
Industrial Processes - Petroleum Refineries	☑	☑				
Industrial Processes - Pulp & Paper	☑					
Industrial Processes - Storage and Transfer	☑	☑				4.6
Miscellaneous Non-Industrial NEC: Residential Charcoal Grilling		☑				4.17
Miscellaneous Non-Industrial NEC: Portable Gas Cans		☑				4.18
Miscellaneous Non-Industrial NEC: Nonpoint Hg		☑				4.2
Miscellaneous Non-Industrial NEC (All other)	☑	☑				
Mobile – Aircraft	☑					3.2
Mobile - Commercial Marine Vessels		☑				4.19
Mobile – Locomotives	☑	☑				3.3 & 4.20
Mobile - NonRoad Equipment – Diesel	☑			☑		5
Mobile - NonRoad Equipment – Gasoline	☑			☑		5
Mobile - NonRoad Equipment – Other	☑			☑		5
Mobile - Onroad – Diesel Heavy Duty Vehicles			☑			6
Mobile - Onroad – Diesel Light Duty Vehicles			☑			6
Mobile - Onroad – Gasoline Heavy Duty Vehicles			☑			6
Mobile - Onroad – Gasoline Light Duty Vehicles			☑			6
Solvent - Consumer & Commercial Solvent Use: Agricultural Pesticides		☑				4.21
Solvent - Consumer & Commercial Solvent Use: Asphalt Paving		☑				4.22
Solvent - Consumer & Commercial Solvent Use: All Other Solvents		☑				4.23
Solvent - Degreasing	☑	☑				4.23
Solvent - Dry Cleaning	☑	☑				4.23
Solvent - Graphic Arts	☑	☑				4.23
Solvent - Industrial Surface Coating & Solvent Use	☑	☑				4.23
Solvent - Non-Industrial Surface Coating		☑				4.23
Waste Disposal: Open Burning		☑				4.24
Waste Disposal: Nonpoint POTWs		☑				4.25
Waste Disposal: Nonpoint Hg		☑				4.2
Waste Disposal (all remaining sources)	☑	☑				

2.2 How is the NEI constructed?

Data in the NEI come from a variety of sources. The emissions are predominantly from S/L/T agencies for both CAP and HAP emissions. In addition, the EPA quality assures and augments the data provided by states to assist with data completeness, particularly with the HAP emissions since the S/L/T HAP reporting is voluntary.

The NEI is built by data category for point, nonpoint, nonroad mobile, onroad mobile and events. Each data category has a self-contained inventory where multiple datasets are blended to create the final NEI "selection." Each data category selection includes S/L/T data and numerous other datasets that are discussed in more detail in each of the following sections in this document. In general, S/L/T data take precedence in the selection hierarchy, which means that it supersedes any other data that may exist for a specific county/tribe/facility/pollutant/process. In other words, the selection hierarchy is built such that the preferred source of data, usually S/L/T, is chosen when multiple sources of data are available. There are exceptions, to this general rule, which arise based on quality assurance checks and feedback from S/L/Ts that we will discuss in later sections. These exceptions are implemented by NEI developers using "tags" within EIS.

The EPA uses augmentation and additional EPA datasets to create the most complete inventory for stakeholders, for use in such applications as NATA, air quality modeling, national rule assessments, international reporting, and other reports and public inquiries. Augmentation to S/L/T data, in addition to EPA datasets, fill in gaps for sources and/or pollutants often not reported by S/L/T agencies. The basic types of augmentation are discussed in the following sections.

2.2.1 Toxics Release Inventory data

The EPA used air emissions data from the 2014 Toxics Release Inventory (TRI) to supplement point source HAP and NH_3 emissions provided to EPA by S/L/T agencies. For 2014, all TRI emissions values that could reasonably be matched to an EIS facility were loaded into the EIS for viewing and comparison if desired, but only those pollutants that were not reported anywhere at the EIS facility by the S/L/T agency were considered for inclusion in the 2014 NEI.

The TRI is an EPA database containing data on disposal or other releases including air emissions of over 650 toxic chemicals from approximately 21,000 facilities. One of TRI's primary purposes is to inform communities about toxic chemical releases to the environment. Data are submitted annually by U.S. facilities that meet TRI reporting criteria. Section 3 provides more information on how TRI data was used to supplement the point inventory.

2.2.2 Chromium speciation

The 2014 reporting cycle included 5 valid pollutant codes for chromium, as shown in Table 2-2.

Table 2-2: Valid chromium pollutant codes

Pollutant Code	Description	Pollutant Category Name	Speciated?
1333820	Chromium Trioxide	Chromium Compounds	yes
16065831	Chromium III	Chromium Compounds	yes
18540299	Chromium (VI)	Chromium Compounds	yes
7440473	Chromium	Chromium Compounds	no
7738945	Chromic Acid (VI)	Chromium Compounds	yes

In the above table, all pollutants but "chromium" are considered speciated, and so for clarity, chromium (pollutant 7440473) is referred to as "total chromium" in the remainder of this section. Total chromium could contain a mixture of chromium with different valence states. Since one key inventory use is for risk assessment, and since the valence states of chromium have very different risks, speciated chromium pollutants are the most useful pollutants for the NEI. Therefore, the EPA speciates S/L/T-reported and TRI-based total chromium into hexavalent chromium and non-hexavalent chromium. Hexavalent chromium, or Chromium (VI), is considered high risk and other valence states are not. Most of the non-hexavalent chromium is trivalent chromium

(Chromium III); therefore, the EPA characterized all non-hexavalent chromium as trivalent chromium. The 2014 NEI does not contain any total chromium, only the speciated pollutants shown in Table 2-2.

This section describes the procedure we used for speciating chromium emissions from total chromium that was reported by S/L/T agencies.

We used the EIS augmentation feature to speciate S/L/T agency reported total chromium. For point sources, the EIS uses the following priority order for applying the factors:

1) By Process ID
2) By Facility ID
3) By County
4) By State
5) By Emissions Type (for NP only)
6) By SCC
7) By Regulatory Code
8) By NAICS
9) A Default value if none of the others apply

For the 2014 chromium augmentation, only the "By Facility ID" (2), "By SCC" (6), and "By Default" (9) were used. The EIS generates and stores an EPA dataset containing the resultant hexavalent and trivalent chromium species.

For all other data categories (e.g., nonpoint, onroad and nonroad), chromium speciation is performed at the SCC level.

This procedure generated hexavalent chromium (Chromium (VI)) and trivalent chromium (Chromium III), and it had no impact on S/L/T agency data that were provided as one of the speciated forms of chromium. The sum of the EPA-computed species (hexavalent and trivalent chromium) equals the mass of the total chromium (i.e., pollutant 7440473) submitted by the S/L/T agencies.

The EPA then used this dataset in the 2014 NEI selection by adding it to the data category-specific selection hierarchy and by excluding the S/L/T agency unspeciated chromium from the selection through a pollutant exception to the hierarchy. It was not necessary to speciate chromium from any of the EPA datasets, because the EPA data contains only speciated chromium.

Most of the speciation factors used in the 2014 NEI are SCC-based and are the same as were used in 2011, based on data that have long been used by the EPA for NATA and other risk projects. However, some of the values were updated based on data used or developed by OAQPS during rule development and for the 2011 NATA review. The speciation factors are accessed in the EIS through the reference data link "Augmentation Priority Order." The "Priority Data" table provides the factors used for point sources, and the "Priority Data Area" provides the factors used for data in the nonpoint/onroad/nonroad categories. For access by non-EIS users, the factors are included in the zip file ChromiumAugFactors.zip. If a particular emission source of total chromium is not covered by the speciation factors specified by any of these attributes, a default value of 34 percent hexavalent chromium, 66 percent trivalent chromium is applied.

2.2.3 HAP augmentation

The EPA supplements missing HAPs in S/L/T agency-reported data. HAP emissions are calculated by multiplying appropriate surrogate CAP emissions by an emissions ratio of HAP to CAP emission factors. For the 2014 NEI, we augmented HAPs for the point and nonpoint data categories. Generally, for point sources, the CAP-to-HAP ratios were computed using uncontrolled emission factors from the WebFIRE database (which contains primarily AP-42 emissions factors). For nonpoint sources, the ratios were computed from the EPA-generated nonpoint data, which contain both CAPs and HAPs where applicable.

HAP augmentation is performed on each emissions source (i.e., specific facility and process for point sources, county and process level for nonpoint sources) using the same EIS augmentation feature as described in chromium speciation. However, unlike chromium speciation, there is no default augmentation factor so that not every process that has S/L/T CAP data will end up with augmented HAP data.

HAP augmentation input pollutants are S/L/T-submitted VOC, PM10-PRI, PM25-PRI, SO2, and PM10-FIL. The resulting output can be a single output pollutant or a full suite of output pollutants. Not every source that has a CAP undergoes HAP augmentation (i.e., livestock NH_3, fugitive dust PM25-PRI). The sum of the HAP augmentation factors does not need to equal 1 (100%); however, we try to ensure, for example, that the sum of HAP-VOC factors is less than 1 for mass balance. HAP augmentation factors are grouped into profiles that contain unique output pollutant factors related to a type of source. Assigning these profiles to the individual sources depends on the source attributes, commonly the SCC.

There are business rules specific to each data category discussed in the point (Section 3) and nonpoint (Section 4). The ultimate goal is to prevent double-counting of HAP emissions between S/L/T data and the EPA HAP augmentation output, and to prevent, where possible, adding HAP emissions to S/L/T-submitted processes that are not desired. NEI developers use their judgment on how to apply HAP augmentation to the resulting NEI selection.

Caveats

HAP augmentation does have limitations; HAP and CAP emission factors from WebFIRE do not necessarily use the same test methods. In some situations, the VOC emission factor is less than the sum of the VOC HAP emission factors. In those situations, we normalize the HAP ratios so as not to create more VOC HAPs than VOC. We are also aware that there are many similar SCCs that do not always share the same set of emission factors/output pollutants. We do not apply ratios based on emission factors from similar SCCs other than for mercury from combustion SCCs. We would prefer to get HAPs reported from reporting agencies or get the data from other sources (compliance data from rule), but such data are not always available.

Because much of the AP-42 factors are 20+ years old, many incremental edits to these factors have been made over time. We have removed some factors based on results of the 2011 NATA review. For example, we discovered ethylene dichloride was being augmented for SCCs related to gasoline distribution. This pollutant was associated with leaded gasoline which is no longer used. Therefore, we removed it from our HAP augmentation between 2011 NEI v2 and 2014. We also received specific facility and process augmentation factors, which we incorporated into for the augmentation for 2014 NEI.

HAP augmentation can sometimes create HAP emissions that exceed the largest S/L/T-reported value nationally for a given pollutant and SCC. These high values are screened out via tags (see Section 2.2.6) and are not in the 2014 NEI. These tagged values are available for S/L/T air agency review. While they could be valid, they could also indicate a CAP emissions overestimate or incorrect SCC assignment for a source.

For point sources, HAPs augmentation data are not used when S/L/T air agency data exists at any process at the facility for the same pollutant. That means that if a S/L/T reports a particular HAP at some processes but misses others, then those other processes will not be augmented with that HAP. A more thorough review of that situation will be done for mercury for version 2, which could lead to some additional augmented Hg being used.

2.2.4 PM augmentation

Particulate matter (PM) emissions species in the NEI are: primary PM_{10} (called PM10-PRI in the EIS and NEI) and primary $PM_{2.5}$ (PM25-PRI), filterable PM_{10} and filterable $PM_{2.5}$ (PM10-FIL and PM25-FIL) and condensable PM (PM-CON). The EPA needed to augment the S/L/T agency PM components for the point and nonpoint inventories to ensure completeness of the PM components in the final NEI and to ensure that S/L/T agency data did not contain inconsistencies. An example of an inconsistency is if the S/L/T agency submitted a primary $PM_{2.5}$ value that was greater than a primary PM_{10} value for the same process. Commonly, the augmentation added condensable PM or PM filterable (PM10-FIL and/or PM25-FIL) where none was provided, or primary $PM_{2.5}$ where only primary PM_{10} was provided.

In general, emissions for PM species missing from S/L/T agency inventories were calculated by applying factors to the PM emissions data supplied by the S/L/T agencies. These conversion factors were first used in the 1999 NEI's "PM Calculator" as described in an NEI conference paper [ref 1]. The resulting methodology allows the EPA to derive missing PM10-FIL or PM25-FIL emissions from incomplete S/L/T agency submissions based on the SCC and PM controls that describe the emissions process. In cases where condensable emissions are not reported, conversion factors are applied to S/L/T agency reported PM species or species derived from the PM Calculator databases. The PM Calculator, has undergone several edits since 1999; now called the "PM Augmentation Tool," this Microsoft ® Access ® database is available at https://www.epa.gov/air-emissions-inventories/pm-augmentation.

The PM Augmentation Tool is used only for point and nonpoint sources, and the output from the tool is heavily-screened prior to use in the NEI. This screening is done to prevent trivial overwriting of S/L/T data from PM Augmentation Tool calculations, particularly for primary PM submittals by S/L/Ts. More details on the caveats to using the PM Augmentation Tool are discussed in Section 3 on point sources and Section 4 on nonpoint sources.

2.2.5 Other EPA datasets

In addition to TRI, chromium speciation, HAP and PM augmentation, the EPA generates other data to produce a complete inventory. A new EPA dataset in the 2014 NEI "2014EPA_PMspecies", provides speciated PM2.5 and "DIESEL" PM emissions for the point, nonpoint, onroad mobile, and nonroad mobile data categories. This dataset is a result of offline emissions speciation where the NEI PM25-PRI emissions are split into the five $PM_{2.5}$ species: elemental (also referred to as "black") carbon (EC), organic carbon (OC), nitrate (NO3), sulfate (SO4), and the remainder of PM25-PRI (PMFINE). Also adds a copy of PM2.5-PRI and PM10-PRI from diesel engines, relabeled as DIESEL-PM25 and DIESEL-PM10, respectively, are added pollutants in this dataset.

Examples of EPA data for point sources, discussed in Section 3, include EPA landfills, electric generating units (EGUs), airports, railyards, and offshore oil and gas platforms.

For nonpoint sources, discussed in Section 4, other EPA data are the defaults that are provided in the EPA nonpoint tools that S/L/Ts agency staff can generate emission estimates. Examples of these nonpoint tools include residential wood combustion, industrial and commercial/institutional fuel combustion, solvent utilization, fugitive dust, oil and gas exploration and production and agricultural pesticide application. The EPA also generates emission estimates as stand-alone datasets that do not have editable inputs; examples of these datasets include biogenics, agricultural livestock and fertilizer application.

We develop and document EPA-generated nonroad mobile-type sources that are in the nonpoint inventory separate from the nonroad equipment sources. These nonpoint, but nonroad mobile-type, sources include rail emissions except railyards and commercial marine vessel ports and in-transit (underway) sources.

We only incorporate data from these other EPA datasets for sources and pollutants that are not provided by S/L/T data. We perform analysis to prevent double-counting of S/L/T agency and EPA data, including using the information included in a nonpoint survey that S/L/T air agencies provided. The information provided by the survey indicates whether nonpoint source categories are covered in partly or wholly in point submittals, represented by another reported process (SCC) type, or are not present in their state or local jurisdiction.

2.2.6 Data Tagging

S/L/T agency data generally is used first when creating the NEI selection. When S/L/T data are used, then the NEI would not use other data (primarily EPA data from stand-alone datasets or HAP, PM or TRI augmentation) that also may exist for the same process/pollutant. Thus, in most cases the S/L/T agency data are used; however, for several reasons, sometimes we need to exclude, or "tag out" S/L/T agency data. Examples of these "S/L/T tags" are when S/L/T agency staff alert the EPA to exclude their data (because of a mistake or outdated value), or when EPA staff find problems with submitted data. An example of the latter scenario is when a S/L/T agency reported only one HAP where several others would be expected, or a S/L/T agency has resubmitted older inventory data. The EPA sector leads contact S/L/T data submitters in cases where the EPA tags out S/L/T data and gives the S/L/T agencies an opportunity to correct problems themselves.

In addition to S/L/T tags, a more common tag is to block EPA-generated data from being used, which would otherwise backfill in "gaps" in S/L/T agency data. For example, S/L/T agencies may inventory all Stage 1 gasoline distribution in their point inventory submittal and have none remaining for the nonpoint inventory; EPA nonpoint Stage 1 gasoline distribution estimates therefore need to be tagged out to prevent EPA nonpoint data from backfilling a complete (point) S/L/T inventory. The EPA tags are far more common and automated for the nonpoint data category where a new nonpoint survey was created for the 2014 NEI. The nonpoint survey is described in more detail in Section 4.

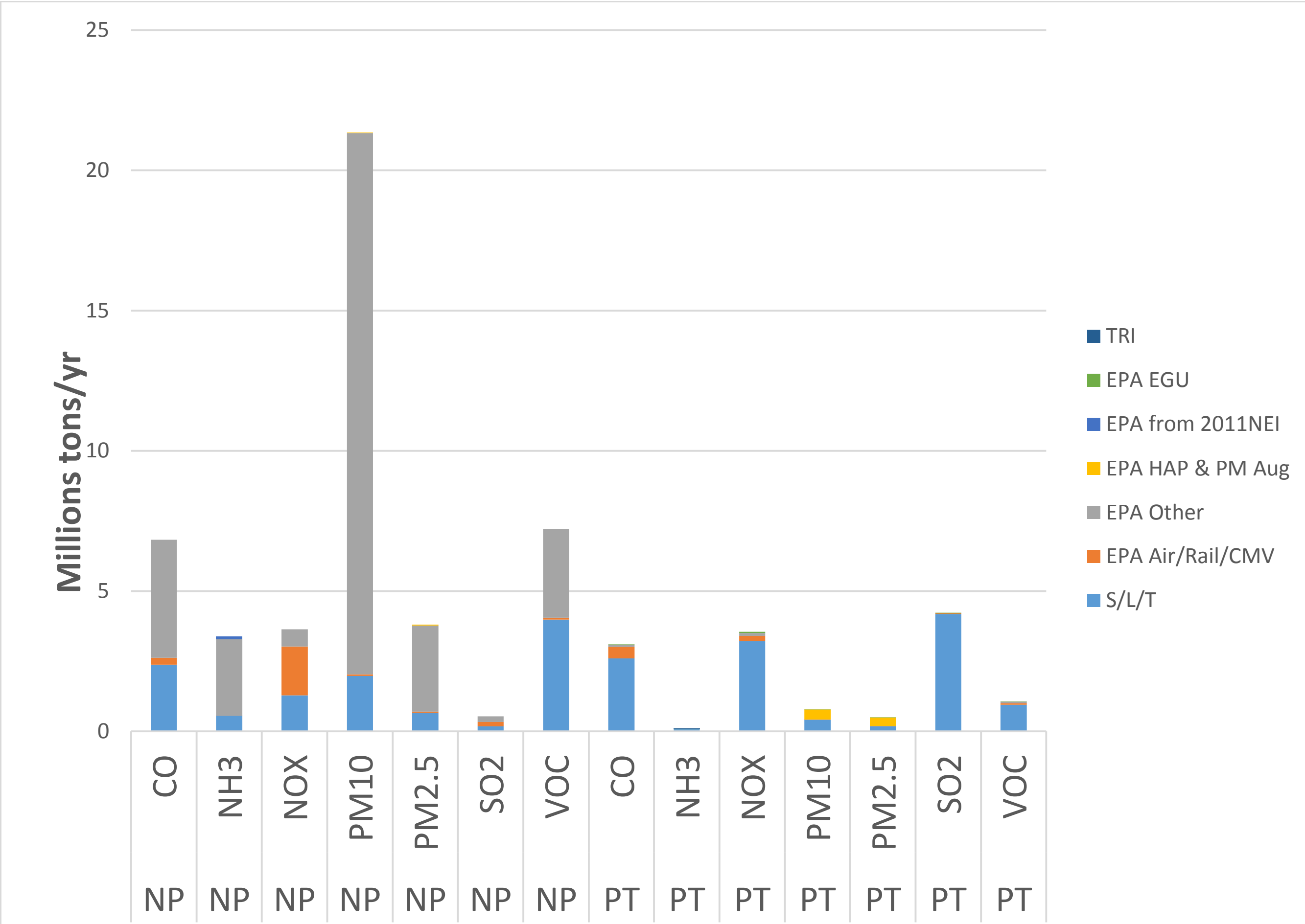
2.2.7 Inventory Selection

Once all S/L/T and EPA data are quality assured in the EIS, and all augmentation and data tagging are complete, then we use the EIS to create a data category-specific inventory selection. To do this, each EIS dataset is assigned a priority ranking prior to running the selection with EIS. The EIS then performs the selection at the most detailed inventory resolution level for each data category. For point sources, this is the process and pollutant level (which includes facility and unit). For nonpoint sources, it is the process (SCC)/shape ID (i.e., rail lines, ports and shipping lanes) and pollutant level. For onroad and nonroad sources, it is process/pollutant, and for events it is day/location/process and pollutant. At these resolutions, the inventory selection process uses data based on highest priority and excludes data where it has been tagged. The EPA then quality assures this final blended inventory to ensure expected processes/pollutants are included or excluded. The EIS uses the inventory selection to also create the SMOKE Flat Files, EIS reports and data that appear on the NEI website.

2.3 What are the sources of data in the 2014 NEI?

This section shows the contributions of S/L/T agency data to total emissions for each major data category. Figure 2-1 shows the proportion of CAP emissions from various data sources in the NEI for point and nonpoint sources. For the nonpoint data in the figure (left 7 bars), most of the emissions come from EPA sources of data, with S/L/T agency data the majority for VOC and SO_2. The large "EPA Other" bar for PM_{10} is predominantly dust sources from unpaved roads (11.4 million tons), agricultural dust from crop cultivation (5.8 million tons), and construction dust (1.4 million tons). For point data in the figure (right 7 bars), most of the emissions come from S/L/T agency data, with EPA data making up a large proportion only for the $PM_{2.5}$ with the EPA PM Augmentation dataset (a component of the "EPA HAP & PM Aug" in the figure, see Section 2.2.3). The data sources shown in the figure are described in more detail in Section 3.

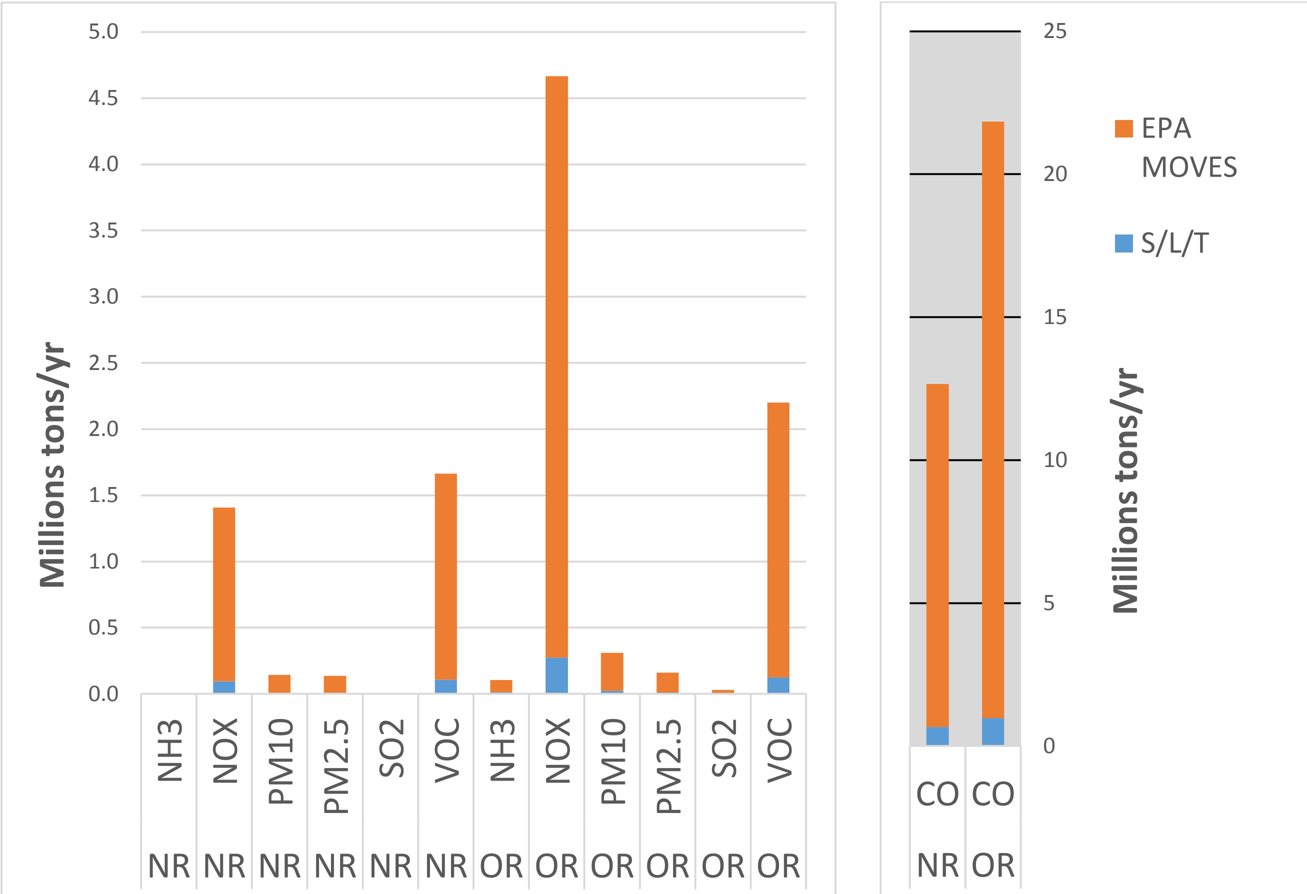
Figure 2-1: Data sources for point and nonpoint emissions for criteria pollutants



[1] Nonpoint emission shown here exclude biogenic sources, which are all EPA data

The data sources for the emissions from nonroad and onroad data categories are shown in Figure 2-2. California, which uses its own onroad and nonroad mobile models, was the only state that provided emissions rather than inputs for EPA models (this is in accordance with the AERR). All other states were required to provide inputs to the EPA models; therefore, the S/L/T bars in this figure represent only California. All other data were generated by the EPA MOVES model and are comprised primarily of data from the EPA. Onroad and nonroad mobile data categories use the MOVES emissions model, and the EPA primarily collected model inputs from S/L agencies for these categories and ran the models using these inputs to generate the emissions. The S/L agencies that provided inputs are presented in the nonroad and onroad portions of the document, Section 5 and Section 6, respectively. Note that the scale for CO in Figure 2-2 is on the right vertical axis in the chart.

Figure 2-2: Data sources for onroad and nonroad mobile emissions for criteria pollutants



In Figure 2-3, the nonpoint acid gases are very small, with 5,700 tons from S/L/T agencies and 2,900 tons from the EPA Other dataset. For point sources, the bulk of the acid gases (92,000 tons) and HAP VOC emissions (168,000 tons) comes from S/L/T agencies. TRI data contributes only around 28,000 tons of HAP VOC emissions and 2,900 tons of Acid Gases.

Figure 2-3: Data sources of emissions for acid gases and HAP VOCs, by data category

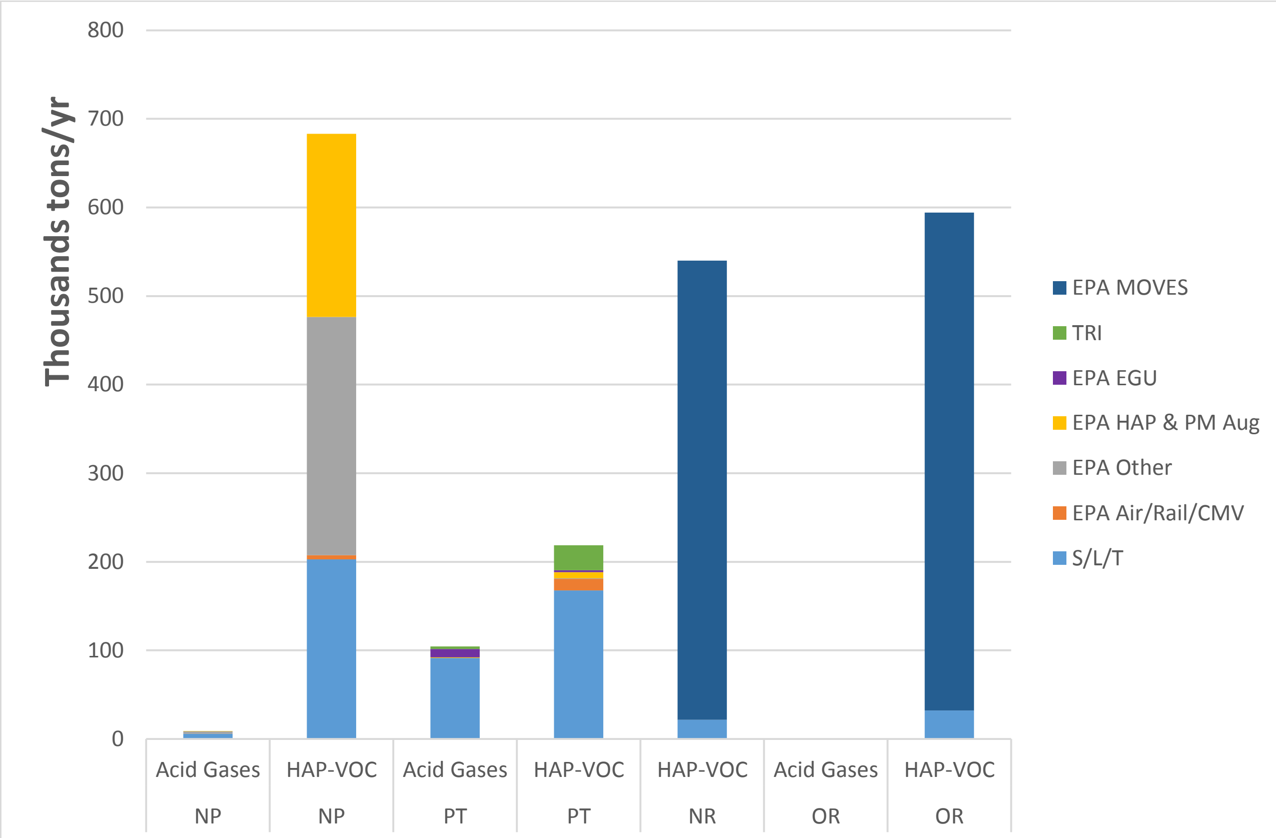
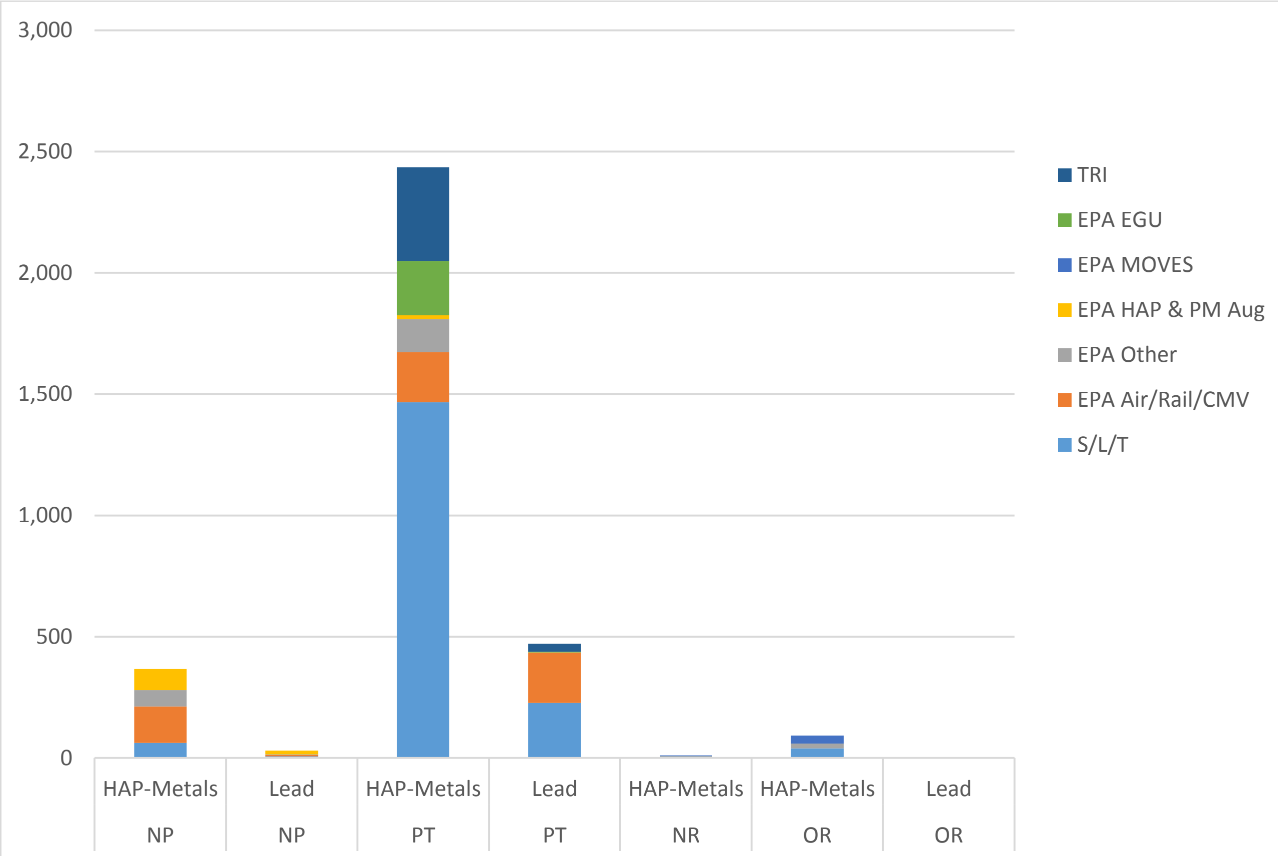


Figure 2-4 shows emissions sources for Pb and HAP metal emissions. HAP metal emissions consist of the following compound groups: Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Mercury, Nickel and Selenium.

For nonpoint sources, almost all of the HAP-metal emissions are from the EPA airports, locomotives, and commercial marine vessels datasets. Nonpoint Pb emissions are primarily from HAP augmentation of S/L/T data from industrial fuel combustion; all nonpoint in-flight Pb emissions (228 tons) were removed from this analysis because these emissions were not assigned to valid state-county FIPS codes, but rather generic county FIPS that end in “777.” For point sources, about half of the Pb comes from S/L/T agency data (230 tons), while the EPA in-flight airport emissions nonpoint dataset composes much of the rest (210 tons). For metals, the point sources data has a significant portion from S/L/T agencies (1,470 tons), with the rest from the EPA EGU dataset (225 tons), TRI (385 tons), and other EPA datasets (135 tons).

Figure 2-4: Data sources of emissions for Pb and HAP metals, by data category



The tables below provide more detail about which S/L/T agencies submitted data to the NEI for the point and nonpoint data categories. In Sections 3 through 6, we explain more about what data actually were used by the EPA to create the NEI for each sector. Usually, the EPA uses the data provided by the S/L/T agencies as described above in Section 2.2.6. Table 2-3 presents the percentages of total agency-wide point source emissions mass provided by that air agency. A value of 100 percent reflects a pollutant where all emissions were submitted by the S/L/T agency and no other data or augmentation was used. Conversely, missing entries reflect that the reporting agency provided no emissions for that pollutant; a value of zero indicates very small, but not-zero, emissions submitted by the reporting agency.

Table 2-4 provides a similar table, but for the entire nonpoint data category, excluding biogenic emissions. We did not create similar tables for nonroad and onroad mobile data categories because input data, not emissions are collected from S/L/T reporting agencies (except for California, where all emissions come from the state). Sections 5 and 6 describe which reporting agencies submitted MOVES inputs for these sectors. Similar tables are provided at a more refined level in Section 4 for various nonpoint data category sector groups such as Residential Wood Combustion, Oil and Gas Production, Industrial and Commercial/Institutional Fuel Combustion and Gasoline Distribution.

Table 2-3: Point inventory percentage submitted by reporting agency to total emissions mass

Reporting Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Alabama Department of Environmental Management	87	90	95			100	93	48	90	64	98

Reporting Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Alaska Department of Environmental Conservation	52	99	94	89	25	92	62	82		79	
Arizona Department of Environmental Quality	64	84	86	77	58	97	50	62	32	75	58
Arkansas Department of Environmental Quality	83	80	95	98	8	100	97	40	90	81	99
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	0		97	4	1	56	96		11	1	
California Air Resources Board	52	97	72	86	85	84	91	11	83	22	51
Chattanooga Air Pollution Control Bureau (CHCAPCB)	67	92	63	93	38	63	91	50	92	27	100
City of Albuquerque	58	1	74	54	35	79	75	1	54	1	29
Clark County Department of Air Quality and Environmental Management	84	85	72	94	76	91	52		11	90	18
Coeur d'Alene Tribe	100		100	81	56	100	100	8		0	
Colorado Department of Public Health and Environment	80		94	98	95	99	98	20	86	58	95
Confederated Tribes of the Colville Reservation, Washington	100		100	66	84	100	100				
Connecticut Department of Energy and Environmental Protection	47	94	93	92	91	97	85	6	43	43	99
DC-District Department of the Environment	98		96	97	96	100	97	86		39	
Delaware Department of Natural Resources and Environmental Control	80	64	85	92	87	96	71	10	56	84	99
Florida Department of Environmental Protection	73	64	87		0	99	86	22	81	42	100
Fond du Lac Band of Lake Superior Chippewa											
Georgia Department of Natural Resources	79	92	89	54	49	99	94	27		5	
Gila River Indian Community											
Hawaii Department of Health Clean Air Branch	50	100	87	91	90	98	80	31	28	11	93
Idaho Department of Environmental Quality	75	99	79	29	32	99	81	6	17	9	2
Illinois Environmental Protection Agency	100	99	100	100	92	100	100	98	98	93	100
Indiana Department of Environmental Management	97	75	96			100	84	81	63	68	97
Iowa Department of Natural Resources	90	93	96	99	97	100	98	65	96	66	100

Reporting Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Kansas Department of Health and Environment	87	96	94			99	94	21	88	49	100
Kentucky Division for Air Quality	96		98			100	99	67	77	58	61
Knox County Department of Air Quality Management	87		88	0		99	95	89	78	53	32
Louisiana Department of Environmental Quality	94	92	98			100	98	50	89	61	64
Louisville Metro Air Pollution Control District	65	91	91	99	99	100	97	55	83	93	100
Maine Department of Environmental Protection	86	100	97	0		99	95	33	90	74	71
Maricopa County Air Quality Department											
Maryland Department of the Environment	48	43	84	0	0	99	63	35	45	43	100
Massachusetts Department of Environmental Protection	39	99	83			95	82	4	3	2	14
Memphis and Shelby County Health Department - Pollution Control	51	20	55	19	3	98	79	37	71	39	100
Metro Public Health of Nashville/Davidson County	26		59	90	62	92	82		59	7	100
Michigan Department of Environmental Quality	88	65	97	23	17	100	97	50	77	69	98
Minnesota Pollution Control Agency	76	100	95	11	0	99	97	56	96	90	100
Mississippi Dept of Environmental Quality	82	72	92	2	2	100	93	34	90	37	100
Missouri Department of Natural Resources	93	96	97	32	24	100	96	58	87	54	98
Montana Department of Environmental Quality	73	9	94			100	94	47	0	44	0
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	100		100	100	7	100	100		100		
Navajo Nation											
Nebraska Environmental Quality	84	95	91	33	15	100	90	30	75	36	10
Nevada Division of Environmental Protection	92		92	98		100	92	31		14	
New Hampshire Department of Environmental Services	67	95	93			99	70	31	50	87	2
New Jersey Department of Environment Protection	48	100	81	95	94	92	92	36	60	49	34
New Mexico Environment Department Air Quality Bureau	90	55	98	97	91	99	94	11	69	12	93

Reporting Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
New York State Department of Environmental Conservation	69	84	82	93	88	98	82	25	73	78	97
Nez Perce Tribe	100		100	100	100	100	100	100	100	99	100
North Carolina Department of Environment and Natural Resources	75	91	92	96	84	99	95	33	92	79	100
North Dakota Department of Health	83	73	98	0	0	100	92	38	86	45	100
Northern Cheyenne Tribe											
Ohio Environmental Protection Agency	94	94	97			100	97	44	28	74	95
Oklahoma Department of Environmental Quality	91	81	97	97	80	100	97	62	79	68	95
Omaha Tribe of Nebraska											
Oregon Department of Environmental Quality	77		80	97	58	98	93	20		8	0
Pennsylvania Department of Environmental Protection	84	89	97			100	95	69	87	55	100
Puerto Rico	58		97	98	96	97	57	61		11	
Rhode Island Department of Environmental Management	66	100	82	92	40	88	91	5	86	22	95
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100		100	100		100	100		100		
South Carolina Department of Health and Environmental Control	94	98	95	98	90	100	96	45	95	71	100
South Dakota Department of Environment and Natural Resources	65		98	66	64	100	96				
Southern Ute Indian Tribe	91		99	95		92	99		91		
Tennessee Department of Environmental Conservation	90	37	97	86	61	100	99	33	91	70	99
Texas Commission on Environmental Quality	100	54	100	100	91	100	100	96	90	72	99
Tohono O-Odham Nation Reservation											
Utah Division of Air Quality	83	96	95	98	97	99	89	0	7	0	97
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico, Utah											
Vermont Department of Environmental Conservation	56		76	87	85	91	82	0	42	0	8
Virgin Islands											
Virginia Department of Environmental Quality	70	79	90	97	76	88	87	56	56	40	99

Reporting Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Washington State Department of Ecology	84	77	88	93	90	97	91	15	33	42	23
Washoe County Health District	1	86	3	17	11	3	78				
West Virginia Division of Air Quality	92	76	99			100	96	67	86	83	100
Wisconsin Department of Natural Resources	84	99	96	98	14	99	97	24	88	79	96
Wyoming Department of Environmental Quality	97	100	97	100	86	100	99	21	91	56	99
Yakama Nation Reservation	100		100	100	52	100	100				

Table 2-4: Nonpoint inventory percentange submitted by reporting agency to total emissions mass

Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Alabama Department of Environmental Management											
Alaska Department of Environmental Conservation	3		8	0	0	4	1				
Arizona Department of Environmental Quality	33	2	14	1	8	32	66	6	16	2	
Arkansas Department of Environmental Quality	18	1	17	3		6	0	8	0	2	
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	100	100	100	42	60	100	100	100	100	95	
California Air Resources Board	38	48	91	91	72	72	50	51	57	35	100
Chattanooga Air Pollution Control Bureau (CHCAPCB)	23	10	53	31	45	98	76	57	5	16	
City of Albuquerque	30	27	81	1	3	87	2	13	0	3	
Clark County Department of Air Quality and Environmental Management	4	5	32	65	52	92	0				
Coeur d'Alene Tribe	100	100	100	100	99	100	100	100	100	98	100
Colorado Department of Public Health and Environment	20		28	0	2		44				
Connecticut Department of Energy and Environmental Protection	6	2	34	3	6	8	69	19	4	3	
DC-District Department of the Environment	33	2	52	1	3	11	90	31	6	3	
Delaware Department of Natural Resources and Environmental Control	0		0	0	1		35		8		

Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Florida Department of Environmental Protection	52	51	22	14	38	43	69	27	59	1	
Georgia Department of Natural Resources	92	73	26	7	29	56	76	10	12	1	
Hawaii Department of Health Clean Air Branch	33	40	18	2	10	37	3		20		
Idaho Department of Environmental Quality	40	81	41	24	25	65	82	94	60	98	100
Illinois Environmental Protection Agency	94	100	100	36	54	99	98	82	63	57	100
Indiana Department of Environmental Management	2	0	8	0	1	11	10	34	12	10	
Iowa Department of Natural Resources	1	0	3	38	46	5	51	17	6	5	
Kansas Department of Health and Environment	1	0	3	0	0	64	20	24	2	6	
Kentucky Division for Air Quality											
Knox County Department of Air Quality Management	6	2	28	6	8	12	77	15	6	3	
Kootenai Tribe of Idaho	100	100	100	99	98	100	100	100	99	94	100
Louisiana Department of Environmental Quality	10	0	4	3	11	32	26	12	4	1	
Louisville Metro Air Pollution Control District	15	4	39	8	26	50	49	7	5	2	
Maine Department of Environmental Protection	4	26	33	1	3	19	60	31	5	5	100
Maricopa County Air Quality Department											
Maryland Department of the Environment	33	7	69	92	70	74	87	79	30	33	29
Massachusetts Department of Environmental Protection	12	53	61	68	38	91	43				
Memphis and Shelby County Health Department - Pollution Control	21	3	70	2	7	27	1	76	0	21	
Metro Public Health of Nashville/Davidson County	12		44	38		6	38	38	38	63	0
Michigan Department of Environmental Quality	76	12	58	4	22	82	94	74	35	32	50
Minnesota Pollution Control Agency	89	2	36	5	26	68	82	75	57	35	75

Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Mississippi Dept of Environmental Quality											
Missouri Department of Natural Resources	4	0	12	0	1	8	21	74	0	36	
Montana Department of Environmental Quality											
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	100		100	100	100	100	100	100	45	29	100
Nebraska Environmental Quality											
Nevada Division of Environmental Protection											
New Hampshire Department of Environmental Services	6	2	87	29	25	94	33				
New Jersey Department of Environment Protection	21	81	79	73	49	90	89				
New Mexico Environment Department Air Quality Bureau											
New York State Department of Environmental Conservation	16	2	67	24	49	94	65	50	88	69	94
Nez Perce Tribe	100	100	100	99	97	100	100	100	99	99	100
North Carolina Department of Environment and Natural Resources	33	0	31	6	20	49	1	6	2	1	100
North Dakota Department of Health											
Northern Cheyenne Tribe	100		100	100	99	100	100	100		93	
Ohio Environmental Protection Agency	9	0	28	1	4	33	77	42	14	13	75
Oklahoma Department of Environmental Quality	51	0	77	1	4	62	89	32	2	6	
Oregon Department of Environmental Quality	46	2	28	1	9	59	71	16	25	4	
Pennsylvania Department of Environmental Protection	11	1	49	5	12	12	63	3	7	0	
Puerto Rico	0		4	0	0	0	0	0		0	
Rhode Island Department of Environmental Management	6	4	35	3	6	19	2	8	0	1	
Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	100	100	100	14	25	100	100	100	24	96	100

Agency	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb	HAP VOC	HAP Metals	Acid Gases
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100	100	97	90	100	100	100	96	99	100
South Carolina Department of Health and Environmental Control	23	5	21	4	17	15	65	4	11	0	
South Dakota Department of Environment and Natural Resources											
Tennessee Department of Environmental Conservation	11	1	15	9	16	5	0	84	0	31	
Texas Commission on Environmental Quality	61	1	99	1	8	92	95	41	2	46	
United Keetoowah Band of Cherokee Indians in Oklahoma		100									
Utah Division of Air Quality	56	26	74	18	24	39	87				
Vermont Department of Environmental Conservation	88	10	58	10	48	95	51	28	67	8	
Virgin Islands											
Virginia Department of Environmental Quality	13	3	32	4	13	61	70	65	54	17	0
Washington State Department of Ecology	70	26	82	85	84	90	19	13	43	1	100
Washoe County Health District	43	2	83	85	53	66	76	94	3	84	100
West Virginia Division of Air Quality	69	0	82	3	10	83	78	9	58	2	0
Wisconsin Department of Natural Resources	9	0	25	2	9	21	54	23	4	5	
Wyoming Department of Environmental Quality	27		27	0	1	66	72		63		

2.4 What are the top sources of some key pollutants?

Table 2-5 provides a summary of CAP and total HAP emissions for all of the EIS sectors, including the biogenic emissions from vegetation and soil. Emissions in federal waters and from vegetation and soils have been split out and totals both with and without these emissions are included. Emissions in federal waters include offshore drilling platforms and commercial marine vessel emissions outside the typical 3-10 nautical mile boundary defining state waters. All emissions values are subject to change in 2014 v2 and are bounded by the caveats and methods described by this documentation.

Table 2-5: EIS sectors and associated 2014v1 CAP emissions and total HAP (1000 short tons/year)

Sector	CO	NH_3	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC	Black Carbon	Lead	Total HAPs[1]
Agriculture - Crops & Livestock Dust				1,162	5,842			0.23		0.01
Agriculture - Fertilizer Application		1,016								
Agriculture - Livestock Waste		2,157		9.73	35		34	0.31	2.63E-04	0.19

Sector	CO	NH_3	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC	Black Carbon	Lead	Total HAPs[1]
Bulk Gasoline Terminals	0.90	4.12E-04	0.44	0.03	0.04	8.01E-03	127	3.59E-04	2.01E-04	6.23
Commercial Cooking	56			125	134		21	4.26	4.79E-05	8.28
Dust - Construction Dust	0.07		0.08	142	1,379	0.02	0.04	5.36E-05	1.08E-03	0.09
Dust - Paved Road Dust				256	1,098			2.66		2.18E-03
Dust - Unpaved Road Dust				1,134	11,407			1.10		2.59E-03
Fires - Agricultural Field Burning	591	92	21	65	88	6.48	41	7.14	2.23E-04	32
Fires - Prescribed Fires	8,679	138	152	781	920	72	1,980	79		390
Fires - Wildfires	10,327	169	118	873	1,030	70	2,429	83		438
Fuel Comb - Comm/Institutional - Biomass	18	0.18	8.56	11	13	0.92	0.69	0.41	2.96E-04	0.22
Fuel Comb - Comm/Institutional - Coal	4.53	0.01	12	1.76	2.93	37	0.21	0.08	1.69E-03	1.42
Fuel Comb - Comm/Institutional - Natural Gas	121	1.48	161	6.09	6.31	1.42	11	2.34	1.91E-03	1.31
Fuel Comb - Comm/Institutional - Oil	13	0.52	54	4.83	5.16	26	3.16	0.64	8.59E-04	0.18
Fuel Comb - Comm/Institutional - Other	11	0.05	12	0.64	0.67	1.38	1.13	0.24	3.5E-04	0.19
Fuel Comb - Electric Generation - Biomass	22	0.74	12	1.73	2.04	2.63	1.04	0.06	1.42E-03	1.60
Fuel Comb - Electric Generation - Coal	576	8.80	1,506	146	197	3,148	22	6.01	0.04	68
Fuel Comb - Electric Generation - Natural Gas	82	13	144	24	24	5.57	9.28	9.11	8.99E-04	3.39
Fuel Comb - Electric Generation - Oil	9.66	0.79	72	6.99	8.21	63	1.72	1.52	1.49E-03	0.39
Fuel Comb - Electric Generation - Other	31	2.19	25	2.87	3.24	16	3.67	0.76	9.41E-04	1.79
Fuel Comb - Industrial Boilers, ICEs - Biomass	313	3.02	120	148	177	22	10	5.49	7.08E-03	4.67
Fuel Comb - Industrial Boilers, ICEs - Coal	54	0.84	163	30	80	452	1.18	1.27	0.01	13
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	321	9.08	611	23	24	15	61	8.87	2.98E-03	21
Fuel Comb - Industrial Boilers, ICEs - Oil	22	0.37	72	5.78	6.76	35	4.57	1.30	0.01	0.48
Fuel Comb - Industrial Boilers, ICEs - Other	111	0.92	58	13	14	48	8.39	2.99	2.69E-03	2.24
Fuel Comb - Residential - Natural Gas	95	47	220	3.60	3.85	1.45	13	0.24	1.14E-04	0.81
Fuel Comb - Residential - Oil	9.19	1.75	35	3.73	4.28	66	1.17	0.41	2.41E-03	0.09
Fuel Comb - Residential - Other	13	0.14	34	0.23	0.28	1.76	1.44	0.02	4.78E-06	0.06
Fuel Comb - Residential - Wood	2,166	16	32	334	335	8.12	353	19	8.32E-05	63
Gas Stations	0.04	1.87E-04	0.01	9.07E-04	9.08E-04	4.6E-04	426	4.E-05	2.03E-04	53
Industrial Processes - Cement Manuf	99	1.01	118	6.76	12	41	5.83	0.20	3.09E-03	2.54
Industrial Processes - Chemical Manuf	150	23	72	17	23	125	88	0.92	2.97E-03	28
Industrial Processes - Ferrous Metals	347	0.19	60	27	33	26	14	1.12	0.05	2.11
Industrial Processes - Mining	11	0.10	5.53	61	477	1.14	1.35	0.12	4.93E-03	0.84
Industrial Processes - NEC	185	16	175	81	135	142	194	2.72	0.05	55
Industrial Processes - Non-ferrous Metals	268	0.62	16	13	17	67	14	0.69	0.03	6.82
Industrial Processes - Oil & Gas Production	846	0.81	816	22	23	80	3,180	0.58	4.76E-03	122
Industrial Processes - Petroleum Refineries	48	2.39	69	16	19	57	50	1.17	2.31E-03	7.73
Industrial Processes - Pulp & Paper	100	5.30	74	32	41	29	125	0.92	4.01E-03	52
Industrial Processes - Storage and Transfer	9.22	5.43	5.78	19	49	3.37	202	0.26	3.04E-03	12
Miscellaneous Non-Industrial NEC	241	5.00	7.37	15	18	0.04	86	0.61	1.97E-04	18
Mobile - Aircraft	413		149	9.39	11	17	48	7.19	0.46	13
Mobile - Commercial Marine Vessels	64	0.15	391	11	12	47	11	5.02	1.02E-03	1.17
Mobile - Locomotives	127	0.39	844	25	27	7.58	44	19	2.26E-03	3.77
Mobile - Nonroad Equipment - Diesel	584	1.41	1,112	84	93	2.13	115	65	7.39E-05	53
Mobile - Nonroad Equipment - Gasoline	11,701	0.86	235	50	55	1.17	1,537	6.10		485
Mobile - Nonroad Equipment - Other	418	0.01	67	2.22	2.22	0.45	14	0.40		2.46
Mobile - Onroad Diesel Heavy Duty Vehicles	668	6.74	2,175	94	133	3.62	174	53	2.05E-04	37
Mobile - Onroad Diesel Light Duty Vehicles	239	0.77	112	4.44	6.77	0.28	26	2.68	4.89E-05	5.00
Mobile - Onroad non-Diesel Heavy Duty Vehicles	898	1.13	89	1.78	4.65	0.61	41	0.30	2.2E-05	12
Mobile - Onroad non-Diesel Light Duty Vehicles	20,030	96	2,289	59	166	24	1,811	11	1.53E-03	501
Solvent - Consumer & Commercial Solvent Use				0.01	0.01		1,541	5.33E-04		279
Solvent - Degreasing	5.35E-03	0.04	0.01	0.08	0.08	2.95E-05	165	5.37E-04	3.84E-04	20
Solvent - Dry Cleaning	1.27E-03		3.84E-04	7.87E-03	7.91E-03	4.E-05	6.13	1.09E-04		0.84
Solvent - Graphic Arts	0.12	0.08	0.13	0.13	0.14	0.02	356	1.E-03	2.61E-05	30
Solvent - Industrial Surface Coating & Solvent Use	5.56	0.44	2.81	3.73	4.20	0.17	548	0.11	2.52E-03	78

Sector	CO	NH_3	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC	Black Carbon	Lead	Total HAPs[1]
Solvent - Non-Industrial Surface Coating		0.02					324			45
Waste Disposal	2,155	22	114	252	305	37	191	28	0.01	32
Sub Total (no federal waters)	**63,252**	**3,869**	**12,643**	**6,223**	**24,506**	**4,812**	**16,478**	**446**	**0.73**	**3,017**
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	65		54	0.33	0.33	0.03	1.40	0.13		
Fuel Comb - Industrial Boilers, ICEs - Oil	4.06		28	0.47	0.48	3.13	0.46	0.37		
Fuel Comb - Industrial Boilers, ICEs - Other	9.95E-04		1.18E-03	2.53E-05	2.53E-05	7.11E-06	6.52E-05	9.7E-06		
Industrial Processes - Oil & Gas Production	1.65		1.92	0.03	0.03	0.03	52	2.88E-03		
Industrial Processes - Storage and Transfer							0.93			
Mobile - Commercial Marine Vessels	111	0.28	825	24	26	127	27	7.60	1.91E-03	1.21
Sub Total (federal waters)	**182**	**0.28**	**910**	**25**	**26**	**130**	**82**	**8.09**	**1.91E-03**	**1.21**
Sub Total (all but vegetation and soil)	**63,434**	**3,869**	**13,552**	**6,248**	**24,532**	**4,942**	**16,560**	**454**	**0.73**	**3,019**
Biogenics - Vegetation and Soil[2]	6,655	22	903				38,679			5,295
Total	**70,089**	**3,891**	**14,455**	**6,248**	**24,532**	**4,942**	**55,239**	**454**	**0.73**	**206,698**

[1] Total HAP does not include diesel PM, which is not a HAP listed by the Clean Air Act.

[2] Biogenic vegetation and soil emissions excludes emissions from Alaska, Hawaii, and territories.

2.5 How does this NEI compare to past inventories?

Many similarities between the 2014 NEI approaches and past NEI approaches exists, notably that the data are largely compiled from data submitted by S/L/T agencies for CAPs, and that the HAP emissions are augmented by the EPA to differing degrees depending on geographical jurisdiction because they are a voluntary contribution from the partner agencies. In 2014, S/L/T participation was somewhat more comprehensive than in 2011, though both were good. The NEI program continues with the 2014 NEI to work towards a complete compilation of the nation's CAPs and HAPs. The EPA provided feedback to S/L/T agencies during the compilation of the data on critical issues (such as potential outliers, missing SCCs, missing Hg data and coke oven data) as has been done in the past, collected responses from S/L/T agencies to these issues, and improved the inventory for the release based on S/L/T agency feedback. In addition to these similarities, there are some important differences in how the 2014 NEI has been created and the resulting emissions, which are described in the following two subsections.

2.5.1 Differences in approaches

With any new inventory cycle, changes to approaches are made to improve the process of creating the inventory and the methods for estimating emissions. The key changes for the 2014 cycle are highlighted here.

To improve the process, we learned from the prior two triennial inventories (for 2008 and 2011) compiled with the EIS. We made changes to pollutant and SCC codes, refined quality assurance checks and features that were used to assist in quality assurance, and created a Nonpoint Survey to assist with S/L/T and EPA data reconciliation for the nonpoint data. The nonpoint survey helped S/L/Ts and EPA avoid double counting and ensure a complete inventory between the different sources of data.

In addition to process changes, we improved emissions estimation methods for all data categories. For point sources, the primary changes were our use of HAP emission rates for EGUs, HAP augmentation improvements, and the use of an expected pollutant QA check. For EGUs, we chose to defer to S/L/T-provided HAP data rather than override their submissions using emission factors developed from the Mercury and Air Toxics Standards (MATS) test program as we had done in 2008 and 2011. Instead, we provided these the HAP emission factors to S/L/T agencies so their inventory staff could use them. HAP augmentation improvements are described in Section 3.1.6 and the expected pollutant QA is described in Section 3.1.1. More information on point source improvements is available in Section 3.

We also made method improvements for many stationary nonpoint sectors (see also in Section 4). The EPA creates and provides emissions tools to S/L/T agencies for their use, and we use these tools ourselves to fill in emissions values where not provided by S/L/T/ agencies. We updated methods for residential wood combustion to improve the geographic allocation of appliances, burn rates and controls. We updated the agricultural livestock ammonia method to reflect a new method devised by researchers to incorporate more process-based methods and new observational data. We updated the approach for agricultural tilling to use USDA Census of Agriculture data on harvested acres and tillage type rather than a national top-down approach. We refined emissions calculation approaches for the oil and gas exploration and production sectors to reflect new processes and made use of newly available data. For all nonpoint categories except for nonpoint mercury sectors, we updated the activity data to use the newest data available, at the time, to represent the 2014 inventory year.

One method change was made for road dust that was not an improvement, and will be updated for 2014 NEI v2. In 2014 NEI v1, we did not use a "precipitation" adjustment for road dust that was included in the 2011 NEI. We removed this adjustment because air quality modelers use gridded meteorology, soil moisture, snow cover and other parameters to remove (zero out) dust emissions on an hourly basis, and we did not want to have this effect applied twice in air quality modeling and in two different methods. The 2011 precipitation adjustment is essentially smoothed over the entire year and likely uses different (not gridded, temporally-resolved) data. However, the resulting emissions do not reflect the actual emissions associated from the road dust processes, and so we will update this for version 2 in the 2014 NEI.

For mobile sources, we updated mobile source activity data such as vehicle miles travelled (VMT) to reflect 2014, we used updated mobile source models, and we used new mobile model inputs provided by S/L/T agencies and other sources. Sections 5 and 6 provide more detail on these improvements.

We also made several improvements to approaches for fire sources, as further described in Section 7. For agricultural fires, we used an improved satellite-based approach and added a distinction between grass and pasture burning processes. For wildfires and prescribed fires, we used 2014-specific satellite data and collected 2014-specific ground based observational data from many state forestry agencies. For these fires, we also estimated the flaming and smoldering components of emissions separately and retained this delineation in the final inventory. Finally, we revised several HAP emission factors based on the peer reviewed literature.

2.5.2 Differences in emissions between 2014 and 2011 NEI

This section presents a comparison from the 2011 NEI (v2) to the 2014 NEI (v1). Table 2-6 and Table 2-7 compare emissions for the CAPs and for select HAPs using seven highly aggregated emission sectors. Emissions from the biogenic (natural) sources are excluded, and the wildfire sector is shown separately for CAPs and HAPs. While Pb is a CAP for the purposes of the NAAQS, due to toxic attributes and inclusion in the previous national air toxics assessment (NATA 2005), it is reviewed here with the HAPs. The HAPs selected for comparison are based on their national scope of interest as defined by NATA 2005.

With a couple notable exceptions, CAP emissions are lower overall in 2014 than in 2011. Some specific sector/pollutants increased in 2014 from 2011. The increases in industrial processes NO_X, and VOC are off-set by more substantial cumulative decreases in fuel combustion and mobile sources, resulting in an overall emissions decrease for these pollutants. Mobile source sector emissions are lower in 2014 than 2011, continuing a trend found between 2008 and 2011. Wildfire CAP emissions are lower in 2014 than in 2011, which is consistent with the general observation that 2014 was a generally quiet year for such fires. CAP emission increases in 2014 occur for the following sectors:

- Fuel Combustion – natural gas from residential and industrial boilers and internal combustion engines (NH_3)

- Industrial Processes – oil and gas production (VOC, NO_X).
- Miscellaneous – unpaved road dust, agricultural crops and livestock dust, waste disposal ($PM_{2.5}$, PM_{10}); agricultural field burning (NH_3). The large increase in miscellaneous PM emissions is driven by the temporary elimination of the precipitation adjustment for road dust and other changes for agricultural tilling.

Table 2-6: Emission differences (tons) for CAPs, 2014 minus 2011

Broad Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Fuel Combustion	-467,270	5,378	-417,008	-49,566	-56,797	-1,492,419	-97,251
Industrial Processes	-15,711	-13,165	99,190	-36,693	-29,275	-94,967	407,668
Miscellaneous	-490,283	-301,092	-3,081	4,250,395	528,974	-1,996	-546,965
Highway Vehicles	-5,520,350	-19,379	-1,205,139	-60,994	-38,236	-836	-589,607
Nonroad Mobile	-1,641,376	-459	-283,053	-23,667	-28,798	-51,372	-387,819
Total Difference, excluding wildfires	**-8,134,991**	**-328,717**	**-1,809,091**	**4,079,476**	**375,869**	**-1,641,591**	**-1,213,974**
Total % Difference, excluding wildfires	-13%	-8%	-13%	21%	8%	-26%	-8%
Wildfires	-2,374,714	-34,283	-67,225	-296,005	-252,286	-25,403	-462,710

For the select HAPs reviewed, Table 2-7 indicates a mixture of overall increases and decreases between 2011 and 2014, with the largest increases in some VOC HAPs for miscellaneous and nonroad sources. Some of the largest decreases are for highway vehicle VOC HAPs and fuel combustion. VOC HAPs increases for nonroad mobile sources mostly result from using a new model (MOVES2014 rather than NONROAD) and newer emission factors for nonroad equipment in 2014 and resulting different emissions factors in MOVES2014. Unlike CAPs, updated HAP emission factors from wildfires result in HAP emissions that are higher in 2014 than in 2011, with the most substantial increase for acetaldehyde. HAP emission increases in sectors, include the following:

- Fuel Combustion – biomass, coal and oil combustion (1,4-dichlorobenzene, ethyl benzene, Pb).
- Industrial Processes –oil and gas production (1,3-butadiene, acetaldehyde, acrolein, ethyl benzene, formaldehyde)
- Miscellaneous - agricultural field burning (acrolein); commercial cooking (acetaldehyde, formaldehyde), prescribed fires (acetaldehyde, acrolein, formaldehyde); construction and road dust (chromium, Pb), crops and livestock dust (chromium), consumer and commercial solvents (1,4-dichlorobenzene, formaldehyde), non-industrial surface coating (acetaldehyde), residential charcoal grilling (acetaldehyde, formaldehyde)
- Highway Vehicles – light duty gasoline vehicles (chromium, Pb)
- Nonroad Mobile – aircraft (1,3-butadiene, acetaldehyde, acrolein, formaldehyde), diesel equipment (acetaldehyde, acrolein, ethyl benzene, formaldehyde), gasoline equipment (1,3-butadiene, acetaldehyde, ethyl benzene, formaldehyde), other equipment (acetaldehyde, formaldehyde)

Table 2-7: Emission differences (tons) for select HAPs, 2014 minus 2011

Broad Sector	1,3-Butadiene	1,4-Dichlorobenzene	Acetaldehyde	Acrolein	Arsenic Compounds	Chromium Compounds	Ethyl Benzene	Formaldehyde	Lead	Tetrachloroethylene
Fuel Combustion	-373	9	-1,373	-230	-9	-111	4	-2,506	11	-4
Industrial Processes	374	-2	1,273	432	-5	-64	656	9,113	-68	-14
Miscellaneous	-2,595	157	37,225	5,426	-1	47	-3,069	712	3	-4,528
Highway Vehicles	-2,621		-5,163	-618	0	19	-11,253	-7,663	2	
Nonroad Mobile	1,497		4,515	2,260	-7	-4	7,657	16,849	-30	
Total Difference, excluding wildfires	-3,718	164	36,477	7,270	-22	-112	-6,006	16,505	-83	-4,546
Total % Difference, excluding wildfires	-9%	9%	38%	25%	-19%	-25%	-7%	6%	-10%	-37%
Wildfires	-10,575		48,591	195				32		

2.6 How well are tribal data and regions represented in the 2014 NEI?

Twelve tribes submitted data to the EIS for 2014 as shown in Table 2-8. In this table, a “CAP, HAP” designation indicates that both criteria and hazardous air pollutants were submitted by the tribe. CAP indicates that only criteria pollutants were submitted. Facilities on tribal land were augmented using TRI, HAPs and PM in the same manner as facilities under the state and local jurisdictions, as explained in Section 3.1; therefore, Tribal Nations in Table 2-8 with just a CAP flag will also have some HAP emissions in most cases.

Seven additional tribal agencies, shown in Table 2-9, which did not submit any data, are represented in the point data category of the 2014 NEI due to the emissions added by the EPA. The emissions for these facilities are from the EPA gap fill datasets for airports, EGUs, TRI data, and data carried forward from the 2011 NEI that were not provided in the 2014 submittal. Furthermore, many nonpoint datasets included in the NEI are presumed to include tribal activity. Most notably, the oil & gas nonpoint emissions have been confirmed to include activity on tribal lands because the underlying database contained data reported by tribes. See Section 4.16 for more information.

Table 2-8: Tribal participation in the 2014 NEI

Tribal Agency	Point	Nonpoint	Onroad*	Nonroad*
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	CAP, HAP	CAP,HAP		
Coeur d’Alene Tribe	CAP, HAP	CAP, HAP	CAP, HAP	CAP, HAP
Confederated Tribes of the Colville Reservation, Washington	CAP			
Kootenai Tribe of Idaho		CAP, HAP	CAP, HAP	CAP, HAP
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	CAP, HAP	CAP, HAP	CAP	
Nez Perce Tribe	CAP, HAP	CAP, HAP	CAP, HAP	CAP, HAP
Northern Cheyenne Tribe		CAP, HAP	CAP	CAP

Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation		CAP, HAP		
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	CAP, HAP	CAP, HAP	CAP, HAP	CAP, HAP
Southern Ute Indian Tribe	CAP, HAP			
United Keetoowah Band of Cherokee Indians in Oklahoma		CAP		
Yakama Nation Reservation	CAP			

*Onroad and nonroad tribal emissions are not part of the 2014 NEI sector/tier data. They are available from Tribal Lands Emissions Summaries posted with the 2014 NEI Data or from summaries of the Tribal datasets in the EIS.

Table 2-9: Facilities on Tribal lands with 2014 NEI emissions from EPA only

Tribal Agency	EPA data used
Fond du Lac Band of Lake Superior Chippewa	Airport Emissions
Gila River Indian Community	TRI data
Navajo Nation	EGU Emissions, 2011 NEI Carry-forward
Northern Cheyenne Tribe	Airport Emissions
Omaha Tribe of Nebraska	Airport Emissions
Tohono O-Odham Nation Reservation	TRI data
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico & Utah	Airports, EGU Emissions

2.7 What does the 2014 NEI tell us about mercury?

This documentation includes this Hg section because of the importance of this pollutant and because the sectors used to categorize Hg are different than the sectors presented for the other pollutants. The Hg sectors primarily focus on regulatory categories and categories of interest to the international community; emissions are summarized by these categories at the end of this section, in Table 2-12.

Mercury emission estimates in the 2014 NEI sum to 55 tons, with 54 tons from stationary sources (not including commercial marine vessels and locomotives) and 1 ton from mobile sources (including commercial marine vessels and locomotives). Of the stationary source emissions, the inventory shows that 22.9 tons come from coal, petroleum coke or oil-fired EGUs with units larger than 25 megawatts (MW), with coal-fired units making up the vast majority (i.e., petroleum coke and oil-fired boilers account for less than 0.1 ton) of that total.

For the 2014 NEI, the EPA carried forward the EPA estimates of the nonpoint non-combustion-related categories from 2011 v2 emissions "as-is." These are reflected in the "EPA Other" dataset seen in Figure 2-13 and Table 2-7 and include:

- switches and relays – emissions from the shredding and crushing of cars containing Hg components at auto crushing yards, SCC = 2650000002: Waste Disposal, Treatment, and Recovery; Scrap and Waste Materials; Scrap and Waste Materials; Shredding (2.1 tons)
- landfill "working face" emissions associated with the release of mercury via churning/crushing of new material added to the landfill, SCC= 2620030001: Waste Disposal, Treatment, and Recovery; Landfills; Municipal; Dumping/Crushing/Spreading of New Materials (working face) (0.4 tons)

- thermometers and thermostats – the portion that emit mercury prior to disposal at landfills or incinerators, SCC=2650000000: Waste Disposal, Treatment, and Recovery; Scrap and Waste Materials; Scrap and Waste Materials; Total: All Processes (0.1 tons)
- dental amalgam – emissions at dentist offices and from evaporation in teeth (0.4 tons)
- human cremation – emissions primarily due to mercury in dental amalgam (1.2 tons)

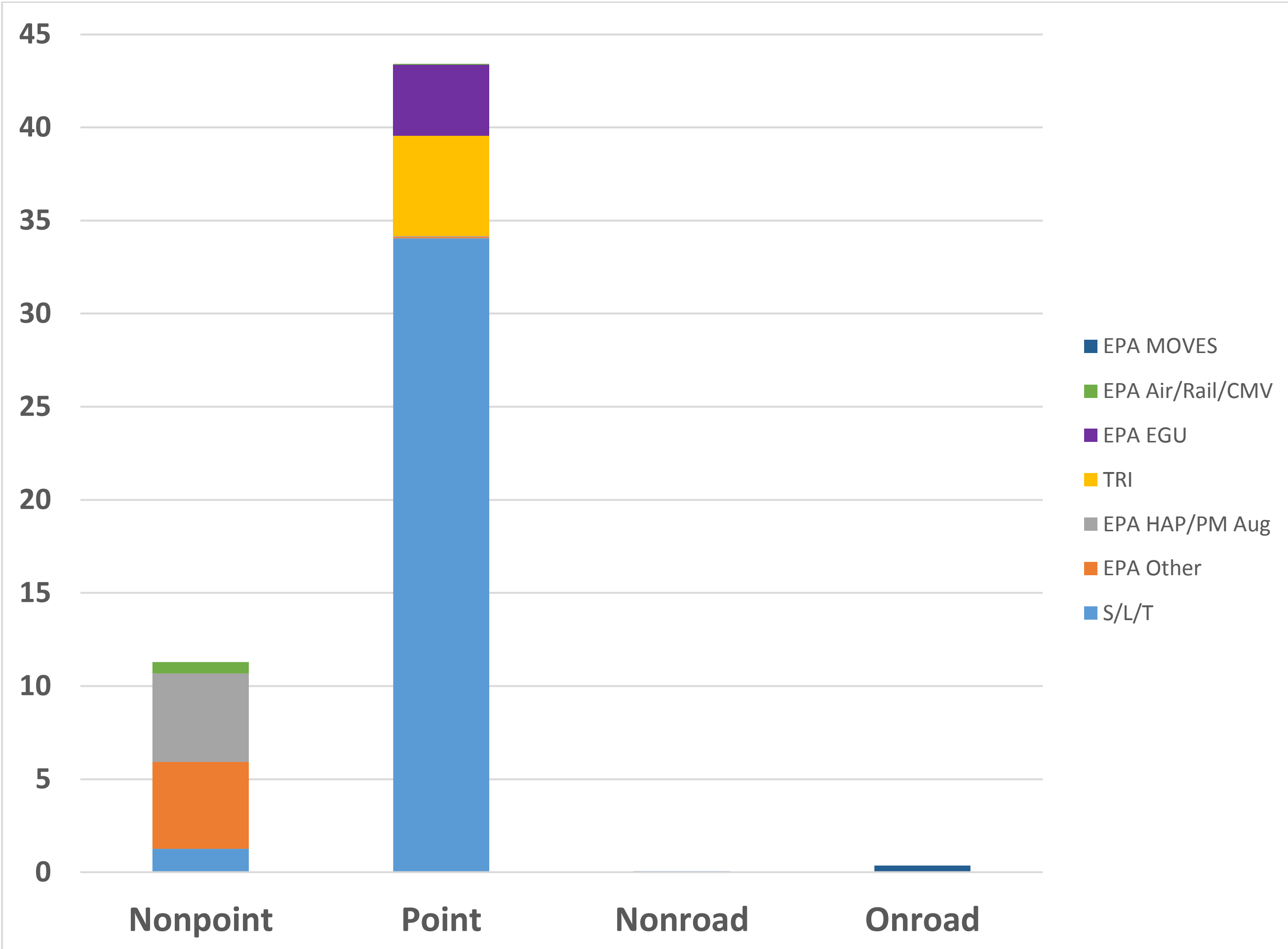
For the 2014 v2 NEI, the EPA is updating estimates for the above categories and carrying forward the 2011 NEI (v2) estimate for general laboratory activities (600 lbs) which was inadvertently left out of the 2014 NEI (v1). The data sources used to create the 2014 v1 Hg inventory are shown in Figure 2-5. The datasets are described in more detail starting in Sections 3 and 4, and we highlight some key datasets here.

For EGUs, we gap-filled where S/L/Ts did not provide emissions using unit specific and "bin"-average emission factors collected from a test program conducted primarily in 2010 to support the MATS rule[4], and used 2014-specific activity from the Clean Air Markets Division Data. The MATS-based Hg data are labeled "EPA EGU" in the figure; all of the mercury emissions from the EPA EGU dataset use MATS-based data.

We gap-filled Hg not reported by S/L/Ts in the same way as other HAPs – including use of the TRI (see Section 3.1.4), EPA HAP Augmentation or "HAP Aug" in the figure (see Section 2.2.3), and other EPA data developed for gap filling (see Section 2.2.5). However, we did find situations where we potentially missed Hg, and we will be reviewing particular categories such as boilers, electric arc furnaces and municipal waste combustors and making revisions where appropriate in the 2014 v2 NEI.

[4] See "Memorandum: Emissions Overview: Hazardous Air Pollutants in Support of the Final Mercury and Air Toxics Standard," EPA-454/R-11-014, 12/1/2011, available at https://www3.epa.gov/ttn/atw/utility/emis_overview_memo_matsfinal.pdf, or at Docket number EPA-HQ-OAR-2009-0234.

Figure 2-5: Data sources of Hg emissions (tons) in the 2014v1, by data category



In addition to Figure 2-5, Table 2-10 lists the specific emissions from each individual dataset used in the selection. More information on these datasets is available in Section 3.1.2 for point, Section 4.1.1 for nonpoint, Section 5 for nonroad mobile, and Section 6 for onroad mobile sources.

Since mercury is a HAP, it is reported voluntarily by S/L/T agencies. For the 2014 NEI, 42 states reported point source Hg emissions; Table 2-11 identifies the states that included state or local data. No tribal agencies reported point source Hg. Sixteen states and two local agencies reported Hg to the nonpoint data category: CA, ID, IL, LA, MD, ME, MI MN, NY, OH, OR, TX, VA, VT, WA, WV, Memphis and Shelby County Health Department and Washoe County Health District. Six tribal agencies reported Hg to the nonpoint data category: Coeur d'Alene Tribe of the Coeur d'Alene Reservation, Idaho; Eastern Band of Cherokee Indians; Kootenai Tribe of Idaho; Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho; Nez Perce Tribe of Idaho, and Sac & Fox Nation of Missouri in Kansas and Nebraska.

In contrast to the 2011 NEI, most of the point Hg in 2014 is from S/L/Ts and not the EPA EGU dataset. This is because we changed the selection hierarchy to use the S/L/T data ahead of the MATS EFs from the EPA's EGU dataset. Instead, the EPA provided the MATS EFs to S/L/Ts, so that they could use them if they chose.

Table 2-10: 2014 NEI Hg emissions for each dataset type and group

Data Category	Dataset short name	Hg Emissions (tons/yr)
Nonpoint	EPA HAP/PM Aug	4.75
	EPA Other	4.66
	S/L/T	1.26
	EPA Air/Rail/CMV	0.63
Point	S/L/T	34.04
	TRI	5.37
	EPA EGU	3.82
	EPA Other	0.08
	EPA HAP/PM Aug	0.06
	EPA Air/Rail/CMV	0.05
Nonroad	S/L/T	0.04
	EPA MOVES	0.02
Onroad	EPA MOVES	0.33
	S/L/T	0.04
TOTAL		**55.14**

Table 2-11: Point inventory percentage submitted by reporting agency to total Hg emissions mass

Agency	Agency Type	Hg
Alabama Department of Environmental Management	State	71
Alaska Department of Environmental Conservation	State	
Arizona Department of Environmental Quality	State	94
Arkansas Department of Environmental Quality	State	81
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	
California Air Resources Board	State	41
Chattanooga Air Pollution Control Bureau (CHCAPCB)	Local	
City of Albuquerque	Local	
Clark County Department of Air Quality and Environmental Management	Local	
Coeur d'Alene Tribe	Tribe	
Colorado Department of Public Health and Environment	State	39
Confederated Tribes of the Colville Reservation, Washington	Tribe	
Connecticut Department of Energy and Environmental Protection	State	99
DC-District Department of the Environment	Local	
Delaware Department of Natural Resources and Environmental Control	State	100
Florida Department of Environmental Protection	State	70
Fond du Lac Band of Lake Superior Chippewa	Tribe	
Georgia Department of Natural Resources	State	
Gila River Indian Community	Tribe	
Hawaii Department of Health Clean Air Branch	State	38

Agency	Agency Type	Hg
Idaho Department of Environmental Quality	State	0
Illinois Environmental Protection Agency	State	100
Indiana Department of Environmental Management	State	95
Iowa Department of Natural Resources	State	97
Kansas Department of Health and Environment	State	100
Kentucky Division for Air Quality	State	65
Knox County Department of Air Quality Management	Local	69
Louisiana Department of Environmental Quality	State	22
Louisville Metro Air Pollution Control District	Local	100
Maine Department of Environmental Protection	State	100
Maricopa County Air Quality Department	Local	
Maryland Department of the Environment	State	
Massachusetts Department of Environmental Protection	State	
Memphis and Shelby County Health Department - Pollution Control	Local	45
Metro Public Health of Nashville/Davidson County	Local	
Michigan Department of Environmental Quality	State	97
Minnesota Pollution Control Agency	State	100
Mississippi Dept of Environmental Quality	State	85
Missouri Department of Natural Resources	State	98
Montana Department of Environmental Quality	State	3
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	
Navajo Nation	Tribe	
Nebraska Environmental Quality	State	5
Nevada Division of Environmental Protection	State	43
New Hampshire Department of Environmental Services	State	97
New Jersey Department of Environment Protection	State	90
New Mexico Environment Department Air Quality Bureau	State	
New York State Department of Environmental Conservation	State	100
Nez Perce Tribe	Tribe	
North Carolina Department of Environment and Natural Resources	State	84
North Dakota Department of Health	State	78
Northern Cheyenne Tribe	Tribe	
Ohio Environmental Protection Agency	State	90
Oklahoma Department of Environmental Quality	State	95
Omaha Tribe of Nebraska	Tribe	
Oregon Department of Environmental Quality	State	
Pennsylvania Department of Environmental Protection	State	96
Puerto Rico	State	
Rhode Island Department of Environmental Management	State	100
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	
South Carolina Department of Health and Environmental Control	State	100

Agency	Agency Type	Hg
South Dakota Department of Environment and Natural Resources	State	
Southern Ute Indian Tribe	Tribe	
Tennessee Department of Environmental Conservation	State	68
Texas Commission on Environmental Quality	State	99
Tohono O-Odham Nation Reservation	Tribe	
Utah Division of Air Quality	State	
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico, Utah	Tribe	
Vermont Department of Environmental Conservation	State	54
Virgin Islands	State	
Virginia Department of Environmental Quality	State	45
Washington State Department of Ecology	State	39
Washoe County Health District	Local	
West Virginia Division of Air Quality	State	99
Wisconsin Department of Natural Resources	State	98
Wyoming Department of Environmental Quality	State	65
Yakama Nation Reservation	Tribe	

Table 2-12 shows the 2014 NEI mercury emissions for the key categories of interest in comparison to 1990. Also shown are the previous 2 triennial NEI years along with the most recent 2005 emissions, which were used in support of the MATS rule. The Microsoft ® 2013 Access ® database included in the zip file, 2014nei_supdata_mercury.zip, provides the category assignments at the facility-process level for point sources, and the county-SCC level for nonpoint, onroad and nonroad data categories. Individual point source processes were matched to categories based on the process-level or unit-level category assignments used in the 2011 NEI v2. In some cases, manual assignments had to be made where data were not reported by the S/L/Ts and were gap-filled using the TRI. SCC and facility category codes were also used.

Table 2-12: Trends in NEI mercury emissions – 1990, 2005, 2008 v3, 2011 v2 and 2014 NEI

Source Category	1990 (tpy) Baseline for HAPs, 11/14/2005	2005(tpy) MATS proposal 3/15/2011	2008 (tpy) 2008 v3	2011 (tpy) 2011 v2	2014 (tpy) 2014 v1	Categorization Notes and known issues
Utility Coal Boilers (Electricity Generation Units – EGUs, combusting coal)	58.8	52.2	29.4	26.8	22.9	This category includes only units > 25 MW. (smaller units are included in boiler and process heater category) Includes coal units (and excludes Hg estimated for startup gas/oil) and 1 integrated gasified coal combustion unit.
Hospital/Medical/ Infectious Waste Incineration	51	0.2	0.1	0.1	0.02	Known issues: missing 2 facilities (UT and ND); these would bring the total to 0.03 tons.
Municipal Waste Combustors	57.2	2.3	1.3	1.0	0.8	Some units appear to be missing (likely less than 300 pounds) and one unit may be overestimated possibly be several hundred pounds.

Source Category	1990 (tpy) Baseline for HAPs, 11/14/2005	2005(tpy) MATS proposal 3/15/2011	2008 (tpy) 2008 v3	2011 (tpy) 2011 v2	2014 (tpy) 2014 v1	Categorization Notes and known issues
Industrial, Commercial/Institutional Boilers and Process Heaters	14.4	6.4	4.2	3.6	3.1	includes electricity generating units where less than 25 MW.
Mercury Cell Chlor-Alkali Plants	10	3.1	1.3	0.5	0.1	
Electric Arc Furnaces	7.5	7.0	4.8	5.4	4.5	Appear to be missing as much as 0.6 tons of hg as previous years included gap filling missing hg emissions and the v1 did not do any gap filling.
Commercial/Industrial Sold Waste Incineration	Not available	1.1	0.02	0.01	0.01	
Hazardous Waste Incineration	6.6	3.2	1.3	0.7	0.8	
Portland Cement Non-Hazardous Waste	5.0	7.5	4.2	2.9	3.2	
Gold Mining	4.4	2.5	1.7	0.8	0.3	
Sewage Sludge Incineration	2	0.3	0.3	0.3	0.3	
Mobile Sources	Not available	1.2	1.8	1.3	1.2	Sum of all of onroad, nonroad, locomotives and commercial marine vessels (locomotives and marine used SCC code)
Other Categories	29.5	18	10.7	13	17.9	Expected to be 3-5 tons overestimated due to augmentation of mercury to nonpoint distillate oil internal combustion emissions augmented by EPA. In particular emission from SCCs 2102004002, 2103004002 and possibly 2310000220 and 2310000660
Total (all categories)	**246**	**105**	**61**	**56**	**55**	

The top emitting 2014 Mercury categories are: EGUs (rank 1); electric arc furnaces (rank 2); Portland cement (excluding hazardous waste kilns) (rank 3); and industrial, commercial and institutional boilers and process heaters (rank 4).

As shown in Table 2-12, 2014 Hg emissions are one ton lower than in the 2011. However, due to the expected overestimate in the “other categories,” it is likely to be four to six tons lower. Almost four tons of this difference is due to lower Hg emissions from EGUs covered by MATS; three other categories with large decreases are industrial, commercial/institutional boilers and process heaters, gold mining and chlor-alkali plants. For EGUs, the decrease is a combination of fuel switching to natural gas, the installation of Hg controls to comply with state rules and voluntary reductions, early compliance with MATS, and the co-benefits of Hg reductions from control devices installed for the reduction of SO_2 and PM as a result of state and federal actions, such as New

Source Review enforcement actions. The lower Hg is consistent with a 28 percent decrease in SO_2 from point sources. For industrial and commercial/institutional boilers, there appears to be fewer boilers using coal, but also there were some categorization issues (EGU boilers larger than 25MW characterized as boilers instead of utility coal boilers). For gold mining, there has been continued decreases shown by the Nevada test program, and also categorization changes that removed fugitive emissions at gold mines from this category. In the Hg chlor alkali industries, facilities have been switching technologies to eliminate Hg emissions from chlorine production. Many switched prior to 2008, and in 2014, there were two facilities still using the Hg chlor alkali process.

2.8 References for 2014 inventory contents overview

1. Strait, R.; MacKenzie, D.; and Huntley, R., 2003. PM Augmentation Procedures for the 1999 Point and Area Source NEI, 12th International Emission Inventory Conference – "Emission Inventories – Applying New Technologies", San Diego, April 29 – May 1, 2003. Available at: https://www3.epa.gov/ttn/chief/conference/ei12/point/strait.pdf.

3 Point sources

This section provides a description of sources that are in the point data category. Point sources are included in the inventory as individual facilities, usually at specific latitude/longitude coordinates, rather than as county or tribal aggregates. These facilities include large energy and industrial sites, such as electric generating utilities (EGUs), mines and quarries, cement plants, refineries, large gas compressor stations, and facilities that manufacture pulp and paper, automobiles, machinery, chemicals, fertilizers, pharmaceuticals, glass, food products, and other products. Additionally, smaller points sources are included voluntarily by S/L/T agencies, and can include small facilities such as crematoria, dry cleaners, and even gas stations. These smaller sources may appear in one state but not another due to the voluntary nature of providing smaller sources. There are also some portable sources in the point source data category, such as hot mix asphalt facilities, which relocate frequently as a road construction project progresses. The point source data category also includes emissions from the landing and take-off portions of aircraft operations, the ground support equipment at airports, and locomotive emissions within railyards. Within a point source facility, emissions are estimated and reported for individual emission units and processes. Those emissions are associated with any number of stack and fugitive release points that each have parameters needed for atmospheric modeling exercises. Stationary sources that are inventoried at county-resolution are discussed in the Nonpoint Section 4.

1.1 Point source approaches

The general approach to building the National Emissions Inventory (NEI) point source inventory is to use state/local/tribal (S/L/T)-submitted emissions, locations, and release point parameters wherever possible. Missing emissions values are gap-filled with EPA data where available. Quality assurance reviews of the emission values, locations, and release point modeling parameters are done by the EPA on the most significant emission sources and where data does not pass quality assurance checks.

3.1.1 QA review of S/L/T data

State/local/tribal agency submittals for the 2014 NEI v1 point sources were accepted through January 15, 2016. We then compared facility-level pollutant sums appearing in either the 2014 NEI S/L/T-submitted values or the 2011 NEI v2. The comparison included all facilities and pollutants, including any missing from the 2014 submittals (i.e., present in 2011 but not 2014) as well as any that were new in the 2014 submittals and all that were common to both years. We included additional columns to the comparison table to show the 2014 emission values from the 2014 Toxics Release Inventory (TRI) and the 2014 Clean Air Markets Division (CAMD) sulfur dioxide (SO_2) and nitrogen oxide (NOx) continuous emissions monitoring (CEM) data. We added columns that showed the percent differences between the 2014 S/L/T agency-submitted facility totals and each of these three comparison datasets. To create a more focused review and comparison table, we limited these results to include only cases where the 2014 S/L/T agency-submitted facility total was more than 50 percent different from the 2011 facility total and with an absolute mass value of the difference greater than a pollutant-specific threshold amount[5]. When a facility-pollutant combination was new in 2014 or appeared only in the 2011 NEI v2, we included those values only when they exceeded the absolute mass values greater than the pollutant-specific thresholds because the percent differences were undefined. We provided[6] the resulting table of 4,428 records to S/L/T agencies for review.

[5] These thresholds are available on the 2014 documentation FTP site folder as file "2014_point_pollutant_thresholds_qa_flag1.xlsx"

[6] We emailed the Emission Inventory System data submitters the table and instructions on February 27, 2016.

State/local/tribal edits to address any emissions values were accepted in the Emissions Inventory System (EIS) until July 1, 2016. The S/L/T agencies did not change most of the highlighted values. Where the comparisons were exceptionally suspect, the EPA contacted the agencies by phone or by email if no edits had been made to obtain confirmation of the reported values. For a small number of cases, neither confirmation nor edits were obtained, and the value was tagged to be excluded from selection for the NEI. In some but not all of these instances, a value from TRI or the CAMD data sets was available as a replacement.

Similar to previous NEI years, we quality assured the latitude-longitude coordinates at both the site level and the release point level. In previous NEI cycles, we had reviewed, verified, and locked (in EIS) approximately 2,500 site-level coordinates of the most significant emitting facilities. For the 2014 NEI coordinate review, we compared all other site coordinate pairs to the county boundaries for the FIPS county codes reported for those facilities. We then identified all facilities that met the following criteria: (1) more than 50 tons total criteria pollutant emissions or more than 20 pounds total hazardous air pollutants (HAPs) for 2014, (2) the coordinates caused the location of the facility to be more than a half mile outside of its indicated county. For these facilities, we reviewed the location using Google Earth, edited the location as needed in EIS, and locked the location in EIS.

In addition, we compared the release point coordinates of all release points with any 2014 emissions to their site level coordinates, whether protected or not. In cases that we found a difference of more than 0.005 degrees (approximately 0.25 miles) in total latitude plus longitude, we reviewed the release point coordinates in Google Earth and edited as needed in EIS, and the *site-level* coordinates were then locked in EIS. This check was able to find two cases: (1) where the independently-reported release point coordinates may indicate either a suspect site-level coordinate, even if plotting within the correct county, or (2) an inaccurate release point coordinate. We also made a third quality assurance check to ensure that the coordinates for any release point that had emissions greater than 10 pounds for any key high-risk HAP that was within 0.005 degrees of a verified site coordinate. This check resulted in additional site coordinate reviews and protections. Finally, the site coordinates as found in the EPA's Facility Registry System were compared to those in EIS. Any facilities where these coordinates differed by more than 0.01 degrees and with greater than 50 tons criteria emissions or 500 pounds HAP emissions were reviewed, edited, and protected as needed.

We also attempted to find important cases of emissions being incorrectly reported as emitting at ground level through a fugitive release rather than through a stack. To do this, we reviewed emission processes with 2014 emissions data to identify instances where S/L/T agencies reported an apparent combustion sources over 50 tons of NOx as emitting through a fugitive release point. The largest such emission processes were individually reviewed to see if there was an existing stack release point with valid parameters in EIS that looked like it may have been the intended release point. Where such a possible match was found, the emissions process in the EIS facility inventory was adjusted to use that stack release point. Where no such stack release point existed within the facility, a new stack release point with a default height of 100 feet, diameter of 1 foot, velocity of 50 feet per second and a temperature of 300 degrees was created and used for the emission process. A total of 57 such new stacks were created under this step.

3.1.2 Sources of EPA data and selection hierarchy

Table 3-1 lists the datasets that we used to compile the 2014 NEI point inventory and the hierarchy used to choose which data value to use for the NEI when multiple data sets are available for the same emissions source (see Section 2.2 for more detail on the EIS selection process).

The EPA developed all datasets other than those containing S/L/T agency data and the dataset containing emissions from offshore oil and gas platforms in federal waters in the Gulf of Mexico. The primary purpose of the EPA datasets is to add or "gap fill" pollutants or sources not provided by S/L/T agencies, to resolve inconsistencies in S/L/T agency-reported pollutant submissions for particulate matter (PM) (Section 3.1.3) and to speciate S/L/T agency reported total chromium into hexavalent and trivalent forms (Section 3.1.4).

The hierarchy or "order" provided in the tables below defines which data are to be used for situations where multiple datasets provide emissions for the same pollutant and emissions process. The dataset with the lowest order on the list is preferentially used over other datasets. The table includes the rationale for why each dataset was assigned its position in the hierarchy. In addition to the order of the datasets, the selection also considers whether individual data values have been tagged (see Section 2.2.6). Any data that were tagged by the EPA in any of the datasets were not used. State/local/tribal agency data were tagged only if they were deemed to be likely outliers and were not addressed during the S/L/T agency data reviews. The 2014 v1 point source selection also excluded greenhouse gases, dioxins and furans, and radionuclides. The EPA has not evaluated the completeness or accuracy of the S/L/T agency dioxin and furan values nor radionuclides, and does not have plans to supplement these reported emissions with other data sources in order to compile a complete estimate for dioxin and furans nor radionuclides as part of the NEI. The EPA's official inventory of greenhouse gases (GHGs) is compiled separately from the NEI criteria and hazardous air pollutant inventory and is available at https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-1990-2014.

Table 3-1: Data sets and selection hierarchy used for point source data category

Dataset name	Description and Rationale for the Order of the Selected Datasets	Order
2014EPA_PM-Aug	PM species added to gap fill missing S/L/T agency data or make corrections where S/L/T agency have inconsistent emissions across PM components. Uses ratios of emission factors from the PM Augmentation Tool for covered source classification codes (SCCs). For SCCs without emission factors in the tool, checks/corrects discrepancies or missing PM species using basic relationships such as ensuring that primary PM is greater than or equal to filterable PM (see Section 3.1.3). This dataset is ahead of the S/L/T agency data in order to correct the S/L/T agency values that had inconsistencies across PM components.	1
Responsible Agency Selection	S/L/T agency submitted data. These data are selected ahead of lower hierarchy datasets except where individual values in the S/L/T agency emissions were suspected outliers that were not addressed during the draft review and therefore tagged by the EPA.	2
2014EPA_EGU	HAP and CAP emissions from 3 sources: 1. Emissions factors (EFs) for lead (Pb), mercury (Hg), other HAP metals, acid gas HAP and PM emissions from the Mercury and Air Toxics (MATS) rule testing program for electric generating utilities(EGUs) along with 2014 CAMD heat input data 2. Annual sum of CAMD hourly CEM data for SO_2 and NOx 3. EFs used in previous year inventories from AP-42 and other sources along with 2014 CAMD heat input data.	3
2014EPA_Cr_Aug	Hexavalent and trivalent chromium speciated from S/L/T agency reported chromium. EIS augmentation function creates the dataset by applying multiplication factors by SCC, facility, process or North American Industry Classification System (NAICS) code to S/L/T agency total chromium. See Section 3.1.4.	4
2014EPA_Oth_CarryFwd	2011 emissions values for 212 facilities and 12 pollutants not reported in 2014 S/L/T datasets but appear to still be operating and were above CAP reporting thresholds in 2011. Includes Coke Oven Emissions adds for 5 facilities.	5

Dataset name	Description and Rationale for the Order of the Selected Datasets	Order
2014EPA_TRI	TRI data for the year 2014 (see Section 3.1.5). These data are selected for a facility only when the S/L/T agency data do not include emissions for a given pollutant at any process for that facility.	6
2014EPA_Airports	CAP and HAP emissions for aircraft operations including commercial, general aviation, air taxis and military aircraft, auxiliary power units and ground support equipment computed by the EPA for approximately 20,000 airports. Methods include the use of the Federal Aviation Administration's (FAA's) Emissions and Dispersion Modeling System (EDMS) (see Section 3.2).	7
2014EPA_Rail	CAP and HAP emissions for diesel rail yard locomotives. CAP emissions computed using yard-specific EFs, yard-specific fleet information, and using national fuel values that have been allocated to rail yards using an approximation of line haul activity within the yard. HAP emissions computed using HAP-to-CAP emission ratios (see Section 3.3).	8
2011EPA_LF	Landfill emissions developed by EPA using methane data from the EPA's GHG reporting rule program. The dataset contains only those landfills for which no pollutants were reported to EIS by the S/L/T agency in the 2014 reporting year.	9
2014EPA_HAPAug	HAP data computed from S/L/T agency criteria pollutant data using HAP/CAP EF ratios based on the EPA Factor Information Retrieval System (WebFIRE) database as described in Section 3.1.6. These data are selected below the TRI data and 2014EPA_Oth_CarryFwd because the TRI data are expected to be better. These data are selected for a facility only when not included in the S/L/T agency data.	10
2014EPA_HAP-Aug_PMaug	This dataset was created in the same fashion as the 2014EPA_HAPAug dataset above and is a supplement to it. This dataset contains HAPs calculated by applying a ratio to PM10-FIL emissions, for those instances where the S/L/T dataset did not contain any PM10-FIL emissions, but the PM augmentation routine was able to calculate a PM10-FIL value from some PM species that was reported by the S/L/T.	11
2014EPA_BOEM	2011 CAP Emissions from Offshore oil platforms located in Federal Waters in the Gulf of Mexico developed by the U.S. Department of the Interior, Bureau of Ocean and Energy Management, Regulation, and Enforcement in the National Inventory Input Format and converted to the CERS format by the EPA. See http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/Air-Quality/GOADS-2011.aspx. The state code for data from this data set is "DM" (Federal Waters). For v1 of the 2014 NEI, we are using the 2011 BOEM data because the 2014 BOEM data was not available in time for v1.	12
2014EPA_PMspecies	Adds speciated PM2.5 data to resulting selection. This is a result of offline emissions speciation where the resulting PM25-PRI selection emissions are split into the 5 PM species: elemental (black) carbon (EC), organic carbon (OC), nitrate (NO3), sulfate (SO4), and the remainder of PM25-PRI (PMFINE). Also adds a copy of PM2.5-PRI and PM10-PRI from diesel engines, relabeled as DIESEL-PM pollutants.	13
2014_EPA_MOVES	This dataset was listed in the point source hierarchy in error. It does not contain any point source emissions values.	14

3.1.3 Particulate matter augmentation

Particulate matter emissions components[7] in the NEI are: primary PM10 (called PM10-PRI in the EIS and NEI) and primary PM2.5 (PM25-PRI), filterable PM10 (PM10-FIL) and filterable PM2.5 (PM25-FIL) and condensable PM (PM-CON, which is all within the PM2.5 portion on PM, i.e., PM25-PRI = PM25-FIL + PM-CON). The EPA needed to augment the S/L/T agency PM components to ensure completeness of the PM components in the final NEI and to ensure that S/L/T agency data did not contain inconsistencies. An example of an inconsistency is if the S/L/T agency submitted a primary PM2.5 value that was greater than a primary PM10 value for the same process. Commonly, the augmentation added condensable PM or PM filterable (PM10-FIL and/or PM25-FIL) where no value was provided, or primary PM2.5 where only primary PM10 was provided. Additional information on the procedure is provided in the 2008 NEI PM augmentation documentation [ref 1].

In general, emissions for PM species missing from S/L/T agency inventories were calculated by applying factors to the PM emissions data supplied by the S/L/T agencies. These conversion factors were first used in the 1999 NEI's "PM Calculator" as described in an NEI conference paper [ref 2]. The resulting methodology allows the EPA to derive missing PM10-FIL or PM25-FIL emissions from incomplete S/L/T agency submissions based on the SCC and PM controls that describe the emissions process. In cases where condensable emissions are not reported, conversion factors developed are applied to S/L/T agency reported PM species or species derived from the PM Calculator databases. The PM Calculator, has undergone several edits since 1999; now called the "PM Augmentation Tool," this Microsoft ® Access ® database is available at https://www.epa.gov/air-emissions-inventories/pm-augmentation.

3.1.4 Chromium speciation

An overview of chromium speciation, as it impacts both the point and nonpoint data category, is discussed in Section 2.2.2.

The EIS generates and stores an EPA dataset containing the resultant hexavalent and trivalent chromium species. The EPA then used this dataset in the 2014 NEI selection by adding it to the selection hierarchy shown in Table 3-1, excluding the S/L/T agency total chromium from the selection through a pollutant exception to the hierarchy. This EIS feature does not speciate chromium from any of the EPA datasets because the EPA data contains only speciated chromium.

For the 2014 NEI, the EPA named this dataset "2014EPA_Cr_Aug." Most of the speciation factors used in the 2014 NEI are SCC-based and are the same as were used for the 2008 and 2011 NEIs. The factors are based on data that have long been used by the EPA for the National Air Toxics Assessment and other risk projects.

3.1.5 Use of the 2014 Toxics Release Inventory

The EPA used air emissions data from the 2014 TRI to supplement point source HAP and ammonia emissions provided to the EPA by S/L/T agencies. The resulting augmentation dataset is labeled as "2014EPA_TRI" in the Table 3-1 selection hierarchy shown above. For 2014, all TRI emissions values that could reasonably be matched to an EIS facility were loaded into the EIS for viewing and comparison if desired, but only those pollutants that were not reported anywhere at the EIS facility by the S/L/T agency were considered for inclusion in the 2014 NEI.

[7] We use the term "components" here rather than "species" to avoid confusion with the PM2.5 "species" that are used for air quality modeling (e.g., organic carbon, elemental carbon, sulfate, nitrate, and other PM).

The basis of the 2014EPA_TRI dataset is the US EPA's 2011 TRI (www.epa.gov/tri). The TRI is an EPA database containing data on disposal or other releases including air emissions of over 650 toxic chemicals from approximately 21,000 facilities. One of TRI's primary purposes is to inform communities about toxic chemical releases to the environment. Data are submitted annually by U.S. facilities that meet TRI reporting criteria. The TRI database used for this project was named TRI_2014_US.csv and was downloaded on February 10, 2016, from https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-2015.

The approach used for the 2014 NEI was the same as that used for the 2011 NEI. The TRI emissions were included in the EIS (and the NEI) as facility-total stack and facility-total fugitive emissions processes, which matches the aggregation detail of the TRI database. Double-counting of TRI and other data sources was prevented by tagging (and not using) any TRI pollutant emissions for a facility where the S/L/T agency or a higher priority (as per Table 3-1) EPA dataset also had a pollutant emissions value for any unit and process within that facility.

The following steps describe in more detail the development of the 2014EPA_TRI dataset.

1. **Update the TRI_ID to EIS_ID facility-level crosswalk**
   For the 2014 NEI, the same crosswalk list of TRI IDs that was used for the 2011 NEI was used as a starting point. A review of the 2014 TRI facilities was conducted to identify new facilities with significant emissions that had not been previously matched to an EIS facility. A total of approximately 150 additional TRI facilities were added to the crosswalk for 2014.
2. **Map TRI pollutant codes to valid EIS pollutant codes and sum where necessary**
   Table 3-2 provides the pollutant mapping from TRI pollutants to EIS pollutants. Many of the 650 TRI pollutants do not have any EIS counterpart, and so are not shown in Table 3-2. In addition, several EIS pollutants may be reported to TRI as either of two TRI pollutants. For example, both Pb and Pb compounds may be reported to TRI, and similarly for several other metal and metal compound TRI pollutants. Table 3-2 shows where such pairs of TRI pollutants both correspond to the same EIS pollutant. In such cases, we summed the two TRI pollutants together as part of the step of assigning the TRI emissions to valid EIS pollutant codes. For the 2014 NEI, a total of 184 TRI pollutant codes were mapped to 172 unique EIS pollutant codes. Similar to the 2011 NEI, we did not use TRI emissions reported for TRI pollutants: "Certain Glycol Ethers," "Dioxin and Dioxin-like Compounds," Dichlorobenzene (mixed isomers)," and "Toluene di-isocyanate (mixed isomers)," because they do not represent the same scope as the EIS pollutants: "Glycol ethers," "Dioxins/Furans as 2,3,7,8-TCDD TEQs," "1,4-Dichlorobenzene," and "2,4-Di-isocyanate," respectively. We maintained TRI stack and fugitive emissions separately during the summation step and maintained that separation through the storage of the TRI emissions in the EIS.

Table 3-2: Mapping of TRI pollutant codes to EIS pollutant codes

TRI CAS	TRI Pollutant Name	EIS Pollutant Code	EIS Pollutant Name
79345	1,1,2,2-TETRACHLOROETHANE	79345	1,1,2,2-TETRACHLOROETHANE
79005	1,1,2-TRICHLOROETHANE	79005	1,1,2-TRICHLOROETHANE
57147	1,1-DIMETHYL HYDRAZINE	57147	1,1-DIMETHYL HYDRAZINE
120821	1,2,4-TRICHLOROBENZENE	120821	1,2,4-TRICHLOROBENZENE
96128	1,2-DIBROMO-3-CHLOROPROPANE	96128	1,2-DIBROMO-3-CHLOROPROPANE
57147	1,1-DIMETHYL HYDRAZINE	57147	1,1-Dimethyl Hydrazine
106887	1,2-BUTYLENE OXIDE	106887	1,2-EPOXYBUTANE
75558	PROPYLENEIMINE	75558	1,2-PROPYLENIMINE
106990	1,3-BUTADIENE	106990	1,3-BUTADIENE
542756	1,3-DICHLOROPROPYLENE	542756	1,3-DICHLOROPROPENE
1120714	PROPANE SULTONE	1120714	1,3-PROPANESULTONE

TRI CAS	TRI Pollutant Name	EIS Pollutant Code	EIS Pollutant Name
106467	1,4-DICHLOROBENZENE	106467	1,4-DICHLOROBENZENE
25321226	DICHLOROBENZENE (MIXED ISOMERS)		NA- pollutant not used
95954	2,4,5-TRICHLOROPHENOL	95954	2,4,5-TRICHLOROPHENOL
88062	2,4,6-TRICHLOROPHENOL	88062	2,4,6-TRICHLOROPHENOL
94757	2,4-DICHLOROPHENOXY ACETIC ACID	94757	2,4-DICHLOROPHENOXY ACETIC ACID
51285	2,4-DINITROPHENOL	51285	2,4-DINITROPHENOL
121142	2,4-DINITROTOLUENE	121142	2,4-DINITROTOLUENE
53963	2-ACETYLAMINOFLUORENE	53963	2-ACETYLAMINOFLUORENE
79469	2-NITROPROPANE	79469	2-NITROPROPANE
91941	3,3'-DICHLOROBENZIDINE	91941	3,3'-Dichlorobenzidine
119904	3,3'-DIMETHOXYBENZIDINE	119904	3,3'-Dimethoxybenzidine
119937	3,3’-DIMETHYLBENZIDINE	119937	3,3’-DIMETHYLBENZIDINE
101144	4,4’-METHYLENEBIS(2-CHLOROANILINE)	101144	4,4’-METHYLENEBIS(2-CHLORANILINE)
101779	4,4’-METHYLENEDIANILINE	101779	4,4’-METHYLENEDIANILINE
534521	4,6-DINITRO-O-CRESOL	534521	4,6-DINITRO-O-CRESOL
92671	4-AMINOBIPHENYL	92671	4-AMINOBIPHENYL
60117	4-DIMETHYLAMINOAZOBENZENE	60117	4-DIMETHYLAMINOAZOBENZENE
100027	4-NITROPHENOL	100027	4-NITROPHENOL
75070	ACETALDEHYDE	75070	ACETALDEHYDE
60355	ACETAMIDE	60355	ACETAMIDE
75058	ACETONITRILE	75058	ACETONITRILE
98862	ACETOPHENONE	98862	ACETOPHENONE
107028	ACROLEIN	107028	ACROLEIN
79061	ACRYLAMIDE	79061	ACRYLAMIDE
79107	ACRYLIC ACID	79107	ACRYLIC ACID
107131	ACRYLONITRILE	107131	ACRYLONITRILE
107051	ALLYL CHLORIDE	107051	ALLYL CHLORIDE
7664417	AMMONIA	NH3	Ammonia
62533	ANILINE	62533	ANILINE
7440360	ANTIMONY	7440360	ANTIMONY
N010	ANTIMONY COMPOUNDS	7440360	ANTIMONY
7440382	ARSENIC	7440382	ARSENIC
N020	ARSENIC COMPOUNDS	7440382	ARSENIC
1332214	ASBESTOS (FRIABLE)	1332214	ASBESTOS
71432	BENZENE	71432	BENZENE
92875	BENZIDINE	92875	BENZIDINE
98077	BENZOIC TRICHLORIDE	98077	BENZOTRICHLORIDE
100447	BENZYL CHLORIDE	100447	BENZYL CHLORIDE
7440417	BERYLLIUM	7440417	BERYLLIUM
N050	BERYLLIUM COMPOUNDS	7440417	BERYLLIUM
92524	BIPHENYL	92524	BIPHENYL
117817	DI(2-ETHYLHEXYL) PHTHALATE	117817	BIS(2-ETHYLHEXYL)PHTHALATE
542881	BIS(CHLOROMETHYL) ETHER	542881	Bis(Chloromethyl)Ether
75252	BROMOFORM	75252	BROMOFORM
7440439	CADMIUM	7440439	CADMIUM
N078	CADMIUM COMPOUNDS	7440439	CADMIUM
156627	CALCIUM CYANAMIDE	156627	CALCIUM CYANAMIDE
133062	CAPTAN	133062	CAPTAN
63252	CARBARYL	63252	CARBARYL
75150	CARBON DISULFIDE	75150	CARBON DISULFIDE
56235	CARBON TETRACHLORIDE	56235	CARBON TETRACHLORIDE
463581	CARBONYL SULFIDE	463581	CARBONYL SULFIDE
120809	CATECHOL	120809	CATECHOL
57749	CHLORDANE	57749	CHLORDANE
7782505	CHLORINE	7782505	CHLORINE
79118	CHLOROACETIC ACID	79118	CHLOROACETIC ACID
108907	CHLOROBENZENE	108907	CHLOROBENZENE
510156	CHLOROBENZILATE	510156	Chlorobenzilate
67663	CHLOROFORM	67663	CHLOROFORM
107302	CHLOROMETHYL METHYL ETHER	107302	CHLOROMETHYL METHYL ETHER
126998	CHLOROPRENE	126998	CHLOROPRENE
7440473	CHROMIUM	7440473	CHROMIUM

TRI CAS	TRI Pollutant Name	EIS Pollutant Code	EIS Pollutant Name
N090	CHROMIUM COMPOUNDS (EXCEPT CHROMITE ORE MINED IN THE TRANSVAAL REGION)	7440473	CHROMIUM
7440484	COBALT	7440484	COBALT
N096	COBALT COMPOUNDS	7440484	COBALT
1319773	CRESOL (MIXED ISOMERS)	1319773	CRESOL/CRESYLIC ACID (MIXED ISOMERS)
108394	M-CRESOL	108394	M-CRESOL
95487	O-CRESOL	95487	O-CRESOL
106445	P-CRESOL	106445	P-CRESOL
98828	CUMENE	98828	CUMENE
N106	CYANIDE COMPOUNDS	57125	CYANIDE
74908	HYDROGEN CYANIDE	57125	Cyanide
132649	DIBENZOFURAN	132649	DIBENZOFURAN
84742	DIBUTYL PHTHALATE	84742	DIBUTYL PHTHALATE
111444	BIS(2-CHLOROETHYL) ETHER	111444	DICHLOROETHYL ETHER
62737	DICHLORVOS	62737	DICHLORVOS
111422	DIETHANOLAMINE	111422	DIETHANOLAMINE
64675	DIETHYL SULFATE	64675	DIETHYL SULFATE
131113	DIMETHYL PHTHALATE	131113	DIMETHYL PHTHALATE
77781	DIMETHYL SULFATE	77781	DIMETHYL SULFATE
79447	DIMETHYLCARBAMYL CHLORIDE	79447	DIMETHYLCARBAMOYL CHLORIDE
N120	DIISOCYANATES		NA- pollutant not used
26471625	TOLUENE DIISOCYANATE (MIXED ISOMERS)		NA- pollutant not used
584849	TOLUENE-2,4-DIISOCYANATE	584849	2,4-Toluene Diisocyanate
N150	DIOXIN AND DIOXIN-LIKE COMPOUNDS		NA- pollutant not used
106898	EPICHLOROHYDRIN	106898	EPICHLOROHYDRIN
140885	ETHYL ACRYLATE	140885	ETHYL ACRYLATE
51796	URETHANE	51796	ETHYL CARBAMATE
75003	CHLOROETHANE	75003	ETHYL CHLORIDE
100414	ETHYLBENZENE	100414	ETHYL BENZENE
106934	1,2-DIBROMOETHANE	106934	ETHYLENE DIBROMIDE
107062	1,2-DICHLOROETHANE	107062	ETHYLENE DICHLORIDE
107211	ETHYLENE GLYCOL	107211	ETHYLENE GLYCOL
151564	ETHYLENEIMINE	151564	Ethyleneimine
75218	ETHYLENE OXIDE	75218	ETHYLENE OXIDE
96457	ETHYLENE THIOUREA	96457	ETHYLENE THIOUREA
75343	ETHYLIDENE DICHLORIDE	75343	ETHYLIDENE DICHLORIDE
50000	FORMALDEHYDE	50000	FORMALDEHYDE
N230	CERTAIN GLYCOL ETHERS	171	N/A Pollutant not used
76448	HEPTACHLOR	76448	HEPTACHLOR
118741	HEXACHLOROBENZENE	118741	HEXACHLOROBENZENE
87683	HEXACHLORO-1,3-BUTADIENE	87683	HEXACHLOROBUTADIENE
77474	HEXACHLOROCYCLOPENTADIENE	77474	HEXACHLOROCYCLOPENTADIENE
67721	HEXACHLOROETHANE	67721	HEXACHLOROETHANE
110543	N-HEXANE	110543	HEXANE
302012	HYDRAZINE	302012	HYDRAZINE
7647010	HYDROCHLORIC ACID (1995 AND AFTER “ACID AEROSOLS” ONLY)	7647010	HYDROCHLORIC ACID
7664393	HYDROGEN FLUORIDE	7664393	HYDROGEN FLUORIDE
123319	HYDROQUINONE	123319	HYDROQUINONE
7439921	LEAD	7439921	LEAD
N420	LEAD COMPOUNDS	7439921	LEAD
58899	LINDANE	58899	1,2,3,4,5,6-HEXACHLOROCYCLOHEXANE
108316	MALEIC ANHYDRIDE	108316	MALEIC ANHYDRIDE
7439965	MANGANESE	7439965	MANGANESE
N450	MANGANESE COMPOUNDS	7439965	MANGANESE
7439976	MERCURY	7439976	MERCURY
N458	MERCURY COMPOUNDS	7439976	MERCURY
67561	METHANOL	67561	METHANOL
72435	METHOXYCHLOR	72435	METHOXYCHLOR
74839	BROMOMETHANE	74839	METHYL BROMIDE
74873	CHLOROMETHANE	74873	METHYL CHLORIDE
71556	1,1,1-TRICHLOROETHANE	71556	METHYL CHLOROFORM

TRI CAS	TRI Pollutant Name	EIS Pollutant Code	EIS Pollutant Name
74884	METHYL IODIDE	74884	METHYL IODIDE
108101	METHYL ISOBUTYL KETONE	108101	METHYL ISOBUTYL KETONE
624839	METHYL ISOCYANATE	624839	METHYL ISOCYANATE
80626	METHYL METHACRYLATE	80626	METHYL METHACRYLATE
1634044	METHYL TERT-BUTYL ETHER	1634044	METHYL TERT-BUTYL ETHER
75092	DICHLOROMETHANE	75092	METHYLENE CHLORIDE
60344	METHYL HYDRAZINE	60344	METHYLHYDRAZINE
121697	N,N-DIMETHYLANILINE	121697	N,N-DIMETHYLANILINE
68122	N,N-DIMETHYLFORMAMIDE	68122	N,N-DIMETHYLFORMAMIDE
91203	NAPHTHALENE	91203	NAPHTHALENE
7440020	NICKEL	7440020	NICKEL
N495	NICKEL COMPOUNDS	7440020	NICKEL
98953	NITROBENZENE	98953	NITROBENZENE
684935	N-NITROSO-N-METHYLUREA	684935	N-Nitroso-N-Methylurea
90040	O-ANISIDINE	90040	O-ANISIDINE
95534	O-TOLUIDINE	95534	O-TOLUIDINE
123911	1,4-DIOXANE	123911	P-DIOXANE
56382	PARATHION	56382	Parathion
82688	QUINTOZENE	82688	PENTACHLORONITROBENZENE
87865	PENTACHLOROPHENOL	87865	PENTACHLOROPHENOL
108952	PHENOL	108952	PHENOL
75445	PHOSGENE	75445	PHOSGENE
7803512	PHOSPHINE	7803512	PHOSPHINE
7723140	PHOSPHORUS (YELLOW OR WHITE)	7723140	PHOSPHORUS
85449	PHTHALIC ANHYDRIDE	85449	PHTHALIC ANHYDRIDE
1336363	POLYCHLORINATED BIPHENYLS	1336363	POLYCHLORINATED BIPHENYLS
120127	ANTHRACENE	120127	Anthracene
191242	BENZO(G,H,I)PERYLENE	191242	BENZO[G,H,I,]PERYLENE
85018	PHENANTHRENE	85018	PHENANTHRENE
N590	POLYCYCLIC AROMATIC COMPOUNDS	130498292	PAH, total
106503	P-PHENYLENEDIAMINE	106503	P-PHENYLENEDIAMINE
123386	PROPIONALDEHYDE	123386	PROPIONALDEHYDE
114261	PROPOXUR	114261	PROPOXUR
78875	1,2-DICHLOROPROPANE	78875	PROPYLENE DICHLORIDE
75569	PROPYLENE OXIDE	75569	PROPYLENE OXIDE
91225	QUINOLINE	91225	QUINOLINE
106514	QUINONE	106514	QUINONE
7782492	SELENIUM	7782492	SELENIUM
N725	SELENIUM COMPOUNDS	7782492	SELENIUM
100425	STYRENE	100425	STYRENE
96093	STYRENE OXIDE	96093	STYRENE OXIDE
127184	TETRACHLOROETHYLENE	127184	TETRACHLOROETHYLENE
7550450	TITANIUM TETRACHLORIDE	7550450	TITANIUM TETRACHLORIDE
108883	TOLUENE	108883	TOLUENE
95807	2,4-DIAMINOTOLUENE	95807	TOLUENE-2,4-DIAMINE
8001352	TOXAPHENE	8001352	TOXAPHENE
79016	TRICHLOROETHYLENE	79016	TRICHLOROETHYLENE
121448	TRIETHYLAMINE	121448	TRIETHYLAMINE
1582098	TRIFLURALIN	1582098	TRIFLURALIN
108054	VINYL ACETATE	108054	VINYL ACETATE
75014	VINYL CHLORIDE	75014	VINYL CHLORIDE
75354	VINYLIDENE CHLORIDE	75354	VINYLIDENE CHLORIDE
108383	M-XYLENE	108383	M-XYLENE
95476	O-XYLENE	95476	O-XYLENE
106423	P-XYLENE	106423	P-XYLENE
1330207	XYLENE (MIXED ISOMERS)	1330207	XYLENES (MIXED ISOMERS)

3. **Split TRI total chromium emissions into hexavalent and trivalent emissions**
   The TRI allows facilities to report either “Chromium” or “Chromium compounds,” but not the hexavalent or trivalent chromium species that are needed for the NEI (see Section 3.1.3). Because the only

characterization available for the TRI facilities or their emissions is the facilities' NAICS codes, we created a NAICS-based set of fractions to split the TRI-reported total chromium emissions into the hexavalent and trivalent chromium species. A table of Standard Industrial Classification (SIC)-based chromium split fractions was available from earlier year NEI usage of TRI databases, which had been compiled by SIC rather than NAICS. The earlier SIC-based fractions were used wherever they could be re-assigned to a closely matching NAICS description.

Unfortunately, not all SIC-based fractions could be assigned this way, so we computed NAICS-based split fractions for any NAICS codes in the 2014 TRI data that did not already have an SIC-to-NAICS assigned split fraction. These factors were used for the remaining TRI-reported chromium. To calculate the NAICS-based factors, we summed by NAICS the total amounts of chromium III and chromium VI for the entire U.S. in the 2014 draft NEI data. These 2014 NEI S/L/T emissions were either reported directly by the S/L/T agencies as chromium III and chromium VI, or they had been split from S/L/T agency-reported total chromium by the EPA using the procedures described in Section 3.1.4. Those procedures largely rely on either SCC-based or Regulatory code-based split factors. The derived NAICS split factors, therefore, represent a weighted average of the SCC and Regulatory code-based split factors, weighted according to the mass of each chromium valence in the 2014 draft NEI for that NAICS.

After all TRI facilities with chromium had been assigned a NAICS-based split factor, the factors were applied separately to both the TRI stack and fugitive total chromium emissions. This resulted in speciated chromium emissions for each facility's stack and fugitive emissions that were included in the EIS as part of the 2014EPA_TRI dataset.

4. **Review high TRI emissions values for and exclude any data suspected to be outliers**
   A review and comparison of the largest TRI emissions values was conducted for several key high risk pollutants. The following pollutants were specifically reviewed, although a few extremely large values for some of the other TRI pollutants were also noticed and treated in the same manner: Hg, Pb, chromium, manganese, nickel, arsenic, 1,3 butadiene, benzene, toluene, ethyl benzene, p-xylene, methanol, acrolein, carbon tetrachloride, tetrachloroethylene, methylene chloride, acrylonitrile, 1,4-dichlorobenzene, ethylene oxide, hydrochloric acid, hydrogen fluoride, chlorine, 2,4-toluene diisocyanate, hexamethylene diisocyanate, and naphthalene. The review included looking at the largest 10 emitting facilities for each of the pollutants in the 2014 TRI dataset itself to identify large differences between facilities and unexpected industry types. Comparisons were then made to the 2011 TRI and the 2014 draft NEI emissions values from S/L/T agencies for any suspect facilities identified by that review (as described above in Section 3.1.1).

5. **Write the 2014 TRI emissions to EIS Process IDs with stack and fugitive release points**
   The total facility stack and total facility fugitive emissions values from the above steps were written to a set of EIS process IDs created to reflect those facility total type emissions. In most cases, the EIS process IDs for a given facility already existed in EIS as a result of the 2002 and 2005 NEI inventories which were used to populate the original EIS data system. Those NEI years contained the TRI stack and fugitive totals as single processes. Where such legacy NEI process IDs did not exist in the EIS, they were created.

6. Revise SCCs on the EIS Processes used for the TRI emissions

The 2002 and 2005 NEIs had assigned all of the TRI emissions to a default process code SCC of 39999999, which caused a large amount of HAP emissions to be summed to a misleading "miscellaneous" sector. The 2008 NEI approach reduced this problem somewhat because it apportioned all TRI emissions to the multiple processes and SCCs that were used by the S/L/T agencies to report their emissions, but this apportioning created other distortions. The 2011 NEI reverted back to loading the TRI emissions as the single process stack and fugitive values as reported by facilities to the TRI, but we revised the SCCs on those single processes to something other than the default 39999999 wherever possible. The purpose of this is to allow the TRI emissions to map to a more appropriate EIS sector. For the 2014 NEI, we retained the 2011 approach, process IDs, and SCCs.

To assign a SCC, we first determined for each facility and release type (stack or fugitive) which EIS Sector had the largest amount of S/L/T agency-reported emissions in the 2011 draft NEI. Within the largest EIS sector for the facility and release type, we then determined which single SCC had the largest emissions. The emissions values used were sums of emissions across all pollutants except carbon monoxide (CO), carbon dioxide (CO_2), and NO_X, with all units converted to tons. Excluding CO and CO_2 was done because their high mass would overwhelm the contribution of the other criteria pollutants, and NO_X was excluded because the HAPs that we are trying to assign to an appropriate summation sector are more closely associated with SO_2 or PM emissions. The usage of the default 39999999 SCC has not been completely eliminated as a result of this approach, because there remain a number of S/L/T agency-reported criteria emissions for some facilities in EIS for which that is the most viable SCC choice. In the rare cases that the S/L/T agency used 39999999 for the majority of their emissions, this SCC assignment approach did not work.

7. Tag TRI pollutant emissions in EIS to avoid double counting with other datasets

Because the 2014 NEI does not attempt to place the TRI emissions at the same processes used by the S/L/T agency datasets or other EPA datasets that are higher in the EIS selection hierarchy, it is necessary to tag any TRI emissions values stored in the EIS wherever the same pollutant is already reported by a S/L/T agency or one of the more preferred EPA datasets for a given EIS facility. In addition to a direct comparison of individually matching pollutants between these datasets, it is also necessary to compare to any of the related EIS pollutant codes that are in the same pollutant group.

Table 3-3 shows the EIS pollutant groups that had to be accounted for in this comparison. For example, if the S/L/T agency data or the 2014EPA_EGU dataset included "Xylenes (Mixed Isomers)" for a facility, any of the related individual xylene isomers would be tagged in the 2014EPA_TRI dataset in the EIS as well as any "Xylenes (Mixed Isomers)." Tagging an emissions value in the EIS in any dataset makes that emissions value not available for selection to the NEI.

Table 3-3: Pollutant groups

Group Name	Pollutant Code	Pollutant
Chromium	7440473	Chromium
	1333820	Chromium Trioxide
	7738945	Chromic Acid (VI)
	18540299	Chromium (VI)
	16065831	Chromium III
Xylenes (Mixed Isomers)	1330207	Xylenes (Mixed Isomers)
	95476	o-Xylene

Group Name	Pollutant Code	Pollutant
	106423	p-Xylene
	108383	m-Xylene
Cresol/Cresylic Acid (Mixed Isomers)	1319773	Cresol/Cresylic Acid (Mixed Isomers)
	95487	o-Cresol
	108394	m-Cresol
	106445	p-Cresol
Polychlorinated Biphenyls	1336363	Polychlorinated Biphenyls (PCBs)
	2050682	4,4'-Dichlorobiphenyl (PCB-15)
	2051243	Decachlorobiphenyl (PCB-209)
	2051607	2-Chlorobiphenyl (PCB-1)
	25429292	Pentachlorobiphenyl
	26601649	Hexachlorobiphenyl
	26914330	Tetrachlorobiphenyl
	28655712	Heptachlorobiphenyl
	53742077	Nonachlorobiphenyl
	55722264	Octachlorobiphenyl
	7012375	2,4,4'-Trichlorobiphenyl (PCB-28)
Polycyclic Organic Matter (POM)	130498292	PAH, total
	120127	Anthracene
	129000	Pyrene
	189559	Dibenzo[a,i]Pyrene
	189640	Dibenzo[a,h]Pyrene
	191242	Benzo[g,h,I,]Perylene
	191300	Dibenzo[a,l]Pyrene
	192654	Dibenzo[a,e]Pyrene
	192972	Benzo[e]Pyrene
	193395	Indeno[1,2,3-c,d]Pyrene
	194592	7H-Dibenzo[c,g]carbazole
	195197	BenzoIphenanthrene
	198550	Perylene
	203123	Benzo(g,h,i)Fluoranthene
	203338	Benzo(a)Fluoranthene
	205823	Benzo[j]fluoranthene
	205992	Benzo[b]Fluoranthene
	206440	Fluoranthene
	207089	Benzo[k]Fluoranthene
	208968	Acenaphthylene
	218019	Chrysene
	224420	Dibenzo[a,j]Acridine
	226368	Dibenz[a,h]acridine
	2381217	1-Methylpyrene
	2422799	12-Methylbenz(a)Anthracene
	250	PAH/POM – Unspecified
	26914181	Methylanthracene
	3697243	5-Methylchrysene
	41637905	Methylchrysene
	42397648	1,6-Dinitropyrene

Group Name	Pollutant Code	Pollutant
	42397659	1,8-Dinitropyrene
	50328	Benzo[a]Pyrene
	53703	Dibenzo[a,h]Anthracene
	5522430	1-Nitropyrene
	56495	3-Methylcholanthrene
	56553	Benz[a]Anthracene
	56832736	Benzofluoranthenes
	57835924	4-Nitropyrene
	57976	7,12-Dimethylbenz[a]Anthracene
	602879	5-Nitroacenaphthene
	607578	2-Nitrofluorene
	65357699	Methylbenzopyrene
	7496028	6-Nitrochrysene
	779022	9-Methyl Anthracene
	8007452	Coal Tar
	832699	1-Methylphenanthrene
	83329	Acenaphthene
	85018	Phenanthrene
	86737	Fluorene
	86748	Carbazole
	90120	1-Methylnaphthalene
	91576	2-Methylnaphthalene
	91587	2-Chloronaphthalene
Cyanide & Compounds	57125	Cyanide
	74908	Hydrogen Cyanide
Nickel & Compounds	7440020	Nickel
	12035722	Nickel Subsulfide
	1313991	Nickel Oxide
	604	Nickel Refinery Dust

3.1.6 HAP augmentation based on emission factor ratios

The 2014EPA_HAP-augmentation dataset was used for gap filling missing HAPs in the S/L/T agency-reported data. These missing HAPs are determined by comparing the "Expected Pollutant List for Point SCCs" with those that S/L/T agencies submitted. We calculated HAP emissions by multiplying the appropriate surrogate CAP emissions (provided by S/L/T agencies) by an emissions ratio of HAP to CAP EFs. For point sources, these EF ratios were largely the same as were used in the 2008 NEI v3, though additional quality assurance resulted in some changes. The ratios were computed using the EFs from WebFIRE (http://www.epa.gov/ttn/chief/webfire/index.html) and are based solely on the SCC code. The computation of these point HAP to CAP ratios is described in detail in the 2008 NEI documentation, Section 3.1.5.

For pollutants other than Hg, we computed ratios for only the SCCs in WebFIRE that met specific criteria: 1) the CAP and HAP WebFIRE EFs were both based on uncontrolled emissions and, 2) the units of the EF had to be the same or be able to be converted to the same units. In addition, for Hg, we added ratios for point SCCs that were not in WebFIRE for both PM10-FIL (the CAP surrogate for Hg) and Hg by using Hg or PM10-FIL factors for similar SCCs and computing the resulting ratio. That process is described (and supporting data files provided) in the

2008 NEI documentation (Section 3.1.5.2), since these additional Hg augmentation factors were used in the 2008 NEI v3 as well.

A HAP augmentation feature was built into the EIS for the 2011 cycle, and the HAP EF ratios are available to the EIS users through the reference data link "Augmentation Priority Order." The same tables ("Priority Data" and "Priority Data Area") provide both the HAP augmentation factors and chromium speciation factors. The "Priority Data" table provides chromium speciation and HAP augmentation factors for point sources; the "Priority Data Area" table provides them for nonpoint sources. These tables provide the SCC, CAP surrogate, HAP and multiplication factor (HAP to CAP ratio). For access by non-EIS users, the zip file called "2014HAPAugFactors.zip" provides the emission ratios used for point and nonpoint data categories.

A key facet of our approach is that the resulting HAP augmentation dataset does duplicate HAPs from the S/L/T agency data or other EPA datasets. The extra step of data tagging of the HAP augmentation dataset was taken to ensure the NEI would not use the data from the HAP augmentation dataset for facilities where the HAP was reported by an S/L/T agency at any process at the facility or where the HAP was included in the EPA TRI dataset. For example, if a facility reported formaldehyde at process A only, and the WebFIRE emission factor database yields formaldehyde emissions for processes A, B, and C, then we would not use any records from the HAP augmentation dataset containing formaldehyde from any processes at the facility. If that facility had no formaldehyde, but the TRI dataset had formaldehyde for any processes at that facility, then the NEI would still not use formaldehyde from the HAP augmentation dataset for any of the processes (it would use the TRI data). If the EPA EGU dataset contained formaldehyde for that facility, we would use the HAP augmentation set but not for any process at the same unit as EPA EGU dataset. If the EPA EGU dataset contained formaldehyde at process A or any other process within the same unit as process A, then the HAP augmentation dataset would be used for processes B and C, but not process A.

This approach was taken to be conservative in our attempt to prevent double counted emissions, which is necessary because we know that some states aggregate their HAP emissions and assign to fewer or different processes than their CAP emissions. These types of differences are expected since CAPs are required to be submitted at the process level, but HAPs are entirely voluntary for the NEI's reporting rule. We used the EIS tagging to tag records from the 2014EPA_HAP-augmentation dataset to prevent double counting. Because some HAPs are in pollutant groups, if any one HAP in that group was reported by the state anywhere at the facility, then we tagged all HAPs in that group. We used the same groups as provided in Table 3-3.

We also tagged all point source HAP augmentation values where the HAP augmentation value exceeded the maximum emissions reported by any S/L/T agency for the same SCC/pollutant combination, or if no S/L/T agency reported any values for the same SCC/pollutant. This occurred a total of 9607 times.

3.2 Airports: aircraft-related emissions

The EPA estimated emissions related to aircraft activity for all known U.S. airports, including seaplane ports and heliports, in the 50 states, Puerto Rico, and U.S. Virgin Islands. All of the approximately 20,000 individual airports are geographically located by latitude/longitude and stored in the NEI as point sources. As part of the development process, S/L/T agencies had the opportunity to provide both activity data as well emissions to the NEI. When activity data were provided, the EPA used that data to calculate the EPA's emissions estimates.

3.2.1 Sector Description

The aircraft sector includes all aircraft types used for public, private, and military purposes. This includes four types of aircraft: (1) commercial, (2) air taxis (AT), (3) general aviation (GA), and (4) military. A critical detail about the aircraft is whether each aircraft is turbine- or piston-driven, which allows the emissions estimation model to assign the fuel used, jet fuel or aviation gas, respectively. The fraction of turbine- and piston-driven aircraft is either collected or assumed for all aircraft types.

Commercial aircraft include those used for transporting passengers, freight, or both. Commercial aircraft tend to be larger aircraft powered with jet engines. Air taxis carry passengers, freight, or both, but usually are smaller aircraft and operate on a more limited basis than the commercial aircraft. General aviation includes most other aircraft used for recreational flying and personal transportation. Finally, military aircraft are associated with military purposes, and they sometimes have activity at non-military airports.

The national AT and GA fleets include both jet- and piston-powered aircraft. Most of the AT and GA fleets are made up of larger piston-powered aircraft, though smaller business jets can also be found in these categories. Military aircraft cover a wide range of aircraft types such as training aircraft, fighter jets, helicopters, and jet- and piston-powered planes of varying sizes.

The NEI also includes emission estimates for aircraft auxiliary power units (APUs) and aircraft ground support equipment (GSE) typically found at airports, such as aircraft refueling vehicles, baggage handling vehicles and equipment, aircraft towing vehicles, and passenger buses. These APUs and GSE are located at the airport facilities as point sources along with the aircraft exhaust emissions.

3.2.2 Sources aircraft emissions estimates

Aircraft exhaust, GSE, and APU emissions estimates are associated with aircrafts' landing and takeoff (LTO) cycle. LTO data were available from both S/L/T agencies and FAA databases. For airports where the available LTO included detailed aircraft-specific make and model information (e.g., Boeing 747-200 series), we used the FAA's EDMS to estimate emissions. For airports where FAA databases do not include such detail, the EPA used assumptions regarding the percent of these LTOs that were associated with piston-driven (using aviation gas) versus turbine-driven (using jet fuel) aircraft. Then, the EPA estimated emissions based on the percent of each aircraft type, LTOs, and EFs. In addition to airport facility point, the EPA also estimated in-flight Pb (from aviation gas) emissions that are allocated to counties in the nonpoint inventory. Details about EPA's estimates can be found at https://www.epa.gov/sites/production/files/2016-08/documents/neiair2014_fin.pdf. State agencies listed in Table 3-4 provided at least some component of aircraft-related emissions to the NEI.

Table 3-4: The following agencies submitted aircraft-related emissions:

Agency	Summary	Notes
Georgia Department of Natural Resources	Unpaved airstrip (nonpoint) in 2 counties	
Illinois Environmental Protection Agency	737 airports' emissions	
Tennessee Department of Environmental Conservation	Military aircraft emissions at one facility	
Texas Commission on Environmental Quality	2005 airports' emissions	EPA o- and m-xylene tagged to avoid double count with TX's 'mixed xylene' records
Utah Division of Air Quality	Military aircraft emissions at one facility	

3.3 Rail yard-related emissions

See Section 4.20 for details on the emission estimation for rail line segment emissions which are stored in the nonpoint sector. The point fraction of the rail data includes estimates for nearly 800 rail yards. These emissions are associated with the operation of switcher engines at each yard.

3.3.1 Sector Description

The locomotive sector includes railroad locomotives powered by diesel-electric engines. A diesel-electric locomotive uses 2-stroke or 4-stroke diesel engines and an alternator or a generator to produce the electricity required to power its traction motors.

3.3.2 Sources rail yard emissions estimates

The EPA used the EPA's 2011 national rail estimates for 2014 v1 for S/L/T agencies that did not submit 2014 rail yard emissions. The 2011 emissions were not adjusted for changes between 2011 and 2014, nor were 2011 submitted estimates from S/L/T agencies included. The EPA 2011 rail estimates were developed by applying growth factors to the 2008NEI values based on railroad freight traffic data from the 2008 and 2011 R-1 reports submitted by all Class I rail lines to the Surface Transportation Board and employment statistics from the American Short Lines and Regional Railroad Association for class II and III. For more information on the development of the 2008 and 2011 EPA estimates, refer to the NEI web site: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. The emissions were spatially allocated using shapefiles for line haul segments (shape IDs) and yard locations based on 2008 allocations of these features.

Rail yard emissions are limited to one SCC (28500201). For 2014, the following agencies submitted rail yards: Illinois, Maryland, Minnesota, and Texas. These submitted data were compared to EPA estimates. Where necessary, the EPA values were tagged to prohibit double counting. Nonpoint rail yard submittals were allowed and were also checked for double counting with point.

3.4 EGUs

The EPA developed a single combined dataset of emission estimates for EGUs to be used to fill gaps for pollutants and emission units not reported by S/L/T agencies. For the 2014EPA_EGU dataset, the emissions were estimated at the unit level, because that is the level at which the CAMD heat input activity data and the MATS-based emissions factors and the CAMD CEM data are available. The 2014EPA_EGU dataset was developed from three separate estimation sources. The three sources were the 2010 MATS rule development testing program EFs for 15 HAPs; annual sums of SO2 and NOx emissions based on the hourly CEM emissions reported to the EPA's CAMD's database; and heat-input based EFs that were built from AP-42 EFs and fuel heat and sulfur contents as part of the 2008 NEI development effort. We used the 2014 annual throughputs in BTUs from the CAMD database with the two EF sets to derive annual emissions for 2014. A small number of the AP-42-based estimates were discarded because the fuels or control configurations were found to be different than what they were during the 2008 development effort that provided the heat-input based EFs that were available.

As shown above in Table 3-1, the selection hierarchy was set such that S/L/T-submitted data was used ahead of the values in the 2014EPA_EGU dataset. In the 2011 NEI, the EPA EGU estimated emissions that were derived from the MATS testing program were used ahead of the S/L/T values, unless the S/L/T submittal indicated that the value was from either a CEM or a recent stack test. For the 2014 NEI, we used the S/L/T-reported values wherever they were reported (unless they were tagged out as an outlier), including where a MATS-based value existed in the 2014EPA EGU dataset. In addition, we made the MATS emission factors available to S/L/T agencies far in advance of the data being submitted so that facilities and/or S/L/T agencies could choose to use that information to compute emissions if it was most applicable.

We assumed that all heat input came from the primary fuel, and the EFs used reflected only that primary fuel. This introduces a small amount of uncertainty as many EGU units use a small amount of alternative fuels. The resultant unit-level estimates had to be loaded into EIS at the process-level to meet the EIS requirement that emissions can only be associated with the most detailed level. To do this for the EGU sectors, we needed to bridge the unit level (i.e., the boiler or gas turbine unit as a whole) to the process level (i.e., the individual fuels burned within the units). So, the EPA emissions were assigned to a single process for the primary fuel that was used by the responsible S/L/T agency for reporting the largest portion of their emissions. The EPA emissions were then “tagged out” wherever the S/L/T agency had reported the same pollutant at any process within the same emission unit. This approach prevented double counting of a portion of the S/L/T-reported emissions in cases where the S/L/T agency may have reported a unit’s emissions using two different coal processes and a small oil process, for example.

The matching of the 2014EPA_EGU dataset to the responsible agency facility, unit and process IDs was done largely by using the ORIS plant and CAMD boiler IDs as found in the CAMD heat input activity dataset, and linking these to the same two IDs as had been stored in EIS. We also compared the facility names and counties for agreement between the S/L/T-reported values and those in CAMD, and we made revisions to the matches wherever discrepancies were noted. As a final confirmation that the correct emissions unit and a reasonable process ID in EIS had been matched to the EPA data, the magnitudes of the SO_2 and NOx emissions for all preliminary matches were compared between the S/L/T agency-reported datasets and the EPA dataset. We identified and resolved several discrepancies from this emissions comparison.

Alternative facility and unit IDs needed for matching with other databases

The 2014 NEI data contains two sets of alternate unit identifiers related to the ORIS plant and CAMD boiler IDs (as found in the CAMD heat input activity dataset) for export to the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling file. The first set is stored in EIS with a Program System Code (PSC) of “EPACAMD.” The alternate unit IDs are stored as a concatenation of the ORIS Plant ID and CAMD boiler ID with “CAMDUNIT” between the two IDs. These IDs are exported to the SMOKE file in the fields named ORIS_FACILITY_CODE and ORIS_BOILER_ID. These two fields are used by the SMOKE processing software to replace the annual NEI emissions values with the appropriate hourly CEM values at model run time. The second set of alternate unit IDs are stored in EIS with a PSC of “EPAIPM” and are exported to the SMOKE file as a field named “IPM_YN.” The SMOKE processing software uses this field to determine if the unit is one that will have future year projections provided by the integrated planning model (IPM). The storage format of these alternate EPAIPM unit IDs, in both EIS and in the exported SMOKE file, replicates the IDs as found in the National Electric Energy Data System **(**NEEDS) database used as input to the IPM model. The NEEDS IDs are a concatenation of the ORIS plant ID and the CAMD boiler ID, with either a “_B_” or a “_G_” between the two IDs, indicating “Boiler” or “Generator.” The ORIS Plant IDs and CAMD boiler IDs as stored in the CAMD Business System(CAMDBS) dataset and in the NEEDS database are almost always the same, but there are occasional differences for the same unit. The EPACAMD alternate unit IDs available in the 2014 NEI are believed to be a complete set of all those that can safely be used for the purpose of substituting hourly CEM values without double-counting during SMOKE processing. The EPAIPM alternate unit IDs in the 2014 NEI are not a complete listing of all the NEEDS/IPM units, although most of the larger emitters do have an EPAIPM alternate unit ID. The NEEDS database includes a much larger set of smaller, non-CEM units.

3.5 Landfills

The point source emissions in the EPA's Landfill dataset includes CO and 28 HAPs, as shown in Table 3-5. This set of pollutants was included in the 1999 NEI, and we continue to use the same set of pollutants each year for a consistent time series. To estimate emissions, we used the methane emissions reported by landfill operators in compliance with Subpart HH of the Greenhouse Gas Reporting Program (GHGRP) as a "surrogate" activity indicator. We converted the methane as reported in Mg CO2 equivalent to Mg as actual methane emitted by dividing by 23 (the Global Warming Potential of methane believed to be used in the version of the 2014 GHGRP facility inventory) to get MG methane emitted, and then multiplied by 1.1023 to get tons methane emitted[8]. We created emission factors for CO and the 28 HAPs on a per ton of methane emitted basis using the default concentrations (ppmv) in AP-42 Section 2.4 (final section dated Jan 1998), Table 2.4-1. The concentrations for toluene and benzene were taken from Table 2.4-2 of AP-42, for the case of "no or unknown" co-disposal history. Per Equation 4 of that AP-42 section, Mp=Qp x MWp x constant (at any given temperature). Writing this equation twice, for the mass of any pollutant "P" and for methane (CH4), and dividing M_p by M_{CH4} yields:

$$M_p / M_{CH4} = (Qp \times MWp \times k) / Q_{CH4} \times MW_{CH4} \times k) = (Qp/Q_{CH4}) \times (MWp/MW_{CH4})$$, units of pounds p/pound CH4

A rearrangement of Equation 3 of that AP-42 section provides $Qp/ Q_{CH4} = 1.82 \times Cp/1000000$, where the 1.82 is based upon a default methane concentration of 55 % (550,000 ppm). Plugging this expression for Qp/ Q_{CH4} into the first expression yields:

$$M_p / M_{CH4} = (1.82 \times Cp/1000000) \times (MWp/ MW_{CH4}) \times 2000$$, units of pounds p/ton CH4

$$M_p / M_{CH4} = (1.82 \times Cp/1000000) \times (MWp/16) \times 2000 = Cp \times MWp / 4395.6$$

Table 3-5: Landfill gas emission factors for 29 EIS pollutants

Pollutant code	Pollutant description	MW	ppmv	MW x ppmv	lbs/Ton CH_4
CO	Carbon monoxide	28.01	141	3949.41	0.89849
108883	toluene	92.13	39.3	3620.709	0.82371
1330207	Xylenes	106.16	12.1	1284.536	0.29223
75092	Dichloromethane (methylene chloride)	84.94	14.3	1214.642	0.27633
7783064	Hydrogen sulfide	34.08	35.5	1209.84	0.27524
127184	Perchloroethylene (tetrachloroethylene)	165.83	3.73	618.5459	0.14072
110543	Hexane	86.18	6.57	566.2026	0.12881
100414	Ethylbenzene	106.16	4.61	489.3976	0.11134
75014	Vinyl chloride	62.5	7.34	458.75	0.10437
79016	Trichloroethylene (trichloroethene)	131.4	2.82	370.548	0.08430
107131	Acrylonitrile	53.06	6.33	335.8698	0.07641
75343	1,1-Dichloroethane (ethylidene dichloride)	98.97	2.35	232.5795	0.05291
108101	Methyl isobutyl ketone	100.16	1.87	187.2992	0.04261
79345	1,1,2,2-Tetrachloroethane	167.85	1.11	186.3135	0.04239

[8] For more information on CO_2 equivalent and global warming potential, please refer to EPA's page "Understanding Global Warming Potentials".

71432	benzene	78.11	1.91	149.1901	0.03394
75003	Chloroethane (ethyl chloride)	64.52	1.25	80.65	0.01835
71556	1,1,1-Trichloroethane (methyl chloroform)	133.41	0.48	64.0368	0.01457
74873	Chloromethane	50.49	1.21	61.0929	0.01390
75150	Carbon disulfide	76.13	0.58	44.1554	0.01005
107062	1,2-Dichloroethane (ethylene dichloride)	98.96	0.41	40.5736	0.00923
106467	Dichlorobenzene	147	0.21	30.87	0.00702
463581	Carbonyl sulfide	60.07	0.49	29.4343	0.00670
108907	Chlorobenzene	112.56	0.25	28.14	0.00640
78875	1,2-Dichloropropane (propylene dichloride)	112.99	0.18	20.3382	0.00463
75354	1,1-Dichloroethene (vinylidene chloride)	96.94	0.2	19.388	0.00441
67663	Chloroform	119.39	0.03	3.5817	0.00081
56235	Carbon tetrachloride	153.84	0.004	0.61536	0.00014
106934	Ethylene dibromide	187.88	0.001	0.18788	0.00004
7439976	Mercury (total)	200.61	0.000292	0.05857812	0.00001

3.6 Other/carry forward

This EPA dataset is used to fill in miscellaneous emissions which were not reported by S/L/T agencies for 2014, and for which no EPA dataset has 2014 emissions, but which are believed to exist in 2014. These unreported facilities and pollutants were identified as part of the QA review steps performed on the S/L/T data (see Section 3.1.1). A total of 212 unique facilities and 12 different pollutants are represented in this dataset. The only HAP pollutant included in this dataset is coke oven emissions, added for five facilities (three in Ohio, one each in Virginia and Michigan), where the States reported other emissions for the facility but not the coke oven emissions pollutant. The 2011 NEI coke oven emissions for these five facilities were carried forward to this 2014 dataset as is, without change. All other pollutants added were criteria pollutants, and only where 2011 emissions values indicated that emissions had been greater than the required pollutant reporting thresholds. Many of these additions were for Maricopa County, Arizona (15 facilities) and the Navajo Nation (12 facilities), neither of which submitted any point emissions for 2014, and for Indiana (171 facilities), which submitted a large amount of facilities including both criteria and many HAP pollutants but which did not get some criteria pollutants included in 2014 for some facilities due to a processing error. In addition, eight facilities in California and one facility in Wisconsin were also included in this dataset. All emissions values for 2014 were set equal to the 2011 NEI v2 emissions values.

3.7 BOEM

The U.S. Department of the Interior, Bureau of Ocean and Energy Management (BOEM) estimates emissions of CAPs in the Gulf of Mexico from offshore oil platforms in Federal waters, and these data have been previously incorporated into the NEI. The 2014 offshore data were not available in time for inclusion in the 2014 v1 NEI, thus, we carried forward the 2011 BOEM emissions. The only step taken with the data from BOEM for 2011 was convert the data to the CERS format needed to load to EIS, which included using the code "DM" for Federal waters in place of a state postal code. More information on these data is available at the BOEM 2011 Gulfwide Emission Inventory website.

3.8 PM species

The "2014EPA_PMspecies" dataset was created by the EPA by calculating speciated PM2.5 emissions from all contains a speciation of PM2.5-PRI into five component species (EC, OC, SO_4, NO_3, and other). These calculations were made using the EPA's 2011 version 6.3 emissions modeling platform available from the Emissions Modeling Clearinghouse website. In addition, this dataset contains a copy of PM2.5-PRI and PM10-PRI pollutants from locomotive diesel engines processes at railyards and aircraft ground support equipment using diesel fuel. These copied data records are simply relabeled as PM-diesel pollutants so that the diesel PM "pollutant" can more easily be identified in the inventory. No stationary sources running with diesel fuel are labeled as PM-diesel "pollutants".

3.9 References for Stationary sources

1. Dorn, J, 2012. *Memorandum: 2011 NEI Version 2 – PM Augmentation approach.* Memorandum to Roy Huntley, US EPA. (PM augmt 2011 NEIv2 feb2012.pdf, accessible in the reference documents of the 2008 NEI documentation found at, ftp://ftp.epa.gov/EmisInventory/2008v3/doc/2008nei_references.zip
2. Strait et al. (2003). Strait, R.; MacKenzie, D.; and Huntley, R., 2003. *PM Augmentation Procedures for the 1999 Point and Area Source NEI*, 12th International Emission Inventory Conference – "Emission Inventories – Applying New Technologies", San Diego, April 29 – May 1, 2003. (http://www.epa.gov/ttn/chief/conference/ei12/point/strait.pdf)

4 Nonpoint sources

This section includes all sources that are in the nonpoint data category. These sources are reported/generated at the county level, though some sources such as rail lines and shipping lanes and ports are more-finely resolved to the county/shape identifier (ID) (polygon) level. Stationary sources that are inventoried at facilities and stacks (coordinates) are discussed in the previous Point Section 3. This section discusses all sources in the Nonpoint inventory except Biogenics which is discussed in Section 8. Some "nonroad" mobile sources such as trains and commercial marine vessels reside in the nonpoint data category and are discussed here and not in the Nonroad Equipment Section 6.

4.1 Nonpoint source approaches

Nonpoint source data are provided by state, local, and tribal (S/L/T) agencies, and for certain sectors and/or pollutants, they are supplemented with data from the EPA. This section describes the various sources of data and the selection priority for each of the datasets to use for building the National Emissions Inventory (NEI) when multiple data sources are available for the same emissions source. Section 2.2 provides more information on the data selection process.

4.1.1 Sources of data overview and selection hierarchies

Table 3-1 describes the datasets comprising the nonpoint inventory, and the hierarchy for combining these datasets in construction of the NEI. While the bulk of these datasets are for stationary sources of emissions, some of these datasets contain mobile sources so that emissions from ports, shipping lanes and rail yards could be included as nonpoint sources. The table includes the rationale for why each dataset was assigned its position in the hierarchy. We excluded certain pollutants from stationary sources in the 2014 NEI as shown in the last row of the table: greenhouse gases and pollutants in the pollutant groups "dioxins/furans" and "radionuclides"[9].

Table 4-1: Data sources and selection hierarchy used for nonpoint sources

Dataset name	Description and Rationale for the Order of the Selected Datasets	Order
2014EPA_PMspecies	Adds speciated $PM_{2.5}$ data to resulting selection. This is a result of offline emissions speciation where the resulting PM25-PRI selection emissions are split into the 5 PM species: elemental (black) carbon (EC), organic carbon (OC), nitrate (NO3), sulfate (SO4), and the remainder of PM25-PRI (PMFINE). Also adds a copy of PM2.5-PRI and PM10-PRI from diesel engines, relabeled as DIESEL-PM pollutants. See Section 2.2.5.	1
2014EPA_NonPt_PM-Aug	Adds nonpoint inventory PM species to fill in missing S/L/T agency data or make corrections where S/L/T agency data have inconsistent emissions across PM species. Uses the PM Augmentation Tool for processes covered by that database. For SCCs without emission factors in the tool, checks/corrects discrepancies or missing PM species using basic	2

[9] Dioxins/furans include all pollutants with pollutant category name of: Dioxins/Furans as 2,3,7,8-TCDD TEQs, or Dioxins/Furans as 2,3,7,8-TCDD TEQs – WHO2005, both of which were valid pollutant groups for reporting 2014 emissions. Radionuclides have the pollutant category name of "radionuclides" The specific compounds and codes are in the pollutant code tables in EIS.

Dataset name	Description and Rationale for the Order of the Selected Datasets	Order
	relationships such as ensuring that PMXX FIL is less than or equal PMXX PRI (See Section 2.2.2).	
Responsible Agency Selection	S/L/T agency submitted data; multiple datasets – one for each reporting agency. These data are selected ahead of other datasets. The only other situation where S/L/T agency emissions are not used is where certain records are tagged in the Emissions Inventory System (EIS) (at the specific source/pollutant level). This occurs: 1) for hierarchy purposes to allow EPA nonpoint emissions to be used ahead of S/L/T agency data where states asked for EPA data to be used in place of their data and 2) where S/L/T agency data were suspected outliers.	3
2014EPA_Cr_Augt	Hexavalent and trivalent chromium speciated from S/L/T agency reported chromium. The EIS augmentation function creates the dataset by applying multiplication factors by source classification code (SCC) to S/L/T agency "total" chromium. See Section 2.2.2.	4
2014EPA_HAPAug	HAP data computed from S/L/T agency criteria pollutant data using ratios of HAP to CAP emission factors. The emission factors used to create the ratios are the same emission factors as are used in creating the EPA estimates (i.e., in the EPA nonpoint emission tools). This dataset is below the S/L/T agency data so that the S/L/T agency HAP data are used first. HAP augmentation is discussed in Section 2.2.3.	5
2014EPA_CMV	EPA commercial marine vessel (CMV) emissions estimates. See Section 4.19.	6
2014EPA_Rail	EPA locomotive (referred to as "rail" in this document) emissions estimates. See Section 4.20.	7
2014EPA_NONPOINT	All nonpoint EPA estimates are included in this dataset except those listed elsewhere in this table. This dataset includes sources with and without point source subtraction and outputs from most of the EPA tools. This dataset also includes biogenic emissions. Examples of sources in this dataset include: fertilizer, most livestock, industrial and commercial/ institutional fuel combustion, residential wood combustion, solvent utilization, oil and gas exploration and production, open burning, agricultural burning, road and construction dust, and portable fuel containers.	8
2014EPA_NP_PM25_ ICI	PM Augmentation Tool output for EPA-generated industrial and commercial/institutional fuel combustion sources. The ICI tool used for EPA estimates did not compute condensable and filterable PM emission components.	9
2014EPA_NP_Mercury	Mercury data for select source categories within the waste disposal and Miscellaneous Non-Industrial NEC sectors. See Section 4.2. These data are carried forward from the 2011 v2 NEI.	10
2014_EPA_NP_ from2011	2011 v2 NEI data from 2011 EPA nonpoint estimates that were not updated for 2014: livestock waste from ducks, geese, horses, goats and sheep.	11
2014EPA_MOVES	Gasoline distribution data from the EPA MOVES.	12

Dataset name	Description and Rationale for the Order of the Selected Datasets	Order
Exceptions to the hierarchy: Excluded dioxin/furan individual pollutants and groups, greenhouse gas pollutants, and radionuclides. The EPA has not evaluated the completeness or accuracy of the S/L/T agency dioxin and furan values nor radionuclides, and does not have plans to supplement these reported emissions with other data sources in order to compile a complete estimate for dioxin and furans nor radionuclides as part of the NEI.		

The EPA developed all datasets listed above except for the "Responsible Agency Selection," which contains only S/L/T agency data. We used various methods and databases to compile the EPA generated datasets, which are further described in subsequent subsections. The primary purpose of the EPA datasets is to add or "gap fill" pollutants or sources not provided by S/L/T agencies, to resolve inconsistencies in S/L/T agency-reported pollutant submissions for PM (Section 2.2.4) and to speciate S/L/T agency reported total chromium into hexavalent and trivalent forms (Section 2.2.2).

The hierarchy or "order" provided in Table 4-1 defines which data are preferentially used when multiple datasets could provide emissions for the same pollutant and emissions process. The dataset with the lowest order on the list is preferentially used over other datasets. In addition to the order of the datasets, the hierarchy was also influenced by the EIS feature of data tagging (Section 2.2.6). Any data that were tagged by EPA in any of the datasets were not used. S/L/T agency data were tagged for two reasons: 1) S/L/Ts requested that their data not be used, and 2) EPA found unexpected pollutants for a source. Many EPA nonpoint data were tagged, primarily because of S/L/T feedback in the Nonpoint Survey (see Section 4.1.2).

Special caveat on backfilling with non-S/L/T data

The hierarchal backfilling that occurs in the selection process can create unexpected artifacts to the resulting inventory selection. For example, if S/L/T agencies do not submit emissions for a pollutant, and emissions for that pollutant exist in other datasets, then non-S/L/T data will show up in the NEI selection for these pollutants. If S/L/T agencies report zero emissions, then backfilling with other datasets will not occur. There are two ways that S/L/T agencies can prevent inappropriately backfilled emissions from being included in the NEI: 1) S/L/T agencies can submit zeros for any pollutant they do not want filled in (the EPA will otherwise fill in for all pollutants that are on the nonpoint expected pollutant list), or 2) the EPA can add tags to backfill datasets that prevent the tagged pollutants from being included in the NEI. The first option is more straightforward and takes care of any possible augmentation from the numerous other datasets in the selection hierarchy.

4.1.2 The Nonpoint Survey

The purpose of the nonpoint survey is to increase the accuracy and transparency in how the nonpoint inventory is built using EPA and S/L/T agency data. The nonpoint inventory includes many source categories that can overlap with sources that can also be reported as a point source; and because the potential for overlap varies by source category and reporting agency, it is important that we have information about how each agency treats inventory development for all nonpoint source types. For example, some agencies voluntarily report gas stations as point sources, which are sources that overlap with the nonpoint refueling emissions used by most states. Thus, in building the EPA nonpoint inventory, the EPA needs to know whether *all* gas stations are reported as point sources or only some of them (such as for certain counties), so that we know to what degree we should include nonpoint refueling emissions in the NEI for that state or local area.

The nonpoint survey is available only to reporting agencies and is organized by emissions sector, where the first yes/no question is whether the sector exists in an agency's jurisdiction. If the answer is "no", then the user moves on to the next sector. If the answer is "yes", then the survey provides numerous additional questions using drop-down lists for agencies to choose responses. These questions include whether the data are reported solely in the point or nonpoint inventories and whether the EPA or alternative nonpoint SCCs are used by the S/L/T agency. The survey also allows the S/L/T agency to specify their preference for the NEI to include EPA emissions rather than S/L/T emissions; this goes against the hierarchy in Table 2-1; therefore, a response to use EPA emissions rather than S/L/T emissions help to automate the generation of S/L/T nonpoint "tags". When the entire survey is complete, EPA generates a couple sets of data tags:

1) EPA tags: where S/L/T agencies indicate that the sources do not exist in their area, or where all data are reported in the point submittal. Any EPA data for these sources will be tagged out.
2) S/L/T tags: where S/L/T agencies indicate that they would prefer that the EPA data are used instead of their nonpoint submittal. Without the tags, the EPA data will not be used where S/L/T agency data exists because the EPA data are lower in the selection hierarchy (see Table 3-1).

To explain the nonpoint survey for the 2014 NEI cycle, the EPA provided a webinar to S/L/T agencies on the nonpoint survey in July of 2015. This webinar is available on the available on the Air Emissions Inventory Training website.

4.1.3 Nonpoint PM augmentation

Section 2.2.4 provides an overview of PM augmentation in the 2014 NEI and explains that we used a PM Augmentation Tool. The tool creates two output tables for each data category: Additions and Overwrites. We post-processed these output tables prior to loading the data in the EIS. In this section, we describe the post-processing issues that are specific to the nonpoint inventory.

We post-processed these data to prevent inadvertently overriding S/L/T agency primary PM_{10} and $PM_{2.5}$ data (i.e., EIS pollutants PM10-PRI and PM2.5-PRI). The PM Augmentation Tool computes the condensable (PM-CON) and filterable PM components (PM10-FIL and PM25-FIL) and re-computes primary PM_{10} and $PM_{2.5}$ when the sum of the components differed by more than the slim tolerance assumed by the tool. We decided to remove all of these "overwrites" for primary PM_{10} and $PM_{2.5}$ whenever the summed PM from the components was within 0.01 tons of S/L/T-provided primary PM_{10} or $PM_{2.5}$ totals. This tolerance was higher than the one used by the tool, but we wanted the NEI to reflect that the data source for the primary PM_{10} and $PM_{2.5}$ was from the S/L/T agency and not the EPA augmentation dataset.

We used summed components from the tool to overwrite the S/L/T agency data in the NEI selection when this difference exceeded 0.01 tons and S/L/T agencies reported both primary PM_{10} and $PM_{2.5}$; however, this was a rare occurrence. Nationally, these overwrites resulted in only a 264-ton increase in primary $PM_{2.5}$ and was found primarily for fuel combustion sources where primary PM_{10} greatly exceeded primary $PM_{2.5}$ and computed condensable and filterable components indicated that the submitted primary $PM_{2.5}$ was too low. In some cases, S/L/T agencies reported all 5 PM components, but the sum of (for example) PM-CON and PM25-FIL was different from S/L/T-reported PM25-PRI. We recommended that the S/L/T agencies review PM25-PRI overwrite values during the NEI review period prior to NEI release.

4.1.4 Nonpoint HAP augmentation

For nonpoint sources, we derived HAP augmentation ratios were derived from the emission factors used to develop the EPA nonpoint source estimates. The EPA nonpoint HAP emission estimates are computed in EPA nonpoint spreadsheet and database "tools". Because we used the same emission factors for these augmentation ratios, the ratios of HAP to CAPs for augmented S/L/T agency data are the same as the HAP to CAP ratios for the EPA-only data.

For access by non-EIS users, the zip file called "2014HAPAugFactors.zip" provides the emission ratios that the EPA used for augmenting point and nonpoint data categories. The nonpoint HAP augmentation factors were greatly improved as compared to what was used for the 2011 NEI, particularly for the oil and gas sector. For 2014, instead of national average factors, we added county-specific factors to the HAP augmentation, consistent with what is in the Oil and Gas Tool. We made this improvement in response to comments from the National Oil and Gas Committee that gas composition is highly variable and is dependent on geographic formations at a finer spatial granularity than the oil and gas basin.

The EPA staff responsible for the nonpoint sectors use their discretion for how to augment HAP emissions and work with the S/L/T agencies to reflect as complete and accurate set of pollutants as possible for the many source types. In general, if a S/L/T agency submitted a partial list of the HAPs that would be augmented for a given category, then we allowed the missing HAPs to be gap-filled with the HAP augmentation data. These missing HAPs are determined by comparing the "Expected Pollutant List for Nonpoint SCCs" with those that S/L/T agencies submitted. However, this approach has a risk of potentially violating VOC mass balance, whereby the sum of the VOC HAPs exceeds the VOC total. Thus, special cases occur when such problems are identified. For example, for agricultural burning we removed all of the S/L/T agency HAPs and used only the HAP augmentation (computed from the S/L/T-submitted CAPs.

We also tagged records from the HAP Augmentation dataset where they duplicated records in certain other EPA datasets, but for which the EIS selection hierarchy would not do everything we wanted. Thus, we tagged HAP augmentation values where the HAP Augmentation pollutant belonged to the same pollutant group as a *different* pollutant reported by the S/L/T agency. For example, if the HAP Augmentation dataset had o-xylene, and the S/L/T agency reported total xylenes, then we tagged the o-xylene in the HAP Augmentation dataset. The resultant tagging was done for the xylenes, Polycyclic Aromatic Hydrocarbons (PAHs) and cresols groups listed in Table 3-4 and discussed in Section 3.1.5 in the context of a similar issue that comes up using the Toxics Release Inventory (TRI) for point source augmentation.

4.1.5 EPA nonpoint data

For the 2014 NEI, the EPA developed emission estimates for many nonpoint sectors in collaboration with a consortium of inventory developers from various state agencies regional planning organizations called the NOnpoint Method Advisory (NOMAD) Committee. The broad NOMAD committee meets monthly to discuss the overall progress on the various sectors for which tools and/or estimates are being developed or refined. More detailed NOMAD subcommittees were established for key nonpoint source categories/sectors including, but not limited to: oil and gas exploration and production, residential wood combustion, agricultural NH_3 sources including agricultural pesticides, fertilizer and livestock, various dust sources, solvents, industrial and commercial/institutional fuel combustion, mercury, and gasoline distribution. These subgroups collaborate on methodologies, emission factors, and SCCs, allowing the EPA to prepare the "default" emission estimates for

S/L/T agencies using the group's final approaches. The NOMAD committees were formed in preparation for the 2014 NEI; however, time and resource constraints limited the scope of some of the work that could be accomplished. For example, the mercury NOMAD team identified several source categories where methodology and/or activity data need revision, and this collaboration will propagate into a future NEI, but for the 2014 NEI, 2011 NEI estimates are carried forward.

During the 2014 NEI inventory development cycle, S/L/T agencies, using the nonpoint survey (Section 4.1.2), could accept the NOMAD/EPA estimates to fulfill their nonpoint emissions reporting requirements. The EPA encouraged S/L/T agencies that did not use the EPA's estimates or tools to improve upon these "default" methodologies and submit further improved data.

Table 4-2 and Table 4-3 describe the sectors for which EPA developed emission estimates. They separately list emissions sectors entirely comprised of data in the nonpoint (i.e., not point source) data category (Table 4-2), such as residential heating, from sectors that may overlap with the point sources (Table 4-3). For sectors that overlap, some emissions will be submitted as point sources and other emissions in the same state or county are submitted as nonpoint, for example, fuel combustion at commercial or institutional facilities. The EPA attempted to include all of the EPA-estimated nonpoint emissions that overlap if it was determined that the category was missing from the S/L/T agency data.

Unless a directory is specified, all methodologies are provided in zip files posted at ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/, which is the directory containing most supporting data files listed in Table 4-2 and Table 4-3. Agricultural field burning and nonpoint mercury estimates are provided in other directories listed in Table 4-2. Emission sources that use data from former NEIs are identified in the column "Carried Forward?" in these tables. The SCCs associated with the EPA nonpoint data categories are in an Excel® file called SCCs EPA Plan to Estimate in 2014. The sections following these tables include information on key pollutants submitted by S/L/T agencies for each nonpoint source category or EIS sector.

Table 4-2: EPA-estimated emissions sources expected to be exclusively nonpoint

EPA-estimated emissions source description	Carried Forward?	EIS Sector Name	Name of supporting data file or other reference
Agricultural Tilling		Agriculture – Crops & Livestock Dust	2014_Agricultural_Tilling_v3.1_10mar2016.zip
Fertilizer Application		Agriculture – Fertilizer Application	2014_Fertilizer_Application_v1.0_22apr2016.zip
Animal Husbandry		Agriculture – Livestock Waste	2014_Ag_Livestock_v1.0_20may2016.zip
Commercial Cooking		Commercial Cooking	2014_Commercial_Cooking_x1.2_08mar2016.zip
Dust from Residential, Commercial/Institutional and Road Construction		Dust – Construction Dust	2014_Construction_Dust_v3.0_18feb2016.zip
Paved and Unpaved Roads		Dust – Paved Road Dust	2014_Road_Dust_v2.1_09mar2016.zip

EPA-estimated emissions source description	Carried Forward?	EIS Sector Name	Name of supporting data file or other reference
Crop and range/pasture-land burning		Fires – Agricultural Field Burning	https://www.epa.gov/sites/production/files/2015-08/documents/crop_residue_burning_in_2014.pdf
Residential Heating: bituminous and anthracite coal, distillate oil, kerosene, natural gas, LPG		Fuel Comb – Residential – Other	2014_Residential_Heating_non-Wood_v1.2_09mar2016.zip
Residential Heating; Fireplaces, woodstoves, fireplace inserts, pellet stoves, indoor furnaces, outdoor hydronic heaters, and firelogs.		Fuel Comb – Residential – Wood	2014_RWC_v3.0_28apr2016.zip
Aviation Gasoline Stage 1		Gas Stations	2014_Av_Gas_Stage_1_15nov2015.zip
Aviation Gasoline Stage 2		Gas Stations	2014_Av_Gas_Stage_2_15nov2015.zip
Mining and Quarrying		Industrial Processes – Mining	2014_Mining_and_Quarrying_v2.3_09mar2016.zip
Portable Gas Cans: Residential and Commercial		Miscellaneous Non-Industrial NEC	2014_Portable_Fuel_Containers_25nov2015.zip
Agricultural Pesticide Application		Solvent – Consumer & Commercial Solvent Use	2014_Agricultural_Pesticides_v2.0_18feb2016.zip
Cutback Asphalt Paving -Cutback and Emulsified		Solvent – Consumer & Commercial Solvent Use	2014_NPt_Asphalt_18nov2015_edit03302016.zip
Open Burning – Brush, Residential Household Waste, Land Clearing Debris		Waste Disposal	2014_Open_Burning_v1.1_03mar2016.zip
Mercury from: Dental Amalgam Production, Fluorescent Lamp Breakage (Landfill emissions), Fluorescent Lamp Recycling, Human and Animal Cremation, Switches and Relays, Working Face Landfill, Thermometers and Thermostats	X	Miscellaneous Non-Industrial NEC Waste Disposal	ftp://ftp.epa.gov/EmisInventory/2011nei/doc/epa_nonpoint_mercury_2011v2nei_may2014.zip

"Carried Forward" indicates whether EPA data were carried forward from the 2011v2 NEI.

Table 4-3: Emissions sources with potential nonpoint and point contribution

EPA-estimated emissions source description	Carried Forward?	EIS Sector(s) Name	Link to supporting data file
Gasoline Distribution – Stage 1: Bulk Plants, Bulk Terminals, Pipelines, Service Station Unloading, Underground Storage Tanks, Trucks in Transit;		Bulk Gasoline Terminals Gas Stations Industrial Processes – Storage and Transfer	2014_Gasoline_Distribution_v1.0_with_PT_subtraction_01apr2016.zip
Industrial, Commercial/Institutional Fuel Combustion		Fuel Comb – Industrial Boilers, ICEs – All Fuels Fuel Comb – Commercial/ Institutional – All Fuels	ICI Tool v1_4.zip
Oil and Gas Production		Industrial Processes - Oil & Gas Production	Access2013 version: OIL_GAS_TOOL_2014_NEI_PRODUCTION_V1_5_Access2013.zip Access2007 version: OIL_GAS_TOOL_2014_NEI_PRODUCTION_V1_5_Access2007.zip
Oil and Gas Exploration		Industrial Processes - Oil & Gas Production	OIL_GAS_TOOL_2014_NEI_EXPLORATION_V1_5.zip
Publicly Owned Treatment Works		Waste Disposal	2014_POTW_nonpoint_emissions_23mar2016.zip
Solvent Utilization: Degreasing		Solvent – Consumer & Commercial Solvent Use (except Ag Pesticides and Asphalt Paving) Solvent – Degreasing Solvent – Graphic Arts Solvent – Dry Cleaning Solvent – Graphic Arts Solvent – Industrial Surface Coating & Solvent Use Solvent – Non-Industrial Surface Coating	ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/Solvent_Tool_v1_5.zip
"Carried Forward" indicates whether EPA data were carried forward from the 2011v2 NEI.			

4.2 Nonpoint non-combustion-related mercury sources

4.2.1 Source Description

This source category includes numerous nonpoint mercury sources from a variety of waste disposal and other activities. For the 2014 v1 NEI, the EPA carried forward estimates of mercury for several nonpoint emissions sources that had been newly developed for 2011. The general laboratory activities emissions, carried forward from 2008 for the 2011 v2 NEI were erroneously dropped in the 2014 NEI selection. These emissions, 600 pounds of Hg, will be included in the 2014 v2 NEI. Additional descriptions of the individual types of activities are provided in the source-specific sub-sections below. Table 4-4 provides the emissions sources and SCCs for nonpoint mercury.

Table 4-4: SCCs used for nonpoint non-combustion Hg emissions sources in the 2014 NEI

Description	SCC	Sector	SCC Description	Emissions (lbs)
Landfill working face	2620030001	Waste Disposal	Landfills; Municipal; Dumping/Crushing/Spreading of New Materials (working face)	828
Scrap waste: Thermostats and Thermometers	2650000000	Waste Disposal	Scrap and Waste Materials; Scrap and Waste Materials; Total: All Processes	243
Shredding: Switches and Relays	2650000002	Waste Disposal	Scrap and Waste Materials; Scrap and Waste Materials; Shredding	4,293
Human Cremation	2810060100	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Other Combustion; Cremation; Humans	2,292
Animal Cremation	2810060200	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Other Combustion; Cremation; Animals	80.2
Dental Amalgam Production	2850001000	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Health Services; Dental Alloy Production; Overall Process	804
Fluorescent Lamp Breakage	2861000000	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Fluorescent Lamp Breakage; Non-recycling Related Emissions; Total	803
Fluorescent Lamp Recycling	2861000010	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Fluorescent Lamp Breakage; Recycling Related Emissions; Total	0.2
General Laboratory Activities	2851001000	Miscellaneous Non-Industrial NEC	Miscellaneous Area Sources; Laboratories; Bench Scale Reagents; Total	N/A
			TOTAL	**9,343**

None of these categories are distinct regulatory sectors and are therefore put into the "EPA Other" category in the mercury summary provided in Table 2-12. Detailed documentation on the methods is provided in a memorandum "Nonpoint Sources of Mercury - documentation 6-26-2014.docx" provided in the supplemental documentation.

The 2011 nonpoint Hg estimates used in 2014 were developed in collaboration with an Eastern Regional Technical Advisory (ERTAC, http://www.ertac.us/) workgroup set up for focus on these nonpoint emissions sources. To use for 2014 NEI, we compiled the EPA estimates for these categories into a single dataset (2014EPA_NP_Mercury), which was then merged with S/L/T agency data as part the NEI selection hierarchy defined in Section 3.1.2. The EPA encouraged S/L/T agencies that did not use EPA's estimates or tools to improve upon these "default" 2011 methodologies and submit further improved data. The S/L/T data replaced the EPA estimates in the counties where S/L/T agencies provided data. Table 4-5 lists the agencies, SCCs and emissions that were submitted for these nonpoint mercury sources; the S/L/T emissions from these agencies replace EPA estimates in 2014 NEI.

Table 4-5: S/L/T-reported mercury nonpoint non-combustion emissions

Region	Agency	S/L/T	SCC	Description	Sector	S/L/T Emissions (lbs)
1	Maine Department of Environmental Protection	State	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	9
1	Vermont Department of Environmental Conservation	State	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	14
2	New York State Department of Environmental Conservation	State	2620030001	Landfill Working Face	Waste Disposal	25
2	New York State Department of Environmental Conservation	State	2650000000	Scrap Waste: Thermostats and Thermometers	Waste Disposal	14
2	New York State Department of Environmental Conservation	State	2650000002	Shredding: Switches and Relays	Waste Disposal	248
2	New York State Department of Environmental Conservation	State	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	204
2	New York State Department of Environmental Conservation	State	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	5
2	New York State Department of Environmental Conservation	State	2850001000	Dental Amalgam Production	Miscellaneous Non-Industrial NEC	33

Region	Agency	S/L/T	SCC	Description	Sector	S/L/T Emissions (lbs)
2	New York State Department of Environmental Conservation	State	2861000000	Fluorescent Lamp Breakage	Miscellaneous Non-Industrial NEC	50
3	Maryland Department of the Environment	State	2861000000	Fluorescent Lamp Breakage	Miscellaneous Non-Industrial NEC	36
5	Illinois Environmental Protection Agency	State	2850001000	Dental Amalgam Production	Miscellaneous Non-Industrial NEC	61
5	Illinois Environmental Protection Agency	State	2851001000	General Laboratory Activities	Miscellaneous Non-Industrial NEC	31
5	Illinois Environmental Protection Agency	State	2861000000	Fluorescent Lamp Breakage	Miscellaneous Non-Industrial NEC	41
5	Illinois Environmental Protection Agency	State	2861000010	Fluorescent Lamp Recycling	Miscellaneous Non-Industrial NEC	0
5	Minnesota Pollution Control Agency	State	2850001000	Dental Amalgam Production	Miscellaneous Non-Industrial NEC	15
5	Minnesota Pollution Control Agency	State	2851001000	General Laboratory Activities	Miscellaneous Non-Industrial NEC	9
5	Minnesota Pollution Control Agency	State	2861000000	Fluorescent Lamp Breakage	Miscellaneous Non-Industrial NEC	14
5	Ohio Environmental Protection Agency	State	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	41
9	Washoe County Health District	Local	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	72
9	Washoe County Health District	Local	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	53
10	Coeur d’Alene Tribe	Tribe	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	0

Region	Agency	S/L/T	SCC	Description	Sector	S/L/T Emissions (lbs)
10	Coeur d'Alene Tribe	Tribe	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	0
10	Idaho Department of Environmental Quality	State	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	8
10	Idaho Department of Environmental Quality	State	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	0
10	Nez Perce Tribe	Tribe	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	0
10	Nez Perce Tribe	Tribe	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	0
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2810060100	Human Cremation	Miscellaneous Non-Industrial NEC	0
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2810060200	Animal Cremation	Miscellaneous Non-Industrial NEC	0
					Total	**984**

4.2.2 EPA-developed mercury emissions from landfills (working face)

The EPA estimated mercury emissions for landfill working face emissions. While the amount of mercury in products placed in landfills has tended to decrease in recent years, there is still a significant amount of mercury in place at landfills across the country. There are three main pathways for mercury emissions at landfills: (1) emissions from landfill gas (LFG) systems, including flare and vented systems; (2) emissions from the working face of landfills where new waste is placed; and (3) emissions from the closed, covered portions of landfills [ref 1]. Emissions from LFG systems are considered point sources and are already included in the NEI as submissions from S/L/T agencies or from the point source dataset that gap fills these landfill emissions (2014EPA_LF). Lindberg et al. (2005) [ref 1] found that emissions from the closed, covered portions of landfills are negligible and are similar to background soil emission rates. Therefore, this methodology focuses on emissions from the working face of landfills.

4.2.2.1 *Activity Data*

The U.S. EPA's Landfill Methane Outreach Program (LMOP) maintains a database of the landfills in the United States with information on the total amount of waste in place, as well as the opening and closing years of the landfill and the county where the landfill is located [ref 2]. The average number of tons of waste each landfill receives is estimated by dividing the total waste in place by the number of years the landfill has been operating.

Only landfills that were open in 2011 are included in the analysis, since the method has not yet been updated for the 2014 inventory year.

4.2.2.2 *Allocation Approach*

The EPA LMOP database provides data at the county level.

4.2.2.3 *Emission Factor*

Lindberg et al. (2005) [ref 2], measured mercury emissions from the working face of four landfills in Florida and determined emission factors per ton of waste placed in a landfill annually, ranging from 1-6 mg per ton of waste. The average of these emission factors is 2.5 mg/ton of waste, or 5.51×10^{-6} lbs/ton of waste.

4.2.2.4 *Example Calculation*

The City of Durham landfill in Durham County, NC is estimated to receive approximately 144,000 tons of waste annually.

144,000 tons of waste × 5.51×10^{-6} lbs Hg/ton of waste = 0.79 lbs Hg emissions

4.2.3 EPA-Developed Emissions from Thermostats

Mercury has been used in thermostats to switch on or off a heater or air conditioner based on the temperature of a room. Most of the historic production of mercury thermostats came from three corporations: Honeywell, White-Rogers, and General Electric. In 1998, these corporations formed the Thermostat Recycling Corporation (TRC), a voluntary program that attempts to collect and recycle mercury thermostats as they come out of service.

4.2.3.1 *Activity Data*

The 2002 EPA report estimated that 2-3 million thermostats came out of service in 1994 [ref 3]. A 2013 report from a consortium of environmental groups assumes that the estimate from the 2002 report remains viable, and it estimates that the TRC collects at most 8% of the retired thermostats each year [ref 4]. Therefore, using this estimate, there are approximately 2.3 million thermostats that are not recycled each year.

4.2.3.2 *Allocation Approach*

The national-level mercury emissions are apportioned to each county based on 2011 population from the U.S. Census Bureau, except for 2010 population data used for the Virgin Islands.

4.2.3.3 *Emission Factor*

The 2002 EPA report estimates that there are 3 grams of mercury per thermostat [ref 3]. Cain et al. (2007) [ref 5] estimate that 1.5% of mercury in "control devices," including thermostats, is emitted to the air before it is disposed of at a landfill or incinerator. Therefore, the amount of mercury emitted is 0.045 grams per thermostat, or 9.9×10^{-5} lbs. per thermostat.

4.2.3.4 *Example Calculation*

2.3 million improperly disposed thermostats × 9.9×10^{-5} lbs per thermostat = 228 lbs mercury emissions

Shelby County, TN has 933,902 people, or 0.3% of the national population. The mercury emissions from thermostats in Shelby County, TN are estimated by the following:

$$228 \text{ lbs national mercury emissions} \times 0.3\% = 0.684 \text{ lbs mercury emissions}$$

4.2.4 EPA-Developed Emissions from Thermometers

Mercury thermometers have all but been phased out in the United States, with the U.S. EPA and National Institute of Standards and Technology (NIST) working to phase out mercury thermometers in industrial and laboratory settings. NIST issued a notice in 2011 that it would no longer calibrate mercury-in-glass thermometers for tracking purposes. The EPA issued a rule in 2012 that provides flexibility to use alternatives to mercury thermometers when complying with certain regulations pertaining to petroleum refining, power generation, and polychlorinated biphenyl (PCB) waste disposal [ref 6]. Furthermore, thirteen states have laws that limit the manufacture, sale, and/or distribution of mercury-containing fever thermometers [ref 6].

Nevertheless, given the historical prevalence of mercury thermometers, it is likely that a significant amount of mercury remains in thermometers in homes in the United States.

4.2.4.1 *Activity Data*

Data from the Northeast Waste Management Officials' Association (NEWMOA) Interstate Mercury Education and Reduction Clearinghouse (IMERC) database suggests that there were 713 lbs of mercury used in thermometers in 2007 [ref 7]. We assume that this value is held constant each year through 2011.

The U.S. EPA assumes that the average lifespan of a glass thermometer is 5 years, and that 5% of glass thermometers are broken each year [ref 3].[10] Therefore, if 713 lbs. of mercury are used in thermometers each year there would be an estimated 3,228 lbs of mercury remaining in thermometers in 2011 (accounting for the breakage rate each year).

NEWMOA [ref 7] estimates that during the period 2000-2006 there were 350 lbs of mercury from thermometers collected in recycling programs.

Therefore, there were 2,878 lbs (1.44 tons) of mercury available for release in 2011.

4.2.4.2 *Allocation Approach*

The national-level mercury emissions from thermometers are allocated to the county level based on 2011 population.

4.2.4.3 *Emission Factor*

Cain et al. (2007) [ref 5] estimates that 10% of mercury from thermometers is emitted to the air before disposal in a landfill, and Leopold (2002) [ref 3] estimates that 5% of thermometers are broken each year. Therefore, the emission factor is estimated to be 10 lbs of mercury emissions per ton of mercury in thermometers.

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[10] The US EPA does not explain what happens to the remaining 75% of unbroken thermometers after the estimated 5-year lifespan, but it does suggest that recycling, such as through Fisher Scientific's thermometer trade-in program, may account for some of the remaining thermometers.

4.2.4.4 *Example Calculation*

1.44 tons of mercury in broken thermometers × 10 lbs emissions per ton = 14.4 lbs of emissions

Boise County, ID has 7,028 people, or 0.0023% of the national population. The mercury emissions from broken thermometers for Boise County are estimated by the following:

14.4 lbs national emissions × 0.0023% = 0.00033 lbs emissions

4.2.5 EPA-Developed Emissions from Switches and Relays

Switches and relays make up the largest potential source of mercury from products that intentionally contain mercury. Mercury is an excellent electrical conductor and is liquid at room temperature, making it useful in a variety of products, including switches used to indicate motion or tilt, as the mercury will flow when the switch is in a certain position, completing the circuit.

While mercury switches in cars were phased out as of the 2002 model year, there are still millions of cars on the road that contain them, which are potential emissions sources when the cars are crushed and shredded during recycling at the end of their useful lives. The shredded material is then sent to an arc furnace to recycle the steel. To avoid double counting point source emissions from arc furnaces, this source category only includes an estimate of nonpoint emissions from crushing and shredding operations.

4.2.5.1 *Activity Data*

A 2011 report from the North Carolina Department of Environment and Natural Resources [ref 8] provides information on the estimated number of switches available for recovery in each state and the amount of switches actually recovered in 2011. There were 3.4 million mercury-containing automobile switches available nationwide in 2011 and 664,690 switches collected for recycling, for a collection rate of 19.4%. These nationwide estimates are supported by similar data from the Quicksilver Caucus [ref 9]. Therefore, there were approximately 2.7 million unrecycled automotive switches in 2011.

4.2.5.2 *Allocation Approach*

The number of unrecovered switches is apportioned to each county based on the number of car recycling facilities (NAICS 423930) from the 2011 U.S. Census Bureau County Business Patterns.

4.2.5.3 *Emission Factor*

The response to comments for the 2007 EPA Significant New Use Rule on Mercury Switches (72 FR 56903), suggests that the weighted average amount of mercury in switches is 1.2 grams (0.0026 lbs). A 2001 report by Griffith et al. [ref 10] shows that 60% of mercury in switches is released at the shredding operation, while 40% is sent to arc furnaces for smelting. Therefore, the emission factor for switches is 0.00156 lbs. per switch.

4.2.5.4 *Example Calculation*

Alabama had 80,892 unrecovered vehicle switches in 2011. Baldwin County, AL has 3 car recycling facilities, which represents 1.53% of the facilities in the state. Therefore, that county is apportioned switches as follows:

80,892 switches in AL × 1.53% = 1,238 switches in Baldwin County, AL

Emissions are estimated as follows:

1,238 switches × 0.00156 lbs/switch = 1.93 lbs Hg emissions

4.2.6 EPA-Developed Emissions for Human Cremation

The cremation of individuals with mercury fillings and mercury in blood and tissues can result in mercury emissions. Cremation is becoming increasingly popular, with 40.6% of individuals being cremated in 2010, up from 33% in 2006, according to the Cremation Association of North America (CANA) [ref 11].

4.2.6.1 *Activity Data*

The Centers for Disease Control and Prevention WONDER database contains information on the number of deaths in each county in each year for 13 different age groups through 2010 [ref 12]. Table 4-6 provides the data that we pulled from the WONDER database, which withheld data from some counties. Emission factor data is derived from the Bay Area Air Quality Management District (BAAQMD) [ref 13]. The county gaps were filled using the state totals (which included the number of deaths that were withheld at the county level). The difference between the state-level data and the sum of the reported county-level deaths was apportioned to the counties not included in the WONDER database based on their 2011 population.

The CANA data [ref 11] provides statistics on cremation rates by state as of 2010. It is assumed that the state-level cremation rate applies to all counties in the state.

Table 4-6: Comparison of age groups in the CDC WONDER database (activity data) and the BAAQMD memorandum

Age Groups in CDC WONDER Database	Age Groups in BAAQMD Memorandum	Avg. Material in Restored Teeth (g)	% of Fillings Containing Mercury	% of Mercury in Dental Amalgam
< 1 year	0-4 years*	0.000	0.0%	45.0%
1-4 years		0.160	31.6%	45.0%
5-9 years	5-14 years	0.720	31.6%	45.0%
10-14 years		0.720	31.6%	45.0%
15-19 years	15-24 years	1.070	31.6%	45.0%
20-24 years		1.070	50.0%	45.0%
25-34 years	25-34 years	2.230	50.0%	45.0%
35-44 years	35-44 years	3.290	62.5%	45.0%
45-54 years	45-54 years	4.310	62.5%	45.0%
55-64 years	55-64 years	4.320	75.0%	45.0%
65-74 years	65-74 years	3.780	75.0%	45.0%
75-84 years	75-84 years	3.650	75.0%	45.0%
85+ years	85+ years	2.960	75.0%	45.0%

* It is assumed that children under the age of 1 have no dental mercury.

4.2.6.2 *Allocation Approach*

The CDC WONDER database contains data at the county level. The CANA statistics on the cremation rate are at the state level, but it is assumed that this rate applies to all counties in the state.

4.2.6.3 *Emission Factor*

The Bay Area Air Quality Management District (BAAQMD) issued a memorandum calculating the average amount of dental mercury in each human in ten different age groups based on data from the CDC's National Health and Nutrition Examination Survey (NHANES) [ref 13]. The age groups from the BAAQMD memorandum match well with the age groups from the CDC WONDER database (Table 4-6).

The emission factors were developed using the NHANES data to determine the number of individuals in each age group with 1, 2, 3, or 4 or more restored teeth. These numbers were used along with a published report that estimated the average mass of material in tooth restorations used in 1, 2, 3, or 4 or more teeth to determine a weighted average mass of material in tooth restorations per individual in each age group [ref 14].

The approach then accounts for the fact that not all fillings are made with mercury. According to the American Dental Association [ref 15] more than 75% of restorations before the 1970s used dental amalgam, which declined to 50% by 1991. Using these numbers, it is assumed that 50% of the filled teeth for 20-34 age group contain amalgam, 62.5% of filled teeth in the 35-49% age group, and 75% of filled teeth for people over 50. The BAAQMD memorandum was used to estimate that 31.6% of filled teeth in the 1-19 age group contain amalgam. The analysis also assumes that 45% of all amalgam-containing fillings are mercury.

The BAAQMD memorandum states that their assumptions are conservative, and could result in an overestimation of mercury emissions given that the analysis assumes that none of the mercury initially placed in the teeth is lost over time, despite the fact that data shows some loss of mercury from dental restorations, though the rate of loss is dependent on many factors, including area, age, and composition of the amalgam.

In addition to the amount of mercury in teeth, Reindl [ref 16] estimates mercury emissions from blood and tissues (but not dental amalgam) from humans at 0.000132 lbs./cremation, assuming an average weight at cremation of 176 lbs.

4.2.6.4 *Example Calculations*

<u>Estimating mercury in teeth:</u>

There were 103 deaths in the 75-84 age group in Autauga County, AL in 2010. The emission factor for that age group is 1.6425 grams of mercury, or 0.0036 lbs., per cremated human. Alabama has a cremation rate of 17.2%. To calculate the mercury emissions from this age group, these numbers are multiplied together:

103 deaths in the 75-84 year age group × 17.2% cremation rate × 0.0027 lbs. Hg/cremation

= 0.047 lbs. Hg emissions for the 75-84 year age group in Autauga County, AL

<u>Estimating mercury in blood and tissues:</u>

103 deaths in the 75-84 year age group × 17.2% cremation rate × 0.000132 lbs. Hg/cremation

= 0.00233 lbs. Hg emissions for the 75-84 year age group in Autauga County, AL

<u>Total mercury emissions:</u>

0.047 + 0.00233 = 0.04933 lbs. Hg emissions

This is repeated for each age group in Table 4-6 in each county.

4.2.7 EPA-Developed Emissions for Animal Cremation

Animal tissues contain mercury, similar to humans. A 2012 survey from the Pet Loss Professionals Alliance [ref 17] found that 99% of deceased pets are cremated, with the remaining 1% receiving burial. Therefore, mercury from animal tissues through cremation can be a source of nonpoint mercury emissions.

4.2.7.1 *Activity Data*

The PLPA survey estimates that there were 1,840,965 pet cremations in 2012. In addition, the Humane Society of the United States [ref 18) estimates that there are 2,700,000 dogs and cats euthanized in animal shelters each year. It is assumed that all of these shelter animals are cremated. Therefore, there are a total of approximately 4,540,965 animal creations each year. Note that this estimate does not double count the number of animal cremations, because the PLPA study counts the number of cremations of pets—i.e. animals that are owned by people—whereas the Humane Society estimates are for animals in shelters that were not adopted.

The population of cats and dogs is approximately 52.5% cats and 48.5% dogs (Humane Society 2014). The average weight of a domestic cat is approximately 12.5 lbs [ref 19]. The average weight of a dog is difficult to determine due to large differences in breeds, but one estimate suggests it is 35 lbs. [ref 20]. Therefore, the total weight of cremated animals is approximately 53,441 tons.

4.2.7.2 *Allocation Approach*

The national-level mercury emissions from animal cremation are allocated to the county level based on 2011 human population.

4.2.7.3 *Emission Factor*

Emission factors for mercury emissions from animal cremations are not available from the literature. Reindl [ref 16) estimates mercury emissions from blood and tissues (but not dental amalgam) from humans at 0.0015 lbs/ton. This emission factor appears to be the most appropriate available emission factor for animals, given that it does not include dental amalgam. This approach assumes that pets have the same exposure, adsorption rates, and accumulation of Hg as humans, on average.

4.2.7.4 *Example Calculation*

Total mercury emissions from animal cremations:

$$53{,}441 \text{ tons cremated animals} \times 0.0015 \text{ lbs/ton} = 80.2 \text{ lbs mercury emissions}$$

Walla Walla County, Washington has 58,781 people, or 0.019% of the national population. The mercury emissions from animal cremations in Walla Walla are estimated by the following:

$$80.2 \text{ lbs national mercury emissions} \times 0.019\% = 0.015 \text{ lbs mercury emissions}$$

4.2.8 EPA-Developed Emissions for Dental Amalgam Production

Dental amalgam is used to fill cavities in teeth, and it is composed of approximately 45% mercury [ref 13]. The use of mercury in dental amalgam is declining, however, due to the increased popularity of composite fillings for teeth [ref 21]. Nevertheless, there is still a small amount of mercury emissions from dental amalgam in restored teeth. There are two potential sources of mercury emissions from dental amalgam: emissions from the preparation of amalgam in dental offices and a small amount of emissions directly from restored teeth.

4.2.8.1 *Activity Data*

The amount of amalgam prepared in dental offices was estimated using NEWMOA's IMERC database [ref 22], which estimates that 13.5 tons (27,000 lbs) of mercury in dental amalgam were used in 2011.

The amount of mercury emissions from restored teeth was estimated using data from the National Institutes of Health's National Institute of Dental and Craniofacial Research [ref 23], which provides estimates of the average number of filled teeth per person in three different age brackets: 20-34 years, 35-49 years, and 50-64 years. The number of filled teeth for other age groups was estimated using the CDC National Health and Nutrition Examination Survey (NHANES). Table 4-7 lists the average number of filled teeth per person by age group.

Table 4-7: Average number of filled teeth per person and percentage of fillings containing mercury by age group

Age Group	Average Number of Filled Teeth Per Person	Percentage of Fillings Containing Mercury
0-5	0.44	31.6
5-19	1.23	31.6
20-34	4.61	50.0
35-49	7.78	62.5
50-64	9.20	75.0
65+	6.47	75.0

According to the American Dental Association [ref 15] more than 75% of restorations before the 1970s used amalgam, which declined to 50% by 1991. Using these numbers, it is assumed that 50% of the filled teeth for 20-34 age group contain amalgam, 62.5% of filled teeth in the 35-49% age group, and 75% of filled teeth for people over 50. The BAAQMD memorandum was used to estimate that 31.6% of filled teeth in the 1-19 age group contain amalgam.

4.2.8.2 *Allocation Approach*

The emissions from dental office preparations were allocated to the county level based on 2011 population.

The emissions from filled teeth were allocated to each county by multiplying the county population by the proportion of the national population in each age group (from 2011 U.S. Census Bureau data, except 2010 vintage for Virgin Islands), the average number of filled teeth per person, and the percentage of fillings containing mercury (Table 4-6). The emissions were then added across age groups.

4.2.8.3 *Emission Factor*

U.S. EPA [ref 24] estimates that 2% of mercury used in dental offices is emitted to the air.

Richardson et al. [ref 25] estimate emissions from filled teeth of approximately 0.3 µg/day of mercury emissions per filled tooth, or 2.4×10^{-7} lbs. per year per filled tooth.

4.2.8.4 *Example Calculation*

<u>Emissions from dental office preparations:</u>

27,000 lbs Hg × 2% = 540 lbs emissions

Orleans Parish, LA has 360,692 people, representing 0.116% of the national population. The mercury emissions from dental office preparations in Orleans Parish are estimated by the following:

540 lbs national emissions × 0.116% = 0.63 lbs Hg mercury emissions from dental offices

Emissions from restored teeth:

Nationally, 13.28% of the population is in the 65+ age group. This age group has an average of 6.47 fillings per person, and 75% of their fillings contain mercury. The emissions from restored teeth in Orleans Parish, LA are estimated by the following:

360,692 people × 13.28% in 65+ age bracket × 6.47 fillings per person × 75% of fillings with mercury × 2.4×10^{-7} lbs per year per filled tooth

= 0.056 lbs mercury in the 65+ age bracket in Orleans Parish

This is repeated for each age group in Table 4-7 for each county.

4.2.9 EPA-Developed Emissions for Fluorescent Lamp Breakage (not recycled)

Fluorescent lights are a potentially significant source of mercury emissions. Although each lamp contains only a small amount of mercury, which has been decreasing in recent years, the increased demand for fluorescent lamps, particularly compact fluorescents, driven partly by the phase out of many types of incandescent bulbs from the Energy Independence and Security Act of 2007 (PL 110-140 § 321), could lead to increases in mercury emissions.

4.2.9.1 *Activity Data*

The most recent data from the Association of Lighting and Mercury Recyclers [ref 26] estimates that an average of 527 million mercury-containing lamps, including compact fluorescent lamps (CFLs) and high impact discharge (HID) lamps, were discarded or recycled each year from businesses and institutions and 142 million bulbs were discarded or recycled each year from residential users, for a total of approximately 668 million bulbs per year during the period 2001-2003.

The recycling rate for business and industrial use was 22.6% and for residential use it was 2.1% over the same period. The U.S. Department of Energy's CFL Market Profile indicates that for the period of 2007-2009 there were an average of 335 million CFLs sold each year [ref 27]. This suggests that CFLs make up approximately half (50.1%) of the discarded or recycled bulbs. In addition, the U.S. Geological Survey (USGS) estimates that high-intensity discharge (HID) bulbs account for 4% of the mercury-containing bulbs in use, which would suggest 26.7 million HID bulbs discarded or recycled each year [ref 28]. Linear fluorescent bulbs would make up the remainder of discarded or recycled mercury-containing bulbs, (306 million bulbs; 45.9%).

Taking into account recycling, this suggests that there are approximately 547 million mercury-containing lamps discarded at landfills each year.

4.2.9.2 *Allocation Approach*

The national-level mercury emissions from fluorescent lamp breakage are allocated to each county based on 2011 population.

4.2.9.3 *Emission Factor*

Cain et. al [ref 29] provides the most comprehensive materials flow analysis of mercury intentionally used in products. Their analysis estimates that 10% of all mercury used in fluorescent light bulbs is eventually released to the atmosphere after production and before disposal, with the majority being released during transport to the disposal facility.

The average amount of mercury in a CFL has been studied extensively, with the amount of mercury in each CFL commonly reported as 1.27–4.0 mg (2.63 mg average, Table 4-8). Linear fluorescent bulbs contain more mercury than CFLs, with a range of 8.3 to 12 mg per bulb (10.15 average, Table 4-9). Data from the USGS suggests that there is an average of 17 mg of mercury per HID bulb [ref 28].

Table 4-8: Mercury used in CFLs (mg/bulb) as determined by three different studies

Study	Average Amount of Mercury per CFL (mg)
Li and Jin [ref 30]	1.27
Katers et al. [ref 31]	4.00
Singhvi et al. [ref 32]	2.63
Average	**2.63**

Table 4-9: Mercury used in linear fluorescent bulbs (mg/bulb) as determined by two different studies

Study	Average Amount of Mercury per Linear Fluorescent Bulb (mg)
Aucott et al. [ref 33]	12.0
NEMA [ref 34]	8.3
Average	**10.2**

Therefore, the emission factor for CFLs would be:

$$2.63 \text{ mg per CFL} \times 10\% = 0.263 \text{ mg of emissions per CFL}$$

The emission factor for linear bulbs would be:

$$10.15 \text{ mg per linear bulb} \times 10\% = 1.015 \text{ mg per linear bulb}$$

The emission factor for HID bulbs would be:

$$17 \text{ mg per HID bulb} \times 10\% = 1.7 \text{ mg per HID bulb}$$

4.2.9.4 *Example Calculation*

Emissions from CFLs:

547 million discarded bulbs × 50.1% CFLs × 0.263 mg per CFL

= 72.07 million mg mercury emissions from CFLs

Emissions from linear bulbs:

547 million discarded bulbs × 45.9% linear bulbs × 1.015 mg per bulb

= 254.84 million mg mercury emissions from linear bulbs

Emissions from HID bulbs:

547 million discarded bulbs × 4% HID bulbs × 1.7 mg per bulb

= 37.20 million mg mercury emissions from HID bulbs

Total mercury emission from breakage of mercury-containing bulbs:

72.1 million mg + 254.8 million mg + 37.2 million mg = 364.1 million mg

= 364.1 kg

= 802.7 lbs mercury emissions

Weston County, WY was estimated to have 7,102 people in 2011, or 0.0023% of the national population. The emissions for Weston County are estimated as follows:

802.7 lbs national Hg emissions × 0.0023% of national population = 0.018 lb. Hg emissions

4.2.10 EPA-Developed Emissions for Fluorescent Lamp Breakage (recycling)

In addition to emissions of mercury from the breakage of fluorescent light bulbs (SCC 2861000000), there are a small amount of emissions from recycling fluorescent bulbs.

4.2.10.1 *Activity Data*

The activity data were previously described in Section 4.2.9.1. Taking into account recycling rates, this suggests that there were approximately 121 million mercury-containing lamps recycled in 2011.

4.2.10.2 *Allocation Approach*

The national-level mercury emissions from the recycling of mercury-containing lamps are allocated to each county based on 2011 population.

4.2.10.3 *Emission Factor*

The U.S. EPA (1997) has estimated an emission factor from mercury-containing bulb recycling of 0.00088 mg/lamp (1.9×10^{-9} lb./lamp).

4.2.10.4 *Example Calculation*

Emissions from recycling of mercury-containing bulbs:

121 million bulbs recycled × 1.9×10^{-9} lb/lamp = 0.23 lbs mercury emissions

Cumberland County, ME has a population of 281,674 people, or 0.091% of the national population. The emissions from the recycling of mercury-containing bulbs in Cumberland County, ME were estimated by the following:

$$0.23 \text{ lbs mercury emissions} \times 0.091\% = 0.00021 \text{ lbs mercury emissions}$$

4.2.11 EPA-Developed Emissions for General Laboratory Activities

Documentation for previous versions of the NEI have cited personal communications with USGS staff for estimates of the amount of mercury used in general laboratory activities. In discussions with Robert Virta of the USGS [ref 35], it was determined that because the USGS stopped conducting its survey of the end uses of mercury in the economy in 2002 it would be impossible to state with any confidence an estimate of the amount of mercury used in general laboratory activities in 2011. A literature search revealed no other data that could be used to estimate mercury emissions for this source category. Therefore, the estimate from the 2008 NEI was pulled forward for the 2011 NEI. The literature search has not been repeated for the 2014 NEI, and thus the 2008 estimates were intended to be pulled forwarded until additional data can be found. This was not done for 2014 v1 but will be corrected in 2014 v2. This category accounts for approximately 600 pounds of mercury of EPA-estimated mercury; however, as seen in Table 4-4, Minnesota and Illinois reported 40 cumulative pounds of mercury for this source in the 2014v1 NEI. These emissions, plus the EPA estimates for the remaining states will be included in 2014 v2.

4.2.12 Agency-reported emissions

Agency-reported emissions for all non-combustion nonpoint mercury sources were summarized in Table 4-5 in Section 4.2.1. Eight states, 1 local and 3 tribal agencies reported one or more of these nonpoint mercury sources for 2014 NEI.

4.2.13 References for nonpoint mercury sources

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4.3 Agriculture – Crops & Livestock Dust

4.3.1 Sector description

The SCCs that are in this sector for the 2014 NEI are provided in Table 4-10. The SCC level 1 description is “Miscellaneous Area Sources” for all SCCs. The EPA estimates emissions for fugitive dust emissions from agricultural tilling (SCC 2801000003), highlighted in the table; the methodology is described in Section 4.3.3.

Table 4-10: SCCs used in the 2014 NEI for the Agriculture – Crops & Livestock Dust sector

SCC	SCC Level 2	SCC Level 3	SCC Level 4
2801000000	Agriculture Production - Crops	Agriculture - Crops	Total
2801000003	Agriculture Production - Crops	Agriculture - Crops	Tilling
2801000005	Agriculture Production - Crops	Agriculture - Crops	Harvesting
2801000007	Agriculture Production - Crops	Agriculture - Crops	Loading
2801000008	Agriculture Production - Crops	Agriculture - Crops	Transport
2801600000	Agriculture Production - Crops	Country Grain Elevators	Total

4.3.2 Sources of data

The agricultural crops and livestock dust sector includes data from S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-11 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-11: Percentage of total PM Agricultural Tilling emissions submitted by reporting agency

Region	Agency	S/L/T	PM_{10}	$PM_{2.5}$
1	New Hampshire Department of Environmental Services	State	100	100
2	New Jersey Department of Environment Protection	State	100	100
3	Maryland Department of the Environment	State	100	100
4	Georgia Department of Natural Resources	State	2	0
4	Metro Public Health of Nashville/Davidson County	Local	100	
5	Illinois Environmental Protection Agency	State	100	100
7	Iowa Department of Natural Resources	State	100	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	100	100
8	Utah Division of Air Quality	State	4	3
9	California Air Resources Board	State	86	83
10	Coeur d'Alene Tribe	Tribe	100	100
10	Idaho Department of Environmental Quality	State	100	100
10	Kootenai Tribe of Idaho	Tribe	100	100
10	Nez Perce Tribe	Tribe	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100	100
10	Washington State Department of Ecology	State	100	100

4.3.3 EPA-developed emissions for Agricultural Tilling

4.3.3.1 *Source Category Description*

Fugitive dust emissions from agricultural tilling (SCC=2801000003) 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-PRI, PM10-FIL, PM25-PRI, and PM25-FIL. Since there is no condensable PM (PM-CON) emissions for this category, PM10-PRI emissions are equal to PM10-FIL emissions and PM25-PRI emissions are equal to PM25-FIL.

Particulate emissions from agricultural tilling were computed by multiplying a crop-specific emissions factor by an activity factor, as described below.

4.3.3.2 *Emission Factor Equation*

The county-level emission factors for agricultural tilling (in lbs per acre) are specific to the crop type and tilling method and were calculated using the following equation [ref 1, ref 2]:

$$EF = 4.8 \times k \times s^{0.6} \times p_{crop,tilling\ type}$$

where:

k = dimensionless particle size multiplier (PM_{10} = 0.21; $PM_{2.5}$ = 0.042),
s = silt content of surface soil (%), and
p = number of passes or tillings in a year for a given crop and tilling method.

The U.S. Department of Agriculture (USDA) and the National Cooperative Soil Survey define silt content of surface soil as the percentage of particles (mass basis) of diameter smaller than 50 micrometers (µm) found in the surface soil.[11] The soil sample data used to estimate county-level, average silt content values are from the National Cooperative Soil Survey Microsoft® Access® Soil Characterization Database [ref 3]. This database contains the most commonly requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities.

The EPA applied specific selection criteria to the database to ensure that all samples are comparable and relevant to this analysis. The selection criteria included selecting only samples taken inside the United States with a preparation code of S and a horizon top of zero centimeters or a master horizon of A or O. A preparation code of S signifies that the sample is the air-dried whole soil passing through a 3-inch sieve and a horizon top of zero or master horizon of A or O ensures that the sample is taken at the surface.

In some cases, the sample metadata did not indicate a county, but included latitude and longitude coordinates. In these cases, the state and county information were reverse geocoded from the coordinates and added to the sample entry in the database.

After gap-filling the missing state and county information, the average silt content for a county was calculated by summing the total silt content of all the samples in the county and dividing by the number of samples in the county. For counties without samples, the average silt content was calculated by summing the total silt content of soil samples in neighboring counties and dividing by the number of samples in the neighboring counties. If neighboring counties also lacked sample data, then the county was assigned the average silt value of soil samples within the state.

Table 4-12 shows the number of passes or tillings in a year for each crop for conservation use, no-till and conventional use [ref 4]. Mulch till and ridge till tillage systems are classified as conservation use, while 0 to 15 percent residue and 15 to 30 percent residue tillage systems are classified as conventional use.

[11] Note that this is different than the U.S. Environmental Protection Agency's definition that includes all particles (mass basis) of diameter smaller than 75 micrometers.

Table 4-12: Number of passes or tillings per year

Crop	Conservation Use	No-Till	Conventional Use
Barley	3	3	5
Beans	3	3	3
Canola	3	3	3
Corn	2	2	6
Cotton	5	5	8
Cover	1	1	1
Fallow	1	1	1
Fall-seeded/Winter Wheat	3	3	5
Forage	3	3	3
Hay	3	3	3
Oats	3	3	5
Peanuts	3	3	3
Peas	3	3	3
Permanent Pasture	0	0	1
Potatoes	3	3	3
Rice	5	5	5
Rye	3	3	5
Sorghum	1	1	6
Soybeans	1	1	6
Spring Wheat	1	1	4
Sugarbeets	3	3	3
Sugarcane	3	3	3
Sunflowers	3	3	3
Tobacco	3	3	3

4.3.3.3 *Activity data*

The basis of agricultural tilling emission estimates is the number of acres of crops tilled in each county by crop type and tillage type. These data were estimated based on data from the USDA *2012 Census of Agriculture* [ref 5]. The USDA Census of Agriculture reports acres harvested for a given crop at the county level, but does not provide tilling data for each crop type at the county level. To calculate acres harvested per tilling type for each crop, the breakdown of tilling types (conservation, no-till, and conventional) at the county-level was applied to the acres harvested for each crop type at the county level. The county-level tilling type data for 2012 was provided by the USDA upon request [ref 6].

Several counties had data for acres harvested by crop type from the USDA Census of Agriculture, but did not have acres for each tilling type. For these counties, we used the state percentages of conservation, no-till, and conventional tilling as a surrogate for county data.

The USDA Census of Agriculture redacts some county-level data to avoid disclosing data for individual farms. Missing county-level data for acres harvested by crop type and tilling type were calculated using the difference between the state and national level reported data and the sum of the county-level data by state.

Tilling data for permanent pasture followed a different methodology. Conventional tilling data were available for the state of Utah [ref 7]. A ratio of the conventional tilling acres to the total acres of permanent pasture for Utah was developed (0.0023) and applied to the total acreage data for permanent pasture from the *2012 Census of Agriculture* to determine the number of conventional tilled permanent pasture acres by county in other states. It is assumed that the remainder of the permanent pasture acres is not tilled, so the remaining distribution of permanent pasture acres was distributed to no till acres and conservation tilling acres were left as zero.

A summary of national-level acres tilled in 2012 for each tilling type are presented in Table 4-13.

Table 4-13: Acres tilled by tillage type, in 2012

Tillage system	**National (millions of) acres tilled in 2012**
No-Till	658.07
Conservation	162.19
Conventional	273.16
Total	**1,093.42**

4.3.3.4 *Example calculation*

The following equation was used to determine the emissions from agricultural tilling for 2012 [ref 1, ref 2]. The county-level activity data are the acres of land tilled for a given crop and tilling type. The equation is adjusted to estimate PM_{10} and $PM_{2.5}$ emissions using the following parameters: a particle size multiplier, the silt content of the surface soil, the number of tillings per year for a given crop and tilling type, and the acres of land tilled for a given crop and tilling type.

$$E = \Sigma c \times k \times s^{0.6} \times p_{crop,tilling\ type} \times a_{crop,tilling\ type}$$

where: *E* = PM10-FIL or PM25-FIL emissions

c = constant 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 passes or tillings in a year
a = acres of land tilled (activity data)

4.3.3.5 *Controls*

No controls were accounted for in the emission estimations.

4.3.3.6 *Changes from 2011 Methodology*

The 2008 emission estimates were based on data from the Conservation Technology Information Center's *National Crop Residue Management Survey* [ref 8]. This survey was discontinued in 2008; therefore, in 2014 the agricultural tilling emissions were created by applying growth factors to the 2008 agricultural tilling dataset. These growth factors were derived from state- level USDA statistics on various crop types.

The 2014 agricultural tilling emissions were estimated using data on harvested acres and tillage type obtained from the USDA's *2012 Census of Agriculture*. This included data on cover crop, fallow, and permanent pasture that were previously estimated using a top-down allocation approach based on farm numbers.

4.3.3.7 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the U.S. Virgin Islands, emissions are based on two proxy counties in Florida: Broward County (FIPS state county code = 12011) for Puerto Rico and Monroe County (FIPS = 12087) for the U.S. Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and U.S. Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.3.4 Summary of quality assurance methods and 2014 v2 issues

Metals for this sector were submitted by only one agency. The emissions were estimated using ratios of metals to $PM_{2.5}$. While these ratios were very small numbers; the resulting calculations gave very large amounts of metals. For example, the state-submitted emissions of Hg from agricultural tilling (for the one agency) was nearly 10 percent of the national mercury inventory. Because these data were not available for other states and because the resulting high emissions seemed extremely suspect, we did not include the state-submitted metals in the NEI.

For the 2014 NEI v2, review from a couple of agencies will lead to changes in methodology for this sector, where no-till passes will be increased and an expected drop in PM emissions will result. This update will be applied to all counties.

4.3.5 References for agricultural crops & livestock dust

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4.4 Agriculture – Fertilizer Application

4.4.1 Sector description

Fertilizer in this category refers to any nitrogen-based compound, or mixture containing such a compound, that is applied to land to improve plant fitness. The SCCs that compose this sector in 2014 NEI are provided in Table 4-14. The SCC level 1 description is "Miscellaneous Area Sources" for all SCCs. EPA-estimated emissions are for SCC 2801700099 and discussed in Section 4.4.3.

Table 4-14: Source categories for agricultural Fertilizer Application

SCC	SCC Level 2	SCC Level 3	SCC Level 4
2801700001	Agriculture Production - Crops	Fertilizer Application	Anhydrous Ammonia
2801700002	Agriculture Production - Crops	Fertilizer Application	Aqueous Ammonia
2801700003	Agriculture Production - Crops	Fertilizer Application	Nitrogen Solutions
2801700004	Agriculture Production - Crops	Fertilizer Application	Urea
2801700005	Agriculture Production - Crops	Fertilizer Application	Ammonium Nitrate
2801700006	Agriculture Production - Crops	Fertilizer Application	Ammonium Sulfate
2801700007	Agriculture Production - Crops	Fertilizer Application	Ammonium Thiosulfate
2801700010	Agriculture Production - Crops	Fertilizer Application	N-P-K (multi-grade nutrient fertilizers)
2801700011	Agriculture Production - Crops	Fertilizer Application	Calcium Ammonium Nitrate
2801700012	Agriculture Production - Crops	Fertilizer Application	Potassium Nitrate
2801700013	Agriculture Production - Crops	Fertilizer Application	Diammonium Phosphate
2801700014	Agriculture Production - Crops	Fertilizer Application	Monoammonium Phosphate
2801700015	Agriculture Production - Crops	Fertilizer Application	Liquid Ammonium Polyphosphate
2801700099	Agriculture Production - Crops	Fertilizer Application	Miscellaneous Fertilizers

4.4.2 Sources of data

The agricultural fertilizer application sector includes data from the S/L/T agencies and the default EPA-generated agricultural fertilizer emissions. The agencies listed in Table 4-15 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (totals of 100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-15: Percentage of total fertilizer application NH_3 emissions submitted by reporting agency

Region	Agency	S/L/T	Ammonia
4	Georgia Department of Natural Resources	State	58
5	Illinois Environmental Protection Agency	State	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100
9	California Air Resources Board	State	68
10	Coeur d'Alene Tribe	Tribe	100
10	Kootenai Tribe of Idaho	Tribe	100

Region	Agency	S/L/T	Ammonia
10	Nez Perce Tribe	Tribe	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100

4.4.3 EPA-developed emissions for fertilizer application

The approach to calculating emissions from this sector in 2014 is a completely new methodology. For 2014, the bidirectional version of CMAQ (v5.0.2) [ref 1] and the Fertilizer Emissions Scenario Tool for CMAQ FEST-C (v1.2) [ref 2] were used to estimate ammonia (NH_3) emissions from agricultural soils. These estimates were then loaded into EIS for use in the 2014 NEI. The approach to estimate 2014 fertilizer emissions consists of these steps:

- Run FEST-C and CMAQ model with bidirectional ("bidi") NH_3 exchange to produce year 2011 nitrate (NO_3) Ammonium (NH_4^+, including Urea), and organic (manure) nitrogen (N) fertilizer usage estimates, and gaseous ammonia NH_3 emission estimates respectively.
- Calculate county-level emission factors for 2011 as the ratio of bidirectional CMAQ NH_3 fertilizer emissions to FEST-C total N fertilizer application.
- Run FEST-C to produce year 2014 NO_3, NH_4^+ (including Urea), and organic (manure) nitrogen fertilizer usage estimates.
- Multiply county-level 2014 FEST-C total fertilizer estimates by the 2011 emission factors to estimate 2014 NH_3 emissions.
- Assign the 2014 NH_3 emissions to one SCC: "…Miscellaneous Fertilizers" (2801700099).

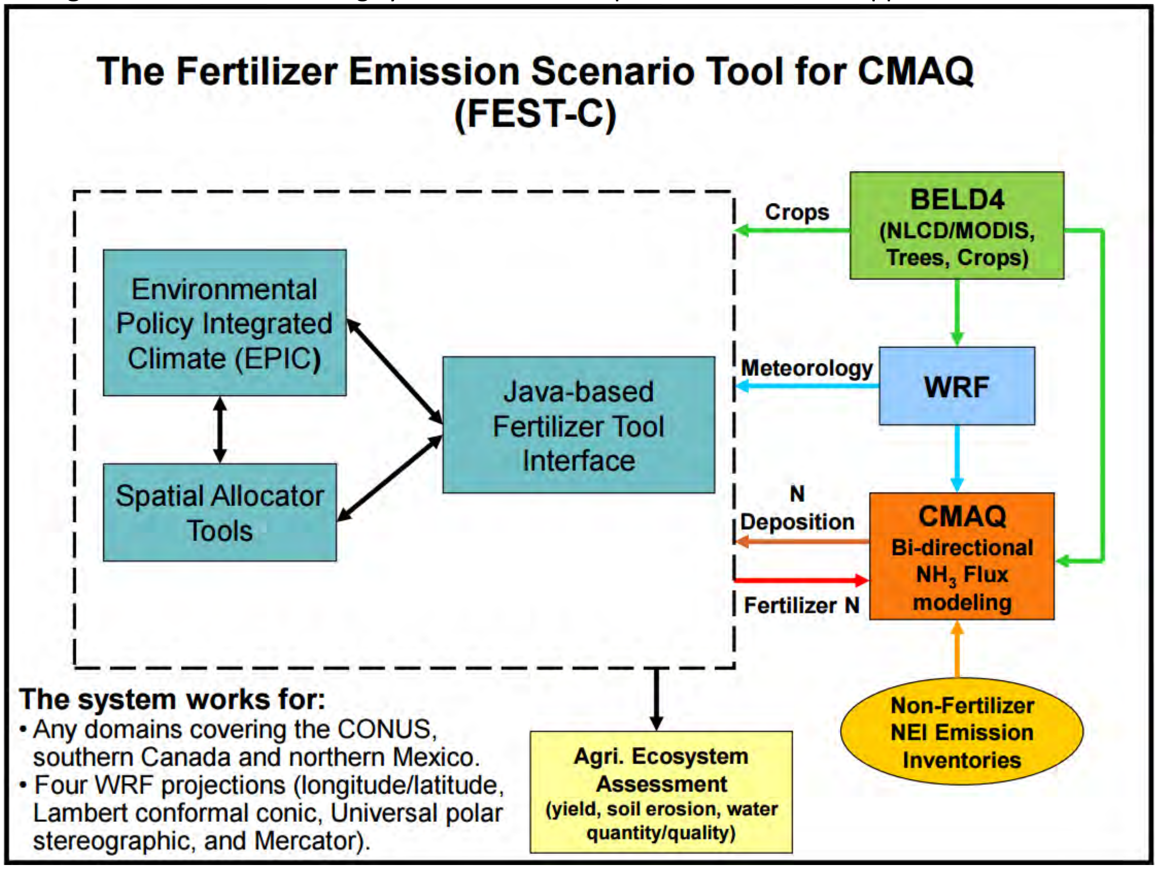
FEST-C reads land use data from the Biogenic Emissions Landuse Dataset (BELD) version 4, meteorological variables from the Weather Research and Forecasting (WRF v3.7.1) model [ref 3], and nitrogen deposition data from a previous or historical average CMAQ simulation. The Environmental Policy Integrated Climate (EPIC) modeling system [ref 4] provides information regarding fertilizer timing, composition, application method and amount.

The FEST-C and CMAQ model runs used to create emission factors were run for 2011 because one input to those runs is other sources of NH_3 emissions from non-fertilizer sources. Since the other 2014 emissions were not available prior to our need to generate these emissions, we used the next best available inventory year to perform this step. Thus, this approach includes an assumption that the per-county emission rates from 2011 are applicable in 2014. Since these emission rates depend on many variables including crop types and meteorological variables, this assumption may not be appropriate. Now that 2014 v1 NEI emissions are available to be input to CMAQ, the FEST-C emission rates could be regenerated based on 2014 inputs only to further refine the fertilizer estimates.

FEST-C model outputs are discussed in detail in the "NH3_Fert_Fact_Sheet_v2.docx" included in the zip file "*2014_Fertilizer_Application_v1.0_22apr2016.zip*" available at: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/

Figure 4-1 provides a comprehensive flowchart if the complete EPIC/FEST-C/WRF "bidi" modeling system.

Figure 4-1: "Bidi" modeling system used to compute 2014 Fertilizer Application emissions



4.4.3.1 *Activity Data*

The following activity parameters were input into the EPIC model:

- Grid cell meteorological variables from WRF (see Table 4-16)
- Initial soil profiles/soil selection
- Presence of 21 major crops: irrigated and rain fed hay, alfalfa, grass, barley, beans, grain corn, silage corn, cotton, oats, peanuts, potatoes, rice, rye, grain sorghum, silage sorghum, soybeans, spring wheat, winter wheat, canola, and other crops (e.g. lettuce, tomatoes, etc.)
- Fertilizer sales to establish the type/composition of nutrients applied
- Management scenarios for the 10 USDA production regions (Figure 4-2) [ref 5]

Figure 4-2: USDA farm production regions used in FEST-C simulations

We used the WRF meteorological model to provide grid cell meteorological parameters for 2014 using a national 12-km rectangular grid covering the continental U.S. The meteorological parameters in Table 4-16 were used as EPIC model inputs.

Table 4-16: Environmental variables needed for an EPIC simulation

EPIC input variable	Variable Source
Daily Total Radiation (MJ m^2)	WRF
Daily Maximum 2-m Temperature (C)	WRF
Daily minimum 2-m temperature (C)	WRF
Daily Total Precipitation (mm)	WRF
Daily Average Relative Humidity (unitless)	WRF
Daily Average 10-m Wind Speed (m s^{-1})	WRF
Daily Total Wet Deposition Oxidized N (g/ha)	CMAQ
Daily Total Wet Deposition Reduced N (g/ha)	CMAQ
Daily Total Dry Deposition Oxidized N (g/ha)	CMAQ
Daily Total Dry Deposition Reduced N (g/ha)	CMAQ
Daily Total Wet Deposition Organic N (g/ha)	CMAQ

Initial soil nutrient and pH conditions in EPIC are based on the 1992 USDA Soil Conservation Service (CSC) Soils-5 survey. The EPIC model then is run for 25 years using current fertilization and agricultural cropping techniques to estimate soil nutrient content and pH for the 2014 EPIC/WRF/CMAQ simulation.

The presence of crops in each model grid cell was determined through the use of USDA Census of Agriculture data (2012) and USGS National Land Cover data (2011). These two data sources were used to compute the fraction of agricultural land in a model grid cell and the mix of crops grown on that land.

Fertilizer sales data and the 6-month period in which they were sold were extracted from the 2006 Association of American Plant Food Control Officials (AAPFCO). AAPFCO data are used to identify the composition (e.g. urea, nitrate, organic) of the fertilizer used, and the amount applied is estimated using the modeled crop demand. These data are useful in making a reasonable assignment of what kind of fertilizer is being applied to which crops.

Management activity data refers to data used to estimate representative crop management schemes. We used the USDA Agricultural Resource Management Survey (ARMS) to provide management activity data. These data cover 10 USDA production regions and provide management schemes for irrigated and rain fed hay, alfalfa, grass, barley, beans, grain corn, silage corn, cotton, oats, peanuts, potatoes, rice, rye, grain sorghum, silage sorghum, soybeans, spring wheat, winter wheat, canola, and other crops (e.g. lettuce, tomatoes, etc.).

4.4.3.2 *Emission Factors*

The emission factors were derived from the 2011 FEST-C outputs. Total fertilizer emission factors for each month and county were computed by taking the ratio of total fertilizer NH_3 emissions (short tons) to total nitrogen fertilizer application (short tons).

12 km by 12 km gridded NH_3 emissions were mapped into a county shape file polygon if the grid level centroid falls within the bounds of the county-level polygon. With additional time and resources, spatial allocator technique could be refined to allow for more accurate county-level estimates.

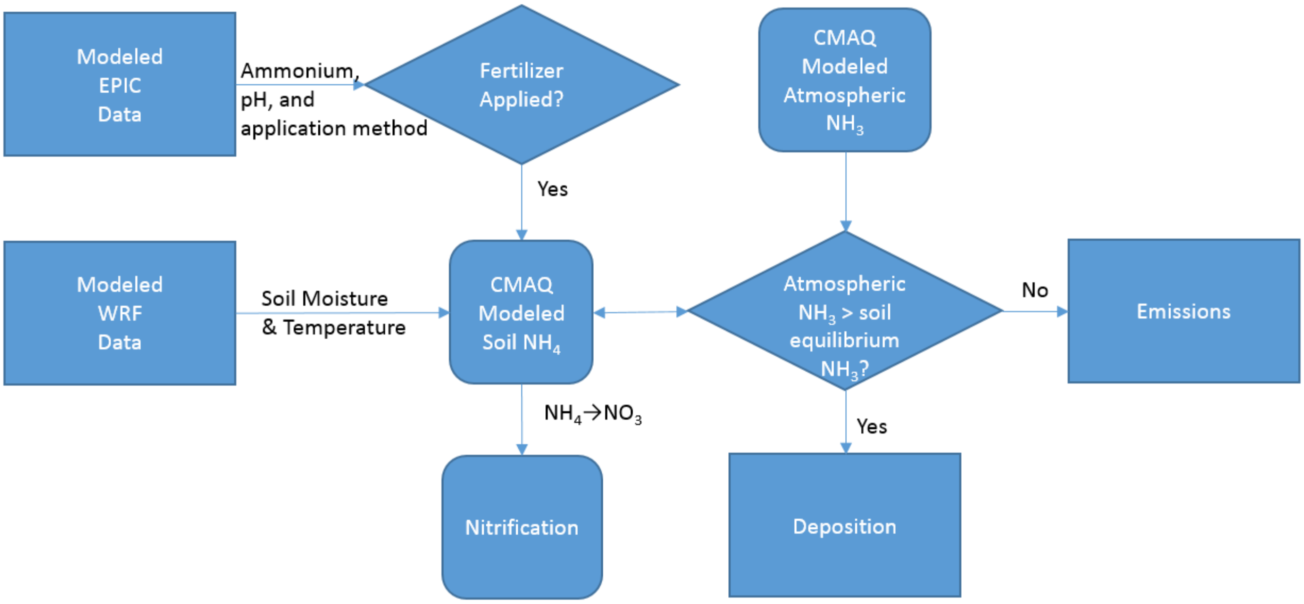
County-level fertilizer emissions (NH_3) for 2014 are computed as:

(2011 Fertilizer Emissions/2011 Total N Fertilizer) * 2014 Total N Fertilizer

4.4.3.3 *Example Calculation*

With this modeling system, it would be difficult to perform a sample calculation; this is not something that could be demonstrated in a spreadsheet. These emissions are computed via the full chemical transport model, as illustrated in Figure 4-3.

Figure 4-3: Simplified FEST-C system flow of operations in estimating NH_3 emissions



4.4.3.4 *Comparison to 2011 Methodology*

The 2014 fertilizer estimates are based on a new "bidi" approach that couples meteorological inputs, CMAQ and the EPIC modeling system. The 2011 v2 NEI fertilizer estimates are based on the Carnegie Mellon (CMU) Ammonia Model v.3.6. In short, the methodologies are completely different. Documentation of the methodology for the 2011 EPA dataset as well as the county-level data and maps are located in the zip file at:

ftp://ftp.epa.gov/EmisInventory/2011nei/doc/ag_fertilizer_application_2011.zip

For 2014, a comparison of the 2011 EPA data, 2014 EPA data, and 2011 NEI selection (EIS) as well as maps for those datasets are located in the zip file "*2014_Fertilizer_Application_v1.0_22apr2016.zip*" available at:

ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/

Emission maps for the 2011 v2 NEI and these 2014 estimates are provided below in Figure 4-4 and Figure 4-5, respectively. In addition, the "*Emissions_and_fertilizer_2011bidi_vs_2014bidi.xlsx*" Excel workbook provided in the previously mentioned 2014 zip file, includes the comparison of these 2014 county-level emissions (column N) to 2011 (not 2011 NEI) estimates (column H) using the "bid" approach. Comparisons to the 2011 NEI at the county-level to the "bidi" approach for 2011 are also available in the workbook "*ORD2011_NEI2011_EIS2011_Fertilizer_*NH3*_bycounty_compare_wREADME.xlsx*".

Figure 4-4: NEI 2011 Fertilizer Application emissions

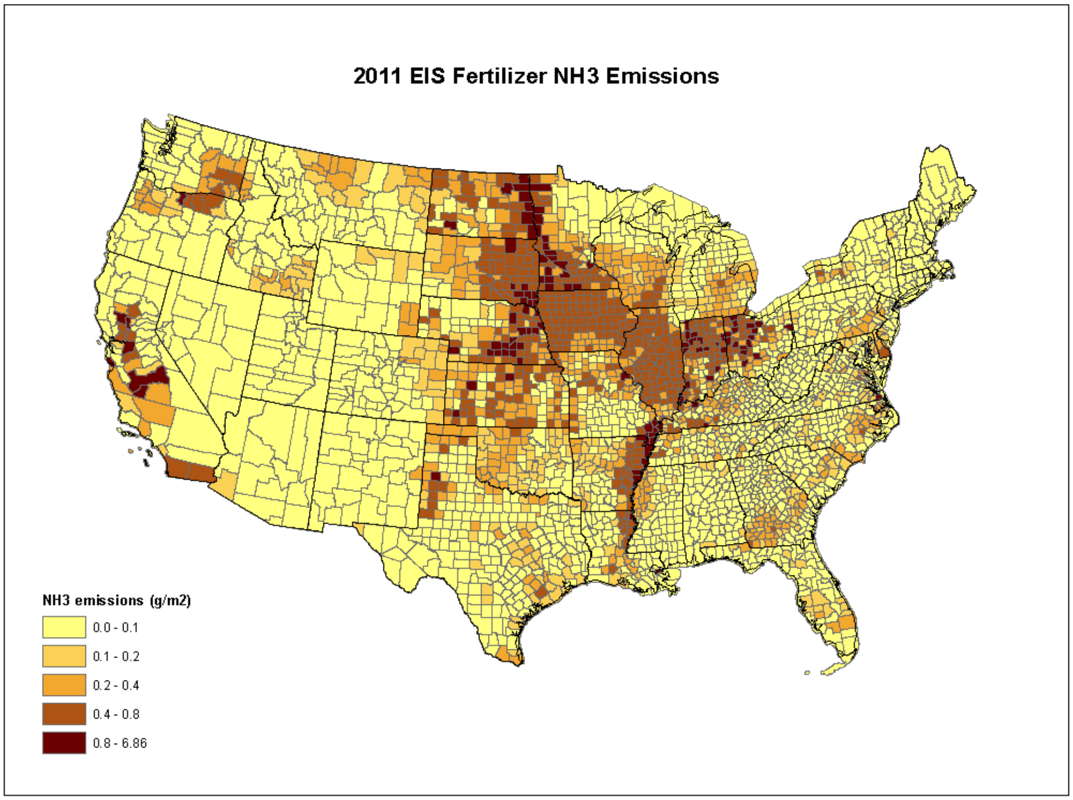
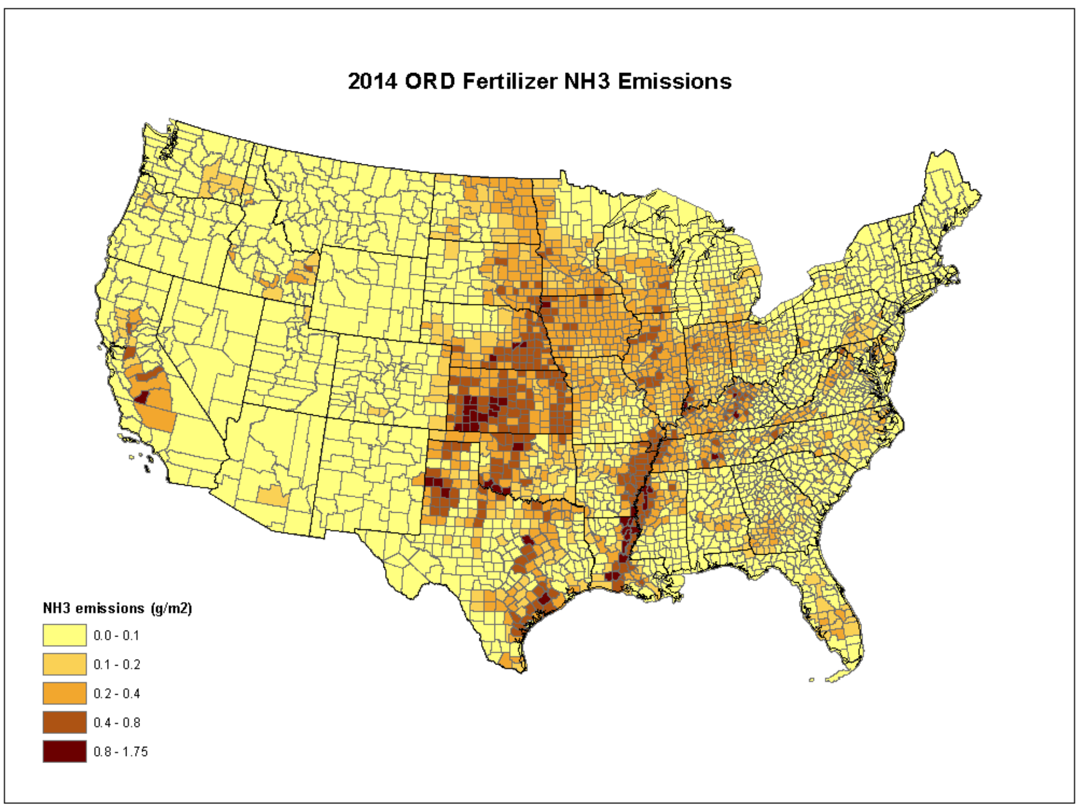


Figure 4-5: 2014 NEI "bidi" Fertilizer Application emissions



4.4.4 References for agriculture fertilizer application

1. Community Multiscale Air Quality (CMAQ v5.1) model, available at: https://www.cmascenter.org/
2. Fertilizer Emission Scenario Tool for CMAQ (FEST-C) system, available at: https://www.cmascenter.org/fest-c/
3. Weather Research Forecast (WRF) model, available at: http://www.wrf-model.org/index.php
4. Environmental Policy Integrated Climate (EPIC) model, available for download at: http://epicapex.tamu.edu/
5. Cooter, E.J., Bash, J.O., Benson V., Ran, L.-M.; Linking agricultural management and air-quality models for regional to national-scale nitrogen deposition assessments, Biogeosciences, 9, 4023-4035, 2012. Also available at: http://www.biogeosciences.net/9/4023/2012/

4.5 Agriculture – Livestock Waste

4.5.1 Sector description

The emissions from this category are primarily from domesticated animals intentionally reared for the production of food, fiber, or other goods or for the use of their labor. The livestock included in the EPA–estimated emissions include beef cattle, dairy cattle, ducks, geese, goats, horses, poultry, sheep, and swine. A few S/L/T agencies reported data from a few other categories in this sector such as domestic and wild animal waste, though these emissions are small compared to the livestock listed above. The domestic and wild animal waste emissions are not included for every state and not estimated by the EPA.

4.5.2 Sources of data

Table 4-17 shows the nonpoint SCCs covered by the EPA estimates and by the S/L/T agencies that submitted data. The SCC level 2, 3 and 4 descriptions are also provided. The SCC level 1 description is “Miscellaneous Area Sources” for all SCCs.

Table 4-17: Nonpoint SCCs with 2014 NEI emissions in the Livestock Waste sector

SCC	Description	EPA	State	Tribe
2805001100	Agriculture Production - Livestock; Beef cattle - finishing operations on feedlots (drylots); Confinement		X	X
2805001200	Agriculture Production - Livestock; Beef cattle - finishing operations on feedlots (drylots); Manure handling and storage		X	X
2805001300	Agriculture Production - Livestock; Beef cattle - finishing operations on feedlots (drylots); Land application of manure		X	X
2805002000	Agriculture Production - Livestock; Beef cattle production composite; Not Elsewhere Classified	X	X	X
2805003100	Agriculture Production - Livestock; Beef cattle - finishing operations on pasture/range; Confinement		X	X
2805007100	Agriculture Production - Livestock; Poultry production - layers with dry manure management systems; Confinement	X	X	X
2805007300	Agriculture Production - Livestock; Poultry production - layers with dry manure management systems; Land application of manure		X	X

SCC	Description	EPA	State	Tribe
2805008100	Agriculture Production - Livestock; Poultry production - layers with wet manure management systems; Confinement		X	X
2805008200	Agriculture Production - Livestock; Poultry production - layers with wet manure management systems; Manure handling and storage		X	X
2805008300	Agriculture Production - Livestock; Poultry production - layers with wet manure management systems; Land application of manure		X	X
2805009100	Agriculture Production - Livestock; Poultry production - broilers; Confinement	X	X	X
2805009200	Agriculture Production - Livestock; Poultry production - broilers; Manure handling and storage		X	X
2805009300	Agriculture Production - Livestock; Poultry production - broilers; Land application of manure		X	X
2805010100	Agriculture Production - Livestock; Poultry production - turkeys; Confinement		X	X
2805010200	Agriculture Production - Livestock; Poultry production - turkeys; Manure handling and storage		X	X
2805010300	Agriculture Production - Livestock; Poultry production - turkeys; Land application of manure		X	X
2805018000	Agriculture Production - Livestock; Dairy cattle composite; Not Elsewhere Classified	X	X	X
2805019100	Agriculture Production - Livestock; Dairy cattle - flush dairy; Confinement		X	X
2805019200	Agriculture Production - Livestock; Dairy cattle - flush dairy; Manure handling and storage		X	X
2805019300	Agriculture Production - Livestock; Dairy cattle - flush dairy; Land application of manure		X	X
2805020002	Agriculture Production - Livestock; Cattle and Calves Waste Emissions; Beef Cows		X	X
2805021100	Agriculture Production - Livestock; Dairy cattle - scrape dairy; Confinement		X	X
2805021200	Agriculture Production - Livestock; Dairy cattle - scrape dairy; Manure handling and storage		X	X
2805021300	Agriculture Production - Livestock; Dairy cattle - scrape dairy; Land application of manure		X	X
2805022100	Agriculture Production - Livestock; Dairy cattle - deep pit dairy; Confinement		X	X
2805022200	Agriculture Production - Livestock; Dairy cattle - deep pit dairy; Manure handling and storage		X	X
2805022300	Agriculture Production - Livestock; Dairy cattle - deep pit dairy; Land application of manure		X	X
2805023100	Agriculture Production - Livestock; Dairy cattle - drylot/pasture dairy; Confinement		X	X

SCC	Description	EPA	State	Tribe
2805023200	Agriculture Production - Livestock; Dairy cattle - drylot/pasture dairy; Manure handling and storage		X	X
2805023300	Agriculture Production - Livestock; Dairy cattle - drylot/pasture dairy; Land application of manure		X	X
2805025000	Agriculture Production - Livestock; Swine production composite; Not Elsewhere Classified (see also 28-05-039, -047, -053)	X	X	X
2805030000	Agriculture Production - Livestock; Poultry Waste Emissions; Not Elsewhere Classified (see also 28-05-007, -008, -009)		X	X
2805030007	Agriculture Production - Livestock; Poultry Waste Emissions; Ducks	X	X	X
2805030008	Agriculture Production - Livestock; Poultry Waste Emissions; Geese	X	X	X
2805035000	Agriculture Production - Livestock; Horses and Ponies Waste Emissions; Not Elsewhere Classified	X	X	X
2805039100	Agriculture Production - Livestock; Swine production - operations with lagoons (unspecified animal age); Confinement		X	X
2805039200	Agriculture Production - Livestock; Swine production - operations with lagoons (unspecified animal age); Manure handling and storage		X	X
2805039300	Agriculture Production - Livestock; Swine production - operations with lagoons (unspecified animal age); Land application of manure		X	X
2805040000	Agriculture Production - Livestock; Sheep and Lambs Waste Emissions; Total	X	X	X
2805045000	Agriculture Production - Livestock; Goats Waste Emissions; Not Elsewhere Classified	X	X	X
2805047100	Agriculture Production - Livestock; Swine production - deep-pit house operations (unspecified animal age); Confinement		X	X
2805047300	Agriculture Production - Livestock; Swine production - deep-pit house operations (unspecified animal age); Land application of manure		X	X
2805053100	Agriculture Production - Livestock; Swine production - outdoor operations (unspecified animal age); Confinement		X	X
2806010000	Domestic Animals Waste Emissions; Cats; Total		X	
2806015000	Domestic Animals Waste Emissions; Dogs; Total		X	
2807020001	Wild Animals Waste Emissions; Bears; Black Bears		X	
2807020002	Wild Animals Waste Emissions; Bears; Grizzly Bears		X	
2807025000	Wild Animals Waste Emissions; Elk; Total		X	
2807030000	Wild Animals Waste Emissions; Deer; Total		X	

Table 4-18 presents the five “Industrial Processes” point SCCs reported by 3 states: California, Wisconsin and Colorado. Point source emissions from this sector are negligible, particularly for NH_3, compared to the nonpoint emissions (3 orders of magnitude lower). The SCC level 1 and 2 descriptions is “Industrial Processes; Food and Agriculture” for all SCCs.

Table 4-18: Point SCCs with 2014 NEI emissions in the Livestock Waste sector – reported only by States

SCC	SCC Level Three	SCC Level Four	CA	CO	WI
30202001	Beef Cattle Feedlots	Feedlots: General	X	X	X
30202020	Dairy Cattle	Enteric, Confinement, Manure Handling, Storage, Land Application	X		
30202070	Silage pile - AFO	Storage and Handling	X		
30202080	Silage TMR - AFO	Storage and Handling	X		
30202101	Eggs and Poultry Production	Manure Handling: Dry	X	X	

The agencies listed in Table 4-19 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-19: Percentage of total Livestock NH_3 emissions submitted by reporting agency

Region	Agency	S/L/T	Ammonia
1	Maine Department of Environmental Protection	State	34
2	New Jersey Department of Environment Protection	State	82
4	Georgia Department of Natural Resources	State	77
5	Illinois Environmental Protection Agency	State	99
6	United Keetoowah Band of Cherokee Indians in Oklahoma	Tribe	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100
8	Utah Division of Air Quality	State	22
9	California Air Resources Board	State	40
10	Coeur d'Alene Tribe	Tribe	100
10	Idaho Department of Environmental Quality	State	100
10	Kootenai Tribe of Idaho	Tribe	100
10	Nez Perce Tribe	Tribe	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100

4.5.3 EPA-developed livestock waste emissions data

In the 2014 NEI, the EPA has updated the methodology for ammonia emissions from the housing/grazing, storage and application of manure from beef cattle, dairy cattle, swine, broiler chicken, and layer chicken production, assigned to the SCCs listed in Table 4-20. The SCC level 1 and 2 descriptions is “Miscellaneous Area Sources; Agriculture Production - Livestock” for all SCCs.

Table 4-20: EPA-estimated livestock emission SCCs

SCC	SCC Level 3 Description	SCC Level 4 Description
2805002000	Beef cattle production composite	Not Elsewhere Classified
2805007100	Poultry production - layers with dry manure management systems; Confinement	Confinement
2805009100	Poultry production - broilers; Confinement	Confinement
2805018000	Dairy cattle composite	Not Elsewhere Classified
2805025000	Swine production composite	Not Elsewhere Classified

The approach to estimate 2014 livestock NH_3 emissions from these animals consists of these general steps:

- Estimate 2014 county-level animal populations using 2012 and 2014 USDA agricultural census data.
- Use a model developed by CMU [ref 1, ref 2, ref 3, ref 4] to produce daily-resolved, climate-level (location and practice specific with respect to meterology and animal type see Figure 4-6) emission factors for a particular distribution of management practices for each county and animal type, as expressed as emissions/animal.
- Multiply the county animal populations by the daily emission factor for each county and animal type to estimate emissions per day. Sum daily emissions across the entire year for each county and SCC to produce annual emissions for use in the NEI.

Cows, swine and chickens account for 95% of national NH_3 emissions from livestock waste in 2014. However, there are also emissions from other animals such as horses, turkeys, goats, etc. Due to resource constraints at EPA, 2014 emissions were not updated for several animal types and are assumed to be the same as 2011 emissions, except in cases where S/L/T agencies provided updated 2014 emissions for these sources. These EPA-estimated emissions, carried forward from the 2011 NEI, are listed in Table 4-21. The SCC level 1 and 2 descriptions is "Miscellaneous Area Sources; Agriculture Production - Livestock" for all SCCs.

Table 4-21: EPA-estimated sources carried forward from 2011

SCC	SCC Level 3 Description	SCC Level 4 Description
2805030007	Poultry Waste Emissions	Ducks
2805030008	Poultry Waste Emissions	Geese
2805035000	Horses and Ponies Waste Emissions	Not Elsewhere Classified
2805040000	Sheep and Lambs Waste Emissions	Total
2805045000	Goats Waste Emissions	Not Elsewhere Classified

4.5.3.1 *Activity Data*

Animal populations for cows, swine and chickens were taken from the 2012 USDA county-level animal census. For Virginia, the county-level census data includes animal populations from Virginia's 39 independent cities. The county-level inventory is only completed once every 5 years, so 2014 population was estimated by adjusting each county's population by the fraction which the state population had changed since 2012 (because state-level data is collected every year).

Counties that had zero animals of a particular type were listed as such. There are some counties for which no population data are available from USDA, which indicates that there was only one farm of a particular animal type in that county. In these counties, animal populations were estimated based on the state total animal population not allocated to an individual county divided by the number of counties in that state with no data. This is demonstrated in equation 1 below.

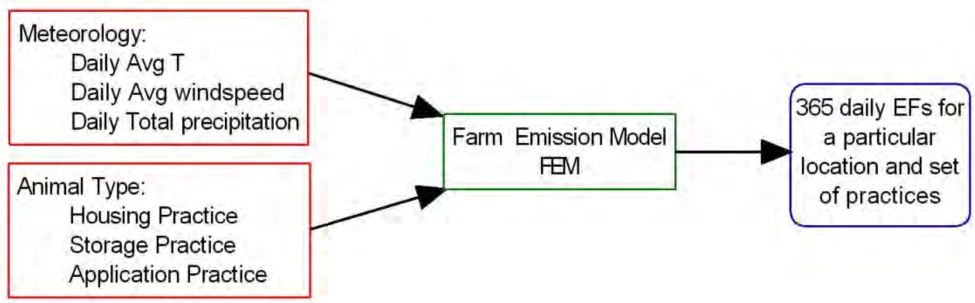
$$Missing\ county\ population = \frac{Total\ State\ population - \sum_{i=1}^{\#\ counties\ w/data} population_i}{number\ of\ missing\ counties} \qquad (1)$$

4.5.3.2 *Emission Factors*

CMU developed a new model to estimate daily ammonia emission factors for cows, swine and chickens. The model estimates emissions from a typical farm, using a particular set of practices, for a particular set of meteorological conditions [refs 1-3]. The model estimates the mass balance of nitrogen through the farm system, accounting for nitrogen lost to the atmosphere and infiltrated into the soil.

The model inputs and outputs are shown in Figure 4-6.

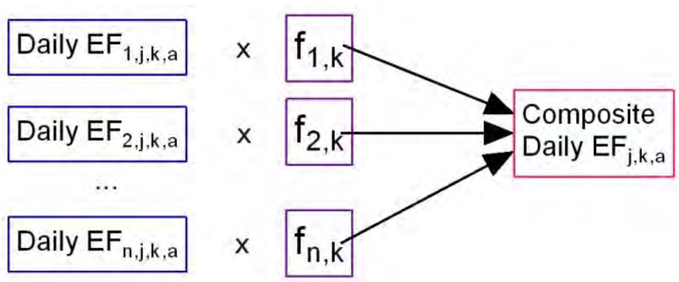
Figure 4-6: Process to produce location and practice specific daily emission factors



The calculation procedure to translate the output for a particular farm/farm configuration is shown in Figure 4-7. The US distribution of management practices is based on reports from the NAHMS (National Animal Health Monitoring Study) [ref 4 – ref 16]:

Management Practice	Reference(s)
Swine	5, 15, 16
Dairy	6, 7
Beef	10
Poultry	4, 9, 14
Layers	12, 13
Feedlots	8, 11

Figure 4-7: Composite emission factors for a specific day, location, and animal type



County-level emissions for a particular animal type for a particular day were calculated as shown in Equation 2.

$$Emissions_{j,k,a}\left(\frac{kg}{d \cdot county}\right) = Daily\ EF_{j,k,a} \times Population_{k,a} \qquad (2)$$

The total emissions in any given day were then be calculated by adding up all the emissions in each county for all animal types. This is shown in Equation 3.

$$Emissions_{j,k}\left(\frac{kg}{d \cdot county}\right) = \sum_{a=1}^{all\ animal\ types} Emissions_{j,k,a}\left(\frac{kg}{d \cdot county}\right) \qquad (3)$$

Total annual emissions for each location were calculated by summing the daily emissions over the entire year; this is described in Equation 4.

$$Emissions_{k}\left(\frac{kg}{y}\right) = \sum_{j=1}^{365} Emissions_{j,k}\left(\frac{kg}{d \cdot county}\right) \qquad (4)$$

The calculation that was completed for total annual emissions (for all animal types and all locations) is shown in Equation 5.

$$Emissions_{total}\left(\frac{kg}{y}\right) = \sum_{k=1}^{US\ Counties} Emissions_{k}\left(\frac{kg}{d \cdot county}\right) \qquad (5)$$

4.5.3.3 *Example Calculation*

Allocation of Populations to 2014 State Inventory

From the 2012 Census of Agriculture [ref 17], the total number of hogs in Arkansas is 109,316. In the 2014 state census [ref 18], the number of hogs had increased to 115,000. The change between 2012 and 2014 is calculated as

Change between 2014 and 2012 Arkansas hog population = (115,000 /109,316) = 1.052

From the 2012 Census of Agriculture, the total number of hogs in Boone County, Arkansas was 66. The 2014 population was estimated based on the statewide change in population between 2012 and 2014, multiplied by the 2012 county hog population.

Hog population in 2014 = 66 * 1.052 = 69

Allocation of Undisclosed Data

From the 2012 Census of Agriculture, the total national number of beef cattle in Arizona is 911,334. The total number of beef cattle disclosed at the county-level is 778,378.

Total number of beef cattle undisclosed at the county-level = 911,334 – 778,378 = 132,956

From the 2012 Census of Agriculture, the total number of farms in Arizona not disclosing beef cattle numbers is 2 (Yuma and Mohave counties). Therefore, the beef cattle undisclosed at the county level is allocated equally between these two counties.

Total number of beef cattle in Yuma county = 132,956 / 2 = 66,478

Calculation of Emissions

The Daily EF for each state is calculated based on the statewide housing, storage and application practices, combined with temperature, wind speed and precipitation information. For example, in Arizona beef farms, emissions were 0.012 kg of Ammonia per head on 1/1/2014, but due to weather changes that EF increased to 0.016 kg/head on 1/2/2014. To estimate Apache County, Arizona daily emissions, multiply the daily emissions factor with the 2014 beef population.

1/1/2014 Ammonia Emissions in Apache County = 32,682 head * 0.012 kg/head = 401.2 kg

This calculation is repeated for every day with the different daily emissions factor to estimate total ammonia emissions for the county.

4.5.3.4 *Comparison to 2011 methodology*

The NEI 2011v2 EPA methodology was mostly based on the CMU Ammonia Model v. 3.6 which attributed monthly emissions as a function of temperature to calculate ammonia emissions with county-level animal populations and emission factors. The EPA did modify some of the emission factors from the original model for the 2011 NEI. Additional documentation for the 2011 inventory can be found at: https://www.epa.gov/sites/production/files/2015-10/documents/nei2011v2_tsd_14aug2015.pdf

In contrast, the 2014 emissions inventory for dairy and beef cattle, hogs and poultry are based on the daily emission factors for a regionally specific distribution of manure management practices. 2014 emissions for all other animals are unchanged from 2011 methodology.

4.5.4 References for agriculture livestock waste

1. Pinder, R., Strader, R., Davidson, C. & Adams, P. A temporally and spatially resolved ammonia emission inventory for dairy cows in the United States. Atmos. Environ. 38.23, 3747–3756 (2004).
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4.6 Nonpoint Gasoline Distribution

This section includes discussion of all nonpoint sources in three EIS sectors: Bulk Gasoline Terminals, Gas Stations, and Industrial Processes – Storage and Transfer. Many of the sources in these sectors include sources reported to the point inventory as well; therefore, the EPA nonpoint survey is useful to avoid double-counting S/L/T-reported point emissions with EPA-estimated nonpoint emissions.

4.6.1 Description of sources

This section is broken into two categories: those sources related to Stage 1 gasoline distribution, and those related to aviation gasoline.

4.6.1.1 Stage 1 Gasoline Distribution

Stage 1 gasoline distribution is covered by the 2014 NEI in both the point and nonpoint data categories. In general terms, Stage 1 gasoline distribution is the emissions associated with gasoline handling excluding emissions from refueling activities. Stage 1 gasoline distribution includes the following gasoline-specific emission sources: 1) bulk terminals; 2) pipeline facilities; 3) bulk plants; 4) tank trucks; and 5) service stations (which can be further subdivided into Filling and Breathing & Emptying). Emissions from Stage 1 gasoline distribution occur as gasoline vapors are released into the atmosphere. These stage 1 processes are subject to the EPA's maximum available control technology (MACT) standards for gasoline distribution.

Emissions from gasoline distribution at bulk terminals and bulk plants take place when gasoline is loaded into a storage tank or tank truck, from working losses (for fixed roof tanks), and from working losses and roof seals (for floating roof tanks). Working losses consist of both breathing and emptying losses. Breathing losses are the expulsion of vapor from a tank vapor space that has expanded or contracted because of daily changes in temperature and barometric pressure; these emissions occur in the absence of any liquid level change in the tank. Emptying losses occur when the air that is drawn into the tank during liquid removal saturates with hydrocarbon vapor and expands, thus exceeding the fixed capacity of the vapor space and overflowing through the pressure vacuum valve.

Emissions from tank trucks in transit occur when gasoline vapor evaporates from (1) loaded tank trucks during transportation of gasoline from bulk terminals/plants to service stations, and (2) empty tank trucks returning from service stations to bulk terminals/plants. Pipeline emissions result from the valves and pumps found at pipeline pumping stations and from the valves, pumps, and storage tanks at pipeline breakout stations. Stage 1 gasoline distribution emissions also occur when gasoline vapors are displaced from storage tanks during unloading of gasoline from tank trucks at service stations (Gasoline Service Station Unloading) and from gasoline vapors evaporating from service station storage tanks and from the lines going to the pumps (Underground Storage Tank Breathing and Emptying).

4.6.1.2 *Aviation Gasoline, Stage 1 and 2*

Aviation gasoline is another piece of the Gasoline Distribution grouping in the NEI, and fall under the sector "gas stations." It is the only aviation fuel that contains lead as a knock-out component for small reciprocating, piston-engine crafts in civil aviation. Commercial and military aviation rarely use this fuel. Aviation Gasoline is shipped to airports and is filled into bulk terminals, and then into tanker trucks. These processes fall under the definition of stage 1, displacement vapors during the transfer of gasoline from tank trucks to storage tanks, and vice versa. These processes are subject to EPA's maximum available control technology (MACT) standards for gasoline distribution. Stage 2, on the other hand, involves the transfer of fuel from the tanker trucks into general aviation aircraft.

4.6.2 Sources of data

Sources in the EIS sectors for Bulk Gasoline Terminals, Gas Stations, and Industrial Processes – Storage and Transfer do not focus solely on gasoline; however, for the purposes of developing the NEI, these SCCs are the only ones that EPA estimates in these sectors. EPA does not develop calculation tools that estimate emissions from transfer of naphtha, distillate oil, inorganic chemicals, kerosene, residual oil, or crude oil. Therefore, sector level emissions for these three EIS sectors will include sources not related to gasoline distribution, some from the point inventory.

Table 4-22 shows all non-Aviation Gasoline SCCs in the nonpoint data category for EIS sectors Bulk Gasoline Terminals, Gas Stations, and Industrial Processes – Storage and Transfer. For Stage 1 Gasoline Distribution, the nonpoint SCCs covered by the EPA estimates are also noted. Table 4-23 shows, for Aviation Gasoline, the nonpoint SCCs covered by the EPA estimates and by the S/L/T agencies that submitted data. The SCC level 2, 3 and 4 SCC descriptions are also provided. The SCC level 1 description is "Storage and Transport" for all SCCs in both tables.

Table 4-22: Nonpoint Bulk Gasoline Terminals, Gas Stations, and Storage and Transfer SCCs with 2014 NEI emissions

SCC	Description	Sector	EPA	State	Local	Tribe
2501000150	Petroleum and Petroleum Product Storage; All Storage Types: Breathing Loss; Jet Naphtha	Industrial Processes - Storage and Transfer		X		
2501050120	Petroleum and Petroleum Product Storage; Bulk Terminals: All Evaporative Losses; Gasoline	Bulk Gasoline Terminals	X	X	X	
2501055120	Petroleum and Petroleum Product Storage; Bulk Plants: All Evaporative Losses; Gasoline	Bulk Gasoline Terminals	X	X	X	
2501060050	Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Total	Gas Stations		X		
2501060051	Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Submerged Filling	Gas Stations	X	X	X	
2501060052	Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Splash Filling	Gas Stations	X	X		X
2501060053	Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Balanced Submerged Filling	Gas Stations	X	X	X	X
2501060201	Petroleum and Petroleum Product Storage; Gasoline Service Stations; Underground Tank: Breathing and Emptying	Gas Stations	X	X	X	X
2501070053	Petroleum and Petroleum Product Storage; Diesel Service Stations; Stage 1: Balanced Submerged Filling	Gas Stations		X		X
2501070201	Petroleum and Petroleum Product Storage; Diesel Service Stations; Underground Tank: Breathing and Emptying	Gas Stations				X
2501995120	Petroleum and Petroleum Product Storage; All Storage Types: Working Loss; Gasoline	Industrial Processes - Storage and Transfer		X		
2501995180	Petroleum and Petroleum Product Storage; All Storage Types: Working Loss; Kerosene	Industrial Processes - Storage and Transfer		X		

SCC	Description	Sector	EPA	State	Local	Tribe
2505000120	Petroleum and Petroleum Product Transport; All Transport Types; Gasoline	Industrial Processes - Storage and Transfer		X		
2505010000	Petroleum and Petroleum Product Transport; Rail Tank Car; Total: All Products	Industrial Processes - Storage and Transfer		X		
2505020000	Petroleum and Petroleum Product Transport; Marine Vessel; Total: All Products	Industrial Processes - Storage and Transfer		X		
2505020030	Petroleum and Petroleum Product Transport; Marine Vessel; Crude Oil	Industrial Processes - Storage and Transfer		X		
2505020060	Petroleum and Petroleum Product Transport; Marine Vessel; Residual Oil	Industrial Processes - Storage and Transfer		X		
2505020090	Petroleum and Petroleum Product Transport; Marine Vessel; Distillate Oil	Industrial Processes - Storage and Transfer		X		
2505020120	Petroleum and Petroleum Product Transport; Marine Vessel; Gasoline	Industrial Processes - Storage and Transfer		X		
2505020150	Petroleum and Petroleum Product Transport; Marine Vessel; Jet Naphtha	Industrial Processes - Storage and Transfer		X		
2505020180	Petroleum and Petroleum Product Transport; Marine Vessel; Kerosene	Industrial Processes - Storage and Transfer		X		
2505020900	Petroleum and Petroleum Product Transport; Marine Vessel; Tank Cleaning	Industrial Processes - Storage and Transfer		X		
2505030120	Petroleum and Petroleum Product Transport; Truck; Gasoline	Industrial Processes - Storage and Transfer	X	X	X	X
2505040120	Petroleum and Petroleum Product Transport; Pipeline; Gasoline	Industrial Processes - Storage and Transfer	X	X		
2510000000	Organic Chemical Storage; All Storage Types: Breathing Loss; Total: All Products	Industrial Processes - Storage and Transfer			X	
2520010000	Inorganic Chemical Storage; Commercial/Industrial: Breathing Loss; Total: All Products	Industrial Processes - Storage and Transfer		X		
2525000000	Inorganic Chemical Transport; All Transport Types; Total: All Products	Industrial Processes - Storage and Transfer		X		

Table 4-23: Nonpoint Aviation Gasoline Distribution SCCs with 2014 NEI emissions

SCC	Description	Sector	EPA	State	Local	Tribe
2501080050	Petroleum and Petroleum Product Storage; Airports: Aviation Gasoline; Stage 1: Total	Gas Stations	X	X		
2501080100	Petroleum and Petroleum Product Storage; Airports: Aviation Gasoline; Stage 2: Total	Gas Stations	X	X		
2501080201	Petroleum and Petroleum Product Storage; Airports: Aviation Gasoline; Underground Tank Breathing and Emptying	Gas Stations		X		

The agencies listed in Table 4-24 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-24: Percentage of Gasoline Distribution VOC emissions submitted by reporting agency

Region	Agency	Sector	VOC
1	Maine Department of Environmental Protection	Gas Stations	27
1	Massachusetts Department of Environmental Protection	Bulk Gasoline Terminals	100
1	Massachusetts Department of Environmental Protection	Gas Stations	85
1	Massachusetts Department of Environmental Protection	Industrial Processes - Storage and Transfer	15
1	New Hampshire Department of Environmental Services	Gas Stations	55
1	New Hampshire Department of Environmental Services	Industrial Processes - Storage and Transfer	100
2	New Jersey Department of Environment Protection	Gas Stations	100
2	New Jersey Department of Environment Protection	Industrial Processes - Storage and Transfer	100
2	New York State Department of Environmental Conservation	Bulk Gasoline Terminals	100
2	New York State Department of Environmental Conservation	Gas Stations	100
2	New York State Department of Environmental Conservation	Industrial Processes - Storage and Transfer	100
3	Maryland Department of the Environment	Gas Stations	100
3	Maryland Department of the Environment	Industrial Processes - Storage and Transfer	100
3	Virginia Department of Environmental Quality	Gas Stations	95
3	Virginia Department of Environmental Quality	Industrial Processes - Storage and Transfer	51
4	Knox County Department of Air Quality Management	Bulk Gasoline Terminals	100
4	Knox County Department of Air Quality Management	Gas Stations	100
4	Knox County Department of Air Quality Management	Industrial Processes - Storage and Transfer	2
4	Metro Public Health of Nashville/Davidson County	Gas Stations	13
4	Metro Public Health of Nashville/Davidson County	Industrial Processes - Storage and Transfer	49
5	Illinois Environmental Protection Agency	Gas Stations	100
5	Illinois Environmental Protection Agency	Industrial Processes - Storage and Transfer	31
5	Michigan Department of Environmental Quality	Bulk Gasoline Terminals	100
5	Michigan Department of Environmental Quality	Gas Stations	100
5	Michigan Department of Environmental Quality	Industrial Processes - Storage and Transfer	11
6	Texas Commission on Environmental Quality	Bulk Gasoline Terminals	100
7	Iowa Department of Natural Resources	Gas Stations	71
8	Utah Division of Air Quality	Bulk Gasoline Terminals	19
8	Utah Division of Air Quality	Gas Stations	100

Region	Agency	Sector	VOC
8	Utah Division of Air Quality	Industrial Processes - Storage and Transfer	13
9	California Air Resources Board	Bulk Gasoline Terminals	25
9	California Air Resources Board	Gas Stations	100
9	California Air Resources Board	Industrial Processes - Storage and Transfer	91
9	Clark County Department of Air Quality and Environmental Management	Bulk Gasoline Terminals	49
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Gas Stations	100
9	Washoe County Health District	Gas Stations	100
9	Washoe County Health District	Industrial Processes - Storage and Transfer	100
10	Alaska Department of Environmental Conservation	Bulk Gasoline Terminals	51
10	Coeur d'Alene Tribe	Gas Stations	100
10	Coeur d'Alene Tribe	Industrial Processes - Storage and Transfer	100
10	Idaho Department of Environmental Quality	Gas Stations	68
10	Idaho Department of Environmental Quality	Industrial Processes - Storage and Transfer	100
10	Kootenai Tribe of Idaho	Gas Stations	100
10	Kootenai Tribe of Idaho	Industrial Processes - Storage and Transfer	100
10	Nez Perce Tribe	Gas Stations	100
10	Nez Perce Tribe	Industrial Processes - Storage and Transfer	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Gas Stations	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Industrial Processes - Storage and Transfer	100

4.6.3 EPA-developed emissions for Stage 1 Gasoline Distribution

The detailed calculation approach used by the EPA to estimate emission from stage I gasoline distribution can be found on the FTP site (ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint) in the file "2014_Gasoline_Distribution_v1.0_with_PT_subtraction_01apr2016.zip." In short, the EPA broke stage 1 gasoline emissions into six basic parts: 1) bulk terminals; 2) pipeline facilities; 3) bulk plants; 4) tank trucks; and 5) service stations (which can be further subdivided into Filling and Breathing & Emptying).

For bulk terminals and pipeline facilities, there are no activity-based VOC emission factors, so estimates from 1998 developed in support of the Gasoline Distribution MACT standard [ref 1] are scaled up to 2014, based on a ratio of the national volume of wholesale gasoline supplied. This information comes from the Petroleum Supply Annual, provided by the Energy Information Administration [ref 2].

For bulk plants, the activity information comes from the national volume of gasoline passing through bulk plants in 2014, which is assumed to be nine percent of total gasoline consumption. The gasoline consumption data was obtained from the Energy Information Administration's Petroleum Navigator website.

The activity data for tank trucks in transit also comes from the EIA's Petroleum Navigator website, and the gasoline throughput for tank trucks was computed by multiplying the county-level gasoline consumption estimates by a factor of 1.09, to account for gasoline that is transported more than once in a given area (for example, transported from bulk terminal to bulk plant and then from bulk plant to service station [ref 3].

Underground storage tank breathing and emptying, as well as filling operations, depend on more complicated information that takes into account vapor pressures, average temperatures, and molecular weights, and relies on the MOtor Vehicle Emission Simulator (MOVES) for some of the inputs for these equations [ref 4].

4.6.3.1 *Point Source Subtraction*

Point source subtraction removes the activity and emissions associated with point source contributions to the total activity. For example, emissions from transfer stations are included in the S/L/T agency submissions for those transfer stations with large enough emissions to trigger point source reporting (see Section 1.5). The EPA performed the point source subtraction of S/L/T agency point inventory emissions and uploaded the results to the 2014EPA_NONPOINT dataset. The crosswalk for point to nonpoint sources that EPA used is included in the Access database in the zipped file noted in Section 4.6.3 above.

4.6.3.2 *EPA Tagged Data*

The results of the nonpoint survey showed that many states submit several SCCs for gasoline distribution in the point sector of their inventories. All of the EPA nonpoint data were therefore tagged for these S/L/T-SCC combinations, shown in Table 4-25, to avoid double counting emissions.

Table 4-25: S/L/Ts and SCCs where EPA Gasoline Stage 1 Distribution estimates were tagged out

Tag Reason	SCC	S/L/T agencies
All in Point	2501050120 (bulk gas terminals)	Chattanooga, CO, IL, KY, ME, Maricopa County, MS, NE, OR, Washoe County, WY
	2501055120 (bulk plants)	Chattanooga, CO, IL, KY, ME, Maricopa County, MD, MS, NE, NH, OR, RI, Washoe County, WY
	2501060051, 52, 53, and 201 (gas service stations stage 1)	CO
	2505030120 (truck)	CA, NE
	2505040120 (pipeline)	NE
Do not have this type of source	2501050120 (bulk gas terminals)	NJ
	2501055120 (bulk plants)	AK, NJ
	2501060052 (splash filling)	Chattanooga, Knox County, OH, UT, VA
	2501060053 (balanced submerged)	Chattanooga, OH
	2505030120 (truck)	Washoe County
	2505040120 (pipeline)	CO, DE, MD, RI, Washoe County
Use different SCCs	2501055120 (bulk plants)	CA

4.6.4 EPA-developed emissions for Aviation Gasoline

The detailed calculation approach used by EPA to estimate emission from stage I gasoline distribution can be found on the FTIP site ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint in the files

"2014_Av_Gas_Stage_1_15nov2015.zip" and "2014_Av_Gas_Stage_2_15nov2015.zip." The amount of aviation gasoline consumed by each state in 2013 was obtained from the Energy Information Administration (EIA) State Energy Data System (SEDS) [ref 5]. This information was used to calculate county-level emissions estimates for one criteria pollutant and ten HAPs. More information on the assumptions (e.g., number of bulk plant processes) and details on emission factors can be found in the zip file documentation.

4.6.5 State Submittals for Aviation Gasoline

Only a handful of states submitted to these SCCs for Aviation Gasoline. These states were Illinois, Maryland, Maine, Michigan, New Jersey and Utah. A few states indicated in the Nonpoint Survey that the EPA should supplement their submissions with EPA data, with the reasoning that they do not have this type of source. These S/L/Ts were New York, Chattanooga, Tennessee and Knox County, Tennessee. In addition, California and Colorado indicated that all of their emissions for aviation gasoline are covered in the point source category of their submissions, so no EPA estimates were included in 2014 v1 for these states.

4.6.6 References for nonpoint gasoline distribution

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4.7 Commercial Cooking

4.7.1 Sector description

Commercial cooking refers to the cooking of meat, including steak, hamburger, poultry, pork, and seafood, and french fries on five different cooking devices: chain-driven (conveyorized) charbroilers, underfired charbroilers, deep-fat fryers, flat griddles and clamshell griddles. Table 4-26 lists the SCCs in the commercial cooking sector; EPA estimates emissions for all SCCs in this sector. The SCC level 1 and 2 descriptions are "Industrial Processes; Food and Kindred Products: SIC 20" for all SCCs.

Table 4-26: Source Classification Codes used in the Commercial Cooking sector

SCC	SCC Description, level 3	SCC Descriptions, level 4
2302002100	Commercial Cooking – Charbroiling	Conveyorized Charbroiling
2302002200	Commercial Cooking – Charbroiling	Under-fired Charbroiling
2302003000	Commercial Cooking – Frying	Deep Fat Frying

SCC	SCC Description, level 3	SCC Descriptions, level 4
2302003100	Commercial Cooking – Frying	Flat Griddle Frying
2302003200	Commercial Cooking – Frying	Clamshell Griddle Frying

4.7.2 Sources of data

The agencies listed in Table 4-27 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-27: Percentage of Commercial Cooking $PM_{2.5}$ and VOC emissions submitted by reporting agency

Region	Agency	$PM_{2.5}$	VOC
2	New Jersey Department of Environment Protection	100	100
2	New York State Department of Environmental Conservation	100	100
3	Delaware Department of Natural Resources and Environmental Control	19	22
3	Maryland Department of the Environment	100	100
4	Knox County Department of Air Quality Management	100	100
5	Illinois Environmental Protection Agency	100	100
6	Texas Commission on Environmental Quality	100	100
9	California Air Resources Board	18	91
9	Washoe County Health District	100	100
10	Coeur d'Alene Tribe	100	100
10	Idaho Department of Environmental Quality	100	100
10	Kootenai Tribe of Idaho	100	100
10	Nez Perce Tribe	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100

4.7.3 EPA-developed emissions for commercial cooking

The approach for estimating emissions from commercial cooking in 2014 consists of three general steps, as follows:

- Determine county-level activity, i.e., the number of restaurants in each county in 2014;
- Determine the fraction of restaurants with commercial cooking equipment, the average number of units of each type of equipment per restaurant, and the average amount of food cooked on each type of equipment; and
- Apply emission factors to each type of food for each type of commercial cooking equipment.

More information on the estimation methods can be found in the documentation for commercial cooking, entitled "2014_Commercial_Cooking_v1.2_08mar2016.zip" on the ftp site ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/.

4.7.3.1 *Activity Data*

Data on the number of restaurants in each county are available from the U.S. Census Bureau County Business Patterns database [ref 1], which reports the number of restaurants (categorized by NAICS code) in each county.

In general, our approach for the 2014 NEI was to grow the detailed activity data from the 2002 NEI, and so we will provide more information about the 2002 NEI approach here.

The 2002 NEI is the most recent inventory for which we estimated emissions from commercial cooking using restaurant-level data rather than population data. The 2002 approach used the Dun and Bradstreet industry database, which contains more specific information on the type of restaurant in each county. The approach for the 2002 NEI identifies five specific categories of restaurants that are likely to have the equipment that matches the source categories for commercial cooking emissions, including: ethnic food restaurants, fast food restaurants, family restaurants, seafood restaurants, and steak & barbecue restaurants. Because Dun and Bradstreet data for 2014 were not readily available, the number of restaurants in each county was estimated using a two-step process. First the number of restaurants in 2002 was estimated using the following equation:

$$REST_{i,2002} = \frac{E_{ijmn,2002}}{FRAC_j \times UNITS_j \times FOOD_{jm} \times EF_{jmn}} \quad (1)$$

where:

$REST_{i,2002}$	=	the total number of restaurants in county *i* in 2002
$E_{ijmn,2002}$	=	the emissions of pollutant *n* from food *m* cooked on source category *j* in county *i* in 2002, as reported in the National Emissions Inventory
$FRAC_j$	=	the fraction of restaurants in those categories that have equipment in source *j*
$UNITS_j$	=	the average number of units of source category *j* in each restaurant
$FOOD_{jm}$	=	the average amount of food *m* cooked on source category *j*
EF_{jmn}	=	the emission factor for pollutant *n* from food *m* cooked on source category *j*

Next, a growth factor based on the change in the number of restaurants in each county between 2002 and 2013 was generated using data from the U.S. Census Bureau County Business Patterns database for NAICS code 722511 (*Full-Service Restaurants*) and NAICS code 722513 (*Limited-Service Restaurants*). Note that 2013 was the most recent data year available at the time of analysis and so was used to estimate 2014 values; [ref 1]. For example, if the number of restaurants in a particular county increased from 100 to 125 between 2002 and 2013, the growth factor would be 1.25; in some cases, the number of restaurants decreased, and the growth factor was less than 1. This growth factor was multiplied by the number of restaurants in each county in 2002, as shown in equation 2, to estimate the number of restaurants in 2014:

$$REST_{i,2014} = REST_{i,2002} \times GF_i \quad (2)$$

where GF_i is the growth factor for county *i*.

4.7.3.2 *Emission Factors*

Emission factors for each type of food on each type of commercial cooking equipment (EF_{jmn}) came from a technical memorandum developed by E.H. Pechan and Associates [ref 2]. This information remains the most complete catalog of emission factors for commercial cooking; a recent review of the literature on emissions from cooking revealed no new studies with a similar breadth of pollutants analyzed [ref 4]. The PM emission factors from E.H. Pechan and Associates only contain primary PM. The emission factors for filterable PM were derived by applying ratios to primary PM (Table 4-28). The condensable particulate matter condensable PM emission factors were derived by subtracting PM10-FIL from PM_{10}-PRI. A complete list of emission factors is provided in the documentation for Commercial Cooking, entitled "2014_Commercial_Cooking_v1.2_08mar2016.zip" on the ftp site ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/.

Table 4-28: Ratio of filterable particulate matter to primary particulate matter for $PM_{2.5}$ and PM_{10} by SCC

Cooking Device	SCC	PM25-FIL / PM25-PRI	PM10-FIL / PM10-PRI
Conveyorized Charbroiling	2302002100	0.00321	0.00331
Underfired Charbroiling	2302002200	0.00287	0.00297
Flat Griddle Frying	2302003100	0.00201	0.00264
Clamshell Griddle Frying	2302003200	0.00241	0.00283

4.7.3.3 *Emissions*

After estimating the number of restaurants in 2014 using Equation 2, the amount of emissions in 2014 was determined by rearranging Equation 1, as shown in Equation 3:

$$E_{ijmn,2014} = REST_{i,2014} \times FRAC_j \times UNITS_j \times FOOD_{jm} \times EF_{jmn} \qquad (3)$$

where $E_{ijmn,2014}$ is the emissions of pollutant *n* from food *m* cooked on commercial equipment *j* in county *i* in 2014.

The fraction of restaurants with commercial cooking equipment ($FRAC_j$), the average units of equipment per restaurant ($UNITS_j$), and the average amount of each type of food cooked on each type of equipment ($FOOD_j$), were obtained from Potepan (2001) [ref 3]. Potepan reports the fraction of restaurants with commercial cooking equipment subcategorized by restaurant types: ethnic food restaurants, fast food restaurants, family restaurants, seafood restaurants, and steak & barbecue restaurants). To use these data, we calculated a weighted average of these fractions to determine an overall fraction of the number of all restaurants across all five subcategories that utilize commercial cooking equipment. Furthermore, because Potepan reports that 31% of all restaurants fall into one of those five subcategories, the weighted averages were multiplied by 0.31 to determine the fraction of all restaurants in each county with commercial cooking equipment. These numbers are reported in Table 4-29. The percentage of restaurants with under-fired charbroilers (12.5%) is similar to a more recent survey in North Carolina [ref 5], which found that 13% of surveyed restaurants employed charbroilers. The North Carolina survey did not include the other types of commercial cooking equipment reported here.

Table 4-29: Fraction of restaurants with source category equipment and average number of units per restaurant

Source Category	SCC	Percent of Restaurants with Equipment ($FRAC_j$)	Average Number of Units Per Restaurant ($UNITS_j$)
Conveyorized Charbroiling	2302002100	3.6%	1.3
Under-fired Charbroiling	2302002200	12.5%	1.5
Deep Fat Frying	2302003000	28.0%	2.5
Flat Griddle Frying	2302003100	18.4%	1.6
Clamshell Griddle Frying	2302003200	2.8%	1.7

Potepan also estimated the average annual amount of food cooked on each type of commercial cooking equipment ($FOOD_j$). These numbers are reported in Table 4-30 below. The amount of french fried potatoes cooked in deep-fat fryers was estimated by dividing the total weight of frozen potatoes utilized in domestic food service (6.9 million tons, [ref 6]) by the estimated number of deep-fryers in the United States (303,918 deep-fryers).

Table 4-30: Average amount of food cooked per year (tons/year) on each type of Commercial Cooking equipment

Food	Conveyorized Charbroiling	Under-fired Charbroiling	Deep Fat Frying	Flat Griddle Frying	Clamshell Griddle Frying
Steak	6.1	4.7	4.7	4.3	2.4
Hamburger	20.7	7.0	7.1	9.4	34.2
Poultry	10.7	8.4	14.9	5.2	5.7
Pork	1.5	3.8	1.5	2.9	3.1
Seafood	3.1	3.7	4.1	2.4	16.4
Other	-	1.1	7.1	1.5	-
Potatoes	-	-	21.3	-	-

4.7.3.4 *Example Calculations*

Determining the Number of Restaurants in Each County in 2002

$$REST_{i,2002} = \frac{E_{ijmn,2002}}{FRAC_j \times UNITS_j \times FOOD_{jm} \times EF_{jmn}}$$

$$203 \text{ restaurants} = \frac{8.76_{PM25,Underfired-Charbroilers}}{0.125 \times 1.54 \times 7.02 \times 0.032}$$

Emissions of $PM_{2.5}$ from underfired charbroilers in county *i* in 2002 were 8.76 tons. To determine the number of restaurants that generated these emissions in 2002, the emissions are divided by the fraction of restaurants that use underfired charbroilers (0.125), the average number of underfired charbroilers used at each restaurant (1.54), the average amount of hamburger cooked on each underfired charbroiler (7.02 tons/year), and the emission factor for $PM_{2.5}$ from hamburger cooked on underfired charbroilers (0.032 tons $PM_{2.5}$ per ton of hamburger). The result shows that there were 203 restaurants in county *i* in 2002. This process is repeated for each SCC (Table 4-26) and each type of food (Table 4-30) in each county.

Determining the Number of Restaurants in Each County in 2014

Using the estimated number of restaurants in 2002, the number of restaurants in 2014 was determined by employing a growth factor based on the change in the number of restaurants between 2002 and 2013 as determined by the U.S. Census Bureau County Business Statistics Database [ref 1].

$$REST_{i,2014} = REST_{i,2002} \times GF_i$$

$$235 \text{ restaurants} = 203 \text{ restaurants} \times 1.16$$

There were 203 restaurants estimated to be in county *i* in 2002. Data from the U.S. Census Bureau show that there was a 16% increase in the number of restaurants in county *i* between 2002 and 2014. The growth factor (1.16) was multiplied by 203 to estimate that there were 235 restaurants in county *i* in 2014. Note that the actual number of restaurants in 2014 as determined from the U.S. Census Bureau County Business Statistics database is not equal to $REST_{i,2014}$ as determined by the equation above because the emissions from the 2002 NEI were calculated using activity data from the Dun and Bradstreet database, rather than the U.S. Census Bureau County Business Statistics database.

Determining the Emissions in 2014

The emissions in 2014 were determined using the following equation:

$$E_{ijmn,2014} = REST_{i,2014} \times FRAC_j \times UNITS_j \times FOOD_{jm} \times EF_{jmn}$$

$$10.16\ tons\ PM25 = 235 \times 0.125 \times 1.54 \times 7.02 \times 0.032$$

There were 235 restaurants in county *i* in 2014. This was multiplied by the fraction of restaurants that use underfired charbroilers (0.125), the average number of underfired charbroilers used at each restaurant (1.54), the average amount of hamburger cooked on each underfired charbroiler (7.02 tons/year), and the emission factor for $PM_{2.5}$ from hamburger cooked on underfired charbroilers (0.032 tons $PM_{2.5}$ per ton of hamburger). The result shows that the emissions of $PM_{2.5}$ in county *i* were 10.16 tons in 2014.

4.7.3.5 *Changes from 2011 Methodology*

The growth factors were updated using data on the number of restaurants in 2002 and 2013 from the U.S. Census Bureau County Business Statistics Database.

The methodology for estimating commercial cooking emissions uses emissions data from the 2002 NEI to back-calculate the activity data (number of restaurants) used to estimate those emissions and then projects the 2002 activity data to estimate 2011 and 2014 activity. There are some counties, however, that have some issues with the 2002 data that caused errors in the draft 2014 data. In particular, many counties in Arkansas and Clark County, Nevada, reported zero VOC emissions in 2002 for commercial cooking, but they did report some HAP-VOC emissions. In an earlier version of the commercial cooking calculations, this error was maintained in the draft 2014 calculations, because the activity data is back-calculated for each pollutant. This resulted in zero VOC emissions, but positive HAP-VOC emissions in those counties. This issue was corrected by substituting the positive activity data calculated for VOC-HAPs for the zero activity data calculated for VOCs. This correction was made for all counties where VOC emissions were estimated to be zero but HAP-VOC emissions were positive.

4.7.3.6 *Puerto Rico and US Virgin Islands Emissions Calculations*

Insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands; therefore, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the U.S. Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and U.S. Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.7.3.7 *EPA tags and corrections made for v1*

Some states indicated on their nonpoint survey that they did not have one or more of the sources EPA estimates in this sector, so we did not use EPA estimates for these SCCs in the NEI. These states (or territories) and SCCs are given in Table 4-31.

Table 4-31: State agencies that requested EPA tag out Commercial Cooking sources

State	SCC	Description
Alaska	2302002100	Commercial Cooking – Charbroiling; Conveyorized Charbroiling
Alaska	2302002200	Commercial Cooking – Charbroiling; Under-fired Charbroiling
Nebraska	2302003200	Commercial Cooking – Frying; Clamshell Griddle Frying
Puerto Rico	2302002100	Commercial Cooking – Charbroiling; Conveyorized Charbroiling
Puerto Rico	2302003200	Commercial Cooking – Frying; Clamshell Griddle Frying

4.7.4 References for commercial cooking

1. United States Census Bureau, 2013 County Business Patterns, available at http://www.census.gov/econ/cbp/ (accessed November 2015)
2. E.H. Pechan and Associates. 2003. Methods for Developing a National Inventory for Commercial Cooking Processes: Technical Memorandum, available at http://www.epa.gov/ttnchie1/eiip/techreport/volume03/charbroilingtechmemo_122303.pdf (accessed October 2015)
3. Potepan, M. 2001. Charbroiling Activity Estimation. Public Research Institute, report for the California Air Resources Board and the California Environmental Protection Agency, available at http://www.arb.ca.gov/research/apr/reports/l943.pdf (accessed October 2015)
4. Abdullahi, K.L, J.M. Delgado-Saborit, and R.M. Harrison. 2013. Emissions and indoor concentrations of particulate matter and its specific chemical components from cooking: a review. Atmospheric Environment, 71: 260–294.
5. North Carolina Division of Air Quality. 2013. Supplement Section 110(a)(1) Maintenance Plan - February 2013, Appendix B, Section 4.4.4., available at http://www.ncair.org/planning/triad/Triad_Appendix-B_EI_Documentation_04122013.pdf (accessed October 2015)
6. United States Potato Board. 2011. Potato Sales and Utilization Estimates 2001-2010, available at http://www.uspotatoes.com/newsletters/downloads/2011USPB-SalesUtilizationEstimatesFINAL.pdf (accessed October 2015)

4.8 Dust – Construction Dust

4.8.1 Sector description

Construction dust refers to residential and non-residential construction activity, which are functions of acreage disturbed for construction. This sector will be divided below when describing the calculation of EPA's emissions. Table 4-32Table 4-32: lists the nonpoint SCCs associated with this sector in the 2014 NEI. EPA estimates emissions for the indicated SCCs in the table. The SCC level 1 and 2 descriptions is "Industrial Processes; Construction: SIC 15 - 17" for all SCCs.

Table 4-32: SCCs in the 2014 NEI Construction Dust sector

EPA estimates?	SCC	SCC Level Three	SCC Level Four
Y	2311010000	Residential	Total
	2311010000	Residential	Vehicle Traffic
Y	2311020000	Industrial/Commercial/Institutional	Total
Y	2311030000	Road Construction	Total

4.8.2 Sources of data

The construction dust sector includes data from the S/L/T agency submitted data and the default EPA generated construction dust emissions. The agencies listed in Table 4-33 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-33: Percentage of Construction Dust $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	$PM_{2.5}$
1	New Hampshire Department of Environmental Services	3
2	New Jersey Department of Environment Protection	100
3	Maryland Department of the Environment	100
5	Illinois Environmental Protection Agency	100
8	Utah Division of Air Quality	75
9	California Air Resources Board	100
9	Clark County Department of Air Quality and Environmental Management	100
9	Washoe County Health District	100
10	Coeur d'Alene Tribe	100
10	Idaho Department of Environmental Quality	100
10	Kootenai Tribe of Idaho	100
10	Nez Perce Tribe	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100

4.8.3 EPA-developed emissions for residential construction

Emissions from residential construction activity are a function of the acreage disturbed and volume of soil excavated for residential construction. Residential construction activity is developed from data obtained from the U.S. Department of Commerce (DOC)'s Bureau of the Census.

4.8.3.1 *Activity Data*

There are two activity calculations performed for this SCC, acres of surface soil disturbed and volume of soil removed for basements.

<u>Surface soil disturbed</u>

The US Census Bureau has 2014 data for *New Privately Owned Housing Units Started by Purpose and Design* [ref 1] which provides regional level housing starts based on the groupings of 1 unit, 2-4 units, 5 or more units. A consultation with the Census Bureau in 2002 gave a breakdown of approximately 1/3 of the housing starts being for 2 unit structures, and 2/3 being for 3 and 4 unit structures. The 2-4 unit category was then divided into 2-units, and 3-4 units based on this ratio.

New Privately Owned Housing Units Authorized Unadjusted Units [ref 2] gives a conversion factor to determine the ratio of structures to units in the 5 or more unit category. For example, if a county has one 40-unit apartment building, the ratio would be 40/1. If there are 5 different 8 unit buildings in the same project, the ratio would be 40/5. Structures started by category are then calculated at a regional level.

Annual county building permit data were purchased from the US Census Bureau for 2014 [ref 3]. The 2014 County Level Residential Building Permit dataset has 2014 data to allocate regional housing starts to the county level. This results in county-level housing starts by number of units. Table 4-34 provides surface areas that were assumed disturbed for each unit type:

Table 4-34: Surface soil removed per unit type

Unit type	Surface acres disturbed
1-Unit	1/4 acre/structure
2-Unit	1/3 acre/structure
Apartment	1/2 acre/structure

The 3-4 unit category was considered to be an apartment. Multiplication of housing starts to soil removed results in number of acres disturbed for each unit category.

Basement soil removal

To calculate basement soil removal, the 2014 *Characteristics of New Single-Family Houses Completed, Foundation table* [ref 4] is used 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 is 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 is 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.

4.8.3.2 *Emission Factors*

Initial PM_{10} emissions from construction of single family, two-family, and apartments structures are calculated using the emission factors given in Table 4-35 [ref 5]. The duration of construction activity for houses is assumed to be 6 months and the duration of construction for apartments is assumed to be 12 months.

Table 4-35: Emission factors for Residential Construction

Type of Structure	Emission Factor	Duration of Construction
Apartments	0.11 tons PM_{10}/acre-month	12 months
2-Unit Structures	0.032 tons PM_{10}/acre-month	6 months
1-unit Structures with Basements	0.011 tons PM_{10}/acre-month	6 months
	0.059 tons PM_{10}/1000 cubic yards	
1-Unit Structures w/o Basements	0.032 tons PM_{10}/acre-month	6 months

Regional variances in construction emissions are corrected using soil moisture level and silt content. These correction parameters are applied to initial PM_{10} emissions from residential construction to develop the final emissions inventory.

To account for the soil moisture level, the PM_{10} emissions are weighted using the 30-year average precipitation-evaporation (PE) values from Thornthwaite's PE Index. Average precipitation evaporation values for each State were estimated based on PE values for specific climatic divisions within a State.

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 [ref 6]. This database contains the most commonly requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities.

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

Once PM_{10} adjustments have been made, PM25-FIL emissions are estimated by applying a particle size multiplier of 0.10 to PM10-FIL emissions [ref 7]. Primary PM emissions are equal to filterable emissions since there are no condensable emissions from residential construction.

4.8.3.3 *Example Calculation*

PM_{10} Emissions = $\sum$(A_{unit} x $T_{construction}$ x EF_{unit}) x Adj_{PM}

where:

A_{unit} = HS_{Unit} x SM_{Unit}
HS_{Unit} = Regional Housing Starts x (county building permits/Regional building permits)
SM_{Unit} = Area or volume of soil moved for the given unit type
$T_{Construction}$ = Construction time (in months) for given unit type
EF_{Unit} = Unadjusted emission factor for PM_{10} for the given unit type
Adj_{PM} = PM Adjustment factor

As an example, in Beaufort County, North Carolina, 2010 acres disturbed and PM_{10} emissions from 1-unit housing starts without a basement are calculated as follows:

247,200 * (211 /232280)

A_{unit} = 345,000x (142/342,534) x $0.921_{\text{(Fraction without basement)}}$ * 0.25 acres/unit

= 131.72 units * 0.25 acres/unit = 32.9 acres

Adj_{PM} = (24/110.1) * (39.58/9) = 0.958

PM_{10} Emissions = (32.8 acres x 6 months x 0.032 tons PM_{10}/acre-month) x 0.958 = 6.06 tons

4.8.3.4 *Updates to 2011 Methodology*

The housing starts and soil removed were updated using the latest data from the U.S. Census Bureau. The county-level silt values were updated and are now based on soil sampling data contained in the National Cooperative Soil Survey Microsoft Access Soil Characterization Database.

4.8.3.5 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.8.3.6 *References for residential construction*

1. U.S. Census Bureau, New Privately Owned Housing Units Started by Purpose and Design in 2014, from http://www.census.gov/construction/nrc/pdf/quarterly_starts_completions.pdf (accessed September 2015).
2. U.S. Census Bureau, New Privately Owned Housing Units Authorized - Unadjusted Units for Regions, Divisions, and States, Annual 2010, Table 2au. From https://www.census.gov/construction/bps/txt/tb2u2014.txt (accessed September 2015).
3. U.S. Census Bureau, Annual Housing Units Authorized by Building Permits CO2014A, purchased September 2015.
4. U.S. Census Bureau, Type of Foundation in New One-Family Houses Completed, from http://www.census.gov/construction/chars/completed.html (accessed September 2015).
5. Midwest Research Institute. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District. March 29, 1996.
6. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database, from http://ncsslabdatamart.sc.egov.usda.gov/ (accessed September 2015).
7. "Proposed Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors," C. Cowherd, J. Donaldson and R. Hegarty, Midwest Research Institute; D. Ono, Great Basin UAPCD. From http://www.epa.gov/ttn/chief/conference/ei15/session14/cowherd.pdf (accessed September 2015).

4.8.4 EPA-developed emissions for non-residential construction

Emissions from industrial/commercial/institutional (non-residential) construction activity are a function of the acreage disturbed for non-residential construction.

4.8.4.1 *Activity Data*

The activity data are the number of acres disturbed for non-residential construction and are estimated by multiplying the value of non-residential construction put in place by the number of acres disturbed per million dollars. *Annual Value of Construction Put in Place in the U.S* [ref 1] contains the 2014 national value of non-residential construction. The national value of non-residential construction put in place (in millions of dollars) was allocated to counties using county-level non-residential construction employment data (NAICS Code 2362) obtained from *County Business Patterns (CBP)* [ref 2]. Because some counties' employment data were withheld due to privacy concerns, the following procedure was adopted to estimate the number of county-level withheld employees:

1. State totals for the known county-level employees were subtracted from the total number of employees reported in the CBP state level file [ref 3]. This results in the total number of withheld employees in the state.

2. The midpoint of the range code was used as an initial estimate (so for instance in the 1-19 employees range, an estimate of 10 employees would be used) and a state total of the withheld employees was computed.
3. A ratio of estimated employees (Step 2) to withheld employees (Step 1) was then used to adjust the county-level estimates up or down so that the state total of adjusted estimates matches the state total of withheld employees (Step 1).

For the average acres disturbed per million dollars of non-residential construction, MRI reported a conversion factor of 2 acres/$1 million (in 1992 constant dollars) [ref 4]. EPA adjusted the 1992 conversion factor to 2014 using the Price Deflator (Fisher) Index of New Single-Family Houses Under Construction [ref 5]. By taking the ratio of the 2014 and 1992 Annual Index values and applying it to the 1992 factor, a value of 1.01 acres/$1 million (= 2/(113/57)) was estimated.

4.8.4.2 Emission Factors

Initial PM_{10} emissions from construction of non-residential buildings are calculated using an emission factor of 0.19 tons/acre-month [ref 6]. The duration of construction activity for non-residential construction is assumed to be 11 months. Since there are no condensable emissions, primary PM emissions are equal to filterable emissions. Once PM_{10}-xx emissions are developed, PM25-xx emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10}-xx emissions [ref 7].

Regional variances in construction emissions are corrected using soil moisture level and silt content. These correction parameters are applied to initial PM_{10} emissions from non-residential construction to develop the final emissions inventory.

To account for the soil moisture level, the PM_{10} emissions are weighted using the 30-year average precipitation-evaporation (PE) values from Thornthwaite's PE Index. Average precipitation evaporation values for each State were estimated based on PE values for specific climatic divisions within a State [ref 4].

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 [ref 8]. This database contains the most commonly requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities.

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 State,
S = % dry silt content in soil for area being inventoried.

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

4.8.4.3 *Example Calculation*

$EmissionsPM_{10} = N_{Spending} \times (Emp_{county} / Emp_{National}) \times Apd \times EF_{Adj} \times M$

where:

$N_{Spending}$ = National spending on nonresidential construction (million dollars)
Emp_{county} = County-level employment in nonresidential construction
$Emp_{National}$ = National level employment in nonresidential construction
Apd = Acres per million dollars (national data)
EF_{Adj} = Adjusted PM_{10} emission factor (ton/acre-month)
M = duration of construction activity (months)

As an example, in Grand Traverse County, Michigan, 2014 acres disturbed and PM_{10} emissions from non-residential construction are calculated as follows:

$EmissionsPM_{10} = 347{,}666 \times \$10^6 \times (103/560{,}616) \times 1.01\ acres/\$10^6 \times EF_{Adj} \times M$

$= 70\ acres \times 0.1073\ ton/acre\text{-}month \times 11\ months$

$= 83\ tons\ PM_{10}$

where EF_{Adj} is calculated as follows:

$EF_{Adj} = 0.19\ ton/acre\text{-}month * (24/103.6 * 21.95/9)$

$= 0.1073\ ton/acre\text{-}month$

4.8.4.4 *Changes from 2011 Methodology*

The Annual Value of Construction Put in Place, employment data and the acres/$ million conversion factor were updated using the latest data from the U.S. Census Bureau. The county-level silt values were updated and are now based on soil sampling data contained in the National Cooperative Soil Survey Microsoft Access Soil Characterization Database.

4.8.4.5 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.8.4.6 *References for non-residential construction dust*

1. U.S. Census Bureau, "Value of Construction Put in Place," from http://www.census.gov/construction/c30/c30index.html (accessed September 2015).
2. U.S Census Bureau, County Business Patterns: 2013, *"Complete County File [14.4mb zip],"* from https://www.census.gov/econ/cbp/download/ (accessed September 2015).
3. U.S. Census Bureau, County Business Patterns: 2013, *"Complete State File [9.7mb zip],"* from https://www.census.gov/econ/cbp/download/ (accessed September 2015).
4. Midwest Research Institute. 1999. *Estimating Particulate Matter Emissions from Construction Operations, Final Report* (prepared for the Emission Factor and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency).

5. U.S. Census Bureau, Price Deflator (Fisher) Index of New Single-Family Houses Under Construction, from https://www.census.gov/construction/nrs/pdf/price_uc.pdf (accessed September 2015).
6. Midwest Research Institute. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District. March 29, 1996.
7. Midwest Research Institute. *Background Document for Revisions to Find Fraction Rations Used for AP-42 Fugitive Dust Emission Factors, Proposed Fine Fraction Ratios, Table 1 (prepared for Western Governors' Association)*, from http://www3.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02.pdf .
8. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database, from http://ncsslabdatamart.sc.egov.usda.gov/ (accessed September 2015).

4.8.5 EPA-developed emissions for road construction

Emissions from road construction activity are a function of the acreage disturbed for road construction. Road construction activity is developed from data obtained from the Federal Highway Administration (FHWA).

4.8.5.1 *Activity Data*

The Federal Highway Administration's *Highway Statistics, State Highway Agency Capital Outlay 2012, Table SF-12A* [ref 1], outlines spending by state in several different categories. For this SCC, the following columns are used: New Construction, Relocation, Added Capacity, Major Widening, and Minor Widening. These columns are also differentiated according to the following six classifications:

1. Interstate, urban
2. Interstate, rural
3. Other arterial, urban
4. Other arterial, rural
5. Collectors, urban
6. Collectors, rural

The State expenditure data are then converted to new miles of road constructed using $/mile conversions obtained from the Florida Department of Transportation (FLDOT) in 2014 [ref 2]. A conversion of $6.8 million/mile is applied to the urban interstate expenditures and a conversion of $3.8 million/mile is applied to the rural interstate expenditures. For expenditures on other urban arterial and collectors, a conversion factor of $4.1 million/mile is applied, which corresponds to all other projects. For expenditures on other rural arterial and collectors, a conversion factor of $2.1 million/mile is applied, which corresponds to all other projects.

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 as given in Table 4-36.

Table 4-36: Spending per mile and acres disturbed per mile by highway type

Road Type	Thousand Dollars per mile	Total Affected Roadway Width (ft)*	Acres Disturbed per mile
Urban Areas, Interstate	6,895	94	11.4
Rural Areas, Interstate	3,810	89	10.8
Urban Areas, Other Arterials	4,112	63	7.6
Rural Areas, Other Arterials	2,076	55	6.6
Urban Areas, Collectors	4,112	63	7.6
Rural Areas, Collectors	2,076	55	6.6

Road Type	Thousand Dollars per mile	Total Affected Roadway Width (ft)*	Acres Disturbed per mile
*Total Affected Roadway Width = (lane width (12 ft) * number of lanes) + (shoulder width * number of shoulders) + area affected beyond road width (25 ft)			

The acres disturbed per mile data shown in Table 4-36 are calculated by multiplying the total affected roadway width (including all lanes, shoulders, and areas affected beyond the road width) by one mile and converting the resulting land area to acres. Building permits [ref 3] are used to allocate the state-level acres disturbed by road construction to the county. A ratio of the number of building starts in each county to the total number of building starts in each state is applied to the state-level acres disturbed to estimate the total number of acres disturbed by road construction in each county.

4.8.5.2 *Emission Factors*

Initial PM_{10} emissions from construction of roads are calculated using an emission factor of 0.42 tons/acre-month [ref 4]. 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.

Regional variances in construction emissions are corrected using soil moisture level and silt content. These correction parameters are applied to initial PM_{10} emissions from road construction to develop the final emissions inventory.

To account for the soil moisture level, the PM_{10} emissions are weighted using the 30-year average precipitation-evaporation (PE) values from Thornthwaite's PE Index. Average precipitation evaporation values for each State were estimated based on PE values for specific climatic divisions within a State [ref 4].

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 [ref 5]. This database contains the most commonly requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities.

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 State,
S	= % dry silt content in soil for area being inventoried.

Once PM_{10} adjustments have been made, $PM_{2.5}$ emissions are set to 10% of PM_{10}. Primary PM emissions are equal to filterable emissions since there are no condensable emissions from road construction.

4.8.5.3 *Example Calculation*

$\text{EmissionsPM}_{10} = \sum(HD_{rt} \times MC_{rt} \times AC_{rt}) \times (HS_{County} / HS_{State}) \times EF_{Adj} \times M$

where:

HD_{rt} = Highway Spending for a specific road type
MC_{rt} = Mileage conversion for a specific road type
AC_{rt} = Acreage conversion for a specific road type
HS_{County} = Housing Starts in a given county
HS_{State} = Housing Starts in a given State
EF_{Adj} = Adjusted PM_{10} Emission Factor
M = duration of construction activity

As an example in 2014, in Newport County, Rhode Island, acres disturbed and PM_{10} emissions from urban interstate, urban other arterial, and urban collector road construction are calculated as follows:

$$Emissions PM_{10} = \sum(HD_{rt} \times MC_{rt} \times AC_{rt}) \times (HS_{County} / HS_{State}) \times EF_{Adj} \times M$$

$$= (\$14{,}255/\$6{,}895/mi \times 11.4\ acres/mi) * (185/952) + (\$1{,}304/\$4{,}112/mi \times 7.6\ acres/mi) * (185/952) + (\$7{,}144/\$4{,}112/mi \times 7.6\ acres/mi) * (185/952) \times EF_{Adj} \times M$$

$$= 7.59\ acres \times 0.35\ ton/acre\text{-}month \times 12\ months$$

$$= 32.06\ tons\ PM_{10}$$

where EF_{Adj} is calculated as follows:

$$EF_{Adj} = 0.42\ ton/acre\text{-}month * (24/132 * 41.45/9)$$

$$= 0.35\ ton/acre\text{-}month$$

4.8.5.4 *Updates to 2011 Methodology*

The FHWA data on roadway spending were updated to 2012. The data source for $/mile, total affected roadway width, and acres disturbed per mile for new road construction for interstate, other arterials, and collector roads was changed from the North Carolina DOT 2000 data, used in the 2011 methodology, to the 2014 Florida DOT data.

4.8.5.5 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.8.5.6 *References for road construction*

1. Federal Highway Administration, 2008 Highway Spending, from http://www.fhwa.dot.gov/policyinformation/statistics/2008/sf12a.cfm (accessed September 2015).
2. Florida DOT Generic Cost Per Mile Models for 2014, from ftp://ftp.dot.state.fl.us/lts/co/estimates/cpm/summary.pdf (accessed September 2015).

3. Annual Housing Units Authorized by Building Permits CO2014A, purchased from US Department of Census, September 2015.
4. Midwest Research Institute. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District. March 29, 1996.
5. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database, from http://ncsslabdatamart.sc.egov.usda.gov/ (accessed September 2015).

4.9 Dust – Paved Road Dust

4.9.1 Sector description

The SCCs that belong to this sector are provided in Table 4-37. EPA estimates emissions for particulate matter for the first SCC in this table. Fugitive dust emissions from paved road traffic were estimated for PM10-PRI, PM10-FIL, PM25-PRI, and PM25-FIL. Since there are no PM-CON emissions for this category, PM10-PRI emissions are equal to PM10-FIL emissions and PM25-PRI emissions are equal to PM25-FIL emissions.

Table 4-37: SCCs in the 2014 NEI Paved Road Dust sector

SCC	SCC Level 1	SCC Level 2	SCC Level 3	SCC Level 4
2294000000	Mobile Sources	Paved Roads	All Paved Roads	Total: Fugitives
2294000002	Mobile Sources	Paved Roads	All Paved Roads	Total: Sanding/Salting - Fugitives

4.9.2 Sources of data

The paved road dust sector includes data from the S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-38 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-38: Percentage of Paved Road Dust $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	S/L/T	$PM_{2.5}$
1	Massachusetts Department of Environmental Protection	State	100
1	New Hampshire Department of Environmental Services	State	100
2	New Jersey Department of Environment Protection	State	100
2	New York State Department of Environmental Conservation	State	100
3	Maryland Department of the Environment	State	100
8	Northern Cheyenne Tribe	Tribe	100
8	Utah Division of Air Quality	State	100
9	California Air Resources Board	State	100
9	Clark County Department of Air Quality and Environmental Management	Local	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	100
9	Washoe County Health District	Local	100
10	Coeur dAlene Tribe	Tribe	100
10	Idaho Department of Environmental Quality	State	100
10	Kootenai Tribe of Idaho	Tribe	100
10	Nez Perce Tribe	Tribe	100

Region	Agency	S/L/T	$PM_{2.5}$
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100
10	Washington State Department of Ecology	State	100

4.9.3 EPA-developed emissions for paved road dust

Uncontrolled paved road emissions were calculated at the county level by roadway type and year. This was done by multiplying the county/roadway class paved road vehicle miles traveled (VMT) by the appropriate paved road emission factor. Next, control factors were applied to the paved road emissions in PM_{10} nonattainment and maintenance status counties. Emissions by roadway class were then totaled to the county level for reporting in the NEI. The following provides further details on the emission factor equation, determination of paved road VMT, and controls.

4.9.3.1 *Emission Factors*

Re-entrained road dust emissions for paved roads were estimated using paved road VMT and the emission factor equation from AP-42 [ref 1]:

$$E = [k \times (sL)^{0.91} \times (W)^{1.02}]$$

where:

E = paved road dust emission factor (g/VMT)
k = particle size multiplier (g/VMT)
sL = road surface silt loading (g/ m^2) (dimensionless in eq.)
W = average weight (tons) of all vehicles traveling the road (dimensionless in eq.)

The uncontrolled PM10-PRI/-FIL and PM25-PRI/-FIL emission factors are provided in the tab "Emission Factors" of the calculation workbook by county and roadway class. They are provided without utilizing any precipitation correction.

The particle size multipliers for both PM10-PRI/-FIL and PM25-PRI/-FIL for paved roads came from AP-42.

Paved road silt loadings were assigned to each of the fourteen functional roadway classes (seven urban and seven rural) based on the average annual traffic volume of each functional system by county [ref 2]. The silt loading values per average daily traffic volume come from the ubiquitous baseline values from Section 13.2.1 of AP-42. Average daily traffic volume (ADTV) was calculated by dividing an estimate of VMT by functional road length and then by 365. State FHWA road length by functional road type data was broken down to the county level by multiplying by the ratio of county VMT to state VMT for each FHWA road type.

To better estimate paved road fugitive dust emissions, the average vehicle weight was estimated by road type for each county in the U.S. based on the 2011 VMT by vehicle type. The VMT for each vehicle type (per MOVES road type and county) was divided by the sum of the VMT of all vehicle types for the given road type in each county. This ratio was multiplied by the vehicle type mass (see Table 4-39) and summed to road type for each county to calculate a VMT-weighted average vehicle weight for each county/road type combination in the database. The VMT-weighted average vehicle weight by MOVES vehicle type was converted to FWHA vehicle type using the crosswalk in Table 4-40 in order to be used in the emission factor equation above.

Table 4-39: Average vehicle weights by FWHA vehicle class

MOVES Vehicle Type	Source Mass (tons)
Motorcycle	0.285
Passenger Car	1.479
Passenger Truck	1.867
Light Commercial Truck	2.0598
Intercity Bus	19.594
Transit Bus	16.556
School Bus	9.070
Refuse Truck	23.114
Single Unit Short-haul Truck	8.539
Single Unit Long-haul Truck	6.984
Motor Home	7.526
Combination Short-haul Truck	22.975
Combination Long-haul Truck	24.601

Table 4-40: MOVES and FWHA vehicle type crosswalk

MOVES Road Type Description	FWHA Road Type
Rural Restricted Access	Rural Interstate
Rural Unrestricted Access	Rural Principal Arterial
Rural Unrestricted Access	Rural Minor Arterial
Rural Unrestricted Access	Rural Collector
Rural Unrestricted Access	Rural Local
Urban Restricted Access	Urban Interstate
Urban Unrestricted Access	Urban Principal Arterial
Urban Unrestricted Access	Urban Minor Arterial
Urban Unrestricted Access	Urban Collector
Urban Unrestricted Access	Urban Local

**Note: Other Freeways and Expressways were not included in the crosswalk, and so were assumed to be restricted access like Interstates.*

4.9.3.2 *Activity Data*

Total annual VMT estimates by county and roadway class were derived from a 2011 EPA Motor Vehicle Emission Simulator (MOVES) modelling run. To estimate the portion of the total VMT occurring on paved roads, first the VMT on unpaved roads were estimated using 2013 state-level FHWA data on length of unpaved roads by road type [ref 2] and 1996 ratios from FHWA (the last year these data were available) on average daily traffic volume per mile of unpaved road by road type [ref 3]. The estimated VMT on unpaved roads was subtracted from the total VMT from MOVES to estimate the VMT on paved roads.

4.9.3.3 *Allocation*

Total VMT from the MOVES modelling run is available at the county level. VMT on unpaved roads was estimated at the state level and allocated to the county level based on proportion of rural population. The allocated unpaved VMT was subtracted from the total VMT from MOVES to estimate the paved VMT.

4.9.3.4 *Controls*

Paved road dust controls were applied by county to urban and rural roads in serious PM_{10} nonattainment areas and to urban roads in moderate PM_{10} nonattainment areas. The assumed control measure is vacuum sweeping of paved roads twice per month. A control efficiency of 79% was assumed for this control measure [ref 4]. The assumed rule penetration varies by roadway class and PM_{10} nonattainment area classification (serious or moderate). The rule penetration rates are shown in Table 4-41. Rule effectiveness was assumed to be 100% for all counties where this control was applied.

Table 4-41: Penetration rate of Paved Road vacuum sweeping

PM_{10} Nonattainment Status	Roadway Class	Vacuum Sweeping Penetration Rate
Moderate	Urban Freeway & Expressway	0.67
Moderate	Urban Minor Arterial	0.67
Moderate	Urban Collector	0.64
Moderate	Urban Local	0.88
Serious	Rural Minor Arterial	0.71
Serious	Rural Major Collector	0.83
Serious	Rural Minor Collector	0.59
Serious	Rural Local	0.35
Serious	Urban Freeway & Expressway	0.67
Serious	Urban Minor Arterial	0.67
Serious	Urban Collector	0.64
Serious	Urban Local	0.88

Note that the controls were applied at the county/roadway class level, and the controls differ by roadway class. No controls were applied to interstate or principal arterial roadways because these road surfaces typically do not have vacuum sweeping. In the excel spreadsheet, the total emissions for all roadway classes were summed to the county level. Therefore, the emissions at the county level can represent several different control efficiency and rule penetration levels, and may include both controlled and uncontrolled emissions in the composite value

4.9.3.5 *Changes from 2011 Methodology*

The methodology described above contains several adjustments from the methodology used to compose the 2011 version. This is due in part to differences in data sources used to compile the inventory. In 2014, the factors used to adjust for precipitation were removed from the 2011 emission factor equation, and precipitation was not accounted for in the final inventory.

The VMT data used in 2014 was based on EPA's MOVES model, whereas 2011 VMT data was based on its precursor NMIM model. For this reason, the vehicle types (and as such vehicle weights) changed from 2011 to 2014, though a VMT-weighted average vehicle weight was calculated by county and road type in both years. Furthermore, the VMT data used in 2011 was at the state-level, while the 2014 version had been further broken down into counties. For this reason, subsequent worksheets (including ADTV and silt loading) which were calculated at the state level in 2011 could be immediately calculated at the county level without further manipulation in 2014. The paved roadway types in the 2014 VMT dataset included two additional types not found in the 2011 version. The category "Rural: Other Freeways and Expressways" was newly added, and "Urban: Collector" was further broken down into major and minor collector roads.

4.9.3.6 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.9.3.7 *References for paved road dust*

1. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Section 13.2.1, Paved Roads." Research Triangle Park, NC. January 2011.
2. U.S. Department of Transportation, Federal Highway Administration. *Highway Statistics 2013.* Office of Highway Policy Information. Washington, DC. September 2015. Available at: http://www.fhwa.dot.gov/policyinformation/statistics/2013/.
3. Federal Highway Administration, "Highway Statistics 1996, Table HM-67." 1996. Available at: https://www.fhwa.dot.gov/ohim/1996/text/roads.html
4. E.H. Pechan & Associates, Inc. "Phase II Regional Particulate Strategies; Task 4: Particulate Control Technology Characterization," draft report prepared for U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation. Washington, DC. June 1995.

4.10 Dust – Unpaved Road Dust

4.10.1 Sector description

There is only one SCC for this sector, provided in Table 4-42, in the 2014 NEI. EPA estimates emissions for particulate matter for this SCC. Fugitive dust emissions from unpaved road traffic were estimated for PM10-PRI, PM10-FIL, PM25-PRI, and PM25-FIL. Since there are no PM-CON emissions for this category, PM10-PRI emissions are equal to PM10-FIL emissions and PM25-PRI emissions are equal to PM25-FIL emissions.

Table 4-42: SCC in the 2014 NEI Unpaved Road Dust sector

SCC	SCC Level 1	SCC Level 2	SCC Level 3	SCC Level 4
2296000000	Mobile Sources	Unpaved Roads	All Unaved Roads	Total: Fugitives

4.10.2 Sources of data

The unpaved road dust sector includes data from the S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-43 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-43: Percentage of Unpaved Road Dust $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	S/L/T	$PM_{2.5}$
1	Massachusetts Department of Environmental Protection	State	100
2	New Jersey Department of Environment Protection	State	100
3	Maryland Department of the Environment	State	100
8	Northern Cheyenne Tribe	Tribe	100
9	California Air Resources Board	State	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	100
9	Washoe County Health District	Local	100
10	Washington State Department of Ecology	State	100

4.10.3 EPA-developed emissions for unpaved road dust

Uncontrolled unpaved road emissions were calculated at the county level by roadway type for the year 2014. This was done by multiplying the county/roadway class unpaved road vehicle miles traveled (VMT) by the appropriate unpaved road emission factor. Next, control factors were applied to the unpaved road emissions in PM_{10} nonattainment and maintenance area counties. Emissions by roadway class were then totaled to the county level for reporting in the NEI. The following provides further details on the emission factor equation, determination of unpaved road VMT, and controls.

4.10.3.1 *Emission Factors*

Re-entrained road dust emissions for unpaved roads were estimated using paved road VMT and the emission factor equation from AP-42 [ref 1]:

$$E = [k \times (s/12)^{1} \times (SPD/30)^{0.5}] / (M/0.5)^{0.2} - C$$

Where k and C are empirical constants given in Table 4-44, with:

E = unpaved road dust emission factor (lb/VMT)
k = particle size multiplier (lb/VMT)
s = surface material silt content (%)
SPD = mean vehicle speed (mph)
M = surface material moisture content (%)
C = emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear (lb/VMT)

The uncontrolled emission factors without precipitation corrections are in the worksheet "Emission Factor Calculations" by county and roadway class.

Values used for the particle size multiplier and the 1980's vehicle fleet exhaust, brake wear, and tire wear are provided in Table 4-44, and come from AP-42 defaults.

Average State-level unpaved road silt content values, developed as part of the 1985 NAPAP Inventory, were obtained from the Illinois State Water Survey [ref 2]. Silt contents of over 200 unpaved roads from over 30 States were obtained. Average silt contents of unpaved roads were calculated for each sate that had three or more samples for that State. For States that did not have three or more samples, the average for all samples from all States was used as a default value. The silt content values are by State, and identifies if the values were based on a sample average or default value.

Table 4-44: Constants for unpaved roads re-entrained dust emission factor equation

Constant	PM25-PRI/PM25-FIL	PM_{10}-PRI/PM_{10}-FIL
k (lb/VMT)	0.18	1.8
C	0.00036	0.00047

Table 4-45 lists the speeds modeled on the unpaved roads by roadway class. These speeds were determined based on the average speeds modeled for onroad emission calculations and weighted to determine a single average speed for each of the roadway classes [ref 3] The roadway class "Urban collector" with an average speed of 20 mph was split into two sub-categories, "Urban major collector" and "Urban minor collector", to correspond to the roadway types found in the 2014 VMT data.

Table 4-45: Speeds modeled by roadway type on unpaved roads

Unpaved Roadway Type	Speed (mph)
Rural Minor Arterial	39
Rural Major Collector	34
Rural Minor Collector	30
Rural Local	30
Urban Other Principal Arterial	20
Urban Minor Arterial	20
Urban Major Collector	20
Urban Minor Collector	20
Urban Local	20

The value of 0.5 percent for M was chosen as the national default as sufficient resources were not available at the time the emissions were calculated to determine more locally-specific values for this variable.

4.10.3.2 *Activity Data*

Total annual VMT estimates by county and roadway class were derived from a 2008 NMIM run providing state-level estimates of VMT by road type and by road surface type.

4.10.3.3 *Allocation*

State-level estimates of unpaved road VMT were allocated to the county level based on the proportion of rural population in the county, according to the 2010 Census.

4.10.3.4 *Controls*

The controls assumed for unpaved roads varied by PM_{10} nonattainment area classification and by urban and rural areas. On urban unpaved roads in moderate PM_{10} nonattainment areas, paving of the unpaved road was assumed and a control efficiency of 96 percent and a rule penetration of 50 percent were applied. Controls were not applied to rural unpaved roads in moderate nonattainment areas. Chemical stabilization, with a control efficiency of 75 percent and a rule penetration of 50 percent, was assumed for rural areas in serious PM_{10} nonattainment areas. A combination of paving and chemical stabilization, with a control efficiency of 90 percent and a rule penetration of 75 percent, was assumed for urban unpaved roads in serious PM_{10} nonattainment areas. In counties currently at maintenance status, controls were assumed based on the severity (moderate or serious) of their prior nonattainment status. Some counties had multiple partial areas with differing levels of nonattainment. In these cases, controls were assumed to be applied based on the most serious level of nonattainment found within a given county.

Note that the controls were applied at the county level, and the controls differ by urban vs. rural roadway class. In the final emissions table, the emissions for all roadway classes were summed to the county level. Therefore, the emissions at the county level can represent several different control effectiveness and rule penetration levels. However, the control efficiency and rule penetration values were reported in the Controlled Emissions worksheet at the county level for urban and rural roadways separately.

4.10.3.5 *Changes from 2011 Methodology*

The methodology described above contains several adjustments from the methodology used to compose the 2011 version. This is due in part to differences in data sources used to compile the inventory. In 2014, the factors used to adjust for precipitation were removed from the 2011 emission factor equation, and precipitation was not accounted for in the final inventory.

4.10.3.6 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.10.3.7 *References for unpaved road dust*

1. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Section 13.2.2, Unpaved Roads." Research Triangle Park, NC. January 2011.
2. W. Barnard, G. Stensland, and D. Gatz, Illinois State Water Survey, "Evaluation of Potential Improvements in the Estimation of Unpaved Road Fugitive Emission Inventories," paper 87-58.1, presented at the 80th Annual Meeting of the APCA. New York, New York. June 21-26, 1987
3. United States Environmental Protection Agency, Clearinghouse for Inventories & Emission Factors. "2011 National Emissions Inventory, version 2 Technical Support Document." Research Triangle Park, NC. August 2015. Available at http://www.epa.gov/ttn/chief/net/2011inventory.html#inventorydoc. (accessed September 2015)

4.11 Fires -Agricultural Field Burning

4.11.1 Sector Description

Agricultural burning refers to fires that occur over lands used for cultivating crops and agriculture. Another term for this sector is crop residue burning. In past NEIs for this sector, it was exclusively limited to emissions resulting in the burning of crops. However, in the 2014 NEI, we have included grass/pasture burning SCCs into this sector. Thus, this sector includes both crop residue burning as well as grass/pasture burning.

4.11.2 Sources of data

Table 4-46 shows, the agricultural field burning SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The leading SCC description is “Miscellaneous Area Sources; Agriculture Production - Crops - as nonpoint; Agricultural Field Burning - whole field set on fire;” for all SCCs in the table.

New SCCs were added to this sector compared to the 2011 NEI to house the emissions that occur on grassland/pastures/rangeland. In addition, SCCs were added to better describe the specific crops being burned, including fields in which two or more crops are burned.

Note that many general crops are included in the SCC 2801500000, and it also is the SCC to report into for “crops unknown.” The new SCC (2801500170) was added for grass/pasture burning for this sector for the 2014 NEI. All of the SCCs for “double crops” are also new to the 2014 NEI, and EPA reported emission into these SCCs as part of the methods described below.

Table 4-46: Nonpoint SCCs with 2014 NEI emissions in the Agricultural Field Burning sector

SCC	Description	EPA	State	Tribe
2801500000	Unspecified crop type and Burn Method	X	X	
2801500100	Field Crops Unspecified		X	X
2801500111	Field Crop is Alfalfa: Headfire Burning		X	
2801500120	Field Crop is Asparagus: Burning Techniques Not Significant		X	
2801500141	Field Crop is Bean (red): Headfire Burning	X	X	X
2801500150	Field Crop is Corn: Burning Techniques Not Important	X	X	
2801500151	Double Crop Winter Wheat and Corn	X	X	
2801500152	Double Crop Corn and Soybeans	X	X	
2801500160	Field Crop is Cotton: Burning Techniques Not Important	X	X	
2801500170	Field Crop is Grasses: Burning Techniques Not Important	X	X	X
2801500171	Fallow	X	X	
2801500181	Field Crop is Hay (wild): Headfire Burning		X	X
2801500201	Field Crop is Pea: Headfire Burning		X	
2801500220	Field Crop is Rice: Burning Techniques Not Significant	X	X	
2801500250	Field Crop is Sugar Cane: Burning Techniques Not Significant	X	X	
2801500261	Field Crop is Wheat: Headfire Burning		X	X
2801500262	Field Crop is Wheat: Backfire Burning	X	X	
2801500263	Double Crop Winter Wheat and Cotton	X	X	
2801500264	Double Crop Winter Wheat and Soybeans	X	X	
2801500300	Orchard Crop Unspecified		X	
2801500320	Orchard Crop is Apple		X	X
2801500330	Orchard Crop is Apricot		X	X
2801500350	Orchard Crop is Cherry		X	X
2801500360	Orchard Crop is Citrus (orange, lemon)		X	
2801500390	Orchard Crop is Nectarine		X	X
2801500400	Orchard Crop is Olive		X	
2801500410	Orchard Crop is Peach		X	X
2801500420	Orchard Crop is Pear		X	X
2801500430	Orchard Crop is Prune		X	X

SCC	Description	EPA	State	Tribe
2801500500	Vine Crop Unspecified		X	X
2801500600	Forest Residues Unspecified		X	

The agricultural fire sector includes data from the following: S/L/T agency-provided emissions data, HAP augmentation and the dataset "2014EPA_NONPOINT" created from the EPA methods [ref 1]. The EPA dataset includes emissions from the pollutants VOC, NO_X, SO_2, CO, $PM_{2.5}$, CO2 and methane because we had emission factors available for these. In addition, 29 HAPs were estimated. The Emission Factors are shown in Section 4.11.3.2. The CO2 and methane emissions were not included in the final 2011 NEI, but are available upon request.

The agencies listed in Table 4-47 submitted $PM_{2.5}$ emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-47: Percentage of agricultural fire/grass-pasture burning $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	S/L/T	$PM_{2.5}$
2	New Jersey Department of Environment Protection	State	98
4	Florida Department of Environmental Protection	State	100
4	Georgia Department of Natural Resources	State	100
4	South Carolina Department of Health and Environmental Control	State	100
5	Illinois Environmental Protection Agency	State	100
5	Indiana Department of Environmental Management	State	94
7	Iowa Department of Natural Resources	State	100
9	Arizona Department of Environmental Quality	State	24
9	California Air Resources Board	State	100
9	Hawaii Department of Health Clean Air Branch	State	100
10	Coeur d'Alene Tribe	Tribe	100
10	Idaho Department of Environmental Quality	State	66
10	Kootenai Tribe of Idaho	Tribe	100
10	Nez Perce Tribe	Tribe	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100
10	Washington State Department of Ecology	State	98

When we created the 2014 NEI, the S/L/T data had hierarchy over the EPA data (developed as described in the next section). As such, S/L/T CAP emissions were carried forth in the NEI as submitted and no backfilling with EPA data was done. Any "zero" submissions were left as zero in the 2014 NEI for those counties and pollutants. In addition, EPA augmented HAPs for those states that did not submit any of the HAPs (discussed in 4.11.3.2) using a simple ratio of state-based VOC to the HAP in question in the EPA emissions database. These ratios were applied to the state submitted VOC emission values (all counties in a given state used the same EPA-data based VOC:HAP ratio to estimate HAP emissions). The actual EPA-data based ratios provided along with all of the other HAP augmentation ratios can be accessed in EIS. For agencies that reported any of the HAPs that EPA estimates or any other HAPs, they were left as-is in the final NEI (as long as they passed the QA checks). The hierarchy used to select data for this sector is the same as for other nonpoint sectors, and is described in Section 0.

4.11.3 EPA-developed emissions for agricultural field burning

In the 2008 NEI, crop residue emission estimates were developed using satellite detects occurring over land types classified as "agricultural" and uncertain field sizes or were sporadically reported by a handful of states. In the 2011 NEI, the method described in McCarty et al. 2009 [ref 1] and McCarty 2011 [ref 2] was employed to estimate the emissions from this sector with the exception that states were allowed to submit their own estimates. However, this produced significant state to state variability between states that submitted their own data and states that did not. In addition, we received comments that many false detects (EPA emission estimates were too high) occurred using this method (due to dark fields resulting from irrigation) Therefore, a consistent methodology across multiple years for the CONUS has not yet been developed for this sector. With this in mind, for the 2014 NEI, a simple and efficient method has been developed to estimate emissions from crop residue that can easily be applied across multiple years over the CONUS at minimal cost. The method was developed by EPA Office of Research and Development and the reader is directed to a paper in press for details on the methods described below [ref 3].

The approach developed for use in the 2014 NEI improves on previous estimates [ref 1, ref 2] as follows:

- Multiple satellite detections are used to locate fires using an operational product
- Field Size estimates are based on field work studies in multiple states (rather than a one size fits all approach)
- This method allows for intra-annual as well as annual changes in crop land use
- This method incorporates comments on this sector from past NEI efforts to improve the method and remove some of the false detects that occurred in the 2011 NEI
- Additional processing of the HMS data was done to remove 2 types of duplicates
- This method uses USDA NASS Cropland Data Layer (CDL) (USDA, 2015a) [ref 4] information to separate grass/pasture lands, which include Pasture/Grass, Grassland Herbaceous, and Pasture/Hay lands from all other agricultural burning and to identify the crop type
- Removal of agricultural fires from the Hazard Mapping System (HMS) dataset before the application of the SMARTFIRE2 system for wildfires and prescribed fires to eliminate double counting in the NEI and (4) use of state information to further identify fires as crop residue burning rather than another type of fire
- To further identify fires as crop residue burning rather than some kind of wildfire. Our 2014 NEI approach described in this paper complements the method used to estimate emissions from wildfires and prescribed fires because we use crop level land use information to identify crop residue fires and grassland (aka rangeland) fires. The remaining fire detections are used in SMARTFIRE to estimate emissions in forested areas where fuel loadings are available from the National Forest Service.

4.11.3.1 *Activity Data*

The HMS satellite product is an operational satellite product showing hot spots and smoke plumes indicative of fire locations. It is a blended product using algorithms for the Geostationary Operational Environmental Satellite (GOES) Imager, the Polar Operational Environmental Satellite (POES) Advanced Very High Resolution Radiometer (AVHRR), Moderate Resolution Imaging Spectroradiometer (MODIS) and more recently the Visible Infrared Imaging Radiometer Suite (VIIRS). These satellite detections are provided at 0.001 degrees latitude or longitude but they are derived from active fire satellite products ranging in spatial accuracy from 375 m to 4km. To identify the crop type and to distinguish agricultural fires from all other fires in the HMS product, the USDA Cropland Data Layer (CDL) (USDA, 2015a) [ref 4] was employed. This dataset is produced annually by the USDA National Agricultural Statistics Service and provides high resolution (30 meter) detailed crop information to accurately identify crop types for agricultural fires. According the USDA, the pasture and grass-related land cover categories have traditionally had very low classification accuracy in the CDL (USDA, 2015b) [ref 5]. Moderate spatial and spectral resolution satellite imagery is not ideal for separating grassy land use types, such as urban open space versus pasture for grazing versus CRP grass. To further complicate the matter, the pasture and grass-related categories were not always classified consistently from state to state or year to year (USDA, 2015b). In an effort to eliminate user confusion and category inconsistencies the 1997-2013 CDLs were recoded and re-released in January 2014 to better represent pasture and grass-related categories (USDA, 2015b). A new category named Grass/Pasture (code 176) collapses the following historical CDL categories: Pasture/Grass (code 62), Grassland Herbaceous (code 171), and Pasture/Hay (code 181). This new code (176) has been used to create a single grass/pasture emission source category separate from all other crop types. Based on field reconnaissance of McCarty (2013) [ref 6], a "typical" field size was assumed for each burn location, which varied by region of the country. The assumed field sizes can be found on the 2014 NEI Data web site: http://www.epa.gov/sites/production/files/2015-06/draft_2014_ag_grasspasture_emissions_nei_may62015.xlsx

4.11.3.2 *Emission Factors*

Emission Factors for CO, NOx, SO_2, $PM_{2.5}$ and PM_{10} were based on Table 1 from McCarty (2011) [ref 3]. The emission factors in McCarty (2011) were based on mean values from all available literature at the time. Emission Factors for NH_3 were derived from the 2002 NEI crop residue emission estimates using the ratio of NH_3/NOx and the NOx emission factor in Table 1 from McCarty (2011). Factor ratios for VOC/CO and the CO emission factors from Table 1 in McCarty (2011) were used to estimate VOC Emission Factors.

Table 4-48 summarizes CAP emission factors, fuel loading, and combustion completeness used in this analysis. For the Hazardous Air Pollutants (HAPS), emission factors were used that were identical for all crop types. The Emission Factors for the HAPs were based on the average emission factors that have been previously published, and are shown in Table 4-49. The sources from which the factors were derived are as follows: EPA, 2003 [ref 7]; Akagi et al, 2011 [ref 8]; Jenkins et al, 1996 [ref 9]; Keshtkar et al, 2007 [ref 10]. When there was more than one reference for the emission factor for a specific pollutant, the average of the reported emission factors. If the only source was (EPA, 2003), we did not create a new emission factor for that pollutant. EPA, 2003 has Emission factors for 29 HAPs. Of those 29 HAPs, we created new emission factors for 17 of them. Note that in EPA, 2003, the emission factors were based on a weighting of two emission factors (75% flaming and 25% smoldering). They are included here since they were also applied to the activity data. Table 4-49 shows the HAPs for which emissions were estimated.

Table 4-48: Emission factors (lbs/ton), fuel loading (tons/acre) and combustion completeness (%) for CAPs

Crop Type	Fuel Loading	Combustion %	CO	NO_x	SO_2	$PM_{2.5}$	PM_{10}	VOC	NH_3
corn	4.20 [a]	75 [a]	106.10 [a]	4.60 [a]	2.38 [a]	9.94 [a]	21.36 [a]	6.60 [c]	19.32 [b]
wheat	1.90 [a]	85 [a]	110.28 [a]	4.75 [a]	0.88 [a]	8.07 [a]	14.10 [a]	7.60 [c]	33.73 [b]
soybean	2.50 [a]	75 [a]	127.70 [a]	6.33 [a]	3.13 [a]	12.38 [a]	17.73 [a]	11.97 [c]	44.94 [b]
cotton	2.18 [a]	65 [a]	146.12 [a]	6.89 [a]	3.13 [a]	12.38 [a]	17.73 [a]	11.97 [c]	48.92 [b]
fallow	2.18 [a]	75 [a]	127.79 [a]	5.60 [a]	2.34 [a]	12.31 [a]	17.00 [a]	11.97 [c]	16.24 [b]
rice	3.00 [a]	75 [a]	105.27 [a]	6.23 [a]	2.77 [a]	4.72 [a]	6.61 [a]	5.00 [c]	26.17 [b]
sugarcane	4.75 [a]	65 [a]	116.95 [a]	6.06 [a]	3.32 [a]	8.69 [a]	9.83 [a]	9.00 [c]	43.03 [b]
lentils	2.94 [a]	75 [a]	127.79 [a]	5.60 [a]	2.34 [a]	12.31 [a]	17.00 [a]	11.97 [c]	39.76 [b]
Other crops	1.90 [a]	85 [a]	182.11 [a]	4.31 [a]	0.80 [a]	23.23 [a]	31.64 [a]	10.70 [c]	12.52 [b]
Dbl. Crop	3.05 [d]	80 [d]	108.19 [d]	4.68 [d]	1.63 [d]	9.00 [d]	17.73 [d]	7.10 [d]	26.53 [d]

Crop Type	Fuel Loading	Combustion %	CO	NO_x	SO_2	$PM_{2.5}$	PM_{10}	VOC	NH_3
Dbl. Crop	3.19 [d]	75 [d]	116.95 [d]	5.10 [d]	2.36 [d]	11.13 [d]	19.18 [d]	8.45 [d]	21.41 [d]
Dbl. Crop	2.18 [d]	75 [d]	127.79 [d]	5.60 [d]	2.34 [d]	12.31 [d]	17.00 [d]	11.97 [d]	39.74 [d]
Dbl. Crop	2.04 [d]	80 [d]	119.04 [d]	5.17 [d]	1.61 [d]	10.19 [d]	15.55 [d]	6.35 [d]	36.74 [d]
Dbl. Crop	2.04 [d]	80 [d]	119.04 [d]	5.17 [d]	1.61 [d]	10.19 [d]	15.55 [d]	6.35 [d]	36.74 [d]
Dbl. Crop	3.05 [d]	80 [d]	108.19 [d]	4.68 [d]	1.63 [d]	9.00 [d]	17.73 [d]	10.80 [d]	19.63 [d]
Dbl. Crop	2.04 [d]	75 [d]	128.20 [d]	5.82 [d]	2.01 [d]	10.22 [d]	15.91 [d]	11.97 [d]	41.33 [d]
Dbl. Crop	2.34 [d]	7 [d]	136.91 [d]	6.61 [d]	3.13 [d]	12.38 [d]	17.73 [d]	11.97 [d]	46.94 [d]
Dbl. Crop	2.34 [d]	75 [d]	127.75 [d]	5.96 [d]	2.74 [d]	12.35 [d]	17.36 [d]	11.97 [d]	42.35 [d]
Dbl. Crop	3.35 [d]	75 [d]	116.90 [d]	5.46 [d]	2.76 [d]	11.16 [d]	19.55 [d]	11.97 [d]	22.94 [d]
Dbl. Crop	2.2 [d]	80 [d]	118.99 [d]	5.54 [d]	2.01 [d]	10.22 [d]	15.91 [d]	9.79 [d]	39.33 [d]
Dbl. Crop	2.04 [d]	80 [d]	119.04 [d]	5.17 [d]	1.61 [d]	10.19 [d]	15.55 [d]	9.79 [d]	36.74 [d]
Pasture_Gra	1.9 [a]	85 [a]	182.11 [a]	4.31 [a]	0.80 [a]	23.23 [a]	31.64 [a]	10.70 [c]	12.52 [b]

[a]: McCarty (2011) [ref 2], Fuel Loading and Combustion completeness from Data and Methods Section Table 1 converted to lbs/ton for factors

[b] 2002 NEI NH_3/NO_X ratio

[c] VOC AP42 factors ratio to CO factors from McCarty 2011.

[d] average of two field crops

Table 4-49: HAP emission factors (lbs/ton) used for agricultural field burning

HAP	EF
1,3-butadiene	0.354
Acetaldehyde	1.444
Anthracene	0.004
benzaanthracene	0.004
Benzene	0.713
benzoapyrene	0.001
benzoepyrene	0.002
benzoghiperylene	0.003
benzokfluoranthene	0.002
Chrysene	0.004
fluoranthene	0.008
formaldehyde	3.370
indeno123cdpyrene	0.002
Perylene	0.001
phenanthrene	0.010
Pyrene	0.007
Toluene	0.470

4.11.3.3 *Computing EPA estimates*

The general procedure for generating final 2014 NEI v1 EPA estimates is outlined here. The reader is referred to Pouliot et al., 2016 [ref 3] for further details. The HMS satellite detections were processed through 5 layers of filtering to find crop residue and rangeland burning.

- The first layer of filtering removed all detections outside the lower 48 states.
- The second layer of filtering removed the detections that were identified as wildland and prescribed fires because they occurred in a non-agricultural region. This identification was made by intersecting the USDA Crop Data Layers (CDL) with the remaining HMS detects to determine a crop type. Given that the satellite detections are at best known to 100 meters and the CDL information is known to 30-meter resolution, the process of intersecting these two datasets results in some uncertainty with respect to spatial accuracy of the fire locations.
- The third layer of filtering involved the use of snow cover estimates. Using the daily maximum snow cover data from a Weather Research and Forecasting Model (WRF) model simulation for 2014, HMS satellite detections from GOES, MODIS, and AVHRR that were coincident with snow cover were deemed not to be crop residue burning but some other type of fire.
- The fourth layer of filtering was based on comments (from the draft 2014 NEI estimates posted in June 2015) from specific states regarding specific crops.
    - Corn and soybean detections for these eight Midwestern states (Iowa, Indiana, Illinois, Michigan, Missouri, Minnesota, Wisconsin, and Ohio) were deemed to be a different type of fire other than crop residue burning. The reasoning is based on a communication from Iowa State University Extension and Outreach: "Burning corn and soybean fields is just NOT a practice that is used in Iowa or many other Midwest States as a way of preparing the fields for planting a subsequent crop. Yes, there are rare occasions where corn residue is burnt off a field but it would not even be1% of the crop acres. An example would be if the residue washed and piled up in an area it may be burnt to allow tillage, planting and other practices to occur. Another rare occasion is when accidental field fires occur during harvesting of the corn crop. But again this would be less than 1% of the crop acres."
    - Communication from the state of Indiana was similar to that of Iowa with respect to corn and soybeans.
    - The other six Midwestern states (Illinois, Michigan, Missouri, Minnesota, Wisconsin, and Ohio) were included because of their proximity to the Indiana and Iowa so that the method would consistent at a regional scale. These fires that are not being identified as crop residue burning or rangeland burning are being classified as accidental rather than intentional burning.
    - Also as part of the 4th layer of filtering, if localized state information identified a fire as being accidental but in the vicinity of agricultural land, we deemed these fires not to be crop residue burning but in the wildfire category. This was the case for the state of Delaware.
- The fifth level of filtering was the process of removing duplicates. The remaining HMS satellite detections were checked for two types of duplicates. If a GOES satellite detection was within 2 km and within an hour of another detection, the detection was deemed to be a duplicate and removed. Identical latitude and longitude detections to 3 decimal places on the same day across all satellites were also deemed to be duplicates and they were removed. For the first type of duplicate, approximately 1% of the total detections

Then, using the CAPs and HAPs emission factors in Table 4-48 and Table 4-49, and the assumed state-specific field size, daily emissions were estimated for each fire detection. Emissions for the grass/pasture category were mapped to a single source classification code (SCC 2801500170) for use in the NEI. Emissions for all the remaining CDL categories were mapped to a set of source classification codes. Theses codes and the mapping is available 2014 NEI Documentation web site https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-documentation.

Emission Estimates for 2014

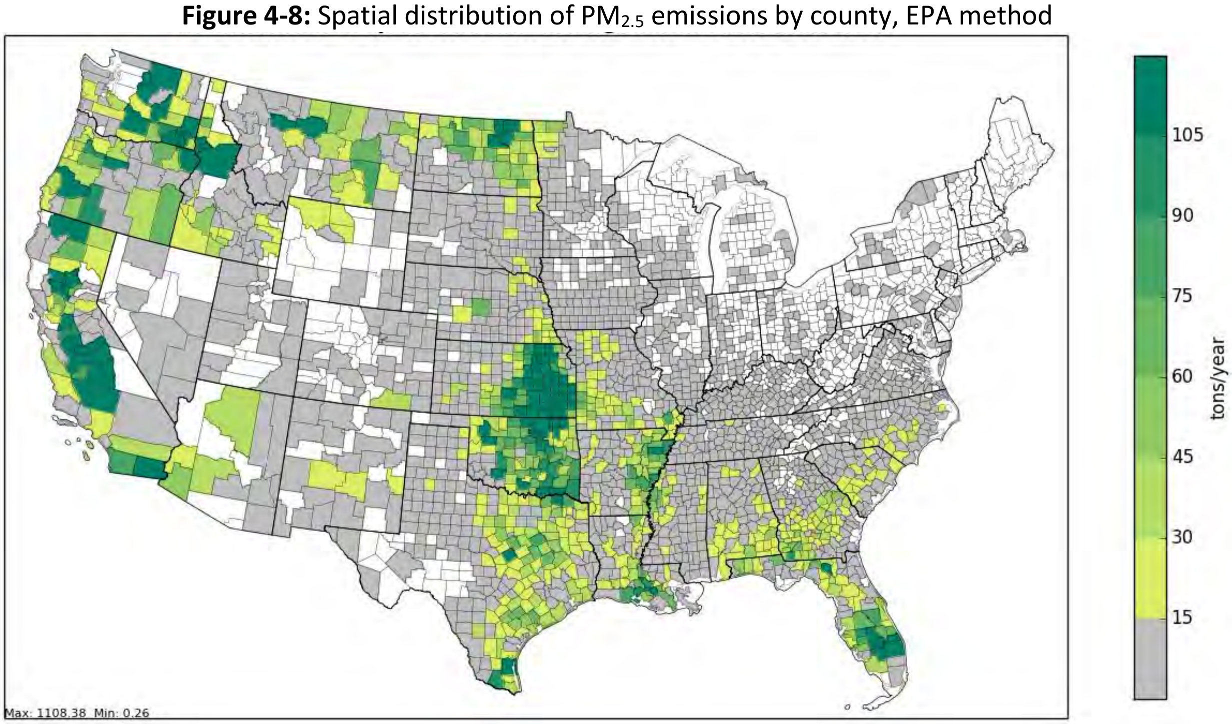
Table 4-50 summarizes state level estimates of crop residue burning by acres burned and $PM_{2.5}$ for 2014 using the EPA methods described above. The top two states for crop residue burning ($PM_{2.5}$ and acres) were California and Kansas. The top two states for grass/pasture burns were Kansas and Oklahoma. For Grasslands, we would expect these two states to have the largest acres burned because of the annual prescribed burning of the Flint Hills Grasslands and the large geographical extent of these regions. The grass/pasture burns are also known as rangeland burning, based on the definition of the grass/pasture land use in the Cropland Data Layer. Figure 4-8 provides a spatial map of the annual emissions by county for 2014 using this method for crop residue and rangeland burning. We note that crop residue and rangeland burning is not widespread but occurs in a few specific regions of the country.

Table 4-50: Acres burned and $PM_{2.5}$ emissions by state using EPA methods

State	2014 Crop Acres	2014 Crop $PM_{2.5}$ (tons/yr)	2014 Grass/Pasture Acres	2014 Grass/Pasture $PM_{2.5}$ (tons/yr)
Alabama	21,000	307	32,240	605
Arizona	8,240	118	2,800	53
Arkansas	137,160	1,371	28,400	533
California	202,560	2,854	51,240	961
Colorado	4,240	63	3,840	72
Florida	147,540	2,142	79,440	1,490
Georgia	100,240	1,351	39,360	738
Idaho	50,880	650	35,400	664
Illinois	1,680	18	7,980	150
Indiana	660	7	3,480	65
Iowa	3,660	69	14,940	280
Kansas	180,720	2,207	461,600	8,655
Kentucky	8,000	110	7,760	146
Louisiana	87,920	1,052	20,000	375
Maryland	800	10	160	3
Massachusetts	80	2	40	1
Michigan	640	11	480	9
Minnesota	17,280	220	4,200	79
Mississippi	45,600	537	21,200	398
Missouri	31,980	327	71,880	1,348
Montana	32,760	428	32,640	612
Nebraska	29,820	419	25,200	473
Nevada	360	5	520	10
New Jersey	160	3	120	2
New Mexico	1,120	17	7,120	134

State	2014 Crop Acres	2014 Crop $PM_{2.5}$ (tons/yr)	2014 Grass/Pasture Acres	2014 Grass/Pasture $PM_{2.5}$ (tons/yr)
New York	600	10	320	6
North Carolina	32,000	406	8,200	154
North Dakota	117,480	1,402	29,700	557
Ohio	400	5	1,320	25
Oklahoma	49,440	506	299,600	5,618
Oregon	29,400	433	54,240	1,017
Pennsylvania	360	6	440	8
South Carolina	16,080	197	12,480	234
South Dakota	18,660	270	8,160	153
Tennessee	8,400	102	10,440	196
Texas	74,480	961	184,000	3,450
Utah	1,520	23	880	17
Vermont	40	1	0	0
Virginia	3,760	56	4,280	80
Washington	70,920	883	43,200	810
West Virginia	200	3	520	10
Wisconsin	720	13	2,640	50
Wyoming	2,720	48	2,240	42
TOTAL	1,542,280	19,623	1,614,700	30,276

Figure 4-8: Spatial distribution of $PM_{2.5}$ emissions by county, EPA method



4.11.3.4 *Quality assurance of final estimates*

Some of the QA was done as part of the new methods used for this sector, and described above. Further review of the quality of EPA's data included addressing of S/L/T comments as outlined in earlier sections of this section. In addition, the following checks were done on EPA data:

- Comparison to past NEI estimates, and explaining differences noted
- Check of diurnal profile using day specific data generated by EPA methods with existing profiles used for air quality modeling
- Using past comments received from S/L/Ts for this sector to ground truth estimates

The QA of S/L/T-submitted data included checking with EPA estimates, working with S/L/Ts to understand why differences exist, and making sure pollutant coverage is complete.

It is not expected that we will make any major changes/improvements to this sector (methods, pollutants reported, etc.) in going from v1 to v2. We will address those comments we do receive to the best of our ability and with resources that we have.

4.11.4 References for agricultural field burning

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4.12 Fuel Combustion -Industrial and Commercial/Institutional Boilers and ICEs

Emissions from Industrial, Commercial, and Institutional (ICI) fuel combustion are a significant portion of the total emissions inventory for many areas. Unless all ICI combustion emission sources are provided in an S/L/T point inventory submittal, it is necessary for inventory preparers to estimate ICI combustion nonpoint source emissions. Because there are specific challenges associated with estimating ICI nonpoint source emissions, the EPA developed a Microsoft® Access-based ICI Combustion Tool to assist S/L/Ts in estimating nonpoint emissions from ICI fuel combustion for the 2014 National Emission Inventory. We discuss the ICI tool in Section 4.12.3.

4.12.1 Sector description

The EIS sectors to be documented here include nonpoint emissions from ICI fuel combustion:

- Fuel Combustion – Commercial/Institutional Boilers, ICEs – Biomass
- Fuel Combustion – Commercial/Institutional Boilers, ICEs – Coal
- Fuel Combustion – Commercial/Institutional Boilers, ICEs – Natural Gas
- Fuel Combustion – Commercial/Institutional Boilers, ICEs – Oil
- Fuel Combustion – Commercial/Institutional Boilers, ICEs – Other
- Fuel Combustion – Industrial Boilers, ICEs – Biomass
- Fuel Combustion – Industrial Boilers, ICEs – Coal
- Fuel Combustion – Industrial Boilers, ICEs– Natural Gas
- Fuel Combustion – Industrial Boilers, ICEs – Oil
- Fuel Combustion – Industrial Boilers, ICEs – Other

We document all these sectors in this sections because EPA generates all of the nonpoint emissions from these EIS sectors via an ICI Tool. S/L/Ts were encouraged to use this tool to generate and submit all of their nonpoint ICI emissions.

4.12.2 Sources of data

Table 4-60 shows, for ICI fuel combustion, the nonpoint SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 2, 3 and 4 SCC descriptions are also provided except for the last SCC (2801520000), where the full SCC description is provided. The SCC level 1 description is "Stationary Source Fuel Combustion" for all SCCs except the last one (2801520000). The leading sector description is "Fuel Comb(ustion)" for all SCCs.

Table 4-51: ICI fuel combustion SCCs with 2014 NEI emissions

Sector type	SCC	Description	EPA	State	Local	Tribe
Comm/Institutional - Biomass	2103008000	Commercial/Institutional; Wood; Total: All Boiler Types	X	X	X	X
Comm/Institutional - Coal	2103001000	Commercial/Institutional; Anthracite Coal; Total: All Boiler Types	X	X	X	X
Comm/Institutional - Coal	2103002000	Commercial/Institutional; Bituminous/Subbituminous Coal; Total: All Boiler Types	X	X	X	
Comm/Institutional - Natural Gas	2103006000	Commercial/Institutional; Natural Gas; Total: Boilers and IC Engines	X	X	X	

Sector type	SCC	Description	EPA	State	Local	Tribe
Comm/Institutional - Oil	2103004000	Commercial/Institutional; Distillate Oil; Total: Boilers and IC Engines		X		X
Comm/Institutional - Oil	2103004001	Commercial/Institutional; Distillate Oil; Boilers	X	X	X	
Comm/Institutional - Oil	2103004002	Commercial/Institutional; Distillate Oil; IC Engines	X	X	X	
Comm/Institutional - Oil	2103005000	Commercial/Institutional; Residual Oil; Total: All Boiler Types	X	X	X	
Comm/Institutional - Oil	2103011000	Commercial/Institutional; Kerosene; Total: All Combustor Types	X	X	X	
Comm/Institutional - Other	2103007000	Commercial/Institutional; Liquified Petroleum Gas (LPG); Total: All Combustor Types	X	X	X	
Industrial Boilers, ICEs - Biomass	2102008000	Industrial; Wood; Total: All Boiler Types	X	X	X	X
Industrial Boilers, ICEs - Coal	2102001000	Industrial; Anthracite Coal; Total: All Boiler Types	X	X	X	
Industrial Boilers, ICEs - Coal	2102002000	Industrial; Bituminous/Subbituminous Coal; Total: All Boiler Types	X	X	X	
Industrial Boilers, ICEs - Natural Gas	2102006000	Industrial; Natural Gas; Total: Boilers and IC Engines	X	X	X	
Industrial Boilers, ICEs - Oil	2102004000	Industrial; Distillate Oil; Total: Boilers and IC Engines		X		
Industrial Boilers, ICEs - Oil	2102004001	Industrial; Distillate Oil; All Boiler Types	X	X	X	X
Industrial Boilers, ICEs - Oil	2102004002	Industrial; Distillate Oil; All IC Engine Types	X	X	X	X
Industrial Boilers, ICEs - Oil	2102005000	Industrial; Residual Oil; Total: All Boiler Types	X	X	X	
Industrial Boilers, ICEs - Oil	2102011000	Industrial; Kerosene; Total: All Boiler Types	X	X	X	X
Industrial Boilers, ICEs - Other	2102007000	Industrial; Liquified Petroleum Gas (LPG); Total: All Boiler Types	X	X	X	X
Industrial Boilers, ICEs - Other	2102012000	Industrial; Waste oil; Total		X		
Industrial Boilers, ICEs - Other	2801520000	Miscellaneous Area Sources; Agriculture Production - Crops; Orchard Heaters; Total, all fuels		X		

The agencies listed in Table 4-61 submitted nonpoint inventory NO_X emissions for these sectors; agencies not listed used EPA estimates for all ICI sectors. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%). Table 4-53 provides the same agency submittal information for SO_2 and Table 4-54 provides the same information for (primary) $PM_{2.5}$ agency submittals.

Table 4-52: Percentage of ICI fuel combustion NO_X emissions submitted by reporting agency

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
1	Connecticut Department of Energy and Environmental Protection	100		100	100	100	100		100	100	100
1	Maine Department of Environmental Protection	100		100	100	100			100	100	
1	Massachusetts Department of Environmental Protection	100		100	100	100	100		100	100	100
1	New Hampshire Department of Environmental Services	100		100	100	100			100	100	100
1	Rhode Island Department of Environmental Management	100		100	100	100	100		100	100	100
1	Vermont Department of Environmental Conservation	100		100	100	100			100	100	100
2	New Jersey Department of Environment Protection			100	100	100			100	100	100
2	New York State Department of Environmental Conservation			100	100	100		100		100	100
2	Puerto Rico				98	3				64	59
3	DC-District Department of the Environment	100		100	100	100				100	100
3	Maryland Department of the Environment		100	100	100	100					
3	Pennsylvania Department of Environmental Protection	100	100	100	100	100	100	100	100	100	100
3	Virginia Department of Environmental Quality	100	100	100	100	100	100		100	100	
3	West Virginia Division of Air Quality	100		100	100	100		100		100	
4	Chattanooga Air Pollution Control Bureau (CHCAPCB)	100	100	100	100	100	100	100	100	100	100
4	Florida Department of Environmental Protection	100		100	100	100	100			100	
4	Georgia Department of Natural Resources			100	100	100			100	11	
4	Knox County Department of Air Quality Management			100	100	100			100	100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
4	Louisville Metro Air Pollution Control District	100		100	100	100	100			100	100
4	Memphis and Shelby County Health Department - Pollution Control	100		100	100	100			100	100	100
4	Metro Public Health of Nashville/Davidson County			100							
4	North Carolina Department of Environment and Natural Resources	100	100	100	100	100	100		100	100	
4	South Carolina Department of Health and Environmental Control	100		100	100	100	100		100	100	
4	Tennessee Department of Environmental Conservation		100	100	100	100	100	100		100	100
5	Illinois Environmental Protection Agency			100	100	100			100	100	
5	Indiana Department of Environmental Management	100		100	100	100	100			100	100
5	Michigan Department of Environmental Quality		100	100	100	100	100	100	100	100	100
5	Minnesota Pollution Control Agency	100		100	100	100	100	100	100	100	100
5	Ohio Environmental Protection Agency	100	100	100	100	100	100		100	100	100
5	Wisconsin Department of Natural Resources	100		100	100	100	100		100	100	100
6	Arkansas Department of Environmental Quality	100		100	100	100	100			100	100
6	City of Albuquerque	100		100	100	100	100	100	100	100	100
6	Louisiana Department of Environmental Quality	100			100	100	100	100		100	100
6	Oklahoma Department of Environmental Quality	100		100	100	100	100			100	100
6	Texas Commission on Environmental Quality			100	100	100			100	100	100
7	Iowa Department of Natural Resources	100		100	100	100	100			100	100
7	Kansas Department of Health and Environment	100		100	100	100		100		100	100
7	Missouri Department of Natural Resources	100		100	100	100			100	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation			100							
8	Northern Cheyenne Tribe	100	100		100	100					

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
8	Utah Division of Air Quality	100		100	100	100	100		100	100	100
9	Arizona Department of Environmental Quality	100		100	100	100	100	100	100	100	100
9	California Air Resources Board			98	100	63			78	100	75
9	Clark County Department of Air Quality and Environmental Management			100	100	100		100		100	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California				100						
9	Washoe County Health District			100	100	100			100	100	100
10	Alaska Department of Environmental Conservation			6	100				0	100	
10	Coeur d'Alene Tribe	100	100	100	100	100	100		100	100	100
10	Idaho Department of Environmental Quality	100	100	100	100	100	100		100	100	100
10	Kootenai Tribe of Idaho	100	100	100	100	100			100	100	100
10	Nez Perce Tribe	100	100	100	100	100	100		100	100	100
10	Oregon Department of Environmental Quality	100		100	100	100		100	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100	100	100	100	100		100	100	100
10	Washington State Department of Ecology	100		100	100	100	100	100	100	100	100

Table 4-53: Percentage of ICI fuel combustion SO_2 emissions submitted by reporting agency

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
1	Connecticut Department of Energy and Environmental Protection	100		100	100	100	100		100	100	100
1	Maine Department of Environmental Protection	100		100	100	100			100	100	
1	Massachusetts Department of Environmental Protection	100		100	100	100	100		100	100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
1	New Hampshire Department of Environmental Services	100		100	100	100			100	100	100
1	Rhode Island Department of Environmental Management	100		100	100	100	100		100	100	100
1	Vermont Department of Environmental Conservation	100		100	100	100			100	100	100
2	New Jersey Department of Environment Protection			100	100	100			100	100	100
2	New York State Department of Environmental Conservation			100	100	100		100		100	100
2	Puerto Rico				52					16	
3	DC-District Department of the Environment	100		100	100	100				100	100
3	Maryland Department of the Environment		100	100	100	100					
3	Pennsylvania Department of Environmental Protection	100	100	100	100	100	100	100	100	100	100
3	Virginia Department of Environmental Quality	100	100	100	100	100	100		100	100	
3	West Virginia Division of Air Quality	100		100	100	100		100		100	
4	Chattanooga Air Pollution Control Bureau (CHCAPCB)	100	100	100	100	100	100	100	100	100	100
4	Florida Department of Environmental Protection	100		100	100	100		100		100	
4	Georgia Department of Natural Resources			100	100	100				94	
4	Knox County Department of Air Quality Management			100	100	100			100	100	100
4	Louisville Metro Air Pollution Control District	100		100	100	100	100			100	100
4	Memphis and Shelby County Health Department - Pollution Control	100		100	100	100			100	92	100
4	Metro Public Health of Nashville/Davidson County			100							
4	North Carolina Department of Environment and Natural Resources	100	100	100	100	100	100		100	100	
4	South Carolina Department of Health and Environmental Control	100		100	100	100	100		100	100	

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
4	Tennessee Department of Environmental Conservation			100	100	100				100	100
5	Illinois Environmental Protection Agency			100	100	100			100	100	
5	Indiana Department of Environmental Management	100		100	100	100	100			100	100
5	Michigan Department of Environmental Quality		100	100	100	100	100	100	100	100	100
5	Minnesota Pollution Control Agency	100		100	100	100	100	100	100	100	100
5	Ohio Environmental Protection Agency	100	100	100	100	100	100		100	100	100
5	Wisconsin Department of Natural Resources	100		100	100	100	100		100	100	100
6	Arkansas Department of Environmental Quality	100		100	100	100				100	100
6	City of Albuquerque	100			100	100	100	100	100	100	100
6	Louisiana Department of Environmental Quality	100			100	100	100	100		100	100
6	Oklahoma Department of Environmental Quality	100		100	100	100	100			100	100
6	Texas Commission on Environmental Quality			100	100	100			100	100	100
7	Iowa Department of Natural Resources	100			100	100	100			100	100
7	Kansas Department of Health and Environment	100		100	100	100		100		100	100
7	Missouri Department of Natural Resources	100		100	100	100			100	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation			100							
8	Northern Cheyenne Tribe	100	100		100	100					
8	Utah Division of Air Quality	100		100	100	100	100		100	100	100
9	Arizona Department of Environmental Quality	100		100	100	100	100	100	100	100	100
9	California Air Resources Board			98	100	99			83	100	99
9	Clark County Department of Air Quality and Environmental Management				100	100		100		100	
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California				100						
9	Washoe County Health District			100	100	100			100	100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
10	Alaska Department of Environmental Conservation			31	100				0	100	
10	Coeur d'Alene Tribe	100	100	100	100	100	100		100	100	100
10	Idaho Department of Environmental Quality	100	100	100	100	100	100		100	100	100
10	Kootenai Tribe of Idaho	100	100	100	100	100			100	100	100
10	Nez Perce Tribe	100	100	100	100	100	100		100	100	100
10	Oregon Department of Environmental Quality	100		100	100	100		100	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100	100	100	100	100		100	100	100
10	Washington State Department of Ecology	100		100	100	100	100	100	100	100	100

Table 4-54: Percentage of ICI fuel combustion $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
1	Connecticut Department of Energy and Environmental Protection	100		100	100	100	100		100	100	100
1	Maine Department of Environmental Protection	100		100	100	100			100	100	
1	Massachusetts Department of Environmental Protection	100		100	2	100	100		100	0	100
1	New Hampshire Department of Environmental Services	100		57	87	100			100	100	100
1	Rhode Island Department of Environmental Management	100		100	100	100	100		100	100	100
1	Vermont Department of Environmental Conservation	100		100	100	100			100	100	100
2	New Jersey Department of Environment Protection			100	100	100			100	100	100
2	New York State Department of Environmental Conservation			100	100	100		100		100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
2	Puerto Rico				2					16	
3	DC-District Department of the Environment	100		100	100	100				100	100
3	Maryland Department of the Environment			100	54	100					
3	Pennsylvania Department of Environmental Protection	100	100	100	100	100	100	100	100	100	100
3	Virginia Department of Environmental Quality	100	100	100	100	100	100		100	100	
3	West Virginia Division of Air Quality	100		100	100	100		100		100	
4	Chattanooga Air Pollution Control Bureau (CHCAPCB)	100	100		100	100	100	100		100	100
4	Florida Department of Environmental Protection	100			100	100	100	100		100	
4	Georgia Department of Natural Resources			100	81	100				2	
4	Knox County Department of Air Quality Management			100	100	100			100	100	100
4	Louisville Metro Air Pollution Control District	100		100	100	100	100			100	100
4	Memphis and Shelby County Health Department - Pollution Control	100		100	2	100			100	100	100
4	Metro Public Health of Nashville/Davidson County										
4	North Carolina Department of Environment and Natural Resources	100	100	100	100	100	100		100	100	
4	South Carolina Department of Health and Environmental Control	100		100	100	100	100		100	100	
4	Tennessee Department of Environmental Conservation	100	100		100	100	91	99		98	100
5	Illinois Environmental Protection Agency			100	83	100			100	100	
5	Indiana Department of Environmental Management	100		100	100	100	100			100	100
5	Michigan Department of Environmental Quality						100				100
5	Minnesota Pollution Control Agency	100		100	100	100	100	100	100	100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
5	Ohio Environmental Protection Agency	100	100	100	100	100	100		100	100	100
5	Wisconsin Department of Natural Resources	100		100	100	100	100		100	100	100
6	Arkansas Department of Environmental Quality										
6	City of Albuquerque	100			100	100	100	100		96	100
6	Louisiana Department of Environmental Quality	100			100	100	100	100		100	100
6	Oklahoma Department of Environmental Quality	100		100	100	100	100			100	100
6	Texas Commission on Environmental Quality			93	99	100			100	94	100
7	Iowa Department of Natural Resources	100			100	100	100			100	100
7	Kansas Department of Health and Environment	100			100	100	100	100		100	100
7	Missouri Department of Natural Resources	100		100	100	100			100	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation										
8	Northern Cheyenne Tribe	100									
8	Utah Division of Air Quality	100		100	8	100	100		100	100	100
9	Arizona Department of Environmental Quality	100		100	100	100	100	100	100	100	100
9	California Air Resources Board			99	48	96			94	98	99
9	Clark County Department of Air Quality and Environmental Management				99	100		100			100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California				100						
9	Washoe County Health District									100	
10	Alaska Department of Environmental Conservation										
10	Coeur d'Alene Tribe	100	100	100	100	100	100		100	100	100
10	Idaho Department of Environmental Quality	100	100	100	100	100	100		100	100	100
10	Kootenai Tribe of Idaho	100	100	100	100	100			100	100	100
10	Nez Perce Tribe	100	100	100	100	100	100		100	100	100

Region	Agency	Comm/Inst Biomass	Comm/Inst Coal	Comm/Inst Nat Gas	Comm/Inst Oil	Comm/Inst Other	Ind Biomass	Ind Coal	Ind Nat Gas	Ind Oil	Ind Other
10	Oregon Department of Environmental Quality	100		100	100	100		100	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100	100	100	100	100		100	100	100
10	Washington State Department of Ecology	100		100	100	100	100	100	100	100	100

4.12.3 EPA-developed emissions for ICI fuel combustion

The primary data source behind the ICI Combustion Tool is total state-level ICI energy consumption data released annually as part of the Energy Information Administration's State Energy Data System (SEDS) [ref 1]. The ICI Combustion Tool processes the SEDS data and adjusts the data to account for the fraction of fuel consumed by nonroad mobile sources whose emissions are included in the nonroad inventory and by non-fuel combustion uses of energy, such as product feedstocks. Through a user-friendly interface, users can update the underlying assumptions in the adjustment methodology. The ICI Combustion Tool also includes a nonpoint source to point source crosswalk and allows the user to perform point source activity subtractions to avoid double counting of emissions between their point and nonpoint inventories. The ICI Combustion Tool generates outputs in EPA's Emissions Inventory System (EIS) format, ready for submission to the EIS. Complete ICI Combustion Tool documentation and a User's Guide are available on the 2014 NEI nonpoint FTP site at: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint.

ICI combustion nonpoint source emissions are calculated using Equation 1.

$$E_{s,f} = A_{s,f} * F_{s,f} \qquad (1)$$

where:

E = computed emissions,
A = emissions activity,
F = emissions factor,
s = sector (Industrial or Commercial/Institutional),
f = fuel type (coal, natural gas, distillate oil, residual oil, liquefied petroleum gas, kerosene and wood).

The key emissions activity data inputs in the emissions estimation methodology are:

1. Total Industrial and total Commercial/Institutional energy consumption by fuel type and state for a given year;
2. Industrial energy consumed for non-fuel purposes by fuel type and state in that year;
3. ICI distillate oil and liquefied petroleum gas (LPG) consumption by state from nonroad mobile sources for the year of interest;
4. ICI energy consumption by sector, state, and fuel type for point sources for the given year; and

5. County-level employment by ICI sector and state for the year of interest.

The ICI Tool also relies on emission factors relating emission rates to the volume of fuel burned by sector/fuel type, and the sulfur content of coal consumed in each sector by state for the given year.

ICI combustion emissions are directly related to the sector, type, and volume of fuel burned. The EIA is responsible for developing official federal government estimates of energy consumption. The EIA estimates annual energy consumption at the state-level as part of the State Energy Data System (SEDS) [ref 1]. The SEDS reports energy consumption estimates by state, sector, fuel type, and year. The SEDS provides data for each of five consuming sectors, including Industrial and Commercial (note that the SEDS' definition of "Commercial" includes Institutional sector use). The EIA also publishes additional detailed estimates of state-level fuel oil and kerosene consumption estimates in their *Fuel Oil and Kerosene Sales* publication [ref 2]. This publication provides state-level annual end use sales of No.1, No. 2, and No. 4 distillate fuel oil for commercial, industrial, oil company, farm, off-highway construction, and other uses – these data are used to differentiate stationary from mobile source distillate fuel consumption.

4.12.3.1 *Activity data adjustments*

Fuel-specific adjustments

Coal – For coal combustion, it is necessary to compile data representing a subset of total sector coal consumption. Data representing non-coke plant consumption are compiled from EIA because coal consumed by coke plants is accounted for in the point source inventory. The SEDS data do not provide coal consumption estimates by type of coal (i.e., anthracite versus bituminous/subbituminous). Therefore, state-level ICI coal distribution data for 2013 from the EIA's *Annual Coal Distribution Report 2013* are used to allocate coal consumption between the two types of coal [ref 3]. The 2013 ratio of anthracite coal consumption to total coal consumption is used for this allocation procedure.

Distillate Oil and LPG – The SEDS ICI distillate oil and LPG consumption data include consumption estimates for equipment that are typically included in the nonroad sector inventory. In particular, SEDS considers the following nonroad source category activities to be part of the industrial sector: farming, logging, mining, and construction.

In order to avoid double-counting of distillate oil consumption between the nonpoint and nonroad sector emission inventories, the more detailed distillate oil consumption estimates reported in EIA's *Fuel Oil and Kerosene Sales* are combined with assumptions used in the regulatory impact analysis (RIA) for EPA's nonroad diesel emissions rulemaking [ref 3, ref 4].

For distillate fuel, Table 4-55 presents the assumptions that are applied to the state-level Commercial sector distillate oil consumption data published in *Fuel Oil and Kerosene Sales* to estimate Commercial sector stationary source consumption.

Table 4-55: Stationary source adjustments for industrial sector distillate fuel consumption

EIA Energy Sector	Distillate Fuel Type	% of Total Consumption from Stationary Sources
Industrial	No. 1 Distillate Fuel Oil	60
	No. 2 Distillate Fuel Oil	100
	No. 2 Distillate/Low and High Sulfur Diesel	15[a]

EIA Energy Sector	Distillate Fuel Type	% of Total Consumption from Stationary Sources
	No. 4 Distillate Fuel Oil	100
Farm	Diesel	0
	Other Distillate Fuel Oil	100
Off-Highway (Construction and Other)	Distillate Fuel Oil	5
Oil Company	Distillate Fuel Oil	50

[a] This value differs from the 0% assumption adopted in EPA's nonroad diesel emissions rulemaking because it is known that some diesel fuel is used by stationary sources (a 15 percent value was selected for use as an approximate mid-point of a potential range of 8% to 24% stationary source use computed from a review of data from the EIA's *Manufacturing Energy Consumption Survey* and *Fuel Oil and Kerosene Sales*).

Table 4-56 presents the assumptions that are applied to the state-level Commercial sector distillate oil consumption data published in Fuel Oil and Kerosene Sales to estimate Commercial sector stationary source consumption.

Table 4-56: Stationary source adjustments for commercial sector distillate fuel consumption

EIA Energy Sector	Distillate Fuel Type	% of Total Consumption from Stationary Sources
Commercial	No. 1 Distillate Fuel Oil	80
	No. 2 Distillate Fuel Oil	100
	No. 2 Distillate/Ultra-Low, Low, and High Sulfur Diesel	0[a]
	No. 4 Distillate Fuel Oil	100

[a] A very small portion of total commercial/institutional diesel is consumed by point sources (SCC 203001xx).

In order to avoid double-counting of LPG consumption, the ICI Tool uses data from the EPA National Mobile Inventory Model (NMIM) for 2006 to calculate the national volume of nonroad LPG consumption from agriculture, logging, mining, and construction source categories. This estimate is then divided into the SEDS total LPG consumption estimate to yield the proportion of total ICI LPG consumption attributable to the nonroad sector in that year (8.72% for industrial sources and 17.72% for commercial/institutional sources). It is assumed that these proportions are appropriate for future inventory years. This estimate of the nonroad portion of LPG consumption is subtracted from each state's ICI LPG consumption estimate reported in SEDS.

Non-fuel specific adjustments

Some industrial sector energy is consumed for non-fuel purposes, such as natural gas that is used as a feedstock in chemical manufacturing plants and to make nitrogenous fertilizer, and LPG that is used to create intermediate products that are ultimately made into plastics. In order to estimate the volume of fuel that is associated with industrial combustion, it is necessary to subtract the volume of fuel consumption for non-energy uses from the volume of total fuel consumption.

The identification of feedstock usage was initially based upon the non-fuel use assumptions incorporated into the EIA's GHG emissions inventory for 2005 [ref 5]. The following fuels are assumed to be used entirely for non-fuel purposes: asphalt and road oil, feedstocks (naphtha <401 °F), feedstocks (other oils >401 °F), lubricants, miscellaneous petroleum products, pentanes plus, special naphthas, and waxes. In addition, it is also assumed that kerosene and motor gasoline are used entirely as fuel without any non-fuel purposes. The remaining fuels (i.e., coal [non-coke], distillate oil, LPG, natural gas, and residual oil) are used both for fuel and non-fuel purposes. The regional non-fuel fractions for distillate oil, LPG, natural gas, non-coke coal and residual oil are derived from non-fuel (feedstock) and total energy use statistics contained in EIA's 2010 Manufacturing Energy Consumption Survey (MECS) [ref 6] and are presented in Table 4-57.

Table 4-57: Industrial sector non-fuel use estimates

Fuel	**% of Total Energy Consumption from Non-Fuel Use**				**Source**
	Northeast	**Midwest**	**South**	**West**	
Non-Coke Coal	63	38	26	4[b]	2010 MECS
Natural Gas	1	5	14	2	2010 MECS
LPG	33	88	99	6[b]	2010 MECS
Distillate Oil	4[a]	4[a]	4[a]	4[a]	2010 MECS
Residual Oil	5[b]	50	68	20[b]	2010 MECS

a Nonfuel use of distillate fuel oil was not reported at the regional level; therefore, the default nonfuel use fractions are based on national nonfuel use of distillate fuel oil.

b Nonfuel use was reported in EIA data as "less than 0.5". In these cases, a value of 0.25 was used to estimate the default nonfuel use fractions.

<u>Point source energy adjustments</u>

To ensure that fuel consumption is not double-counted in the point source inventory, it is also necessary to subtract point source inventory fuel use from the fuel consumption estimates developed from the above steps. Equation 2 illustrates the approach to performing point source subtractions.

$$N_{s,f} = T_{s,f} - P_{s,f} \qquad (2)$$

where:

N = nonpoint fuel consumption,
T = total fuel consumption,
P = point source fuel consumption,
s = sector (Industrial or Commercial/Institutional),
f = fuel type (coal, natural gas, distillate oil, residual oil, liquefied petroleum gas, kerosene and wood).

The first step in the point source subtraction procedure is to identify how each ICI combustion nonpoint source classification code (SCC) links to associated ICI combustion point SCCs. The ICI Combustion Tool includes two such crosswalks: one between each Industrial fuel combustion nonpoint SCC and related point SCCs, and an analogous crosswalk developed for Commercial/Institutional fuel combustion SCCs. One issue to note is that natural gas consumed as pipeline fuel is not included by the SEDS within the Industrial sector. Therefore, it is necessary to exclude pipeline natural gas consumption in performing natural gas combustion subtraction. This consumption may be included within industrial sector natural gas internal combustion engine records (SCC 202002xx).

An issue that must be considered is the geographic resolution at which point source subtractions should be performed. While locations of point sources are accurately known at (and below) the county-level, total ICI combustion activity is much less clear. Because of the level of uncertainty associated with the county distribution of total ICI fuel consumption, S/L/Ts may wish to perform the ICI combustion point source subtractions at the state-level, and then allocate the resulting nonpoint source fuel consumption to counties. On the contrary, if S/L/Ts have more accurate county-level fuel consumption values then point source subtraction can be performed at the county-level. The ICI Tool is designed to prioritize county-level data over state-level data, so where county-level data exists, the ICI Tool will perform county-level subtractions before using state-level data.

If an agency does not have county- or state-level point source activity data, emissions data can be used in the place of activity data in the point source subtraction procedure. The procedure follows the same steps, except that the emissions are calculated first, and then the point source activity data are subtracted from the total emissions.

4.12.3.2 *County allocation of state activity*

Because the EIA only reports energy consumption down to the state-level, it is necessary to develop a procedure to allocate EIA's fuel consumption estimates (after adjustments noted in sections above) to counties. For the NEI, the procedure relies on the use of allocation factors developed from the county-level number of employees in the Industrial sector and the county number of employees in the Commercial/Institutional sector. Because EIA fuel consumption data originate from fuel sector-specific surveys of energy suppliers,[12] we reviewed these survey forms/instructions for further details on what individual economic sectors EIA considers to comprise the Industrial and Commercial sector. Based on this review, we compiled employment data for manufacturing sector North American Industrial Classification System (NAICS) codes (i.e., NAICS 31-33) for use in allocating Industrial fuel combustion. The only source of NAICS-code based EIA definitions of the Commercial energy sector is a "rough crosswalk" between Commercial building types and NAICS codes developed for EIA's Commercial Building Energy Consumption Survey (CBECS) [ref 7]. With the exception of NAICS code 814 (Private Households), this crosswalk links all NAICS codes between 42 and 92 with Commercial building energy consumption.

The ICI Combustion Tool compiles employment data for these NAICS codes from two Bureau of the Census publications – *County Business Patterns* (for private sectors), and *Census of Governments* (for public administration sectors) [ref 8, ref 9]. For NAICS code 92, county-level employment is estimated from local government employment data in the *Census of Governments*.[13] Employment estimates from each source are then combined to estimate total Commercial/ Institutional sector employment by county. The state-level fuel combustion by fuel type estimates in each sector are then allocated to each county using the ratio of the number of Industrial or Commercial/Institutional employees in each county in a given state.

Due to concerns with releasing confidential business information, County Business Patterns (CBP) withholds values for a given county/NAICS code if it would be possible to identify data for individual facilities. In such cases, the Census reports a letter code, representing a particular employment size range. We used the following procedure to estimate data for withheld counties/NAICS codes.

1. County-level employment for counties with reported values are totaled by state for the applicable NAICS code.
2. The value from step 1 is subtracted from the state employment value for the NAICS code.
3. Each of the withheld counties is assigned an initial employment estimate reflecting the midpoint of the CBP range code (e.g., code A, which reflects 1-19 employees, is assigned an estimate of 10 employees).
4. The initial employment estimates from step 3 are then summed to the state level.

[12] For natural gas, for example – EIA-176 "Annual Report of Natural and Supplemental Gas Supply and Disposition."
[13] County-level federal and state government employment data are not available from the Bureau of the Census.

5. The value from step 2 is divided by the value from step 4 to yield an adjustment factor to apply to the initial employment estimates to yield employment values that will sum to the state employment total for the applicable NAICS code.
6. The final county-level employment values are estimated by multiplying the initial employment estimates from step 3 by the step 5 adjustment factors.

Table 4-58 illustrates the employment estimation procedure with an example of CBP data reported for Maine.

Table 4-58: NAICS Code 31-33 (Manufacturing) employment data for Maine

FIPSSTATE	FIPSCTY	NAICS	EMPFLAG	EMP
23	1	31----		6,774
23	3	31----		3,124
23	5	31----		10,333
23	7	31----		1,786
23	9	31----		1,954
23	11	31----		2,535
23	13	31----		1,418
23	15	31----	F	0
23	17	31----		2,888
23	19	31----		4,522
23	21	31----		948
23	23	31----	I	0
23	25	31----		4,322
23	27	31----		1,434
23	29	31----		1,014
23	31	31----		9,749

- The total of employees not including counties 015 and 023 is 52,801.
- *County Business Patterns* reports 59,322 state employees in NAICS 31—the difference is 6,521.
- County 015 is given a midpoint of 1,750 (since range code F is 1,000-2,499) and County 023 is given a midpoint of 17,500.
- State total for these two counties is 19,250.
- 6,521/19,250 = 0.33875.

The final employment estimate for county 015 is 1,750 x 0.33875 = 593. The county 023 final employment estimate is computed as 17,500 x 0.33875 = 5,928.

4.12.3.3 *Emission factors*

Table 4-59 lists the CAP emission factors used in the ICI Combustion Tool. The CAP and HAP emission factors for each nonpoint source fuel combustion category included in the ICI Combustion Tool are primarily EPA emission factors. The majority of the emission factors are from the EPA/ERTAC2 database and EPA's *AP-42* report, Compilation of Air Pollutant Emission Factors [ref 10, ref 11]. The ammonia emission factors for wood combustion are from an Emission Inventory Improvement Program (EIIP) guidance document [ref 12].

For coal combustion, the SO_2 emission factors are based on the sulfur content of the coal burned, and some of the PM emission factors for anthracite coal require information on the ash content of the coal. For the industrial and commercial/institutional sectors, state-specific coal sulfur contents for bituminous coal are obtained from the EIA's quarterly coal report [ref 13]. For anthracite coal, an ash content value of 13.38% and a sulfur content of 0.89% are applied to all states.

Table 4-59: CAP emission factors for ICI source categories

SCC	Description	Emission Factor Units[1]	VOC	NO_x	CO	SO_2	PM25-FIL	PM10-FIL	PM-CON	NH_3
2102001000	Industrial Anthracite Coal	lb/ton	0.3	9	0.6	39 * S%	0.48 * A%	1.1 * A%	0.08*A%	0.03
2102002000	Industrial Bitum/Subbitum Coal	lb/ton	0.05	11	5	38 * S%	1.4	12	1.04	0.03
2102004000	Industrial Distillate Oil	lb/1000 gal	0.2	20	5	142 * S%	0.25	1	1.3	0.8
2102005000	Industrial Residual Oil	lb/1000 gal	0.28	55	5	157 * S%	4.67 * (1.12 * S% + 0.37)	7.17 * (1.12 * S% + 0.37)	1.5	0.8
2102006000	Industrial Natural Gas	lb/MMcf	5.5	100	84	0.6	0.11	0.2	0.322	3.2
2102007000	Industrial LPG [3]	lb/1000 gal	0.52	14.2	8	0.06	0.01	0.02	0.03	0.34
2102008000	Industrial Wood [5]	lb/MMBtu	0.02	0.22	0.6	0.025	0.43	0.5	0.017	0.008
2102011000	Industrial Kerosene	lb/1000 gal	0.19	19.3	4.8	142 * S%[7]	0.24	0.96	1.25	0.77
2103001000	Comm/Inst Anthracite Coal	lb/ton	0.3	9	0.6	39 * S%	0.48 * A%	1.1 * A%	0.08 * A%	0.03
2103002000	Comm/Inst Bitum/Subbitum Coal	lb/ton	0.05	11	5	38 * S%	1.4	12	1.04	0.03
2103004000	Comm/Inst Distillate Oil	lb/1000 gal	0.34	20	5	142 * S%	0.83	1.08	1.3	0.8
2103005000	Comm/Inst Residual Oil	lb/1000 gal	1.13	55	5	157 * S%	1.92 * (1.12 * S% + 0.37)	5.17 * (1.12 * S% + 0.37)	1.5	0.8
2103006000	Comm/Inst Natural Gas	lb/MMcf	5.5	100	84	0.6	0.11	0.2	0.32	0.49

SCC	Description	Emission Factor Units[1]	VOC	NO_x	CO	SO_2	PM25-FIL	PM10-FIL	PM-CON	NH_3
2103007000	Comm/Inst LPG	lb/1000 gal	0.52	14.2	8	0.06	0.01	0.02	0.03	0.05
2103008000	Comm/Inst Wood [5]	lb/MMBtu	0.02	0.22	0.6	0.025	0.43	0.5	0.017	0.006
2103011000	Comm/Inst Kerosene	lb/1000 gal	0.33	19.3	4.8	142 * S%	0.8	1.04	1.3	0.8

Source: Unless otherwise noted, ERTAC emission factors used to support the 2011 NEI (Huntley, 2009).

Notes: [1] lb = pound; ton = short ton; gal = gallon; MMcf = million cubic feet; MMBtu = million British thermal units; bbl = barrels; S% = percent sulfur content; A% = percent ash content

[2] The EPA ERTAC emission factor workbook (Huntley, 2009) for this emission factors (EF) contains an error. The change log in the ERTAC workbook conflicts with the actual changes made to the emission factors spreadsheet. The PM-CON EF should be 0.32 lb/MMcf for 2102006000 instead of the 0.49 lb/MMcf value reported in the ERTAC workbook.

[3] Emission factors from Commercial/Institutional LPG.

[4] The EPA ERTAC emission factor workbook (Huntley, 2009) for this emission factors (EF) contains an error. The change log in the ERTAC workbook conflicts with the actual changes made to the emission factors spreadsheet. The NH_3 EF should be 0.3 lb/1000 gal for 2102007000 instead of the 0.05 lb/1000 gal value reported in the ERTAC workbook.

[5] Emission factors from *AP-42*, Section 1.6, Wood Residue Combustion in Boilers (EPA, 2003).

[6] Emission factor from Pechan, 2004 (converted from lb/ton using 0.08 ton/MMBtu for Industrial sector and 0.0625 ton/MMBtu for Commercial sector).

[7] The EPA ERTAC emission factor workbook (Huntley, 2009) for this emission factors (EF) contains an error. The ERTAC workbook uses the equation 157*S%. The correct EF equation is 142*S%.

4.12.4 References for ICI fuel combustion

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4.13 Fuel Combustion – Residential – Natural Gas, Oil and Other

4.13.1 Sector description

The EIS sectors to be documented here are:

- "Fuel Comb - Residential - Natural Gas" which includes the fuel natural gas only. Residential natural gas combustion is natural gas that is burned to heat residential housing as well as in grills, hot water heaters, and dryers.
- "Fuel Comb - Residential – Oil" which includes the fuels: (1) distillate oil, (2) kerosene and (3) residual oil. Residual oil is not an EPA-estimated category, and no agencies submitted data for it in 2014. Residential distillate oil combustion is oil that is burned in residential housing. Residential kerosene combustion is kerosene that is burned in residential housing. Common uses of energy associated with this sector include space heating, water heating, cooking, and running a wide variety of other equipment.
- "Fuel Comb - Residential – Other" which includes the fuels: (1) coal, (2) liquid petroleum gas (LPG) and (3) "Biomass; all except Wood". Note that "Biomass; all except Wood" is not an EPA-estimated category, and no S/L/T agency submitted data for it for the 2014 NEI. Residential Coal Combustion is coal that is burned to heat residential housing. Residential LPG combustion is liquefied propane gas that is burned in residential housing. Common uses of energy associated with this sector include space heating, water heating, and cooking.

4.13.2 Sources of data

Table 4-60 shows, for non-wood Residential heating, the nonpoint SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 3 and 4 SCC descriptions are also provided. The SCC level 1 and 2 descriptions is "Stationary Source Fuel Combustion; Residential" for all SCCs.

According to the State Energy Data System (SEDS) 2013 Consumption tables published by the Energy Information Administration (EIA) [ref 1], there was no residential coal combustion in 2013. However, the old methodology is retained here and provided in an EPA workbook, and as seen in Table 4-60, with zero emissions, in case a state would like to use their own coal consumption data.

Table 4-60: Non-wood residential heating SCCs with 2014 NEI emissions

Sector Fuel	SCC	Description	EPA	State	Local	Tribe
Natural Gas	2104006000	Natural Gas; Total: All Combustor Types	X	X	X	X
Oil	2104004000	Distillate Oil; Total: All Combustor Types	X	X	X	X
Oil	2104011000	Kerosene; Total: All Heater Types	X	X	X	X
Other	2104001000	Anthracite Coal; Total: All Combustor Types	0	X		X
Other	2104002000	Bituminous/Subbituminous Coal; Total: All Combustor Types	0	X		X
Other	2104007000	Liquified Petroleum Gas (LPG); Total: All Combustor Types	X	X	X	X

The agencies listed in Table 4-61 submitted emissions for these sectors; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-61: Percentage of non-wood residential heating NO_X, $PM_{2.5}$ and VOC emissions submitted by reporting agency

Region	Agency	S/L/T	Sector Fuel	NO_X	$PM_{2.5}$	VOC
1	Massachusetts Department of Environmental Protection	State	Natural Gas	100	100	100
1	Massachusetts Department of Environmental Protection	State	Oil	100	100	100
1	Massachusetts Department of Environmental Protection	State	Other	100	100	100
1	New Hampshire Department of Environmental Services	State	Natural Gas	100	99	100
1	New Hampshire Department of Environmental Services	State	Oil	100	100	100
1	New Hampshire Department of Environmental Services	State	Other	100	100	100
1	Vermont Department of Environmental Conservation	State	Natural Gas	100		100
2	New Jersey Department of Environment Protection	State	Natural Gas	100	100	100
2	New Jersey Department of Environment Protection	State	Oil	100	100	100
2	New Jersey Department of Environment Protection	State	Other	100	100	100
2	New York State Department of Environmental Conservation	State	Natural Gas	100	100	100
2	New York State Department of Environmental Conservation	State	Oil	100	100	100
2	New York State Department of Environmental Conservation	State	Other	100	100	100
3	Maryland Department of the Environment	State	Natural Gas	100		100

Region	Agency	S/L/T	Sector Fuel	NO_X	$PM_{2.5}$	VOC
3	Maryland Department of the Environment	State	Oil	100	100	100
3	Maryland Department of the Environment	State	Other	100	28	100
3	Virginia Department of Environmental Quality	State	Natural Gas	100	100	100
3	Virginia Department of Environmental Quality	State	Oil	100	100	100
3	Virginia Department of Environmental Quality	State	Other	100	100	100
4	Metro Public Health of Nashville/Davidson County	State	Natural Gas	100		100
4	Metro Public Health of Nashville/Davidson County	State	Oil	94		93
4	Metro Public Health of Nashville/Davidson County	State	Other	100		100
5	Illinois Environmental Protection Agency	State	Natural Gas	100	100	100
5	Illinois Environmental Protection Agency	State	Oil	100	100	100
5	Illinois Environmental Protection Agency	State	Other	100	100	100
5	Michigan Department of Environmental Quality	State	Natural Gas	100		100
5	Michigan Department of Environmental Quality	State	Oil	100		100
5	Michigan Department of Environmental Quality	State	Other	100		100
6	Texas Commission on Environmental Quality	State	Natural Gas	100	100	100
6	Texas Commission on Environmental Quality	State	Oil	100	100	
6	Texas Commission on Environmental Quality	State	Other	100	100	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	Other	100		100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	Natural Gas	100		100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	Other	100		100
8	Northern Cheyenne Tribe	Tribe	Natural Gas	100		100
8	Northern Cheyenne Tribe	Tribe	Oil	100		100
8	Northern Cheyenne Tribe	Tribe	Other	100		100
8	Utah Division of Air Quality	State	Natural Gas	100	100	100
8	Utah Division of Air Quality	State	Other	100	100	100
9	Arizona Department of Environmental Quality	State	Natural Gas	100	100	100
9	Arizona Department of Environmental Quality	State	Oil	100	100	100
9	Arizona Department of Environmental Quality	State	Other	100	100	100
9	California Air Resources Board	State	Natural Gas	100	100	100
9	California Air Resources Board	State	Oil	92	93	97
9	California Air Resources Board	State	Other	100	100	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	Natural Gas	100		100
9	Washoe County Health District	Local	Natural Gas	100		100
9	Washoe County Health District	Local	Oil	100		100
9	Washoe County Health District	Local	Other	100		100
10	Alaska Department of Environmental Conservation	State	Natural Gas	9		6
10	Coeur d'Alene Tribe	Tribe	Natural Gas	100	100	100
10	Coeur d'Alene Tribe	Tribe	Oil	100	100	100
10	Coeur d'Alene Tribe	Tribe	Other	100	100	100
10	Idaho Department of Environmental Quality	State	Natural Gas	100	100	100

Region	Agency	S/L/T	Sector Fuel	NO_X	$PM_{2.5}$	VOC
10	Idaho Department of Environmental Quality	State	Oil	100	100	100
10	Idaho Department of Environmental Quality	State	Other	100	100	100
10	Kootenai Tribe of Idaho	Tribe	Natural Gas	100	100	100
10	Kootenai Tribe of Idaho	Tribe	Oil	100	100	100
10	Kootenai Tribe of Idaho	Tribe	Other	100	100	100
10	Nez Perce Tribe	Tribe	Natural Gas	100	100	100
10	Nez Perce Tribe	Tribe	Oil	100	100	100
10	Nez Perce Tribe	Tribe	Other	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	Natural Gas	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	Oil	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	Other	100	100	100

4.13.3 EPA-developed emissions for residential heating – natural gas, oil and other fuels

The general approach to calculating emissions for all fuel types is to take state-level fuel-specific (natural gas, distillate oil, kerosene, coal, and LPG) consumption from the EIA and allocate it to the county level using the methods described below. County-level fuel consumption is multiplied by the emission factors to calculate emissions.

4.13.3.1 *Activity data*

Natural Gas, Distillate Oil, Kerosene, and LPG

The state-level volume of each of these fuel types consumed by residential combustion in the United States was used to estimate emissions. Fuel type consumption by energy use sector was obtained from the State Energy Data System (SEDS) 2013 Consumption tables published by the EIA [ref 1]. Year 2013 consumption data were used as a surrogate for 2014 emissions because these data were the latest data available when this inventory was prepared.

Natural gas consumption is represented in the SEDS table by the Data Series Name (MSN) NGRCP. Distillate consumption is represented in the SEDS table by the Data Series Name (MSN) DFRCP. Kerosene consumption is represented in the SEDS table by the Date Series Name (MSN) KSRCP. LPG consumption is represented in the SEDS table by the Data Series Name (MSN) LGRCP.

State-level fuel type consumption was allocated to each county using the US Census Bureau's 2013 5-year estimate Census Detailed Housing Information [ref 2]. These data include the number of housing units using a specific type of fuel for residential heating. State fuel type consumption was allocated to each county using the ratio of the number of houses burning natural gas, distillate oil, kerosene, or LPG in each county to the total number of houses burning natural gas, distillate oil, kerosene, or LPG in the state.

Coal

The mass of coal consumed by residential combustion in the U.S. was used to estimate emissions. Coal consumption by energy use sector is presented in State Energy Data System (SEDS) 2013 Consumption tables published by the Energy Information Administration (EIA) [ref 1]. Year 2013 consumption data were used as a surrogate for 2014 emissions because year 2013 data were the latest data available when this inventory was prepared. Coal consumption is represented in the SEDS table by the Data Series Name (MSN) CLRCP.

EIA data do not distinguish between anthracite and bituminous coal consumption estimates. The EIA table "Domestic Distribution of U.S. Coal by Destination State, Consumer, Origin and Method of Transportation," provides state-level residential coal distribution data for 2006 that was used to estimate anthracite and bituminous coal consumption. The amount of anthracite distributed to each state and the total coal delivered to each state were used to estimate the proportion of anthracite and bituminous coal consumption [ref 3]. The 2006 ratio of anthracite (and bituminous) coal consumption to total coal consumption was used to distribute the EIA's total residential sector coal consumption data by coal type. Table 4-62 presents the 2006-based percent of total bituminous coal for each state. The percent anthracite coal is computed as the remaining percent (if any).

Table 4-62: 2006 percent bituminous coal distribution for the residential and commercial sectors

State	Percent Bituminous	State	Percent Bituminous
Alabama	100	Montana	100
Alaska	100	Nebraska	100
Arizona	81.4	Nevada	100
Arkansas	81.4	New Hampshire	0
California	100	New Jersey	0
Colorado	99.6	New Mexico	100
Connecticut	0	New York	60
Delaware	81.4	North Carolina	100
Dist. Columbia	100	North Dakota	100
Florida	81.4	Ohio	87.3
Georgia	100	Oklahoma	91.7
Hawaii	100	Oregon	100
Idaho	97.9	Pennsylvania	19.4
Illinois	99.8	Rhode Island	0
Indiana	94.7	South Carolina	99.7
Iowa	99.9	South Dakota	100
Kansas	100	Tennessee	99.4
Kentucky	99.8	Texas	81.4
Louisiana	100	Utah	100
Maine	0	Vermont	0
Maryland	92.9	Virginia	96.3
Massachusetts	50	Washington	100
Michigan	66.7	West Virginia	90.5
Minnesota	99.7	Wisconsin	99.1
Mississippi	100	Wyoming	100
Missouri	100		

State-level coal consumption was allocated to each county using the US Census Bureau's 2013 5-year estimate Census Detailed Housing Information [ref 2]. These data include the number of housing units using a specific type of fuel for residential heating. State coal consumption was allocated to each county using the ratio of the number of houses burning coal in each county to the total number of houses burning coal in the state.

4.13.3.2 *Control factors*

No control measures are assumed for any non-wood residential heating sources.

4.13.3.3 *Emission factors*

Natural Gas

Criteria pollutant emission factors for natural gas are from AP-42 [ref 4]. The ammonia emission factor is from EPA's *Estimating Ammonia Emissions from Anthropogenic Sources, Draft Final Report* [ref 5]. HAP emission factors are from AP-42 and "Documentation for the 1999 Base Year Nonpoint Area Source National Emission Inventory for Hazardous Air Pollutants." [ref 6] According to AP-42 (maximum value provided) [ref 4], natural gas has a heat content of 1,050 million BTU per million cubic feet. This value was required to convert those emission factors originally given in units "pounds per million Btu" to units "pounds per million cubic feet." The grains of sulfur per million cubic feet are assumed to be 2000 [ref 7]. Some emission factors were revised based on recommendations by an ERTAC advisory panel composed of state and EPA personnel.

County-level criteria pollutant and HAP emissions were calculated by multiplying the total natural gas consumed in each county per year by an emission factor. Table 4-63 provides a summary of the pollutants, pollutant codes, and emission factors for residential combustion of natural gas.

Table 4-63: Residential natural gas combustion emission factors

Pollutant Code	Pollutant Code Description	Emission Factor (LB/E6FT3)
129000	PYRENE	0.00000525
206440	FLUORANTHENE	0.00000315
50000	FORMALDEHYDE	0.07875
71432	BENZENE	0.002205
75070	ACETALDEHYDE	0.00001365
85018	PHENANTHRENE	0.00001785
86737	FLUORENE	0.00000294
91203	NAPHTHALENE	0.0006405
CO	CARBON MONOXIDE	40
NH3	AMMONIA	20
NOX	NITROGEN OXIDES	94
PM10-PRI	PRIMARY PM_{10} (INCLUDES FILTERABLES + CONDENSIBLES)	0.52
PM25-PRI	PRIMARY $PM_{2.5}$ (INCLUDES FILTERABLES + CONDENSIBLES)	0.43
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION ONLY	0. 2
PM25-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION ONLY	0.11
PM-CON	PRIMARY PM CONDENSIBLE PORTION ONLY	0.32
SO2	SULFUR DIOXIDE	0.6
VOC	VOLATILE ORGANIC COMPOUNDS	5.5

Distillate Oil

Criteria pollutant emission factors for distillate oil are from AP-42 [ref 4]. For all counties in the United States, the distillate oil consumed by residential combustion is assumed to be No. 2 fuel oil with a heating value of 140,000 Btu per gallon and a sulfur content of 0.30% [ref 7]. Dioxin/furan and HAP emission factors are from

"Documentation of Emissions Estimation methods for Year 2000 and 2001 Mobile Source and Nonpoint Source Dioxin Inventories" [ref 8] and "Documentation for the 1999 Base Year Nonpoint Area Source National Emission Inventory for Hazardous Air Pollutants," [ref 6] respectively. Sulfur content was 0.30% and was obtained from data compiled in preparing the 1999 residential coal combustion emissions estimates [ref 7]. The ammonia emission factor is from EPA's *Estimating Ammonia Emissions from Anthropogenic Sources, Draft Report* [ref 5]. Table 4-64 provides a summary of the pollutants, pollutant codes, and emission factors for residential combustion of distillate oil.

Table 4-64: Residential distillate oil combustion emission factors

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/E3GAL)	Reference
120127	ANTHRACENE	1.22E-06	6
129000	PYRENE	4.21E-06	6
1746016	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	4.66E-10	8
191242	BENZO[G,H,I,]PERYLENE	2.25E-06	6
193395	INDENO[1,2,3-C,D]PYRENE	2.11E-06	6
206440	FLUORANTHENE	4.92E-06	6
208968	ACENAPHTHYLENE	2.53E-07	6
218019	CHRYSENE	2.39E-06	6
3268879	OCTACHLORODIBENZO-P-DIOXIN	5.49E-10	8
39001020	OCTACHLORODIBENZOFURAN	2.50E-10	8
50000	FORMALDEHYDE	3.37E-02	6
51207319	2,3,7,8-TETRACHLORODIBENZOFURAN	4.41E-10	8
53703	DIBENZO[A,H]ANTHRACENE	1.69E-06	6
56553	BENZ[A]ANTHRACENE	4.07E-06	6
71432	BENZENE	2.11E-04	6
7439921	LEAD	1.26E-03	6
7439965	MANGANESE	8.43E-04	6
7439976	MERCURY	4.21E-04	6
7440020	NICKEL	4.21E-04	6
7440382	ARSENIC	5.62E-04	6
7440417	BERYLLIUM	4.21E-04	6
7440439	CADMIUM	4.21E-04	6
16065831	Chromium III	0.000345556	
18540299	Chromium (VI)	7.58538E-05	
75070	ACETALDEHYDE	4.92E-03	6
7782492	SELENIUM	2.11E-03	6
83329	ACENAPHTHENE	2.11E-05	6
85018	PHENANTHRENE	1.05E-05	6
86737	FLUORENE	4.50E-06	6
91203	NAPHTHALENE	1.14E-03	6
CO	CARBON MONOXIDE	5.00E+00	8
NH3	AMMONIA	1.00E+00	5
NOX	NITROGEN OXIDES	1.80E+01	4

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/E3GAL)	Reference
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION ONLY	1.08E+00	4
PM10-PRI	PRIMARY PM_{10} (INCLUDES FILTERABLES + CONDENSIBLES)	2.38E+00	4
PM25-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION ONLY	8.30E-01	4
PM25-PRI	PRIMARY $PM_{2.5}$ (INCLUDES FILTERABLES + CONDENSIBLES)	2.13E+00	4
PM-CON	PRIMARY PM CONDENSIBLE PORTION ONLY (< 1 MICRON)	1.30E+00	4
SO2	SULFUR DIOXIDE	4.26E+01	4
VOC	VOLATILE ORGANIC COMPOUNDS	7.00E-01	4

Kerosene

Emission factors for distillate oil were used for kerosene, but the distillate oil emission factors were multiplied by a factor of 135/140 to convert them for this use. This factor is based on the ratio of the heat content of kerosene (135,000 Btu/gallon) to the heat content of distillate oil (140,000 Btu/gallon) [ref 4]. Criteria pollutant emission factors are from AP-42. [ref 4]. Dioxin/furan and HAP emission factors are from "Documentation of Emissions Estimation methods for Year 2000 and 2001 Mobile Source and Nonpoint Source Dioxin Inventories" [ref 8] and "Documentation for the 1999 Base Year Nonpoint Area Source National Emission Inventory for Hazardous Air Pollutants," [ref 6] respectively. Distillate sulfur content (0.30%) was used for kerosene as well [ref 7]. Table 4-65 provides a summary of the pollutants, pollutant codes, and emission factors for residential combustion of kerosene.

Table 4-65: Residential kerosene combustion emission factors

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/E3BBL)
120127	ANTHRACENE	4.95E-05
129000	PYRENE	0.00017067
1746016	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1.89E-08
191242	BENZO[G,H,I,]PERYLENE	9.10E-05
193395	INDENO[1,2,3-C,D]PYRENE	8.53E-05
206440	FLUORANTHENE	0.00019912
208968	ACENAPHTHYLENE	1.02E-05
218019	CHRYSENE	9.67E-05
3268879	OCTACHLORODIBENZO-P-DIOXIN	2.22E-08
39001020	OCTACHLORODIBENZOFURAN	1.01E-08
50000	FORMALDEHYDE	1.3653684
51207319	2,3,7,8-TETRACHLORODIBENZOFURAN	1.79E-08
53703	DIBENZO[A,H]ANTHRACENE	6.83E-05
56553	BENZ[A]ANTHRACENE	0.00016498
71432	BENZENE	0.00853355
7439921	LEAD	0.05120132
7439965	MANGANESE	0.03413421
7439976	MERCURY	0.01706711
7440020	NICKEL	0.01706711
7440382	ARSENIC	0.02275614

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/E3BBL)
7440417	BERYLLIUM	0.01706711
7440439	CADMIUM	0.01706711
16065831	Chromium III	0.013995026
18540299	Chromium (VI)	0.003072079
75070	ACETALDEHYDE	0.19911623
7782492	SELENIUM	0.08533553
83329	ACENAPHTHENE	0.00085336
85018	PHENANTHRENE	0.00042668
86737	FLUORENE	0.00018205
91203	NAPHTHALENE	0.04608118
NH3	AMMONIA	40.5
CO	CARBON MONOXIDE	202.5
NOX	NITROGEN OXIDES	729
PM10-PRI	PRIMARY PM_{10} (INCLUDES FILTERABLES + CONDENSIBLES)	96.39
PM25-PRI	PRIMARY $PM_{2.5}$ (INCLUDES FILTERABLES + CONDENSIBLES)	86.265
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION ONLY	43.74
PM25-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION ONLY	33.615
PM-CON	PRIMARY PM CONDENSIBLE PORTION ONLY (ALL LESS THAN 1 MICRON)	52.65
SO2	SULFUR DIOXIDE	1,725.30
VOC	VOLATILE ORGANIC COMPOUNDS	28.35

Coal

All emission factors except ammonia are from AP-42 [ref 4]. The ammonia emission factor is from EPA's *Estimating Ammonia Emissions from Anthropogenic Sources, Draft Final Report* [ref 5].

Table 4-66 shows the SO_2 and PM emission factors. The SO_2 emission factors require information on the sulfur content of the coal burned, while some of the PM emission factors for anthracite coal require information on the ash content of the coal. State-specific sulfur and ash contents of anthracite and bituminous coal were obtained from data compiled in preparing the 1999 residential coal combustion emissions estimates [ref 7]. This study mostly relied on data obtained from US Geological Survey COALQUAL database. States not included in the database but that reported coal usage were assigned values based on their proximity to coal seams or using an average value for Pennsylvania (see report for details of the analysis). Note that the PM condensable emission factor provided in AP-42 is 0.04 lb/MMBtu. This was multiplied by the conversion factor of 26 MMBtu/ton provided in AP-42 for bituminous coal. Table 4-67 presents the bituminous coal sulfur content values used for each state. For anthracite coal, an ash content value of 13.38% and a sulfur content of 0.89% were applied to all states except New Mexico (ash content 16.61%, sulfur content 0.77%), Washington (ash content 12%, sulfur content 0.9%), and Virginia (ash content 13.38%, sulfur content 0.43%).

Table 4-66: SO_2 and PM emission factors for residential anthracite and bituminous coal combustion

Pollutant	Emission Factor (lb/ton)	Data Source, AP-42 [ref 4] Table No.
Anthracite Emission Factors (SCC 2104001000)		
PM-CON	0.08 * % Ash	1.2-3 (stoker)

Pollutant	Emission Factor (lb/ton)	Data Source, AP-42 [ref 4] Table No.
PM10-FIL	10	1.2-3 (hand-fired)
PM25-FIL	4.6	Fig. 1.2-1 (ratio of $PM_{2.5}/PM_{10}$=1.25/2.70=0.46) 0.46*10=4.6
PM10-PRI	10 + 0.08 * % Ash	1.2-3
PM25-PRI	4.6 + 0.08 * % Ash	1.2-3 and Fig 1.2-1
SO2	39 * % Sulfur	1.2-1 (residential space heater)
Bituminous Emission Factors (SCC 2104002000)		
PM-CON	1.04	1.1-5 (stoker)
PM10-FIL	6.2	1.1-4 (hand-fed)
PM25-FIL	3.8	1.1-11 (underfeed stoker)
PM10-PRI	7.24	1.1-5 and 1.1-4
PM25-PRI	4.84	1.1-5 and 1.1-11
SO2	31 * % Sulfur	1.1-3 (hand-fed)
NOTE: PM_{10}, $PM_{2.5}$, and condensable PM emission factors for bituminous coal as well as filterable emission factors for PM_{10} and $PM_{2.5}$ for anthracite coal do not require ash content.		

Table 4-67: State-specific sulfur content for bituminous coal (SCC 2104002000)

State	Percent Sulfur Content	State	Percent Sulfur Content
Alabama	2.08	Montana	0.6
Alaska	0.31	Nebraska	2.43
Arizona	0.47	Nevada	2.3
Arkansas	1.2	New Hampshire	2.42
California	0.47	New Jersey	2.42
Colorado	0.61	New Mexico	0.75
Connecticut	2.42	New York	2.42
Delaware	1.67	North Carolina	1.62
District of Columbia	1.67	North Dakota	0.97
Florida	1.28	Ohio	3.45
Georgia	1.28	Oklahoma	3.08
Hawaii	1	Oregon	0.5
Idaho	0.31	Pennsylvania	2.42
Illinois	3.48	Rhode Island	2.42
Indiana	2.49	South Carolina	1.28
Iowa	4.64	South Dakota	0.97
Kansas	5.83	Tennessee	1.62
Kentucky	1.93	Texas	1.14
Louisiana	0.86	Utah	0.8
Maine	2.42	Vermont	2.42
Maryland	1.67	Virginia	1.19
Massachusetts	2.42	Washington	0.5
Michigan	1.2	West Virginia	1.25

State	Percent Sulfur Content	State	Percent Sulfur Content
Minnesota	0.97	Wisconsin	1
Mississippi	1.24	Wyoming	0.87
Missouri	3.39		

Table 4-68 presents a summary of the emission factors for residential anthracite coal combustion (SCC 2104001000) for all pollutants. Table 4-69 presents a summary of the emission factors for residential bituminous coal combustion (SCC 2104002000) for all pollutants. Note that the emission factor provided in AP-42 is 0.04 lb/MMBtu. This was multiplied by the conversion factor of 26 MMBtu/ton provided in AP-42 for bituminous coal.

Table 4-68: Residential anthracite coal combustion emission factors

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/TON)	Data Source, AP-42 [ref 4] Table No.
83329	ACENAPHTHENE	0.000022	1.2-5
208968	ACENAPHTHYLENE	0.000086	1.2-5
120127	ANTHRACENE	0.000025	1.2-5
56553	BENZO[A]ANTHRACENE (Benz[a]Anthracene)	0.000071	1.2-5
50328	BENZO[A]PYRENE	0.0000053	1.2-5
192972	BENZO[E]PYRENE	0.0000062	1.2-5
191242	BENZO[G,H,I,]PERYLENE	0.0000055	1.2-5
207089	BENZO[K]FLUORANTHRENE (Benzo[k]Fluoranthene)	0.000025	1.2-5
218019	CHRYSENE	0.000083	1.2-5
206440	FLUORANTHRENE (Fluoranthene)	0.00017	1.2-5
86737	FLUORENE	0.000025	1.2-5
7647010	HYDROGEN CHLORIDE	1.2	1.1-15
7664393	HYDROGEN FLUORIDE	0.15	1.1-15
91203	NAPHTHALENE	0.00022	1.2-5
7439976	MERCURY	0.00013	1.2-7
198550	PERYLENE	0.0000012	1.2-5
85018	PHENANTHRENE	0.00024	1.2-5
129000	PYRENE	0.00012	1.2-5
CH4	METHANE	8	1.2-6
CO	CARBON MONOXIDE	275	1.1-3
NH3	AMMONIA	2	[ref 5]
NOX	NITROGEN OXIDES	3	1.2-1
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION	10	1.2-3
PM10-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION	4.6	1.2-3 & Fig 1.2-1
VOC	VOLATILE ORGANIC COMPOUNDS	10	1.1-19

Table 4-69: Residential bituminous coal combustion emission factors

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/TON)	Data Source, AP-42 [ref 4] Table No.
532274	2-CHLOROACETOPHENONE	0.000007	1.1-14
121142	2,4-DINITROTOLUENE	0.00000028	1.1-14
3697243	5-METHLY CHRYSENE	2.2E-08	1.1-13
83329	ACENAPHTHENE	0.00000051	1.1-13
208968	ACENAPHTHYLENE	0.00000025	1.1-13
75070	ACETALDEHYDE	0.00057	1.1-14
98862	ACETOPHENONE	0.000015	1.1-14
107028	ACROLEIN	0.00029	1.1-14
120127	ANTHRACENE	0.00000021	1.1-13
56553	BENZ[A]ANTHRACENE	0.00000008	1.1-13
71432	BENZENE	0.0013	1.1-14
50328	BENZO[A]PYRENE	3.8E-08	1.1-13
191242	BENZO[G,H,I,]PERYLENE	2.7E-08	1.1-13
100447	BENZYL CHLORIDE	0.0007	1.1-14
92524	BIPHENYL	0.0000017	1.1-13
117817	BIS(2-ETHYLHEXYL)PHTHALATE	0.000073	1.1-14
75252	BROMOFORM	0.000039	1.1-14
75150	CARBON DISULFIDE	0.00013	1.1-14
108907	CHLOROBENZENE	0.000022	1.1-14
67663	CHLOROFORM	0.000059	1.1-14
218019	CHRYSENE	0.0000001	1.1-13
98828	CUMENE	0.0000053	1.1-14
57125	CYANIDE	0.0025	1.1-14
77781	DIMETHYL SULFATE	0.000048	1.1-14
100414	ETHYL BENZENE	0.000094	1.1-14
75003	ETHYL CHLORIDE	0.000042	1.1-14
106934	ETHYLENE DIBROMIDE	0.0000012	1.1-14
107062	ETHYLENE DICHLORIDE	0.00004	1.1-14
206440	FLUORANTHENE	0.00000071	1.1-13
86737	FLUORENE	0.00000091	1.1-13
50000	FORMALDEHYDE	0.00024	1.1-14
110543	HEXANE	0.000067	1.1-14
7647010	HYDROGEN CHLORIDE	1.2	1.1-15
7664393	HYDROGEN FLUORIDE	0.15	1.1-15
193395	INDENO[1,2,3-C,D]PYRENE	6.1E-08	1.1-13
78591	ISOPHORONE	0.00058	1.1-14
7439976	MERCURY	0.000083	1.1-18
CH4	METHANE	5	1.1-19

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/TON)	Data Source, AP-42 [ref 4] Table No.
74839	METHYL BROMIDE	0.00016	1.1-14
74873	METHYL CHLORIDE	0.00053	1.1-14
80626	METHYL METHACRYLATE	0.00002	1.1-14
1634044	METHYL TERT BUTYL ETHER	0.000035	1.1-14
75092	METHYLENE CHLORIDE	0.00029	1.1-14
91203	NAPHTHALENE	0.000013	1.1-13
N2O	NITROUS OXIDE	0.04	1.1-19
85018	PHENANTHRENE	0.0000027	1.1-13
108952	PHENOL	0.000016	1.1-14
123386	PROPIONALDEHYDE	0.00038	1.1-14
129000	PYRENE	0.00000033	1.1-13
100425	STYRENE	0.000025	1.1-14
127184	TETRACHLOROETHYLENE	0.000043	1.1-14
108883	TOLUENE	0.00024	1.1-14
108054	VINYL ACETATE	0.0000076	1.1-14
1330207	XYLENES	0.000037	1.1-14
CO	CARBON MONOXIDE	275	1.1-3
NH3	AMMONIA	2	[ref 5]
NOX	NITROGEN OXIDES	9.1	1.1-3
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION	6.2	1.1-4
PM25-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION	3.8	1.1-11
PM-CON	PRIMARY PM CONDENSIBLE PORTION	1.04	1.1-5
PM10-PRI	PRIMARY PM_{10} (FILT + COND)	7.24	1.1-4, 1.1-5
PM25-PRI	PRIMARY $PM_{2.5}$ (FILT + COND)	4.84	1.1-5, 1.1-11
VOC	VOLATILE ORGANIC COMPOUNDS	10	1.1-19

For CO and VOC, the emission factors listed for anthracite coal are the emission factors provided in AP-42 for bituminous coal. Emission rates for these pollutants are dependent upon combustion efficiency, with the mass of emissions per unit of heat input generally increasing with decreasing unit size. No anthracite emission rates were provided for residential heaters for these pollutants. Therefore, it was felt that it the AP-42 emission rates from bituminous coal that were derived for smaller hand-fed units, were more appropriate to use than applying anthracite emission factors derived for much larger boilers.

Note that while AP-42 provides emission factors for some metals, these were based on tests at controlled and/or pulverized coal boilers. These are not expected to be a good representation of emission rates for metals from residential heaters, so these pollutants are not included.

The criteria pollutant and HAP emissions were calculated by multiplying the total coal consumed in each county per year by the corresponding emission factor.

LPG

Pollutant emission factors for residential LPG are based on the residential natural gas emission factors [ref 4, ref 6, ref 7]. For all counties in the United States, the natural gas consumed by residential combustion is assumed to have a heating value of 1,020 Btu per cubic foot and a sulfur content of 2,000 grains per million cubic feet [ref 4]. Those natural gas emission factors originally presented in the units "pounds per million cubic feet" were converted to energy-based units using the 1,020 Btu/cubic foot conversion factor. Once all the natural gas emission factors were converted to energy-based units, the natural gas emission factors were converted to LPG emission factors by multiplying by 96,750 Btu/gallon. Some emission factors were revised based on recommendations by an ERTAC advisory panel composed of state and EPA personnel. Table 4-70 provides a summary of the pollutants, pollutant codes, and emission factors for residential combustion of LPG.

Table 4-70: Residential LPG combustion emission factors

Pollutant Code	Pollutant Code Description	Emissions Factor (LB/E3BBL)
129000	Pyrene	2.09E-05
206440	Fluoranthene	1.26E-05
50000	Formaldehyde	3.14E-01
71432	Benzene	8.78E-03
75070	Acetaldehyde	5.44E-05
85018	Phenanthrene	7.11E-05
86737	Fluorene	1.17E-05
91203	Naphthalene	2.55E-03
CO	CO	1.60E+02
NH3	Ammonia	1.95E+00
NOX	NO_X	5.63E+02
PM10-PRI	PRIMARY PM_{10} (INCLUDES FILTERABLES + CONDENSIBLES)	2.07E+00
PM25-PRI	PRIMARY $PM_{2.5}$ (INCLUDES FILTERABLES + CONDENSIBLES)	1.71E+00
PM10-FIL	PRIMARY PM_{10}, FILTERABLE PORTION ONLY	7.97E-01
PM25-FIL	PRIMARY $PM_{2.5}$, FILTERABLE PORTION ONLY	4.38E-01
PM-CON	PRIMARY PM CONDENSIBLE PORTION ONLY (<1 MICRON)	1.28E+00
SO2	SO_2	2.39E+00
VOC	VOC	2.19E+01

4.13.3.4 *Example Calculations*

Natural Gas, Distillate, Kerosene, and LPG Equations

Emissions are calculated for each county using emission factors and activity as:

$$E_{x,p} = FC_x \times EF_{x,p}$$

where:

$E_{x,p}$ = annual emissions for fuel type x and pollutant p,
FC_x = annual fuel consumption for fuel type x,
$EF_{x,p}$ = emission factor for fuel type x and pollutant p,

And FC_x = A_{State} x (H_{county} / H_{State})

where :

A_{State} = state activity data from EIA
H_{County} = number of houses in the county using the fuel type as the primary heating fuel. For distillate and kerosene, this is the sum of both fuels.
H_{State} = number of houses in the state using the fuel type as the primary heating fuel. For distillate and kerosene, this is the sum of both fuels.

Natural Gas Example

Using Allegheny County, PA as an example:

The State of Pennsylvania had a reported use of 226,000 million cubic feet of natural gas in the residential sector in 2013. Allegheny County, PA had 448,595 houses out of the state total of 2,533,628 that use natural gas as the primary heating fuel. This equates to a share of 17.7% of the natural gas used for residential heating in the state. From Table 4-63, the CO emission factor is 40 lb/million ft^3.

E_{CO} = 226,000 million ft^3 × (448,595 houses / 2,533,628 houses) × 40 lb CO/ million ft^3
= 1,600,600 lb CO or 800.3 tons CO

Distillate Oil Example

Using Allegheny County, PA as an example:

The State of Pennsylvania had a reported use of 13,759 thousand barrels of distillate oil and 203 barrels of kerosene in the residential sector in 2013. Allegheny County, PA had 7,881 houses that use distillate fuel oil or kerosene as the primary heating fuel. Using the state ratio of distillate to kerosene, Allegheny County can be assumed to have 7,766.4 houses using distillate as the primary heating fuel, out of 869,165 houses in the state. This equates to a share of 0.89% of the distillate oil used for residential heating in the state. From Table 4-64, the emission factor for CO is 5 lb/thousand gallons. Because the emission factor is in lbs/thousand gallons, a conversion factor of 42 gallons per barrel is applied.

$A_{Alegheny}$ = 13,759 thousand barrels × 7,766.4 houses / 869,165 houses) × 42 gal / barrel
= 5,163.6 thousand gallons

$Emis_{Alegheny, CO}$ = 5,163.6 thousand gallons × 5 lb CO/ thousand gallons
= 25,818 lbs CO or 12.9 tons CO

Kerosene Example

Using Allegheny County, PA as an example:

The State of Pennsylvania had a reported use of 13,759 thousand barrels of distillate oil and 203 thousand barrels of kerosene in the residential sector in 2013. Allegheny County, PA had 7,881 houses that use distillate fuel oil or kerosene as the primary heating fuel. Using the state ratio of distillate to kerosene, Allegheny County can be assumed to have 114.6 houses using kerosene as the primary heating fuel, out of 12,824 houses in the state. This equates to a share of 0.89% of the kerosene used for residential heating in the state. From Table 4-65, the CO Emission factor is 202.5 lb/thousand barrels. Because the emission factor is in lbs/thousand gallons, a conversion factor of 42 gallons per barrel is applied.

Allegheny County, PA had 7,881 houses that use distillate fuel oil or kerosene as the primary heating fuel. Using the state ratio of distillate to kerosene, Allegheny County can be assumed to have 7,766.4 houses using distillate as the primary heating fuel, out of 869,165 houses in the state. This equates to a share of 0.89% of the distillate oil used for residential heating in the state. From Table 5, the emission factor for CO is 5 lb/thousand gallons.

$A_{Alegheny}$ = 203 thousand barrels × (114.6 houses / 12,824 houses)
= 1.8 thousand gallons

$Emis_{Alegheny, CO}$ = 1.8 thousand gallons × 202.5 lb CO/ thousand gallons
= 364.5 lbs CO or 0.18 tons CO

LPG Example

Using Allegheny County, PA as an example:

The State of Pennsylvania had a reported use of 4,947 thousand barrels of LPG in the residential sector in 2013. Allegheny County, PA had 4,264 houses out of the state total of 174,513 that use LPG as the primary heating fuel. This equates to a share of 2.44% of the LPG used for residential heating in the state. From Table 4-70, the CO emission factor is 159.6 lb/thousand barrels.

E_{CO} = 4,947 thousand barrels × (4,264 houses / 174,513 houses) × 159.6 lb/thousand barrels
= 19,291.4 lb CO or 9.65 tons CO

Coal Equations

Annual emissions are calculated for each county using emission factors and activity as:

$$E_{x,p} = FC_x \times (1 - CE_{x,p}) \times EF_{x,p}$$

where:

$E_{x,p}$ = annual emissions for fuel type x and pollutant p (lb/year),
FC_x = annual county-level fuel consumption for fuel type x,
$CE_{x,p}$ = control efficiency for fuel type x and pollutant p, and
$EF_{x,p}$ = emission factor for fuel type x and pollutant p.

County-level fuel consumption is calculated using:

$$FC_x = A_{State} \text{ x } Ratio_{Anth, Bit} \text{ x } Ratio_{County\ houses}$$

where:

A_{State} = total tons of coal reported by the EIA,
$Ratio_{Anth, Bit}$ = ratio reported in Table 4-62, and
$Ratio_{County\ houses}$ = county allocation ratio based on number of houses burning coal.

Coal Example

Using Allegheny County, PA as an example:

(numbers are from 2011 inventory, SEDS data showed no coal consumption in any state in 2013)

The State of Pennsylvania had a reported use of 20,121 tons of coal in the residential sector in 2010. Statewide anthracite coal use is calculated using the ratio of anthracite to bituminous in Table 4-62 for PA: 80.6%.

Allegheny County, PA had 183 houses out of the state total of 67,986 that use coal as the primary heating fuel. This equates to a share of 0.27% of the coal used for residential heating in the state. Thus, the anthracite fuel consumption for Allegheny County is:

$$FC_{Allegheny,\ anth} = 20{,}121 \times 0.806 \times 0.0027 = 44 \text{ tons anthracite coal}$$

The $PM_{2.5}$-PRI emission factor for residential heating with anthracite coal is 4.6 + 0.08 lbs/ton× state-specific % ash content (see Table 4-67). The ash content is 13.38%, (see Section 4.13.3.3) so the emission factor is 5.67 lbs/ton.

$$Emis_{Allegheny,\ anth,}\ PM_{2.5\text{-}PRI} = 44 \text{ tons anthracite coal} \times 5.67 \text{ lbs } PM_{2.5}\text{-PRI per ton coal}$$
$$= 249 \text{ lbs } PM_{2.5}\text{-PRI}$$

4.13.3.5 *Changes from 2011 Methodology*

<u>All fuels</u>

Activity data were updated to 2013 SEDS and allocated to counties using the US Census Bureau's 2013 5-year estimate Census Detailed Housing Information.

<u>Distillate and Kerosene</u>

In addition to the updated activity data, for distillate and kerosene, the more significant difference between 2011 and 2014 was the allocation of distillate oil consumption. The US Census Bureau Detailed Housing Information category for homes using distillate oil also includes kerosene as a fuel source. To tease apart the number of houses using each of these fuels, the number was multiplied by the ratio of state distillate or kerosene consumption to the total state consumption of distillate oil and kerosene. These steps were not taken in 2011.

4.13.3.6 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward County (FIPS state county code = 12011) for Puerto Rico and Monroe County (FIPS = 12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.13.4 References for fuel combustion -residential – natural gas, oil and other

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6. U.S. Environmental Protection Agency, Emission Factors and Inventory Group. "Documentation for the 1999 Base Year Nonpoint Area Source National Emission Inventory for Hazardous Air Pollutants." Prepared by Eastern Research Group, Inc. Morrisville, NC. September 2002.
7. U.S. Environmental Protection Agency. Emission Factor and Inventory Group. "Final Summary of the Development and Results of a Methodology for Calculating Area Source Emissions from Residential Fuel Combustion". Prepared by Pacific Environmental Services, Inc. Research Triangle Park, NC. September 2002. Internet address: http://www.marama.org/visibility/Calculation_Sheets/ResidentialFuelCombustion.doc, accessed September 2015.
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4.14 Fuel Combustion – Residential – Wood

4.14.1 Sector Description

This source category includes residential wood burning devices such as fireplaces, fireplaces with inserts (inserts), free standing woodstoves, pellet stoves, outdoor hydronic heaters (also known as outdoor wood boilers), indoor furnaces, and outdoor burning in firepits and chimeneas. We further differentiate free standing woodstoves and inserts into three categories: conventional (not EPA certified); EPA certified, catalytic; and EPA certified, noncatalytic. Generally speaking, the conventional units were constructed prior to 1988. Units constructed after 1988 had to meet EPA emission standards and they are either catalytic or non-catalytic. For shorthand, we refer to the Residential Wood Combustion sector as "RWC" in the remaining documentation.

Table 4-71 shows the SCCs used in the 2014 NEI from in this sector. EPA estimates emissions for all SCCs in this sector. The SCC level 1 and 2 descriptions is "Stationary Source Fuel Combustion; Residential" for all SCCs.

Table 4-71: RWC sector SCCs in the 2014 NEI

SCC	SCC Level Three*	SCC Level Four
2104008100	Wood	Fireplace: general
2104008210	Wood	Woodstove: fireplace inserts; non-EPA certified
2104008220	Wood	Woodstove: fireplace inserts; EPA certified; non-catalytic
2104008230	Wood	Woodstove: fireplace inserts; EPA certified; catalytic
2104008310	Wood	Woodstove: freestanding, non-EPA certified
2104008320	Wood	Woodstove: freestanding, EPA certified, non-catalytic
2104008330	Wood	Woodstove: freestanding, EPA certified, catalytic
2104008400	Wood	Woodstove: pellet-fired, general (freestanding or FP insert)
2104008510	Wood	Furnace: Indoor, cordwood-fired, non-EPA certified
2104008610	Wood	Hydronic heater: outdoor (“outdoor wood boilers”)
2104008700	Wood	Outdoor wood burning device, NEC (fire-pits, chimeneas, etc)
2104009000	Firelog	Total: All Combustor Types

4.14.2 Sources of data

The RWC sector includes emissions from both S/L/T agencies and from the EPA. As is the case with most nonpoint sources, RWC data submitted by S/L/Ts is used over EPA data when provided. The EPA worked with S/L/Ts to modify the RWC Tool for the 2014 NEI. While many reporting agencies were involved in discussions on the development of the EPA’s RWC Tool used for the 2014 NEI, many opted to run the tool with their own customized inputs and assumptions, or decided to submit their own estimates developed outside the RWC Tool.

The agencies listed in Table 4-72 submitted at least $PM_{2.5}$ and/or VOC emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-72: Reporting agency $PM_{2.5}$ and VOC percent contribution to total NEI emissions for RWC sector

Region	Agency	S/L/T	$PM_{2.5}$	VOC
1	Vermont Department of Environmental Conservation	State	100	100
4	Georgia Department of Natural Resources	State	100	100
4	Metro Public Health of Nashville/Davidson County	Local		84
5	Illinois Environmental Protection Agency	State	100	100
5	Michigan Department of Environmental Quality	State	100	100
5	Minnesota Pollution Control Agency	State	98	99
6	Louisiana Department of Environmental Quality	State	96	99
6	Texas Commission on Environmental Quality	State	100	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100	100
8	Northern Cheyenne Tribe	Tribe	100	100
9	Arizona Department of Environmental Quality	State	100	100
9	California Air Resources Board	State	100	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	100	100
9	Washoe County Health District	Local	91	97
10	Coeur d'Alene Tribe	Tribe	100	100
10	Kootenai Tribe of Idaho	Tribe	100	100
10	Nez Perce Tribe	Tribe	100	100

Region	Agency	S/L/T	$PM_{2.5}$	VOC
10	Oregon Department of Environmental Quality	State	94	95
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100	100
10	Washington State Department of Ecology	State	96	97

4.14.3 EPA-developed emissions for residential wood combustion

The EPA collaborated with State, Local and Regional Planning Organization representatives to create a new methodology for the RWC Tool. The resulting updates are reflected in Version 3.0 of the RWC Tool used for the 2014v1 NEI. The RWC Tool is designed to allow users the ability to apply county-specific inputs on various types of activity data including appliance fractions, burn rates, certification profiles and burn ban assumptions. We also allowed for state-to-county allocations of outdoor wood boilers and indoor furnaces to be computed by inverse population density rather than the default rural population; however, after comparing county allocations between the two methods, very few stakeholders saw the inverse population density option as a better option.

Emissions in the RWC Tool are computed using the equation here:

$$\text{Emissions} = \text{Homes} \times \text{ApplianceFrac} \times \text{BurnRate} \times \text{WoodDensity} \times \text{AdjustFactor} \times \text{EF}$$

where,

Emissions	= annual emissions (ton/year) for a specific appliance (SCC), county and pollutant
Homes	= number of occupied homes in each county,
ApplianceFrac	= fraction of homes in each county that use the appliance,
BurnRate	= average amount of wood burned per appliance (cords/appliance),
WoodDensity	= density of firewood (tons/cord),
AdjustFactor	= county and SCC-specific adjustment factor to account for burn bans,
EF	= emission factor (tons of pollutant emitted/ton of fuel used)

There is a specific approach for different appliance types (SCCs) for each of the terms in the above equation.

4.14.3.1 *Occupied Homes in each County*

The number of occupied housing units is derived from the U.S. Census Bureau 2014 American Community Survey [ref 1], which reports on the number of homes by the type of house:

- Single-family detached homes,
- Single-family attached homes,
- Multi-family homes with 2-4 units,
- Multi-family homes with more than 5 units, and
- Mobile homes, boats, recreational vehicles, vans, etc.

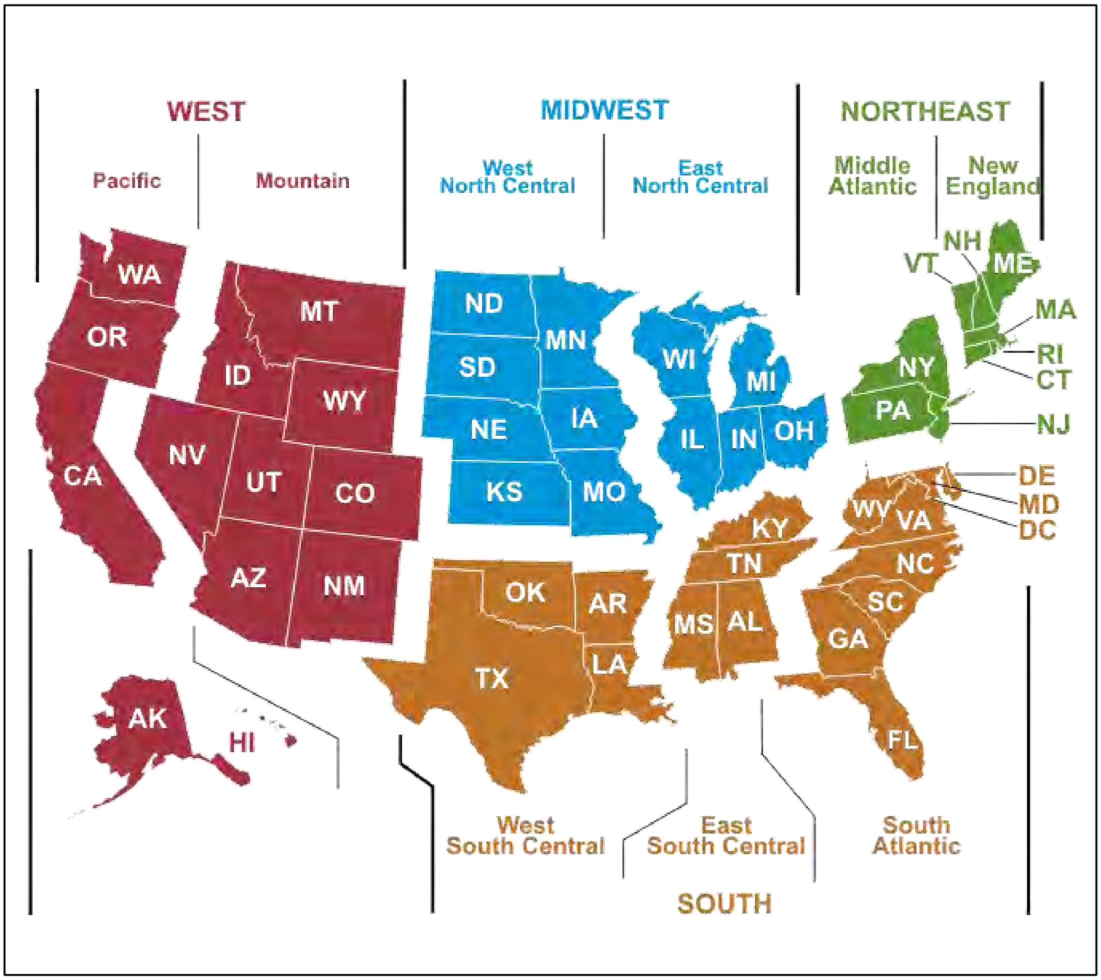
Each of these home types is further divided into urban and rural homes; for example, the number of urban single-family detached homes, the number of rural single-family detached homes, and so on. Using the proportion of total urban and rural homes in each county from the 2010 U.S. Census [ref 2] (U.S. Census Bureau 2010, http://www.census.gov/2010census/), the RWC Tool therefore computes up to 10 different classes occupied housing units per county.

4.14.3.2 *Appliance fractions*

Appliance fractions are the fraction of occupied homes in each county that uses each type of wood burning appliance. These appliance fractions are mapped to the 10 different types of occupied homes in each county. The appliance fractions are calculated using two main data sources: The Energy Information Administration (EIA) year-2009 "RECS" Residential Energy Combustion Survey [ref 3] and the 2013 American Housing Survey (AHS) [ref 4]. It is important to note that the most recent RECS data is for year 2009. As of October 2016, year 2013 RECS data, likely more-aligned with year 2014 wood usage, is not yet available. Year 2014 AHS data was not made available until after the development of this RWC Tool in the spring of 2016. Both the RECS and AHS includes survey data that asks respondents whether they use a given wood burning appliance.

The RECS data includes a nationally representative sample of wood burning characteristics for each type of housing unit. The 2009 RECS is based on 12,083 households used to represent the 113.6 million occupied homes. The RECS provides information on the average wood consumption used as primary and secondary heating by each of the 4 U.S. Census Regions –see Figure 4-9. The AHS data includes information on wood usage for each U.S. Census Division by type of wood burning device: Stoves, Fireplaces with inserts, and fireplaces without inserts. The AHS data also delineates between various population density characteristics within each Census Division: central city of metro area, outside central city but within metro area, and outside the metro area.

Figure 4-9: U.S. Census Regions and Census Divisions



https://www.eia.gov/consumption/residential/maps.cfm

Fireplaces, Woodstoves, and Indoor Furnaces

The methodology for estimating the appliance fraction from fireplaces, fireplace inserts, freestanding woodstoves, pellet stoves, and indoor furnaces uses the EIA's RECS microdata, which consists of 27,187 individual survey responses between 1997 and 2009. RECS asks a wide variety of questions related to home energy use, including several that are important for RWC emissions estimation:

- The appliance used for the main heat source in the home,
- The fuel used for the main heat source in the home,
- Whether the home uses a woodstove for a secondary heat source,
- Whether the home uses a fireplace for a secondary heat source.
- The amount of wood burned (cords) annually by the home.

The RECS data also includes demographic data about the respondent, including their census division location, the number of heating degree days in their area, the type of house they live in, and whether their home is in an urban or rural setting.

The appliance fractions were estimated using a regression technique called logistic regression that estimates the likelihood of a binary (i.e. yes or no) outcome. In this case the outcome is whether or not the home uses the wood burning appliance. The result of the logistic regression analysis is an equation that uses the demographic variables to predict the proportion of homes in each county that uses each appliance:

$$\hat{p} = \frac{1}{1 + e^{-(\beta_0 + \beta_1 \cdot HDD + \beta_2 \cdot HomeType + \beta_3 \cdot UrbanRural + \beta_4 \cdot ApplType + \beta_5 \cdot BurnType)}}$$

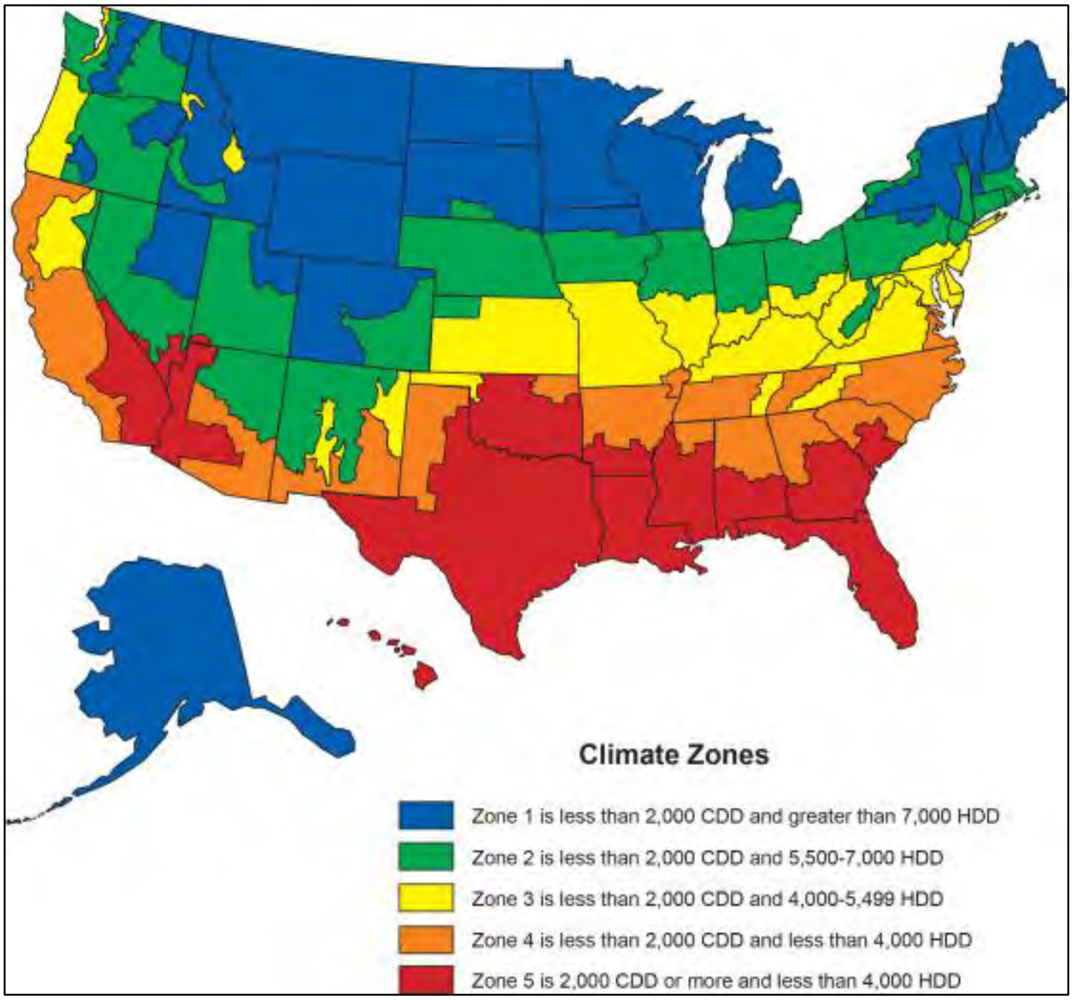
where:

- *p* = the probability that a home in a given county uses a given wood burning appliance
- HDD = the number of heating degree days in each county from NOAA [ref 5]
- HomeType = the type of home (5 types: single-family detached, single-family attached, multifamily with 2-4 units, multifamily with 5+ units, and mobile homes),
- UrbanRural = whether the home is in an urban or rural setting,
- ApplType = appliance type (fireplaces, woodstoves, and furnaces), and
- BurnTypes = whether the appliance is used for primary/main heat or other heating (only main heating was used for furnaces)

The logistic regression analysis estimates the coefficients (β_i) used in the equation. When those coefficients are used with the predictor variables listed above, the equation estimates the probability that a home uses a wood burning appliance.

An example of the distribution of heating degree days is shown in Figure 4-10. We include heating degree days in the logistic regression equation to refine the spatial allocation within the large Census Regions. For example, we would not expect primary heating from woodstoves to be similar between West Virginia and Florida –both states are in the South Census Region. Alternatively, for most regions, there did not appear to be enough survey responses to allocate appliances to more fine-scale Census Division.

Figure 4-10: AIA climate zones from the 1978-2005 RECS



The result of the logistic regression analysis is 40 unique appliance fractions for each county. These appliance fractions are multiplied by the number of homes in each county in each category. For example, the appliance fraction for main heating by woodstoves in urban mobile homes is multiplied by the number of urban mobile homes in each county to determine the total number of woodstoves that were used for main heating in urban mobile homes. This process is repeated for all home types, appliance types, and burn types.

Certification Profiles

Because the data from EIA's RECS does not specify whether the respondent uses a woodstove or fireplace insert that is certified, the general data on the number of woodstoves and fireplaces must be split into specific SCCs based on assumptions. In the RWC tool, we developed "certification profiles" that are grouped by Appliance Type (woodstove or fireplace) and Census Region.

The certification profile assumptions can be adjusted in the tool, but the profile ratios when grouped by appliance type and region should sum to 1. For example, the sum of the profile ratios for woodstoves in the Midwest Census Region should equal 1.

Table 4-73 shows the certification profiles for woodstoves, which are used to split the general data on woodstove populations into four SCCs: freestanding non-EPA certified stoves, freestanding EPA certified non-catalytic stoves, freestanding EPA certified catalytic stoves, and pellet stoves. RECS data is used to estimate these certification profiles. Although RECS does not specifically ask whether the woodstove is EPA certified, the 2009 edition does ask the age of the appliance. It is assumed that any appliance older than 20 years old is uncertified, since the appliance would have been built prior to the first New Source Performance Standard (NSPS) for woodstoves, finalized in 1988. All appliances less than 20 years old are assumed to be EPA certified. The certification profile for pellet stoves is based on the proportion of respondents to RECS that use a woodstove but their main fuel source is wood pellets, rather than cordwood. Reporting agencies have the ability to modify these profiles by appliance type to the county-level, but for EPA estimates, a national default is used. Once the RECS data is used to determine the proportion of stoves that are certified vs. noncertified, data provided by Minnesota from their 2014/2015 residential wood survey is used to determine the proportion of certified stoves that are noncatalytic vs. catalytic. There was not enough information in the RECs data to refine the certification profiles by geographic region; therefore, these profiles are the same nationally for all types of woodstoves.

Table 4-73: Certification profiles for woodstoves

SCC	Description	Northeast	Midwest	South	West
2104008310	Woodstove: freestanding, non-EPA certified	0.286	0.286	0.286	0.286
2104008320	Woodstove: freestanding, EPA certified, non-catalytic	0.355	0.355	0.355	0.355
2104008330	Woodstove: freestanding, EPA certified, catalytic	0.237	0.237	0.237	0.237
2104008400	Woodstove: pellet-fired, general	0.122	0.122	0.122	0.122
	Total	**1**	**1**	**1**	**1**

Table 4-74 shows the certification profiles for fireplaces, which are used to split the general data on fireplace populations into four SCCs: general fireplaces, non-EPA certified fireplace inserts, EPA certified non-catalytic inserts, and EPA certified catalytic inserts. The AHS asks respondents whether their fireplace has an insert, and reports these data at the census region level. The split between certified and non-certified, and catalytic and non-catalytic inserts are based on data provided by Minnesota from their 2014/2015 residential wood survey.

Table 4-74: Certification profiles for fireplaces

SCC	Description	Northeast	Midwest	South	West
2104008110	Fireplace: general	0.487	0.438	0.575	0.523
2104008210	Woodstove: fireplace inserts, non-EPA certified	0.278	0.305	0.23	0.258
2104008220	Woodstove: fireplace inserts, EPA certified, non-catalytic	0.182	0.199	0.151	0.169
2104008230	Woodstove: fireplace inserts, EPA certified, catalytic	0.053	0.058	0.044	0.050
	Total	**1**	**1**	**1**	**1**

<u>Outdoor Hydronic Heaters (OHHs)</u>

For OHHs (outdoor wood boilers), a different approach is used to determine the number of appliances in use. There are not enough survey responses to RECS by respondents that use OHHs to allow for the type of regression analysis used for the other appliance types. Therefore, the appliance fractions for OHHs are calculated using data from the American Housing Survey. In 2011 (the only year in which this question was included in the AHS), the AHS asked whether the respondent used an OHH. Like the RECS data, the AHS includes demographic data about the respondent, including their census region and division location, and climate zone, which is defined by number of heating degree days.

The total number of estimated OHHs are divided into each unique combination of census region and climate zone. This total OHHs population is then distributed to each county within the unique census region and climate zone based on proportion of rural population. For example, there are estimated to be approximately 15,000 OHHs in the coldest climate zone of the Northeast census region, which includes 100 counties. These 15,000 OHHs are distributed to the counties with the highest proportion of rural population.

There are two exceptions to this methodology. The first is that for the West census region, the OHH population is apportioned based on unique combinations of census division (rather than census region) and climate zone. In the west, OHH sales and usage are under significantly more scrutiny in the Pacific census division compared to the mountain census division; it therefore does not make sense to treat appliance profiles the same in the entire region. The second is that there were some states, specifically, Michigan, Ohio, and Wisconsin that (initially) preferred to distribute the OHHs based on inverse population density rather than rural population. In this way, most of the OHHs are distributed to the least dense (people/mi2) counties. The RWC tool offers the capability in the "Edit Assumptions" window to redistribute the emissions from OHHs and furnaces based on inverse population density rather than rural population. On further inspection of the OHH emissions resulting from this method, one of these Midwest states opted to resubmit RWC emissions. In short, we advise to use caution if considering using the inverse population method.

The appliance fractions for OHHs are estimated by dividing the number of OHHs distributed to each county by the number of occupied houses in each county in 2011. This number is then multiplied by the number of occupied houses in 2014 to estimate the county-level OHH population in 2014.

Wax Firelogs and Other Outdoor Wood Burning Devices

Data were unavailable to update the activity data for wax firelogs and outdoor wood burning devices (e.g. firepits or chimeneas). The activity data for these source categories is pulled forward from the 2011 NEI methodology, which is based mostly on AHS data, though for firelogs, includes a 30% downward adjustment to account for natural gas usage (Houck, 2003).

4.14.3.3 *Burn rates*

Burn rates are the amount of wood burned annually for each appliance, reflected in cords for all appliance types except for firelogs, which are expressed as tons. The burn rates for fireplaces, woodstoves and indoor furnaces are estimated from the same 2009 RECS data used to create the appliance fractions.

Similar to the methodology for estimating the appliance fractions, the burn rates are estimated using regression analysis based on each unique combination of home type, urban or rural setting, appliance type, and burn type. The results of the regression analysis show that the number of heating degree days is not a significant predictor variable for most of the United States, and therefore it is not included in the analysis for all census regions, except for the South Atlantic division within the South region. The South Atlantic division –spanning disparate climates from West Virginia to Florida- therefore includes heating degree days for allocation. The rest of the South region –east south central and west south central- uses a "rest-of South region" allocation that does not include heating degree days in its allocation.

The burn rates match the level of specificity of the appliance fractions. For example, there are unique burn rates and appliance fractions for each county for rural mobile homes that use fireplaces as a secondary heat source, as well as all other combinations of home type, appliance type, and burn type.

The AHS data used to estimate the appliance fractions for OHHs does not include data on the amount of wood burned. Therefore, the burn rates for OHHs are pulled forward from the 2011 methodology, which is based largely on expert judgment. Burn rates were zeroed out for all counties with greater than 1,500 housing units per square mile. Additional burn rate information from state or local surveys was carried over from the 2011 methodology for California, Oregon, Washington, Minnesota and Vermont. Otherwise, the general approach uses expert judgment to estimate burn rates for OHHs and scales them based on climate zone.

Similarly, the burn rates for wax firelogs and outdoor wood burning devices are pulled forward from the 2011 NEI methodology, which is also based mostly on expert judgment.

4.14.3.4 *Wood density*

The density of oven dried wood is used to compute average density of wood by county because emission factors developed by EPA are based on oven dried wood mass units. Dried wood density data are obtained from the U.S. Forest Service (USDA, 2007) [ref 6] for various wood species. The Forest Service developed a database (called the Timber Products Output) that contains survey results of sawmill operators that includes the volume of wood by species for several different categories of use - one of the uses being fuel wood.

Using the oven dried density by species multiplied by the per-species volumes gives a per species weight which is summed to calculate the total weight for the county. This is then divided by the total volume of wood in the county to get the average density by county. If a county specific density is not available, regional averages are used instead.

The calculated density by county from the Forest Service data is then converted to tons/cords. Officially a cord is defined as a stack of wood 4 feet wide, 8 feet long, and 4 feet tall or 128 cubic feet. However, we instead assume a value of 80 cubic feet per cord to account for air spaces in the stack.

For wax firelogs, density is assumed to not vary from county to county, and a density of 4.005 tons per cord is used. This is based on the volume of a typical 5 pound firelog. For wax firelogs, a cord is assumed to be 128 ft^3 because air spaces assumptions are not applicable.

4.14.3.5 *Emission factors*

The emission factors in the RWC Tool are expressed as tons of pollutant produced for every ton of wood burned. The emission factors were last reviewed for the 2011 NEI by the Eastern Regional Technical Advisory Committee (ERTAC). The complete list of emission factors and their references are available in the RWC Tool and RWC Tool V3.0 PDF documentation available on the 2014 NEI Nonpoint FTP site.

Many of the emission factors used to determine national emission estimates for RWC are from EPA's AP-42 document (Tables 1.9-1, 1.10-3, and 1.10-4). Some of the stove and insert factors were adjusted based on new data developed in the reference *Review of Wood Heater and Fireplace Emission Factors* (Houck et al. 2001) [ref 7]. The emission factors generated by Houck, et. al. for 7-PAH and 16-PAH are lower than the associated AP-42 emission factors. Therefore, the AP-42 PAH emission factors were adjusted downward by 62% for conventional woodstoves, 51% for catalytic woodstoves, and 40% for non-catalytic woodstoves.

The only update to the emission factors made for the 2014 NEI -version 3.0 of the tool- has been an update of the volatile organic compounds (VOC) emission factor for pellet stoves. Based on a review of the literature, the previous VOC emission factor used in the RWC tool, 0.041 lb./ton of wood, was deemed to be too low, given that it is much lower than emission factors for individual hazardous air pollutant (HAP) VOC compounds as reported in the literature. The pellet stove VOC emission factor was updated based on the ratio of the sum of the HAP-VOC emission factors to the VOC emission factor for EPA certified non-catalytic woodstoves. This ratio is multiplied by the sum of the HAP-VOC emission factors for pellet stoves to estimate the VOC emission factor for pellet stoves, of 2.2 lb./ton of wood.

4.14.3.6 *Other inputs: Appliance and Burn Ban Assumptions*

The RWC tool also allows users to make county and SCC-specific adjustments to account for appliance or burn bans. Users can update the inputs with additional SCCs and counties where the emissions should be adjusted. The calculated throughput and emissions for that SCC and county will be multiplied by the user-specified "Adjustment Factor". If, for example, a particular county has banned OHHs, then add the county FIPS code and the correct SCC (2104008610 for OHHs), and set the adjustment factor to 0. This will zero out the throughput and emissions for OHHs in that county.

Similarly, if a county has instituted a burn ban that is expected to reduce burning by 50%, the adjustment factor could be set to 0.5. This would reduce the calculated throughput and emissions for the listed SCC by 50%. To-date, EPA includes only OHH and indoor furnace zero outs for southern New York, provided by the NY State Department of Environmental Conservation.

4.14.4 Known Issues for v2

There are many known issues in the RWC Tool used for the 2014v1 NEI. Only some of the following items have short-term-possible solutions and resources that will be reflected in version 2 of the 2014 NEI.

4.14.4.1 *Emission factors*

As seen in Table 4-75, the particulate matter (PM_{10}) emission factors in the most recent version of the Residential Wood Combustion (RWC) Tool (v3.0) are based on an average of the Phase I and Phase II emission factors from the 1988 New Source Performance Standards (NSPS) included in AP-42. While EPA did not update the federal NSPS until 2015, the Regulatory Impact Analysis (RIA) for the 2015 NSPS [ref 8] notes that the state of Washington introduced more stringent emissions standards for woodstoves in 1995. These standards result in approximately 40 percent less emissions than the Phase II EPA NSPS.

Table 4-75: PM_{10} woodstove standards and emission factors (lb/ton)

Standard	Source	Years	Catalytic	Non-catalytic
1988 NSPS Phase I	AP-42	1988-1990	19.6	20.0
1988 NSPS Phase II	AP-42	1990-1995	16.2	14.6
Washington Standards	2015 NSPS	1995-2015	9.72	8.76

When EPA calculated the baseline residential wood combustion emissions for the 2015 NSPS RIA, they assumed that shipments of woodstoves after 1995 would meet the more stringent Washington state standards. Because the EPA-certified non-catalytic and catalytic SCCs include many stoves of various ages that meet different standards, we are crafting a methodology to estimate the number of woodstoves that fall under each of the standards. This will enable the creation of a weighted-average emission factor for certified woodstoves.

EIA's RECS contains data on energy use in homes, including the age of heating devices (including woodstoves) used in homes in the United States. RECS data are available for the years 1997, 2001, 2005, and 2009. We can then use the RECS data to determine the proportion of stoves in each data year that fall under each standard, and then, project the data to determine the proportion of stoves in 2014 that would meet each standard. As seen in Table 4-76, we can then use this proportion to determine a weighted average emission factor for PM_{10} and CO.

Table 4-76: 2014v1 and proposed emission factors (lb/ton) for PM_{10} and CO

	2014v1 Factors		Proposed Factors	
	PM_{10}	CO	PM_{10}	CO
Catalytic	20.4	104.4	15.2	92.3
Non-catalytic	19.6	140.8	14.5	122.6

For the different wood stove emissions standards, AP-42 only provides different emission factors for PM_{10} and CO. For all other pollutants, including HAPs, we can adjust the emission factors based on the percent decrease in the PM_{10} emission factor, which is 25% for catalytic and 26% for non-catalytic stoves.

4.14.4.2 *Appliance Profiles*

The default assumption in the current RWC tool is that all woodstoves are 100 percent wood burning. A common comment for the 2014v1 RWC Tool is that for fireplaces, the appliance fractions should be adjusted to account for the fraction of fireplaces that burn natural gas or propane rather than wood. Data from RECS suggests that approximately 49 percent of fireplaces in urban homes and 47 percent of fireplaces in rural homes burn wood. These assumptions about the ratio of wood to gas fireplaces will be adjustable in the next version of the RWC Tool.

4.14.4.3 *Burn Rates*

The next version of the RWC Tool will enable users to provide county and appliance-specific burn rates to override the RECS-based defaults in the current version of the tool.

4.14.4.4 *Inverse Population Density*

The inverse population density approach redistributes the number of estimated OHHs and indoor furnaces within a state so that areas with the lowest population density get the highest number of appliances. There are currently only three states that use this approach: Michigan, Ohio, and Wisconsin. However, feedback from these states suggests that this approach actually results in too many emissions in some very rural counties. The next version of the tool will correct this issue by limiting the redistribution of appliances so that no county is estimated to have more than 10 percent of its homes with an OHH or indoor furnace.

4.14.4.5 *Other possible future work items*

We would like to pursue a longer-term effort to analyze the impact of land cover to better-apportion emissions intra-Census Division or Region and climate zone; intuitively, in the absence of robust survey local data, we would expect less wood burning in areas with less available wood.

Firelogs and Other outdoor equipment

These estimates are carried forward from the 2011v2 NEI. We have not been able to find more updated information on these sources. Discussions with reporting agencies indicate that these emissions, particularly for other outdoor equipment like fire pits and chimeneas, vary greatly by geography from north to south.

Outdoor Hydronic Heaters

Burn rates information for OHHs is generally lacking in RECS and AHS data and in most available surveys. This is an ongoing area of need.

Emission Factors

Emission factors needs longer-term additional work for all appliance types. There are questions about unexpected factors when comparing non-catalytic to catalytic stoves, VOC HAPs to VOC factors, and how single burn-rate devices –not subject to the 1998 NSPS- are accounted for in the appliance profiles. Many emission factors rely on AP-42 factors, ERTAC studies, or worse, an inconsistent blend between multiple sources for the same appliance type.

4.14.5 References for residential wood combustion

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4.15 Industrial Processes – Mining and Quarrying

4.15.1 Sector description

Mining and quarrying activities produce particulate emissions due to the variety of processes used to extract the ore and associated overburden, including drilling and blasting, loading and unloading, and overburden replacement. Fugitive dust emissions for mining and quarrying operations are the sum of emissions from the mining of metallic and nonmetallic ores and coal. Each of these mining operations has specific emission factors accounting for the different means by which the resources are extracted.

The 2014 NEI has emissions for the two SCCs shown in Table 4-77 for this sector. The leading SCC description is "Industrial Processes; Mining and Quarrying: for all SCCs in the table. The EPA-estimated emissions cover only the "All Processes" SCC 2325000000. Emissions for "Lead Ore-Mining and Milling" SCC were submitted by Missouri.

Table 4-77: SCCs for Industrial Processes- Mining and Quarrying

SCC	Description
2325000000	All Processes; Total
2325060000	Lead Ore Mining and Milling; Total

4.15.2 Source of data

The mining and quarrying sector includes data from the S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-78 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-78: Percentage of Mining and Quarrying $PM_{2.5}$ and PM_{10} emissions submitted by reporting agency

Region	Agency	PM_{10}	$PM_{2.5}$
2	New Jersey Department of Environment Protection	100	100
3	Maryland Department of the Environment	100	100
4	Knox County Department of Air Quality Management	100	100
7	Missouri Department of Natural Resources	60	75
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	100	100
8	Utah Division of Air Quality	100	100
9	Clark County Department of Air Quality and Environmental Management	100	100
9	Washoe County Health District	100	100
10	Alaska Department of Environmental Conservation	5	
10	Coeur d’Alene Tribe	100	100
10	Idaho Department of Environmental Quality	100	100
10	Nez Perce Tribe	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	100	100

4.15.3 EPA-developed emissions for mining and quarrying

The below sections explain how the PM_{10} and $PM_{2.5}$ emissions for the EPA data (SCC 2325000000; Industrial Processes; Mining and Quarrying: SIC 14; All Processes; Total) were developed.

4.15.3.1 *Emission Factors*

<u>Metallic Ore Mining</u>

The emissions factor for metallic ore mining includes overburden removal, drilling and blasting, and loading and unloading activities. The total suspended particulate (TSP) emission factors developed for copper ore mining are applied to all three activities with PM_{10}/TSP ratios of 0.35 for overburden removal, 0.81 for drilling and blasting, and 0.43 for loading and unloading operations [ref 1]. The emissions factor equation for metallic ore mining is:

$$EF_{mo} = EF_o + (B \times EF_b) + EF_l + EF_d$$

where,

EF_{mo} = metallic ore mining emissions factor (lbs/ton)
EF_o = PM_{10} open pit overburden removal emission factor for copper ore (lbs/ton)
B = fraction of total ore production that is obtained by blasting at metallic ore mines
EF_b = PM_{10} drilling/blasting emission factor for copper ore (lbs/ton)
EF_l = PM_{10} loading emission factor for copper ore (lbs/ton)
EF_d = PM_{10} truck dumping emission factor for copper ore (lbs/ton)

Applying the copper ore mining TSP emission factors [ref 2] and PM_{10}/TSP ratios yields the following metallic ore mining emissions factor:

EF_{mo} = 0.0003 + (0.57625 x 0.0008) + 0.022 + 0.032 = 0.0548 lbs/ton

Non-Metallic Ore Mining

The emissions factor for non-metallic ore mining includes overburden removal, drilling and blasting, and loading and unloading activities. The emissions factor is based on western surface coal mining operations.

EF_{nmo} = EFv + (D x EF_r) + EF_a + 0.5 (EF_e + EF_t)

where,

EF_{nmo} = non-metallic ore mining emissions factor (lbs/ton)
EF_v = PM_{10} open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
D = fraction of total ore production that is obtained by blasting at non-metallic ore mines
EF_r = PM_{10} drilling/blasting emission factor at western surface coal mining operations (lbs/ton)
EF_a = PM_{10} loading emission factor at western surface coal mining operations (lbs/ton)
EF_e = PM_{10} truck unloading: end dump-coal emission factor at western surface coal mining operations (lbs/ton)
EF_t = PM_{10} truck unloading: bottom dump-coal emission factor at western surface coal mining operations (lbs/ton)

Applying the TSP emission factors developed for western surface coal mining operations from AP-42 [ref 3] and a PM_{10}/TSP ratio of 0.4 [ref 4] yields the following non-metallic ore mining emissions factor:

EF_{nmo} = 0.225 + (0.61542 x 0.00005) + 0.05 + 0.5 (0.0035 + 0.033) = 0.293 lbs/ton

Coal Mining

The emissions factor for coal mining includes overburden removal, drilling and blasting, loading and unloading and overburden replacement activities. The amount of overburden material handled is assumed to equal ten times the quantity of coal mined and coal unloading is assumed to split evenly between end-dump and bottom-dump operations. The emissions factor equation for coal mining is:

EF_c = (10 × (EF_{to} + EF_{or} + EF_{dt})) + EF_v + EF_r +EF_a + (0.5 × (EF_e + EF_t))

where,

EF_c = coal mining emissions factor (lbs/ton)
EF_{to} =PM_{10} emission factor for truck loading overburden at western surface coal mining operations (lbs/ton of overburden)
EF_{or} = PM_{10} emission factor for overburden replacement at western surface coal mining operations (lbs/ton of overburden)
EF_{dt} = PM_{10} emission factors for truck unloading: bottom dump-overburden at western surface coal mining operations (lbs/ton of overburden)
EF_v = PM_{10} open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
EF_r = PM_{10} drilling/blasting emission factor at western surface coal mining operations (lbs/ton)

EF_a = PM_{10} loading emission factor at western surface coal mining operations (lbs/ton)

EF_e = PM_{10} truck unloading: end dump-coal emission factor at western surface coal mining operations (lbs/ton)

EF_t = PM_{10} truck unloading: bottom dump-coal emission factor at western surface coal mining operations (lbs/ton)

Applying the PM_{10} emission factors developed for western surface coal mining operations [ref 3] yields the following coal mining emissions factor:

EF_c = (10 × (0.015 + 0.001 + 0.006)) + 0.225 + 0.00005 + 0.05 + (0.5 × (0.0035 + 0.033)) = 0.513 lbs/ton

PM-FIL emission factors are assumed to be the same as PM-PRI emission factors; however, in reality, there is a small amount of PM-CON emissions included in the PM-PRI emissions but insufficient data exists to tease out the PM-CON portion. In 2006, the EPA adopted new $PM_{2.5}/PM_{10}$ ratios for several fugitive dust categories and concluded that the $PM_{2.5}/PM_{10}$ ratios for fugitive dust categories should be in the range of 0.1 to 0.15 [ref 5]. Consequently, a ratio of 0.125 was applied to the PM_{10} emission factors to estimate $PM_{2.5}$ emission factors for mining and quarrying. A summary of these emission factors is presented in Table 4-79.

Table 4-79: Summary of Mining and Quarrying emission factors

Mining Type	Pollutant Code	Factor Numeric Value	Factor Unit Numerator	Factor Unit Denominator
Coal	PM10-PRI	0.513	LB	TON
Coal	PM10-FIL	0.513	LB	TON
Coal	PM25-PRI	0.064	LB	TON
Coal	PM25-FIL	0.064	LB	TON
Metallic	PM10-PRI	0.0548	LB	TON
Metallic	PM10-FIL	0.0548	LB	TON
Metallic	PM25-PRI	0.0068	LB	TON
Metallic	PM25-FIL	0.0068	LB	TON
Non-Metallic	PM10-PRI	0.293	LB	TON
Non-Metallic	PM10-FIL	0.293	LB	TON
Non-Metallic	PM25-PRI	0.037	LB	TON
Non-Metallic	PM25-FIL	0.037	LB	TON

4.15.3.2 *Activity*

Emissions were estimated by obtaining state-level metallic and non-metallic crude ore handled at surface mines from the U.S. Geologic Survey (USGS) [ref 6] and mine specific coal production data for surface mines from the EIA [ref 7]. Emissions were not estimated for underground mining given that emission factors are calculated exclusively for surface activity. Since some of the USGS metallic and non-metallic minerals waste data associated with ore production are withheld to avoid disclosing company proprietary data, an allocation procedure was developed to estimate the withheld data. For states with withheld waste data, the state fraction of national ore production was multiplied by the national undisclosed waste value to estimate the state withheld data. In addition, the USGS only reports metallic and non-metallic minerals production data separately at the national-level (e.g., the production data are combined at the state-level). To estimate metallic versus non-metallic ore production and associated waste at the state-level, the state-level total production and waste data were multiplied by the national metallic or non-metallic percentage of total production.

4.15.3.3 *Allocation*

State-level metallic and non-metallic crude ore and associated waste handled was allocated to the county-level using employment. Specifically, state-level activity data were multiplied by the ratio of county- to state-level number of employees in the metallic and non-metallic mining industries. See Table 4-80 for a list of these NAICS codes.

Table 4-80: NAICS codes for metallic and non-metallic mining

NAICS Code	Description
2122	Metal Ore Mining
212210	Iron Ore Mining
21222	Gold Ore and Silver Ore Mining
212221	Gold Ore Mining
212222	Silver Ore Mining
21223	Copper, Nickel, Lead, and Zinc Mining
212231	Lead Ore and Zinc Ore Mining
212234	Copper Ore and Nickel Ore Mining
21229	Other Metal Ore Mining
212291	Uranium-Radium-Vanadium Ore Mining
212299	All Other Metal Ore Mining
2123	Nonmetallic Mineral Mining and Quarrying
21231	Stone Mining and Quarrying
212311	Dimension Stone Mining and Quarrying
212312	Crushed and Broken Limestone Mining and Quarrying
212313	Crushed and Broken Granite Mining and Quarrying
212319	Other Crushed and Broken Stone Mining and Quarrying
21232	Sand, Gravel, Clay, and Ceramic and Refractory Minerals Mining and Quarrying
212321	Construction Sand and Gravel Mining
212322	Industrial Sand Mining
212324	Kaolin and Ball Clay Mining
212325	Clay and Ceramic and Refractory Minerals Mining
21239	Other Nonmetallic Mineral Mining and Quarrying
212391	Potash, Soda, and Borate Mineral Mining
212392	Phosphate Rock Mining
212393	Other Chemical and Fertilizer Mineral Mining
212399	All Other Nonmetallic Mineral Mining

Employment data were obtained from the U.S. Census Bureau's 2012 County Business Patterns (*CBP*) [ref 8]. Due to concerns with releasing confidential business information, the *CBP* does not release exact numbers for a given NAICS code if the data can be traced to an individual business. Instead, a series of range codes is used. To estimate employment in counties with withheld data, the following procedure is used for each NAICS code being computed.

1. County-level data for counties with known employment are totaled by state.
2. #1 subtracted from the state total reported in state-level *CBP*.
3. Each of the withheld counties is assigned the midpoint of the range code (e.g., A:1-19 employees would be assigned 10).
4. These midpoints are then summed to the state level.
5. #2 is divided by #4 as an adjustment factor to the midpoints.
6. #5 is multiplied by #3 to get the adjusted county-level employment.

Note that step 5 adjusts all counties with withheld employment data by the same state-based proportion. It is unlikely that actual employment corresponds exactly with this smoothed adjustment method, but this method is the best option given the availability of the data.

For example, take the 2006 *CBP* data for NAICS 31-33 (Manufacturing) in Maine provided in Table 4-81.

Table 4-81: 2006 County Business Pattern data for NAICS 31-33 in Maine

State FIPS	County FIPS	NAICS	Employment Flag	Number of Employees
23	001	31----		6,774
23	003	31----		3,124
23	005	31----		10,333
23	007	31----		1,786
23	009	31----		1,954
23	011	31----		2,535
23	013	31----		1,418
23	015	31----	F	0
23	017	31----		2,888
23	019	31----		4,522
23	021	31----		948
23	023	31----	I	0
23	025	31----		4,322
23	027	31----		1,434
23	029	31----		1,014
23	031	31----		9,749

1. The total of employees not including counties 015 and 023 is 52801.
2. The state-level *CBP* reports 59,322 employees for NAICS 31----. The difference is 6,521.
3. County 015 is given a midpoint of 1,750 (since range code F is 1000-2499) and County 023 is given a midpoint of 17,500.
4. State total for these two counties is 19,250.
5. 6,521/19,250 = 0.33875.
6. The adjusted employment for county 015 is 1,750*0.33875 = 593. County 023 has an adjusted employment of 17,500*0.33875 = 5,928.

In the event that data at the state level are withheld, a similar procedure is first performed going from the U.S. level to the state level. For example, known state-level employees are subtracted from the U.S. total yielding the total withheld employees. Next the estimated midpoints of the withheld states are added together and compared (by developing a ratio) to the U.S. total withheld employees. The midpoints are then adjusted by the ratio to give an improved estimate of the state total.

4.15.3.4 *Controls*

No controls were accounted for in the emissions estimation.

4.15.3.5 *Emissions Equation and Sample Calculation*

Fugitive dust emissions for mining and quarrying operations are the sum of emissions from the mining of metallic and nonmetallic ores and coal:

$$E = E_m + E_n + E_c$$

where,

E = PM_{10} emissions from mining and quarrying operations
E_m = PM_{10} emissions from metallic ore mining operations
E_n = PM_{10} emissions from non-metallic ore mining
E_c = PM_{10} emissions from coal mining operations

Four specific activities are included in the emissions estimate for mining and quarrying operations: overburden removal, drilling and blasting, loading and unloading, and overburden replacement. Not included are the transfer and conveyance operations, crushing and screening operations, and storage since the dust emissions from these activities are assumed to be well controlled. Emissions for each activity are calculated using the following equation:

$$E = EF \times A$$

where,

E = PM_{10} emissions from operation (e.g., metallic ore, non-metallic ore, or coal mining; lbs)
EF = emissions factor associated with operation (lbs/ton)
A = ore handled in mining operation (tons)

As an example, in 2012 Barbour County, Alabama handled 13,507,583 tons of metallic ore and associated waste, 113,501 tons of non-metallic ore and associated waste, and 0 tons of coal. Mining and quarrying PM_{10}-PRI emissions for Barbour County are:

$$EPM_{10\text{-PRI, Barbour County}} = [(13{,}507{,}583 \times 0.0548) + (113{,}501 \times 0.293) + (0 \times 0.513)]/2000 = 386 \text{ tons}$$

The division by 2000 is to convert from pounds to tons.

4.15.3.6 *Changes from 2011 Methodology*

For the 2014 NEI, the activity data are updated to year 2012 using the most recent USGS and EIA data on metallic and non-metallic crude ore handled and coal production. The allocation procedure uses 2012 employment data from the U.S. Census Bureau. In addition, the allocation procedure in 2014 allocates state-level metallic and non-metallic activity to the county-level using the respective county fraction of metallic and non-metallic state employees that work in the county. In 2011, the allocation procedure combined the metallic and non-metallic employees to generate a single county allocation factor. The 2014 allocation methodology is an improvement because it more precisely assigns the mining emissions to counties where the mining is actually occurring.

4.15.3.7 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.15.3.8 *References for mining and quarrying*

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2. United States Environmental Protection Agency, *National Air Pollutant Emission Trends Procedure Document for 1900-1996*, EPA-454/R-98-008, May 1998.
3. United States Environmental Protection Agency, AP-42, Fifth Edition, Volume 1, Chapter 11: Mineral Products Industry, Section 11.9: Western Surface Coal Mining, available at: http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf (accessed July 2015).
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7. Energy Information Administration, "Historical Detailed Coal Production Data (1983-2013)", data pulled for year 2012, available at: http://www.eia.gov/coal/data.cfm#production (accessed July 2015).
8. U.S. Census Bureau, 2012 County Business Patterns, available at http://www.census.gov/econ/cbp/download/12_data/ (accessed July 2015)

4.16 Industrial Processes – Oil & Gas Production

4.16.1 Sector description

This sector includes processes associated with the exploration and drilling at oil, gas, and coal bed methane (CBM) wells and the equipment used at the well sites to extract the product from the well and deliver it to a central collection point or processing facility.

4.16.2 Source of data

Table 4-82 shows the nonpoint SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 3 and 4 descriptions are also provided. The leading SCC description is "Industrial Processes; Oil and Gas Exploration and Production;" for all SCCs.

New SCCs, created for the 2014 inventory are noted in the table. Several of these new SCCs are not used by EPA but were created for states that wanted to preserve the difference between conventional and unconventional formations for their own reporting needs. Note also that the SCCs in this list are only the SCCs that either the EPA used or the submitting State agencies used in the 2014 NEI. All of the SCCs that the EPA Oil and Gas Tool uses are nonpoint SCCs. There are several point inventory SCCs in the oil and gas production sector as well. Emissions or activity from these SCCs, listed in Table 4-83, are subtracted from nonpoint estimates using in the EPA's Oil and Gas Tool, discussed in the next section.

Table 4-82: Nonpoint SCCs with 2014 NEI emissions in the Oil and Gas Production sector

SCC	New?	Description	EPA	State	Tribe
2310000000		All Processes; Total: All Processes		X	
2310000220		All Processes; Drill Rigs	X	X	
2310000230		All Processes; Workover Rigs		X	
2310000330		All Processes; Artificial Lift	X	X	
2310000550		All Processes; Produced Water	X	X	
2310000660		All Processes; Hydraulic Fracturing Engines	X	X	
2310001000		All Processes; On-shore; Total: All Processes		X	X
2310002000		Off-Shore Oil and Gas Production; Total: All Processes		X	
2310002301		Off-Shore Oil and Gas Production; Flares: Continuous Pilot Light		X	
2310002305		Off-Shore Oil and Gas Production; Flares: Flaring Operations		X	
2310002401		Off-Shore Oil and Gas Production; Pneumatic Pumps: Gas and Oil Wells		X	
2310002411		Off-Shore Oil and Gas Production; Pressure/Level Controllers		X	
2310002421		Off-Shore Oil and Gas Production; Cold Vents		X	
2310010000		Crude Petroleum; Total: All Processes		X	
2310010100		Crude Petroleum; Oil Well Heaters	X	X	
2310010200		Crude Petroleum; Oil Well Tanks - Flashing & Standing/Working/Breathing	X	X	
2310010300		Crude Petroleum; Oil Well Pneumatic Devices	X	X	
2310010700		Crude Petroleum; Oil Well Fugitives		X	
2310010800		Crude Petroleum; Oil Well Truck Loading		X	
2310011000		On-Shore Oil Production; Total: All Processes	X	X	
2310011020		On-Shore Oil Production; Storage Tanks: Crude Oil		X	
2310011100		On-Shore Oil Production; Heater Treater		X	
2310011201		On-Shore Oil Production; Tank Truck/Railcar Loading: Crude Oil	X	X	
2310011450		On-Shore Oil Production; Wellhead		X	
2310011500		On-Shore Oil Production; Fugitives: All Processes		X	
2310011501		On-Shore Oil Production; Fugitives: Connectors	X	X	
2310011502		On-Shore Oil Production; Fugitives: Flanges	X	X	
2310011503		On-Shore Oil Production; Fugitives: Open Ended Lines	X	X	
2310011504		On-Shore Oil Production; Fugitives: Pumps		X	
2310011505		On-Shore Oil Production; Fugitives: Valves	X	X	
2310011506		On-Shore Oil Production; Fugitives: Other		X	
2310012000		Off-Shore Oil Production; Total: All Processes		X	
2310012020		Off-Shore Oil Production; Storage Tanks: Crude Oil		X	

SCC	New?	Description	EPA	State	Tribe
2310012511		Off-Shore Oil Production; Fugitives, Connectors: Oil Streams		X	
2310012512		Off-Shore Oil Production; Fugitives, Flanges: Oil		X	
2310012515		Off-Shore Oil Production; Fugitives, Valves: Oil		X	
2310012516		Off-Shore Oil Production; Fugitives, Other: Oil		X	
2310012521		Off-Shore Oil Production; Fugitives, Connectors: Oil/Water Streams		X	
2310012522		Off-Shore Oil Production; Fugitives, Flanges: Oil/Water		X	
2310012525		Off-Shore Oil Production; Fugitives, Valves: Oil/Water		X	
2310012526		Off-Shore Oil Production; Fugitives, Other: Oil/Water		X	
2310020000		Natural Gas; Total: All Processes		X	
2310020600		Natural Gas; Compressor Engines		X	
2310020700		Natural Gas; Gas Well Fugitives		X	
2310020800		Natural Gas; Gas Well Truck Loading		X	
2310021010		On-Shore Gas Production; Storage Tanks: Condensate	X	X	
2310021011		On-Shore Gas Production; Condensate Tank Flaring		X	
2310021030		On-Shore Gas Production; Tank Truck/Railcar Loading: Condensate	X	X	
2310021100		On-Shore Gas Production; Gas Well Heaters	X	X	
2310021101		On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines < 50 HP		X	
2310021102		On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP	X	X	
2310021103		On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines 500+ HP		X	
2310021201		On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines <50 HP		X	
2310021202		On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP	X	X	
2310021203		On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines 500+ HP		X	
2310021251		On-Shore Gas Production; Lateral Compressors 4 Cycle Lean Burn	X	X	
2310021300		On-Shore Gas Production; Gas Well Pneumatic Devices	X	X	
2310021301		On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP		X	
2310021302		On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP	X	X	
2310021303		On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP		X	
2310021310		On-Shore Gas Production; Gas Well Pneumatic Pumps		X	
2310021351		On-Shore Gas Production; Lateral Compressors 4 Cycle Rich Burn	X	X	
2310021400		On-Shore Gas Production; Gas Well Dehydrators	X	X	
2310021401		On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP w/NSCR		X	

SCC	New?	Description	EPA	State	Tribe
2310021402		On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP w/NSCR		X	
2310021403		On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP w/NSCR		X	
2310021411		On-Shore Gas Production; Gas Well Dehydrators - Flaring		X	
2310021450		On-Shore Gas Production; Wellhead		X	
2310021500		On-Shore Gas Production; Gas Well Completion - Flaring		X	
2310021501		On-Shore Gas Production; Fugitives: Connectors	X	X	
2310021502		On-Shore Gas Production; Fugitives: Flanges	X	X	
2310021503		On-Shore Gas Production; Fugitives: Open Ended Lines	X	X	
2310021504		On-Shore Gas Production; Fugitives: Pumps		X	
2310021505		On-Shore Gas Production; Fugitives: Valves	X	X	
2310021506		On-Shore Gas Production; Fugitives: Other	X	X	
2310021509		On-Shore Gas Production; Fugitives: All Processes		X	
2310021600		On-Shore Gas Production; Gas Well Venting		X	
2310021601		On-Shore Gas Production; Gas Well Venting - Initial Completions		X	
2310021602		On-Shore Gas Production; Gas Well Venting - Recompletions		X	
2310021603		On-Shore Gas Production; Gas Well Venting - Blowdowns	X	X	
2310021604		On-Shore Gas Production; Gas Well Venting - Compressor Startups		X	
2310021605		On-Shore Gas Production; Gas Well Venting - Compressor Shutdowns		X	
2310021700		On-Shore Gas Production; Miscellaneous Engines		X	
2310022000		Off-Shore Gas Production; Total: All Processes		X	
2310022010		Off-Shore Gas Production; Storage Tanks: Condensate		X	
2310022051		Off-Shore Gas Production; Turbines: Natural Gas		X	
2310022090		Off-Shore Gas Production; Boilers/Heaters: Natural Gas		X	
2310022105		Off-Shore Gas Production; Diesel Engines		X	
2310022410		Off-Shore Gas Production; Amine Unit		X	
2310022420		Off-Shore Gas Production; Dehydrator		X	
2310022501		Off-Shore Gas Production; Fugitives, Connectors: Gas Streams		X	
2310022502		Off-Shore Gas Production; Fugitives, Flanges: Gas Streams		X	
2310022505		Off-Shore Gas Production; Fugitives, Valves: Gas		X	
2310022506		Off-Shore Gas Production; Fugitives, Other: Gas		X	
2310023010	Y	Coal Bed Methane Natural Gas; Storage Tanks: Condensate	X	X	
2310023030	Y	Coal Bed Methane Natural Gas; Tank Truck/Railcar Loading: Condensate	X	X	
2310023100	Y	Coal Bed Methane Natural Gas; CBM Well Heaters	X	X	
2310023102	Y	Coal Bed Methane Natural Gas; CBM Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP	X	X	
2310023202	Y	Coal Bed Methane Natural Gas; CBM Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP	X	X	
2310023251	Y	Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Lean Burn	X	X	
2310023300	Y	Coal Bed Methane Natural Gas; Pneumatic Devices	X	X	

SCC	New?	Description	EPA	State	Tribe
2310023302	Y	Coal Bed Methane Natural Gas; CBM Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP	X	X	
2310023310	Y	Coal Bed Methane Natural Gas; Pneumatic Pumps	X	X	
2310023351	Y	Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Rich Burn	X	X	
2310023400	Y	Coal Bed Methane Natural Gas; Dehydrators	X	X	
2310023509	Y	Coal Bed Methane Natural Gas; Fugitives		X	
2310023511	Y	Coal Bed Methane Natural Gas; Fugitives: Connectors	X	X	
2310023512	Y	Coal Bed Methane Natural Gas; Fugitives: Flanges	X	X	
2310023513	Y	Coal Bed Methane Natural Gas; Fugitives: Open Ended Lines	X	X	
2310023515	Y	Coal Bed Methane Natural Gas; Fugitives: Valves	X	X	
2310023516	Y	Coal Bed Methane Natural Gas; Fugitives: Other	X	X	
2310023600	Y	Coal Bed Methane Natural Gas; CBM Well Completion: All Processes	X	X	
2310023603	Y	Coal Bed Methane Natural Gas; CBM Well Venting - Blowdowns	X	X	
2310023606	Y	Coal Bed Methane Natural Gas; Mud Degassing	X	X	
2310030401		Natural Gas Liquids; Gas Plant Truck Loading		X	
2310111100		On-Shore Oil Exploration; Mud Degassing	X	X	
2310111401		On-Shore Oil Exploration; Oil Well Pneumatic Pumps	X	X	
2310111700		On-Shore Oil Exploration; Oil Well Completion: All Processes	X	X	
2310112401		Off-Shore Oil Exploration; Oil Well Pneumatic Pumps		X	
2310121100		On-Shore Gas Exploration; Mud Degassing	X	X	
2310121401		On-Shore Gas Exploration; Gas Well Pneumatic Pumps	X	X	
2310121700		On-Shore Gas Exploration; Gas Well Completion: All Processes	X	X	
2310122100		Off-Shore Gas Exploration; Mud Degassing		X	
2310321010	Y	On-Shore Gas Production - Conventional; Storage Tanks: Condensate		X	
2310321100	Y	On-Shore Gas Production - Conventional; Gas Well Heaters		X	
2310321400	Y	On-Shore Gas Production - Conventional; Gas Well Dehydrators		X	
2310321603	Y	On-Shore Gas Production - Conventional; Gas Well Venting - Blowdowns		X	
2310400220	Y	All Processes - Unconventional; Drill Rigs		X	
2310421010	Y	On-Shore Gas Production - Unconventional; Storage Tanks: Condensate		X	
2310421100	Y	On-Shore Gas Production - Unconventional; Gas Well Heaters		X	
2310421400	Y	On-Shore Gas Production - Unconventional; Gas Well Dehydrators		X	
2310421603	Y	On-Shore Gas Production - Unconventional; Gas Well Venting - Blowdowns		X	

Table 4-83: Point SCCs in the Oil and Gas Production sector

SCC(s)	Abbreviated description
31000101 through 31000506	Various descriptions; Excludes 31000104 through 31000108 and 31000140 through 31000145, which are in the sector "Industrial Processes – Storage and Transfer"
31088801 through 31088811	Fugitive Emissions; Specify in Comments Field
31700101	Natural Gas Transmission and Storage Facilities; Pneumatic Controllers Low Bleed

The agencies listed in Table 4-84 submitted emissions for this sector; agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-84: Percentage of total Oil and Gas Production NO_X and VOC nonpoint emissions submitted by reporting agency

Region	Agency	NO_X	VOC
2	New York State Department of Environmental Conservation	99	100
3	Pennsylvania Department of Environmental Protection	53	59
3	West Virginia Division of Air Quality	100	100
5	Illinois Environmental Protection Agency	100	100
5	Michigan Department of Environmental Quality	100	100
5	Ohio Environmental Protection Agency	100	100
6	Oklahoma Department of Environmental Quality	100	100
6	Texas Commission on Environmental Quality	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	100	100
8	Colorado Department of Public Health and Environment	38	55
8	Utah Division of Air Quality	97	89
8	Wyoming Department of Environmental Quality	95	77
9	California Air Resources Board	96	10
10	Alaska Department of Environmental Conservation	11	0

4.16.3 EPA-developed emissions for oil and gas production

The EPA improved the existing Oil and Gas Tool that was developed for the 2011 NEI, which is a MS Access database that uses a bottom up approach to building a national inventory. More information on the tool can be found in the documentation provided by ERG entitled “2014 Nonpoint Oil and Gas Emission Estimation Tool,” found in zip files with the prefix names “OIL_GAS_TOOL_2014_NEI_” on the ftp site ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/. New for 2014 are two modules (rather than one) for the Oil and Gas Tool: Exploration and Production. This was a necessary change due to the increase in input data; when EPA expanded the specificity of the tool (county-level inputs rather than basin level inputs, some division between conventional and unconventional processes), we reached the limitations of MS Access, so dividing the database into two parts was a necessity. Other changes that have been incorporated in the 2014 tool since 2011 are addressed in the changes memo by ERG, entitled “Summary of Revisions to the Nonpoint Oil and Gas Emissions Estimation Tool – 2014 NEI Version 1.5.”

In general, the tool calculates emissions for each piece of equipment on a well pad (like condensate tanks or dehydrators, for example) in a county or basin, based on average equipment counts taken from either surveys, literature searches, or the GHG reporting program, also accounting for control devices and gas composition in each county. County-level details are important, since well pads can vary significantly from region to region, basin to basin, and county to county. A well site in Denver, CO in the Denver-Julesburg Basin might look very different from one in the Marcellus Shale in PA, due to changes in technology over time (when the well was first drilled), geologic formations of the oil and gas reservoirs themselves (which also changes over time—the ratio of oil to gas changes as pressure in the reservoir is released), and regulations in place guiding the equipment needed on site. The math used in the Oil and Gas Tool is more complex than most other categories, as it uses equations like the Ideal Gas Law (PV=nRT) and mass balances, in conjunction with more traditional emission rate equations (activity x EF = emissions) to calculate emissions; thus, the work is best completed in database format.

Overall, there are hundreds of inputs to the Oil and Gas Tool, and these are broken down into three basic categories: activity data, basin factors, and emission factors.

Activity data is taken primarily from a commercially available database developed by DrillingInfo called HPDI (number of wells, oil, gas, condensate and water production, feed drilled, spud counts, and other data). There are cases where this data isn't complete, and in those cases, the state oil and gas commission databases are mined for data. In addition, after verification by the states, sometimes this data is modified to correct the data. Some examples of these are for OH and TX. In the case of Ohio, the state representative noted that the number of conventional versus unconventional well counts was out of proportion, and there were far fewer unconventional wells than HPDI listed. For Texas, the state representative compared the well counts to those of his internal state system, and realized that HPDI data led to double-counting of wells (due to leases). Therefore, these numbers were corrected within the tool, based on corrections by the state.

Basin factors include factors that are secondary to "activity," and include assumptions about equipment counts on a per well basis (e.g. number of pneumatic controllers per well, or average HP of an engine at a well site) as well as gas speciation profiles (fraction of benzene, toluene, xylene or ethylbenzene in natural gas at a particular point in the well pad, e.g. post separator).

Emission factors are also a part of the formula for estimating emissions, and in the Oil and Gas Tool, the nomenclature is set such that we only call the standard national factors, e.g. from AP-42 combustion equations, "emission factors."

These inputs (activity, basin & emission factors) to the tool are filled in by EPA and published with the tool, along with their references. Region specific inputs are preferable and are used when available. Extrapolated inputs from nearby counties in the same basin are then used to fill in gaps in data. National defaults are filled in where no other data is available, and attempts are made to align as much as possible with the Greenhouse Gas Reporting Program (GHGRP) and the Greenhouse Gas Emissions Inventory (GHGEI).

4.16.3.1 *Point Source Subtraction*

Further complication ensues when some states count some wells as point sources, and therefore have a need to subtract these from the nonpoint part of the inventory. The Oil and Gas Tool allows emissions from point sources to be subtracted on an activity or emissions basis. This piece of the puzzle is less perfect, in that if a source has CAP emissions to subtract but not HAPs, the emissions for a single source may be divided across the point and nonpoint parts of the inventory. Thus, when an inventory developer looks at VOC emissions and compares these to a sum of HAP-VOCs, there may appear to be inconsistencies.

Sources of Data Overview and Selection Hierarchy

S/L/Ts have four options for providing data to the NEI for the Oil and Gas sector:

1. Accept the outputs from the EPA Oil and Gas Tools with the EPA-populated defaults,
2. Choose to provide EPA the input data to incorporate in the tools,
3. Run the tools themselves (presumably updating the inputs), or
4. Use their own tools and methodology to provide estimates.

If a reporting agency fails to submit nonpoint data or state a preference via the nonpoint survey, then EPA data was input by default. Table 4-85 summarizes the data, or nonpoint survey option preference, that was submitted by states in the oil and gas sector.

Table 4-85: State involvement with Oil and Gas Production submittals

State	Nonpoint Approach	Point Submittal?
AK	EPA tool for some SCCs (survey) & State submission	Yes
AL	no survey, will use EPA tool	Yes
AR	EPA tool	Yes
AZ	EPA tool	Yes
CA	State submitted nonpoint emissions	Yes
CO	State submitted nonpoint emissions	Yes
CT	No oil and gas	Yes
FL	EPA tool	Yes
GA	No oil and gas	Yes
IA	No oil and gas	Yes
ID	EPA tool	
IL	State submitted nonpoint emissions	Yes
IN	EPA tool	Yes
KS	EPA tool with State inputs	Yes
KY	no survey, will use EPA tool	Yes
LA	EPA tool	Yes
MD	no survey, will use EPA tool	Yes
ME	No oil and gas	Yes
MI	State submitted nonpoint emissions	Yes
MN	No oil and gas	Yes
MO	EPA tool	Yes
MS	no survey, will use EPA tool	Yes
MT	no survey, will use EPA tool	Yes
NC	No oil and gas	Yes
ND	EPA tool	Yes
NE	no survey, will use EPA tool	Yes
NJ	No oil and gas	Yes
NM	EPA tool with State inputs	Yes
NV	EPA tool	Yes
NY	State submitted nonpoint emissions	Yes
OH	EPA & State	Yes
OK	State CAP submissions, relied on HAP aug for HAPs (point source data lacked HAP emissions, so could not be subtracted)	Yes
OR	EPA tool	
PA	EPA (exploration segment) & State (inadvertently forgot entire exploration segment—e.g., drill rigs, fracking engines, heaters)	Yes
SC	No oil and gas	Yes
TN	EPA tool	
TX	State submitted nonpoint emissions	Yes
UT	EPA & State	Yes
VA	EPA tool	Yes

State	Nonpoint Approach	Point Submittal?
WI	No oil and gas	Yes
WV	State submitted nonpoint emissions	Yes
WY	EPA & State	Yes

4.16.4 Notes on observations in 2014 v1 estimates

Alaska: Alaska's VOC emissions went down since 2011. This is because the tool in 2011 assumed storage tanks exist. This was corrected by conversations with industry and AK state representatives, who had a chance to review the tool for 2014, and clarified for EPA that storage tanks do not exist in AK due to the very cold temperatures (everything is sent to pipeline.)

California: On reviewing the data, EPA noticed that CA data when compared to EPA data was very low. A state inventory developer explained that they used the 2011 tool and revised the inputs largely based on an industry survey. This survey, in comparison to default inputs in the EPA Oil and Gas Tool, revealed:

- lower number of dehydrators/well,
- lower activity for artificial lifts (most artificial lifts are electric),
- fewer tanks flared (most use VRUs),
- 30% lower operating hours for compressor engines,
- 50% lower fugitives (no open ended lines),
- more wells per compressor.

Colorado: Colorado's emissions were lower than they were in 2011, and in fact were closer to the tool emissions than they were in 2011. The nonpoint inventory developer clarified that in the Ozone 9-county nonattainment area, the point source inventory omitted well pad sources from his NEI point source submittal to avoid double counting area (nonpoint) source data. Area source oil and gas production also decreased in the nonattainment area between 2011 to 2014 due to decline in production from old wells and much greater control of emissions from new wells.

Idaho: Idaho is a new state in 2014. There are some new wells that were listed by HPDI.

North Dakota: Emissions for VOC have risen significantly, likely due to increased production in the Bakken Shale area.

Pennsylvania: Pennsylvania's emissions were very low. See notes below in Known Issues.

Texas: A state inventory developer noted some discrepancies between what TCEQ ultimately submitted to the 2014 NEI and what the EPA Tools would have generated. Many activity data and parameters in the tool were updated by TCEQ, including:

- well counts and production data,
- fraction of gas wells with compressor engines,
- pneumatic device counts,
- hydraulic pump engine equipment profiles,
- mud degassing VOC content,
- piping fugitive VOC content,
- number of dehydrators per well

For well counts and production data, TCEQ explained how reporting at the lease level to the Texas Railroad Commission leads to double counting in the HDPI data. TCEQ explained that leases can contain multiple wells and both of those wells would report production data at the lease level, so then both wells would be listed with the same production (i.e., double counting). For the variable "fraction of gas wells with compressor engines," TCEQ made revisions to the tool to account for the presumption that in general, most wells do not need compression in the first year, and thereafter, in most areas, about a third of wells need compression.

Furthermore, in order to be consistent with OAP use of HPDI data, the Oil and Gas Tool developers shifted some gas wells to oil wells based on the GHGRP GOR definition – about 10% of gas wells were shifted to oil wells (which impacts compressor engine emissions), and about 95% of condensate was shifted to oil (which impacts storage tank and loading loss emissions).

TCEQ's improved inputs to the Oil and Gas Tool were incorporated into the Oil and Gas Tool for 2014 v1.

Wyoming: Wyoming's emissions, in comparison to EPA's estimates for WY, were much lower, in general, for VOC. This can likely be attributed to tighter regulations on emissions. However, some HAPs such as xylenes and benzene were orders of magnitude higher; this should be revisited by EPA in v2.

4.16.4.1 *Known Issues with Oil and Gas in 2014 v1*

Dehydrator Emissions: In August 2016, EPA found an issue with the dehydrator emissions algorithm (brought to our attention by the Texas Commission on Environmental Quality. As part of the emissions algorithm for dehydrators, the Tool develops estimates for still vents, reboilers, and flaring. It was discovered that the flaring portion of the emissions algorithm was programmed incorrectly. This error affects only states that used the Tool for Dehydrators (one SCC) and if the "fraction to flares" variable is populated. Where this is the case (which EPA believes is only a few states), the VOC and HAP emissions for the flaring portion are 1000 times higher than they should be. However, for the Tool overall, the VOC changes from the dehydrator issue overestimated VOC by ~8.6%. However, almost all of that (7.8%) was for Texas. The states affected by the dehydrator issue in the Tool include TX, UT, WY, SD, ND, and NM, but TX, UT, and WY provide their own nonpoint oil and gas inventories to the NEI. The % change in VOC for the states using the tool are 2.8% (NM), 1.2% (ND), and 6.1% (SD). Also, the error/fix also affect NOx (3.7% total Tool), and CO (14.3% total Tool). As with VOC, most of the NOx and CO change comes from Texas.

Pennsylvania: We found an issue with PA late in the process (September, 2016). For PA, data submittals were provided by the state (PADEP) for unconventional sources, and by MARAMA on behalf of PA for conventional sources. After reviewing the data submittals, there was a potential issue of category incompleteness for the sector—it appears the entire Exploration module was not submitted. Several large sources (drill rigs, fracking engines, heaters, for example) were not included.

Thus, EPA has decided to allow EPA data to backfill where SCCs were not submitted. For version 1, EPA untagged all of EPA data and so there may be some doublecounting (overlapping SCCs—fugitives and engines—PA uses one SCC for fugitives while EPA uses 5, and PA uses one SCC for engines while EPA uses 3 or more). PA did not complete their nonpoint survey for oil and gas with the specificity needed to reconcile this easily. EPA plans to work with PA DEP to interpret their data submittals prior to V2.

Utah: EPA noticed a very high VOC (leading to high HAPs in the augmentation) number for Uintah County. EPA contacted UT's inventory developer, Greg Mortensen, and he replied that the figure is based off the projection from the 2006 WRAP inventory. Utah has not used the Oil and Gas Tool. The 2006 base year for dehydrators (15,327 tons) is grown by the gas production growth factor (2006 vs 2014 production) which is approx. 1.52. This results in about 23,000 tons of VOC for 2014. However, they are in the midst of incorporating some new data they have collected in Uintah County based on a survey they've conducted on operators in the area. According to Greg, this figure will be reduced to around 3686 tons in Uintah County when they substitute the numbers from the producer inventory we recently collected. Utah expects to make this correction in v2 of the 2014 NEI.

4.16.4.2 *Additional potential updates for 2014 v2*

- Update the 2014 activity data using the most current available HPDI data.
- Update the emission estimation algorithm for lateral compressor engines to include HAP control for control devices that reduce VOC.
- Update region specific gas speciation profiles used for several categories based on new SPECIATE data.
- Potential basin factor updates based on data reported for 2015 under subpart W of the Greenhouse Gas Reporting Rule.

4.17 Miscellaneous Non-Industrial NEC: Residential Charcoal Grilling

4.17.1 Source category description

Residential barbecue grilling emissions include emissions from the burning of charcoal and all types of outdoor meat grilling. Combustion emissions from gas barbecues are not included. Emissions estimates are for charcoal and all types of meat cooked on charcoal, gas, and electric grills. This source category (SCC=2810025000) is one of many components in the Miscellaneous Non-Industrial sector. The SCC description is "Miscellaneous Area Sources; Other Combustion; Charcoal Grilling - Residential (see 23-02-002-xxx for Commercial); Total".

4.17.2 Source of data

This is the first time that EPA has provided estimates for this source category; therefore, these emissions are new for the 2014 NEI, and were not covered on a national basis for previous inventory years. Members of the NOMAD Committee (ID and TX) were instrumental in developing this methodology. An inventory developer in Idaho developed the method, based on one used in Idaho for many years. An inventory developer from TCEQ then created a tool in MS Access, and also provided instructions, which makes the method easy to use for all reporting agencies.

This source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-86 submitted 100% of their $PM_{2.5}$ emissions for this sector; agencies not listed used EPA estimates for the entire sector.

Table 4-86: Percentage of Residential Charcoal Grilling $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	S/L/T	SCC	$PM_{2.5}$
6	Texas Commission on Environmental Quality	State	2810025000	100
9	Washoe County Health District	Local	2810025000	100
10	Coeur d'Alene Tribe	Tribe	2810025000	100
10	Idaho Department of Environmental Quality	State	2810025000	100
10	Kootenai Tribe of Idaho	Tribe	2810025000	100
10	Nez Perce Tribe	Tribe	2810025000	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2810025000	100

4.17.3 EPA-developed emissions for residential charcoal grilling

4.17.3.1 *Activity data*

The activity data needed to estimate emissions from residential charcoal grilling is the number of 2013 households from 1-4 units, the amount of charcoal used in 2013, and the amount of meat cooked during outdoor grilling on charcoal, gas, and electric grills. The household data was obtained from the US Census Bureau 2013 5-year estimates [ref 1, ref 2]. The fraction of occupied households to total households was used on the total households of 1-4 units to calculate the occupied 1-4 unit households. The amount of charcoal sold in Idaho was calculated (from the Hearth, Patio and Barbeque Association BBQ Statistics total charcoal sold in 2013 [ref 3]) using national occupied 1-4 unit households. The fraction of each state's occupied 1-4 unit households compared to the national occupied 1-4 unit households was used on the total charcoal sold in the United States to get the state portion of charcoal sold. Each county was then apportioned tons of charcoal based on their fraction of the total number of 1-4 unit households in each state. It was assumed that those in larger apartment units would not have the space to have or use an outdoor grill.

The activity data for the weight of meat cooked was calculated using some generally accepted information about charcoal grilling. It is generally assumed that about 30 charcoal briquettes are needed to cook a pound of meat [ref 4, ref 5]. Information from Kingsford on the average weight of their charcoal briquettes indicated that there are about 17.64262 briquettes/lb of charcoal [ref 6]. Using this figure, the number of briquettes was calculated for each county and divided by 30 to get the total weight of meat cooked with charcoal per county.

The gas and electric grill meat totals were estimated using some HPBA statistics. Their 2011 State of the Barbecue Industry Report [ref 7] estimated that households with charcoal grills cook about 27 times per year. Those with gas grills cook about 45 times per year. The later reports don't have this information, so the assumption is that it has remained about the same. The HPBA 5-year average sales figures indicate that about 41% of the grills sold were charcoal grills [ref 8], and the other 59% are gas/electric grills [ref 9]. Since the number of grilling events for charcoal grills is 27 compared to 45 grilling events for gas/electric grills, and only 41% of grilling households have charcoal grills, estimating the amount of meat cooked by the other methods is more complicated.

4.17.3.2 *Emission factors*

CAP emission factors for charcoal grilling were obtained from "Emissions from Street Vendor Cooking Devices" [ref 10], an EPA report developed by the U.S.-Mexico Border Information Center on Air Pollution. This same report indicates that most of the PM and VOC emissions come from the cooking of meat. The CO and NOx emissions come from the burning of the charcoal. So all VOC and HAPs from VOC, and the $PM_{10}/PM_{2.5}$ emissions use the total tons of meat cooked to estimate emissions. The CO and NOx emissions were estimated using the total tons of charcoal used for cooking. Idaho used averages from Table E-2 of that report which summarizes the g/kg emissions per weight of both charcoal and meat. Tables 3-1 through 3-4 of the EPA report were used for estimating HAPs emissions. These were averaged and used where they match up with pollutants in the EPA NEI pollutant list. The test results from charcoal-only and the one test with a cover were not used in the averages. The g/kg emission factors were converted to lb/ton. The resulting emission factors are listed in Table 4-87.

Table 4-87: Residential Charcoal Grilling emission factors

Code	Pollutant	g/kg	lb/ton
CO	CO	1.66E+02	3.31E+02
NOX	NOx	3.56E+00	7.11E+00

Code	Pollutant	g/kg	lb/ton
PM25-PRI	$PM_{2.5}$ Primary	7.37E+00	1.47E+01
PM10-PRI	PM_{10} Primary	9.21E+00	1.84E+01
VOC	VOC	8.51E-01	1.70E+00
91576	2-Methylnaphthalene	4.06E-03	8.11E-03
100027	4-Nitrophenol	8.14E-03	1.63E-02
208968	Acenaphthylene	1.28E-03	2.55E-03
75070	Acetaldehyde	2.69E-01	5.38E-01
98862	Acetophenone	2.19E-03	4.38E-03
71432	Benzene	4.27E-01	8.54E-01
132649	Dibenzofuran	2.08E-03	4.16E-03
16672392	Diethyl Phthalate	7.14E-03	1.43E-02
100414	Ethyl Benzene	3.19E-02	6.37E-02
206440	Fluoranthene	6.68E-04	1.34E-03
86737	Fluorene	7.74E-04	1.55E-03
50000	Formaldehyde	3.93E-01	7.86E-01
108383	M-Xylene	1.26E-02	2.52E-02
91203	Naphthalene	2.13E-02	4.27E-02
95476	O-Xylene	2.93E-02	5.86E-02
85018	Phenanthrene	1.44E-03	2.88E-03
108952	Phenol	2.50E-02	5.01E-02
106423	P-Xylene	1.26E-02	2.52E-02
129000	Pyrene	6.36E-04	1.27E-03
100425	Styrene	1.62E-01	3.23E-01
108883	Toluene	1.64E-01	3.28E-01

Lighter fluid VOC emissions were estimated [ref 11] to be 0.02 lbs per barbecue event as noted above. These were added to the VOC emissions estimated from the grilling of meat since there is no separate SCC to list these emissions.

Emission calculations are based on the activity data of tons of meat or charcoal used per county multiplied by the g/kg of meat or charcoal emission factors converted to lb/ton.

4.17.3.3 *Control Factors*

No control measures are assumed for this category.

4.17.3.4 *Example Calculation*

Emissions are calculated for each county using emission factors and activity as:

$$E_{x,p} = A_x \times EF_{x,p}$$

where:

$E_{x,p}$ = annual emissions for category x and pollutant p;

A_x = calculated pounds of meat or charcoal associated with category x;

$EF_{x,p}$ = emission factor for category x and pollutant p (pound/ton of meat or charcoal).

Example

The 2013 1-4 unit occupied households for Ada County was 129,646. Using the fraction of the Ada County population compared to Idaho, the total tons of charcoal used in Ada County was 977.2 tons or 1,954,334.3 pounds. Using 30 briquettes needed to cook a pound of meat and figuring that there are 17.64262 charcoal briquettes in a pound of charcoal, the amount of charcoal grilled meat cooked in Ada County was 574.7 tons. (1,954,334.3 lbs of charcoal × 17.64262 briquettes/lbs of charcoal / 30 briquettes/lb of meat cooked / 2000 to convert to tons). Then using the formula noted above, the total meat cooked from all grilling in Ada County was 1,952.9 tons. The calculation would be: 574.7 * 3.3984, or 574.7 * (45*59%) / (27*41%) * 574.7) + 574.7 = 1,952.9.)

The emission factor for PM10-PRI is 18.42 lb/ton of meat grilled

$E_{PM10\text{-}PRI}$ = 1,952.9 tons meat grilled × 18.42 pounds PM10-PRI/ton of meat grilled / 2000
= 17.99 tons PM10-PRI

4.17.3.5 *References for residential charcoal grilling*

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4.18 Miscellaneous Non-Industrial NEC: Portable Gas Cans

4.18.1 Source category description

There are several sources of emissions associated with portable gas cans, hereafter referred to as PFCs (portable fuel containers). These sources, used for gasoline, include vapor displacement and spillage while refueling the gas can at the pump, spillage during transport, permeation and evaporation from the gas can during transport and storage, and vapor displacement and spillage while refueling equipment. Vapor displacement and spillage while refueling nonroad equipment from PFCs are included in the nonroad inventory. This section describes how other types of PFC emissions are accounted for in the NEI. This source category is one of many components in the Miscellaneous Non-Industrial sector.

4.18.2 Source of data

Table 4-88 shows the SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 3 and 4 descriptions are also provided. The leading SCC description is “Storage and Transport; Petroleum and Petroleum Product Storage” for all SCCs.

Table 4-88: SCCs with 2014 NEI emissions for PFCs

SCC	Description	EPA	State	Tribe
2501011011	Residential Portable Gas Cans; Permeation	X	X	X
2501011012	Residential Portable Gas Cans; Evaporation (includes Diurnal losses)	X	X	X
2501011013	Residential Portable Gas Cans; Spillage During Transport	X	X	X
2501011014	Residential Portable Gas Cans; Refilling at the Pump - Vapor Displacement	X	X	X
2501011015	Residential Portable Gas Cans; Refilling at the Pump - Spillage	X	X	X
2501012011	Commercial Portable Gas Cans; Permeation	X	X	X
2501012012	Commercial Portable Gas Cans; Evaporation (includes Diurnal losses)	X	X	X
2501012013	Commercial Portable Gas Cans; Spillage During Transport	X	X	X
2501012014	Commercial Portable Gas Cans; Refilling at the Pump - Vapor Displacement	X	X	X
2501012015	Commercial Portable Gas Cans; Refilling at the Pump - Spillage	X	X	X

This source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. The agencies listed in Table 4-89 submitted at least VOC emissions; agencies not listed used EPA estimates for all PFC sources. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-89: Percentage of PFC VOC emissions submitted by reporting agency

Region	Agency	S/L/T	VOC
10	Idaho Department of Environmental Quality	State	100
5	Illinois Environmental Protection Agency	State	100
3	Maryland Department of the Environment	State	93
2	New Jersey Department of Environment Protection	State	71
2	New York State Department of Environmental Conservation	State	87
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100
10	Coeur d'Alene Tribe	Tribe	100

Region	Agency	S/L/T	VOC
10	Nez Perce Tribe	Tribe	100
10	Kootenai Tribe of Idaho	Tribe	100

4.18.3 EPA-developed emissions for portable gas cans

PFC emissions are impacted by a 2007 regulation controlling emissions of hazardous pollutants from mobile sources (MSAT2 rule). In this rule EPA promulgated requirements to control VOC emissions from gas cans. The methodology used to develop emission inventories for gas cans was initially described in the regulatory impact analysis for the rule and in an accompanying technical support document [ref 1, ref 2]. The inventory development approach used for the NEI is still based on the analyses done for this rule.

Below, data and methods are described for development of portable fuel container (PFC) inventories in the 2014 National Emissions Inventory (NEI).

VOC Allocation

PFC inventories in the MSAT2 rule were developed for different emissions scenarios in several calendar years (1990, 2005, 2010, 2015, 2020, and 2030) at the State level for 6 categories of emissions: 1) vapor displacement while refilling containers at the pump, 2) spillage while refilling at the pump, 3) spillage during transport, 4) vapor displacement while refueling equipment, 5) spillage while refueling equipment, and 6) permeation and evaporation.

For the NEI, emissions had to separate into commercial and residential fuel container emissions. Total state level PFC emissions were allocated to the categories by using national level residential and commercial emission splits from the MSAT2 rule for each of the categories using the following equations:

$$E_{residentid,XXXX,YY} = E \times \left(\frac{Res}{Res + Com} \right) \quad (1)$$

$$E_{commercial,XXXX,YY} = E \times \left(\frac{Com}{Res + Com} \right) \quad (2)$$

where,

E was the emissions of the category being split, XXXX was year, YY was state, and Res and Com were the national residential and commercial PFC emissions.

Permeation and evaporation were also separated as follows:

$$E_{AAA,XXXX,YY,perm} = E_{AAA,XXXX,YY,perm\&evap} \times 0.3387 \quad (3)$$

$$E_{AAA,XXXX,YY,evap} = E_{AAA,XXXX,YY,perm\&evap} \times (1 - 0.3387) \quad (4)$$

The fraction 0.3387 represents the fraction of combined permeation and evaporative emissions attributable to permeation, based on data from the California Air Resources Board.

Once the state VOC emissions were allocated to the residential and commercial components of the categories, they were assigned SCC codes. Finally, state emissions were allocated to the counties using the ratio of county to State fuel consumption:

$$E_{XXXX,YYYYY,AAA,SCC} = E_{XXXX,YY,AAA,SCC} \times \left(\frac{Consumption_{YYYYY}}{Consumption_{YY}} \right) \quad (5)$$

where,

$E_{XXXX,YYYYY,AAA,SCC}$ were the emissions for year XXXX, county with FIPS code YYYYY, emission scenario AAA, and SCC shown in Table 1, $E_{XXXX,YY,AAA,SCC}$ were the state level emissions for year XXXX, state YY, emission scenario AAA, and SCC in Table 4-88, $Consumption_{YYYY}$ was the county fuel consumption and $Consumption_{YY}$ was the state fuel consumption.

Below are descriptions of how 2014 PFC inventories for various types of pollutants were developed for the 2014 NEI, for different groups of SCCs.

4.18.3.1 *VOCs*

Permeation and Evaporation

These emissions are represented by the following SCCs

2501011011 – Residential Portable Fuel Containers: Permeation
2501011012 – Residential Portable Fuel Containers: Evaporation
2501012011 – Commercial Portable Fuel Containers: Permeation
2501012012 – Commercial Portable Fuel Containers: Evaporation

Emissions from these SCCs are impacted by 2007 MSAT rule standards limiting evaporation and permeation emissions from these containers to 0.3 grams of hydrocarbons per day [ref 3]. Inventory estimates developed for calendar year 2018 in EPA's Tier 3 vehicle rule modeling platform [ref 4] reflect the impact of these standards, as well as impacts of RVP and oxygenate use. These Tier 3 inventories were interpolated from earlier 2015 and 2020 MSAT2 rule inventories and assumed 100% E10. They were judged to be reasonable approximations of the 2014 inventory, although increases in activity between 2014 and 2018 means emissions will be overestimated in the 2014 NEI.

Vapor Displacement

Vapor displacement emissions occur while refueling containers at the pump. These emissions are represented by the following SCCs:

25010111014 – Residential Portable Fuel Containers: Refilling at the Pump: Vapor Displacement
25010112014 – Commercial Portable Fuel Containers: Refilling at the Pump: Vapor Displacement

These emissions are not impacted by MSAT2 rule standards, but are impacted by RVP and oxygenate use. Inventory estimates developed for calendar year 2018 in EPA's Tier 3 vehicle rule modeling platform were judged to be reasonable approximations of the 2014 inventory, although increases in activity between 2014 and 2018 means emissions will be overestimated in the 2014 NEI.

Spillage

Spillage occurs during transport and refilling at the pump. These emissions are represented by the following SCCs:

2501011013 – Residential Portable Fuel Containers: Spillage During Transport

2501011015 -- Residential Portable Fuel Containers: Refilling at the Pump: Spillage
2501012013 – Commercial Portable Fuel Containers: Spillage During Transport
2501012015 -- Commercial Portable Fuel Containers: Refilling at the Pump: Spillage

These emissions are not impacted by MSAT2 standards or RVP. However, the composition of the emissions is impacted by oxygenate. VOC emissions for these SCCs are carried forward from 2011.

4.18.3.2 *Air Toxics*

Permeation, Evaporation and Vapor Displacement

MSATs found in liquid gasoline will be present as a component of VOC emissions. These MSATs include benzene, ethanol, and naphthalene. For vapor displacement, toxic to VOC ratios were obtained from headspace vapor profiles from EPAct test fuels [ref 5]. For permeation emissions, vehicle permeation speciation data from Coordinating Research Council (CRC) technical reports E-77-2b and E-77-2c were used [ref 6, ref 7]. We relied on three day diurnal profiles from the CRC data. For evaporative emissions resulting from changes in ambient temperatures, speciation data from the Auto/Oil program were used for E0 and E10 [ref 8]. Table 4-90 lists the toxic to VOC ratios for each type of PFC emission.

Table 4-90: Toxic to VOC ratios for PFCs

Pollutant	Process	Speciation Surrogate	E0	E10
Benzene	Vapor Displacement	Vehicle Headspace	0.0077	0.0087
	Permeation	Vehicle Permeation	0.0250	0.0227
	Evaporation	Vehicle Evap	0.0336	0.0340
Naphthalene	Vapor Displacement	Vehicle Headspace	0.0000	0.0000
	Permeation	Vehicle Permeation	0.0004	0.0004
	Evaporation	Vehicle Evap	0.0004	0.0004
Ethanol	Vapor Displacement	Vehicle Headspace	0	0.0645
	Permeation	Vehicle Permeation	0	0.2020
	Evaporation	Vehicle Evap	0	0.1190

Emissions of other air toxics for permeation, evaporation, and vapor displacement were all estimated from the EPAct headspace vapor displacement profile for E10 (SPECIATE profile 8870). Toxic to VOC ratios are provided in Table 4-91.

Table 4-91: Toxic to VOC ratios for other HAPs (vapor displacement, permeation and evaporation).

Pollutant	Toxic to VOC Ratio
Ethylbenzene	0.0068
Hexane	0.0616
Toluene	0.0521
Xylenes (o,m,p)	0.0300
2,2,4-Trimethylpentane	0.0540

Spillage

Since spillage emissions were carried forward from the 2011 NEI, the HAP estimation approach for these emissions reflects the methods used for that inventory. The methods used in the 2011 NEI are described below.

To calculate the benzene emissions for each PFC SCC in each county the following formulas was used:

$$Benzene_{XXXX,YYYYY,SCC} = VOC_{XXXX,YYYYY,SCC} \times \left(\frac{Benzene_{refuel,XXXX,YYYY}}{VOC_{refuel,XXXX,YYYY}} \right) \times 0.36 \quad (6)$$

where,

XXXX was the year, YYYYY was the FIPS code of the county, and SCC was an SCC code shown in Table 4-88.

In the equations the factor 0.36 represents an adjustment based on the nationwide percentage of benzene in gasoline vapor from gasoline distribution with an RVP of 10 psi at 60˚F [ref 9]. This factor is based on the ratio of the percentage of benzene in gasoline vapor from gasoline distribution of 0.27%, divided by the percentage of benzene in vehicle refueling emissions of 0.74% benzene in vehicle refueling emissions [ref 1].

For all other HAPs, the PFC emissions were created by multiplying the PFC VOC emissions by the county-level ratio of HAP LDGV evaporative emissions by the VOC LDGV evaporative emissions for the county or:

$$HAP_{XXXX,YYYYY,SCC} = VOC_{XXXX,YYYYY,SCC} \times \left(\frac{HAP_{LDGV,XXXX,YYYYY}}{VOC_{LDGV,XXXX,YYYYY}} \right) \quad (7)$$

, where the subscripts are as denoted previously. Using the LDGV evaporative emissions means only HAPs in the onroad inventory with LDGV evaporative emissions would have PFC emissions. Naphthalene was also multiplied by a factor of 0.0054, based on data from the same study used to adjust benzene, where the where the percentage of naphthalene in VOC from gasoline distribution vapor emissions was 0.00027, in contrast to about 0.05% naphthalene in vehicle refueling emissions from highway vehicles.

One modification was made to spillage estimates from the 2011 NEI. The 2011 inventory did not account for impacts of the fuel benzene standard implemented in 2011 as a result of the 2007 MSAT [ref 1]. This rule established a 0.62% volume standard for benzene, whereas the national average benzene content standard prior to the rule was about 1.0%. Thus PFC benzene emissions for these SCCs were scaled by a ratio of 0.62/1 to account for impacts of this rule.

4.18.4 References for PFCs

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4.19 Mobile - Commercial Marine Vessels

The 2014 NEI includes emissions from commercial marine vessel (CMV) activity in the 50 states, Puerto Rico, and US Virgin Isles, out to 200 nautical miles from the US coastline.

4.19.1 Sector description

The CMV sector includes boats and ships used either directly or indirectly in the conduct of commerce or military activity. The majority of vessels in this category are powered by diesel engines that are either fueled with distillate or residual fuel oil blends. For the purpose of this inventory, we assume that Category 3 (C3) vessels primarily use residual blends while Category 1 and 2 (C1 and C2) vessels typically used distillate fuels.

The C3 inventory includes vessels which use C3 engines for propulsion. C3 engines are defined as having displacement above 30 liters per cylinder. The resulting inventory includes emissions from both propulsion and auxiliary engines used on these vessels, as well as those on gas and steam turbine vessels. Geographically, the inventories include port and interport emissions that occur within the area that extends 200 nautical miles (nm) from the official U.S. shoreline, which is roughly equivalent to the border of the U.S. Exclusive Economic Zone. Only some of these emissions are allocated to states based on official state boundaries that typically extend 3 miles offshore.

The C1 and C2 vessels tend to be smaller ships that operate closer to shore, and along inland and intercoastal waterways. Naval vessels are not included in this inventory, though Coast Guard vessels are included as part of the C1 and C2 vessels.

The CMV source category does not include recreational marine vessels, which are generally less than 100 feet in length, most being less than 30 feet, and powered by either inboard or outboard. These emissions are included in those calculated by the MOVES model; they reside in the nonroad data category and EIS "Mobile - Non-Road Equipment" sectors of the 2014 NEI.

Each of the commercial marine SCCs requires an appropriate emissions type (M=maneuvering, H=hotelling, C=cruise, Z=reduced speed zone) because emission factors vary by emission type. Each SCC and emissions type combination was allocated to a shape file identifier in the nonpoint inventory. The allowed combinations are shown in Table 4-92. The default values are those assumed when the actual emission type may be unknown; for example, emissions that occur in shipping lanes are assumed to be 'cruising' and cannot be 'hotelling', which only occurs at ports.

Table 4-92: CMV SCCs and emission types in EPA estimates

SCC	Description	Allowed	Default
2280002100	Marine Vessels, Commercial Diesel Port	M	M
2280002200	Marine Vessels, Commercial Diesel Underway	C	C
2280003100	Marine Vessels, Commercial Residual Port	H	H
2280003100	Marine Vessels, Commercial Residual Port	M	H
2280003200	Marine Vessels, Commercial Residual Underway	C	C
2280003200	Marine Vessels, Commercial Residual Underway	Z	C

4.19.2 Sources of data

This source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. The state agencies listed in Table 4-93 submitted at least $PM_{2.5}$, NO_X and VOC emissions; agencies not listed used EPA estimates for all CMV sources. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%). For this sector, there are sub-county-level estimates from EPA that were backfilled for some shape IDs where the state data did not exist. California and Texas also submitted HAP emissions, but the other states only submitted 6 CAPs: CO, NO_X, PM_{25}, PM_{10}, SO_2, and VOC.

Table 4-93: Percentage of CMV $PM_{2.5}$, NO_X and VOC emissions submitted by reporting agency

Region	Agency	$PM_{2.5}$	NO_X	VOC
1	New Hampshire Department of Environmental Services	100%	100%	100%
2	New Jersey Department of Environment Protection	65%	58%	89%
5	Illinois Environmental Protection Agency	99%	99%	99%
6	Texas Commission on Environmental Quality	100%	100%	100%
9	California Air Resources Board	100%	100%	100%
10	Washington State Department of Ecology	96%	94%	93%

4.19.3 EPA-developed emissions for commercial marine vessels

This section summarizes the approach used to estimate emissions including compilation of 1) activity data (kilowatt hours or kW), 2) engine operating load factors, and 3) emission factors HAP speciation profiles.

Regarding vessel activities, the following data sources were used to develop vessel characteristics and quantify traffic patterns:

- **Entrance and Clearance** (E&C) – This data set captures vessels involved in international trade, documenting where a vessel came from and its next port of call [ref 1]. These vessel-specific ship movements were linked to their individual engine characteristics [ref 2] to calculate kilowatt hours. Most of the vessels in this data set are equipped with Category 3 propulsion engines, although some vessels were identified that are equipped with Category 1 and 2 propulsion engines.
- **Waterborne Commerce** (WC) – The U.S. Army Corps of Engineers provided a data set of domestic vessel movements for tugs and barges, bulk carriers, tankers, and other vessels [ref 3]. These data are provided

as domestic trips along a defined route and mapped to the NEI ports and shipping lane segments. Typical vessel speeds by vessel type were used in conjunction with the distance associated with each trip to estimate the hours of operation which were applied to the vessels' propulsion power to get kilowatt hours.

- **Category 1 and 2 Study** – For this inventory, the EPA's 2007 Category 1 and 2 vessels census was updated with more recent data, specifically for ferries, survey vessels, ships involved with offshore oil and gas activities, dredging, and U.S. Coast Guard operations. For these smaller vessels, less detailed information was available about their characteristics or traffic patterns, therefore, the kilowatt hours were estimated based on typical operations and applied to typical vessel power ratings.

Note all activity data were adjusted for typical engine loads for the modes of operation included in this study (i.e., cruising, reduced speed zone (RSZ), maneuvering, and hoteling). The adjusted kilowatt hours were applied to EPA emission factors by engine category as follows:

$$\text{Emissions} = \text{EF}\left(\frac{\text{g}}{\text{kWh}}\right) \times \frac{\text{D (NM)}}{\text{Vs}\,\frac{\text{NM}}{\text{hr}}} \times \text{LF} \times \text{Vp (kW)}$$

Where:

EF	=	EPA Emission factor, in grams per kilowatt-hour (kWh)
D	=	Distance along segment or RSZ (NM)
Vs	=	0.94 x maximum vessel speed = cruising speed or RSZ speed limit (NM/hr)
LF	=	Load Factor (fraction less than 1)
Vp	=	Vessel Power (kW)

D/Vs is used to estimate operating hours for E&C data and WC data. For C1/C2 study, typical operating hours are used instead. Also, if vessel speed is unknown, typical speed by vessel type was used (nautical miles/hr or knots). More detailed equations are available in Appendix A of the EPA document "Commercial Marine Vessels – 2014 NEI Commercial Marine Vessels Final" [ref 4].

4.19.3.1 *Activity data for entrance and clearance*

<u>Entrance and Clearance</u>

Vessel-specific routing data were available from the U.S. Army Corps of Engineers' 2012 E&C data [ref 1] for approximately 11,000 U.S. and foreign flagged vessels involved in international trade that complies with U.S. Customs and Clearance reporting requirements, as summarized in Table 4-94.

Table 4-94: Vessel-specific routing data

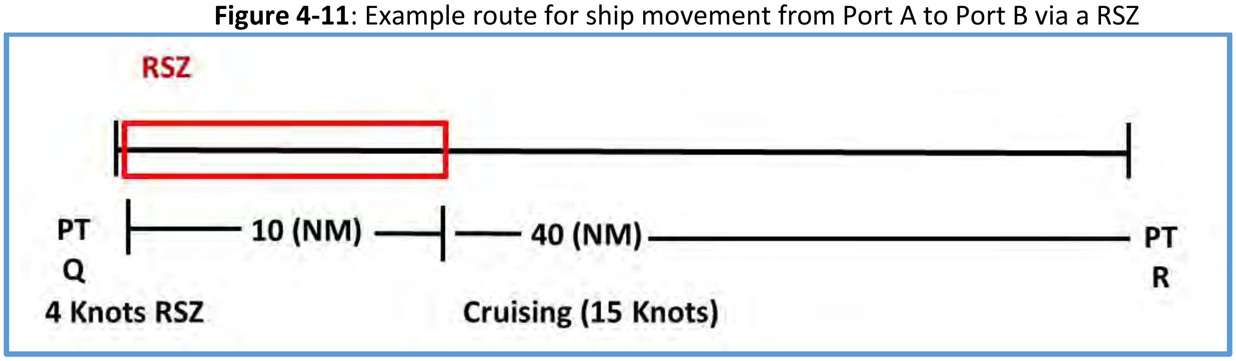
Standard Type	Total Vessel Count	Domestic Flagged	Foreign Flagged
Barge	350	244	106
Bulk Carrier	3,294	11	3,283
Bulk Carrier, Laker	89	35	54
Buoy Tender	4	0	4
Container	1,319	51	1,268
Crude Oil Tanker	754	8	746
Dredger	2	1	1
Drilling	51	7	44
Fishing	248	142	106

Standard Type	Total Vessel Count	Domestic Flagged	Foreign Flagged
FPSO	2	0	2
General Cargo	1,086	24	1,062
Icebreaker	2	0	2
Jackup	4	3	1
LNG Tanker	45	0	45
LPG Tanker	156	0	156
Misc.	47	17	30
Passenger	173	7	166
Pipelaying	14	0	14
Reefer	185	0	185
Research	61	31	30
RORO	92	7	85
Supply	255	197	58
Support	75	34	41
Tanker	1,428	14	1,414
Tug	679	533	146
Vehicle Carrier	465	20	445
Well Stimulation	3	1	2
Total	**10,883**	**1,387**	**9,496**

These vessels were linked to their individual routes based on the originating port and the destination port. For the 2014 NEI, the E&C data were mapped to 7,176 routes comprising 410 unique ports, 174 of which are domestic U.S. ports. The waterway network was also edited to include 1,005 segments associated with RSZs based on the EPA's Regulatory Impact Assessment [ref 5] for Category 3 vessels summarized Appendix B. Where the RSZ speed was unknown, a typical value of 10 knots was used.

To calculate hours of operation, the length of each route was divided by the vessel speed. Where a vessel travels through a RSZ, the vessel speed was reduced, thus increasing the hours of operation along that segment. Figure 4-11 provides an example of a vessel traveling from port Q to port R, moving through a 10 NM RSZ segment followed by a 40 NM normal cruising segment.

Figure 4-11: Example route for ship movement from Port A to Port B via a RSZ



Hours to transit each segment were estimated for each vessel based on the distance traveled and the vessel cruising speed, which was assumed to be 94 percent of the vessel's maximum speed as obtained from Information Handling Services' [ref 2] Register of Ships. These cruising speeds were additionally reduced based on the latest International Maritime Organization (IMO) Greenhouse Gas emission inventory [ref 6] that quantifies actual vessel speeds and engine operating loads for select vessel types, accounting for recent practices to reduce fuel consumption known as slow steaming. The IMO data are presented in Table 4-95.

Table 4-95: IMO-vessel speed data

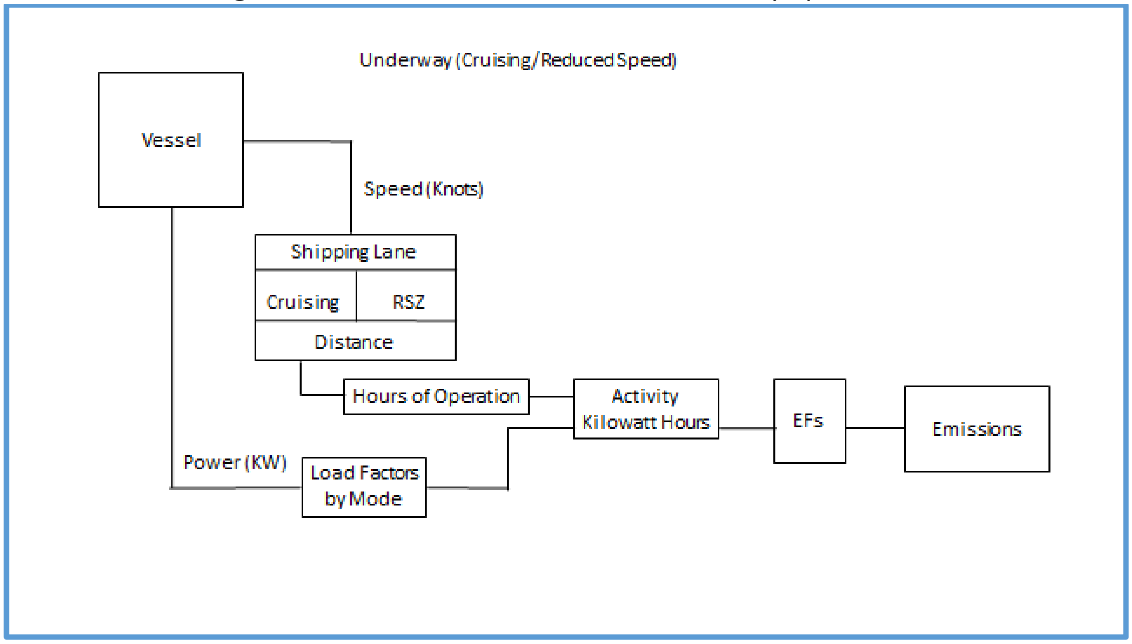
Ship Type	Size Category	Size Units	Ratio of average at-sea speed to design speed	Percent of total population	Weight amount	Weighted Cruising Speed Factor
Bulk Carrier	0-9999	dwt	0.84	0.9%	0.007403	0.822751023
	10000-34999		0.82	25.1%	0.20571	
	35000-59999		0.82	36.0%	0.295272	
	60000-99999		0.83	31.7%	0.263082	
	100000-199999		0.81	6.2%	0.050227	
	200000+		0.84	0.1%	0.001058	
Container	0-999	TEU	0.77	4.9%	0.038087	0.681508656
	1000-1999		0.73	11.8%	0.086059	
	2000-2999		0.7	12.5%	0.087716	
	3000-4999		0.68	32.8%	0.223116	
	5000-7999		0.65	28.6%	0.185944	
	8000-11999		0.65	9.0%	0.058409	
	12000-14500		0.66	0.3%	0.002176	
	14500+		0.6	0.0%	0	
Oil Tanker	0-4999	dwt	0.8	0.1%	0.001094	0.782982216
	5000-9999		0.75	0.3%	0.002052	
	10000-19999		0.76	0.0%	0	
	20000-59999		0.8	3.6%	0.028454	
	60000-79999		0.81	15.6%	0.12632	
	80000-11999		0.78	43.4%	0.338249	
	120000-199999		0.77	32.6%	0.250698	
	200000+		0.8	4.5%	0.036115	

dwt = dead weight tonnage; TEU = twenty foot equivalent units

For RSZs, a vessel's speed was assumed to be the zone's speed unless the vessel's cruising speed was lower. For example, a vessel with a cruising speed of 12 knots traveling through a waterway segment with a reduced speed of 14 knots was assumed to be operating at 12 knots.

The hours of operation were applied to the vessel's power, which was adjusted for typical engine operating loads to get kilowatt hours. In turn, the kilowatt hours were applied to the appropriate EPA emission factor based on the vessel engine's category to estimate criteria pollutant emissions. The flow of emissions calculations for underway vessels is illustrated in Figure 4-12.

Figure 4-12: Emission calculations for underway operations



Vessel characteristics data were compiled from IHS Register of Ships [ref 2] and linked to vessels included in the 2012 E&C data. The vessel characteristics included the following data:

- Vessel identification codes
- Vessel name
- Country of registry
- Call sign
- Vessel type
- Gross/net tonnage
- Vessel power
- Auxiliary engine power
- Piston stroke length/cylinder diameter (to calculate vessel category)
- Maximum vessel speed.

Approximately 89 percent of the E&C vessels could be matched to their characteristics by cross referencing multiple attributes such as IMO identification code, country of registry, gross tonnage, net tonnage, vessel type, and vessel name. For the remaining vessels that could not be matched, vessel attributes were developed for each vessel type based on the matched vessel in the IHS data. If the vessel type was unknown, aggregate attributes derived from all matched vessels in the IHS data set were developed and used. Note that the auxiliary engine data in the IHS data set was poorly populated; therefore, vessel type surrogates were developed based on vessels that reported auxiliary engine power. The vessel power data used in this study are presented in Table 4-96.

Table 4-96: Vessel power attributes by vessel type

Standard Type	Count	Avg Main hrs	Avg Aux kW	Avg Max Speed	Default Vessel Category
Bulk Carrier	3,177	8,990	1,935	14.3	3
Bulk Carrier, Laker	80	7,069	2,216	13.7	3

Standard Type	Count	Avg Main hrs	Avg Aux kW	Avg Max Speed	Default Vessel Category
Buoy Tender	4	4,266		12.6	2
Container	1,218	39,284	7,851	23.2	3
Crude Oil Tanker	731	15,070	2,888	15.1	3
Drilling	7	15,806	12,840	11.7	2
Fishing	123	1,262	272	2.3	1
FPSO	2	18,123		11.5	3
General Cargo	1,020	6,130	1,619	14.6	3
Icebreaker	2	21,844		12.0	2
Jackup	4	1,643	270	3.5	1
LNG Tanker	44	29,607	8,129	19.2	3
LPG Tanker	151	8,557	3,021	15.8	3
Misc.	35	2,805	631	10.0	1
Passenger	168	45,760	4,477	20.4	3
Pipelaying	14	11,355	5,037	12.6	2
Reefer	182	8,930	3,328	18.9	3
Research	55	5,395	1,905	11.2	2
RORO	72	9,479	4,006	16.7	3
Supply	255	3,201	662	10.1	1
Support	73	6,590	2,305	9.7	2
Tanker	1,423	8,474	2,730	14.5	3
Tug	396	3,440	348	7.7	2
Vehicle Carrier	441	13,829	3,729	19.8	3
Well Stimulation	3	7,697	340	8.2	3

Individual vessel movements were compiled as origination and destination pairs for each U.S. port included in the E&C data. The E&C data includes only vessels that enter or leave U.S. waters at some point in the trip. Over 49 percent of the records were for vessels that visit a single U.S. port during a single trip. Similarly, over 49 percent of the records were for vessels that visited multiple U.S. ports in one trip and less than one percent of the records was for between domestic U.S. ports only.

Because the E&C data report the departure of a vessel from a U.S. port and the arrival of the same vessel in the destination port associated with the trip, it was necessary to adjust the vessel movement data to avoid double counting of trips. To avoid the double counting only the entrance or clearance of the trip and not both are counted. Evaluating the duplicate trips was also an important quality check on the E&C data—ideally there should be a duplicate departure and arrival record for every trip, thus validating the completeness of the data. For example, for a vessel traveling from Long Beach to San Diego would typically have four E&C records:

- Arrival at Long Beach
- Departure from Long Beach (to San Diego)
- Arrival at San Diego (from Long Beach)
- Departure from San Diego.

Of the 23,008 unique ship movements for domestic origination and destination pairs, 85 percent of the vessel movements had corresponding arrivals and departures; 3,481 (15 percent) had an odd number of records, indicating that a vessel movement may be missing.

In many cases, the missing vessel movements were associated with an arrival in one port and a departure from an adjacent port, suggesting that the missing vessel movement was between the two adjacent ports. For example, the data may show only three records:

- Arrival at Long Beach
- Departure from Los Angeles (to San Diego)
- Arrival at San Diego (from Los Angeles)
- Departure from San Diego.

This dataset would thus suggest a missing Los Angeles to Long Beach trip.

To account for this type of error, adjacent ports were aggregated, reducing the unique vessel routes or movements to 19,883. Of the final 19,883 routes, only 4 percent of the vessel movements (attributed to 815 routes) had a missing arrival or departure. Many of the remaining missing ship movements were associated with the U.S. protectorates in the Caribbean Sea, where the arrival and departure information occasionally appeared to be switched.

The issue of duplicate trips was not a concern for foreign vessel movements because the E&C documents arrivals and departures for only U.S. ports, which means that a departure from a U.S. port to a foreign port or an arrival from a foreign port to a U.S. port would always be a unique trip.

Adjustments were also made for Alaskan trips. The E&C data reported activity for 52 Alaskan ports, however, the vast majority of those are small ports and have very little traffic. To capture the majority of emissions, only the top 13 Alaska ports, which accounted for 94 percent of the Alaska traffic, were included. Table 4-97 lists the Alaska ports and associated vessel calls.

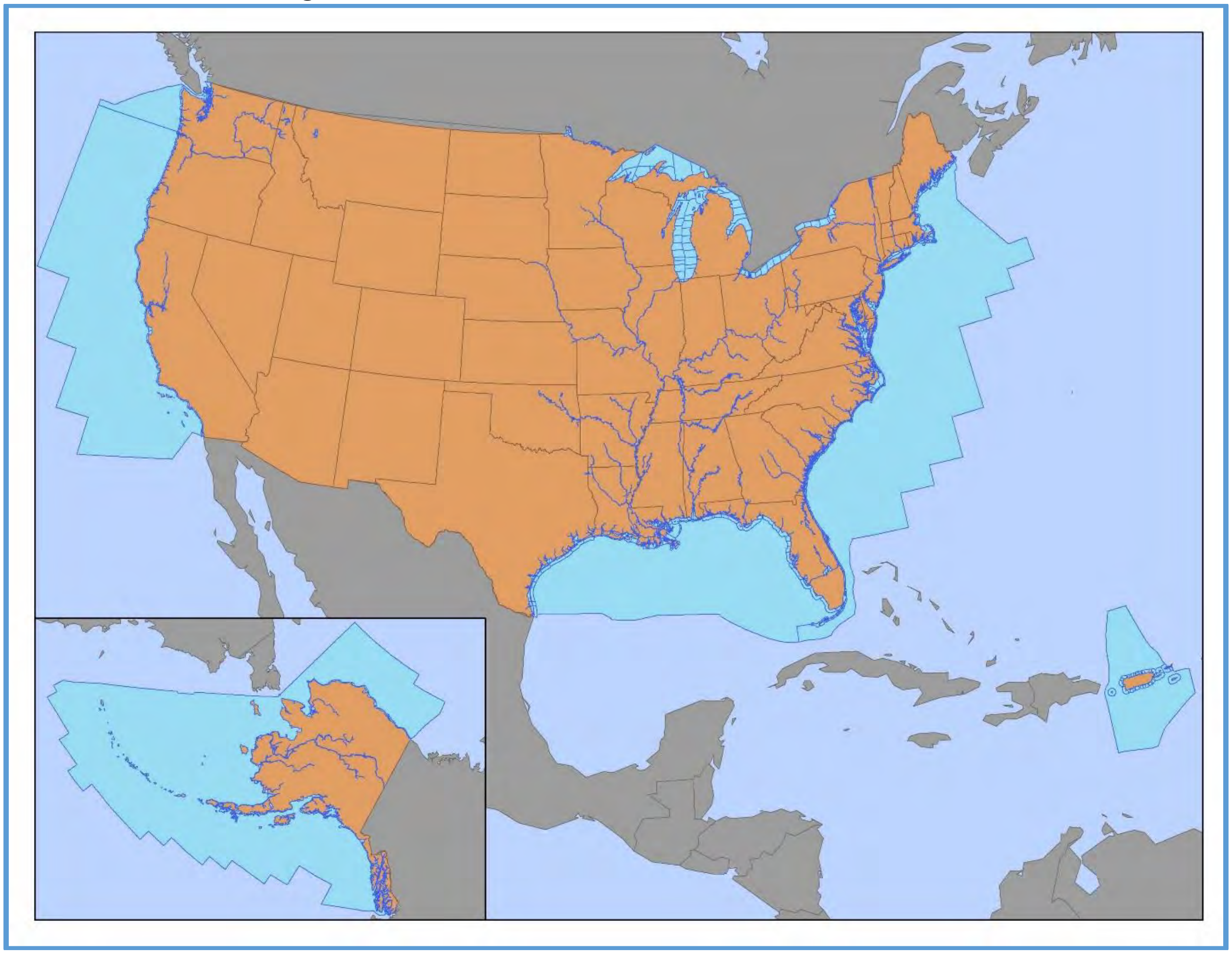
Table 4-97: Alaska ports and vessel calls

Ports	Total of Count	Domestic	Foreign	Fraction of Alaska Total
Juneau, AK	1,892	1,812	80	0.27
Ketchikan, AK	1,699	1,136	563	0.20
Skagway, AK	1,390	1,330	60	0.20
Anchorage, AK	563	526	37	0.08
Kivalina, AK	481		481	0.03
Sitka, AK	326	302	24	0.05
Iliuliuk Harbor, AK	212	76	136	0.02
Dutch Harbor, AK	196	84	112	0.02
Whittier, AK	182	65	117	0.02
Seward, AK	149	109	40	0.02
Icy Strait, AK	132	110	22	0.02
Wrangell, AK	88	15	73	0.01
Haines, AK	82	81	1	0.01

Once the E&C origination and destination port pairs were defined, trips were routed over a custom waterway network based on the U.S. Army Corps of Engineers' navigable waterway network using a Geographic Information System (GIS) and network analysis. The routes were then intersected with EPA's NEI shapefiles of ports and shipping lanes. Shipping lanes associated with RSZs were coded to allow for adjustment in vessel speed, time spent transiting the RSZ, and engine operating load.

Because U.S. territorial waters extend out 200 nautical miles from the coast (Figure 4-13[14], international vessel routes were mapped only to the U.S. federal waters/international waters boundary. The distance traveled was calculated based on the route the vessel was assigned. Each waterway segment was coded to differentiate normal cruising versus RSZ operations.

Figure 4-13: State and federal waters of the United States



Blue/Light Blue = state and federal water boundaries

4.19.3.2 *Activity data for entrance & clearance time spent maneuvering/dockside*

E&C data do not include details about time spent in each ship movement mode. Typical maneuvering times by vessel type were used to estimate time spent in this mode. Maneuvering durations for different vessel types were obtained from Entec's European emission inventory [ref 7] and are presented in Table 4-98. Note half of

[14] These are the official US territorial waters from NOAA, which are generally 200nm but do vary in some places due to foreign entities, etc. Spreading/condensing of emissions depends more on how the emissions were developed than the shapes we use here and is a frequent topic of conversation with modelers.

the maneuvering time presented in Table 4-98 was assumed to be approaching the terminal and half departing from the terminal.

Table 4-98: Estimated maneuvering time by vessel type

Vessel Type	Maneuvering Time (hours)
Bulk Carrier	1
Bulk Carrier, Laker	1
Buoy Tender	1.7
Container	1
Crude Oil Tanker	1.5
General Cargo	1
LNG Tanker	1
LPG Tanker	1
Misc.	1
Passenger	0.8
Reefer	1
RORO	1
Tanker	1
Tug	1.7
Vehicle Carrier	1

To quantify the duration a vessel spends dockside, the E&C data were organized chronologically for individual vessels to determine when a vessel arrives at the dock and when it leaves. Some of the dockside durations seemed unreasonably high, indicating that either an arrival or departure was missing or out of sequence. These anomalies were identified and removed from the analysis. The data were then averaged by vessel type to develop port specific dockside duration times. It should be noted that the E&C data recorded the day the vessel arrived and the day the vessel departed. The daily periods were multiplied by 24 hours to get hourly values. If a vessel arrived and departed in the same day it was assumed that the dockside duration was 12 hours.

The EPA provided hourly containership dockside data for 15 ports [ref 8]. For the 2014 NEI, these containership data replaced containership E&C data for the following ports:

- Ports of Los Angeles and Long Beach
- Ports of New York and New Jersey
- Port of Seattle
- Port of Houston
- Port of Baltimore
- Port of Savannah
- Port of Norfolk
- Port of Charleston
- Port of New Orleans
- Port of Mobile
- Port of Miami
- Port of Philadelphia
- Port of Tampa
- Port of San Juan
- Port of Portland

Additionally, dockside duration data were identified for ports that developed their own inventories. These data were assumed to be the highest quality and replaced E&C and EPA containership data. 2014 Detailed port data were obtained from the following ports:

- Port of Los Angeles
- Ports of New York and New Jersey
- Port of San Francisco
- Port of San Diego

4.19.3.3 *Activity data for waterborne commerce*

As with the E&C data, the Army Corps of Engineers Waterborne Commerce Data (WCD) provides vessel trips for individual vessels operating over a specified route. The WCD also includes vessel power ratings and distance of each route. The distance data were evaluated using typical vessel speeds to calculate hours of operation to transit a specified route. Note, hours of operation were adjusted for slower speeds transiting RSZs. The cruising speeds for each vessel type were compiled from a variety of sources. The primary data source was the IHS data; vessels equipped with Category 1 and 2 propulsion engines were identified and grouped by vessel type and averages of the vessel's maximum speed were developed for each grouping. These values are shown in Table 4-99. The cruising speed was assumed to be 94% of the average maximum speed.

Table 4-99: Category 1 and 2 average maximum speed by vessel type

Vessel Type	Vessel Count	Average Maximum Speed (knots)
Bulk Carrier	376.00	10.09
Bulk Carrier, Laker	27.00	13.74
Buoy Tender	197.00	6.90
Container	111.00	8.48
Crude Oil Tanker	44.00	6.97
Drilling	39.00	11.74
Fishing	13,652.00	5.67
Floating Production and Storage Offloading	10.00	4.90
General Cargo	7,179.00	8.09
Icebreaker	27.00	10.52
Jackup	173.00	4.25
LNG Tanker	3.00	9.33
LPG Tanker	183	10.83
Miscellaneous	2,014	6.83
Passenger	3,017	15.67
Pipelaying	280	6.39
Reefer	183	9.62
Research	951	9.79
RORO	1,997	11.28
Supply	3,409	12.98
Support	1,036	10.42
Tanker	2,880	8.28
Tug	15,660	8.54
Vehicle Carrier	20	14.42
Well Stimulation	30	8.63

Because the WCD contain confidential business information not available to the general public, the activity data were aggregated to develop national total activities and reapportioned to appropriate NEI underway shapes. This approach provided reasonable national estimates while protecting the confidential business aspects of the

WCD. The spatial allocation was developed in GIS using an approach similar to that used for the E&C data. The WCD were evaluated to identify consolidated routes using both the port and location names for the origins and destinations. For example, routes to and from "St. Thomas, VI" were combined with routes to and from "St. Thomas Harbor Virgin Islands." We also removed routes where the origin and destination were the same, because these records were considered to be inter-terminal maneuvering and are likely to be included in the maneuvering assumptions. This consolidation process reduced the number of unique routes from 40,775 to 27,991. The remaining routes were mapped in GIS using a shortest-distance based network analysis, and the routes were again intersected with NEI shapes to identify which routes passed through each shape. This intersection process identified portions of some routes that passed outside of US waters, for example, from Miami to Puerto Rico. For each route, the total length within US waters was divided by the total length of the route to obtain the percentage of the route activity that occurs in US waters. The activity data were adjusted accordingly to remove kilowatt hours that occurred in international waters.

Next, for each shipping lane segment shape, the number of vessel trips that passed through were totaled.

$$T_a = R_1 + R_2$$

Where:

T_a	=	Total number of trips on segment a
R_1	=	Number of trips on route 1
R_2	=	Number of trips on route 2

The length of the waterway through each shape was calculated and multiplied by the number of trips that occur along the shape. This value was divided by the national total for trips multiplied by the length to determine the percentage of the national total activity to allocate to each shape.

$$P = (T * L)/(NT * NL)$$

Where:

P	=	Percentage of national activity
T	=	Total trips for the NEI underway shape
L	=	Waterway segment length within underway shape
NT	=	National trip total
LN	=	National waterway network length total

Updating the Category 1 and 2 Vessel Census activity data

Since E&C includes only larger internationally-travelling vessels, additional data sources were needed to fill data gaps, particularly for smaller C1 and C2 vessel population involved in domestic traffic.

<u>Dredging</u>

As part of the effort to update the EPA's C1 and C2 vessel data, dredging data were compiled as a new vessel category. To estimate dredging activities for different types of dredging vessels, operating days were obtained from the U.S. Army Corps of Engineers database of dredging contracts for the entire country [ref 9]. This database included contracts from 2012 to 2014. For contracts active since 2012, only the portion of the contracts that were active during 2014 were used in this inventory. The 2014 dredging activities are presented in Appendix C [ref 4] by job name, dredging equipment, and actual operating days.

Operating hours were calculated from the number of days active in 2014, assuming a utilization rate documented in the Category 1/2 Vessel Census of 90% time spent dredging, excluding equipment positioning, maintenance, and refueling times. The U.S. Army Corps of Engineers data did not include horsepower or kW ratings for the engines on the dredging vessels but did include a dredging vessel type. A literature search of the dredging vessel types provided a kW rating for a typical vessel in each category, as summarized in Table 4-100.

Table 4-100: Power rating by dredging type

Type	Contract Code	kW	Source
Bucket or mechanical	B	1,600	Anderson, 2008 [ref 10]
Hopper	H	7,272	TCEQ, 2012, [ref4]
Non-conventional (Specialty) Type	N	2,093	Van Oord 2015 [ref 11]
Pipeline (Cutterhead)	P	7,161	TCEQ, 2012 [ref 4]
Pipeline and Hopper Combination	Y	4080	Robinson et al. 2011 [ref 12]
Undefined	U	5028	Average of compiled dredging data

The typical kW ratings in Table 4-100 were matched by dredge type to each contracted vessel noted in Appendix C [ref 4]. The matched power rating was multiplied by the utilization rate and dredging duration to estimate kW-hrs which are summarized in Table 4-101.

Table 4-101: Summary of national kilowatt-hours by dredging vessel type

Type	Total kW-hr
Bucket or mechanical	63,659,520
Hopper	302,526,835
Non-conventional (specialty) type	15,280,574
Pipeline (cutterhead)	654,286,248
Undefined	5,973,264

Dredging activities were spatially apportioned to ship channels based on the job name. The job names indicated general location, such as a bay area or a waterway portion; however, they did not provide sufficient information to precisely locate the dredging activities or even geographic extent of the project. Best effort was given to identify the waterway segments in EPA's GIS shape files that most closely match the limited location information. It should be noted that these activities have been increasing over the past several years to accommodate larger vessels that will be able to transit the new Panama Canal.

Research Vessels

A list of current US research vessels was obtained from the University of Delaware's International Research Ship Information and Schedule database [ref 13]. In the 2007 vessel census study [ref 14], only 31 research vessels were included. Using the University of Delaware's research vessels website for this inventory, 251 vessels were identified. This gave a more accurate representation of C1 research vessels, which were undercounted in the original C1 and C2 census. Twenty-three of these vessels had detailed trip schedules for 2014, and activity in days was determined for these vessels. The list did not have vessel identification numbers or codes, so an online search was implemented to find vessel identification codes for the remaining vessels. Where identification codes could be found, the vessels were linked to research vessels in the IHS database, providing details on the engine power ratings and engine category. However, not all vessels were matched and another online search was implemented to obtain engine power ratings for the unmatched vessels. During this process, 35 vessels were removed from this analysis because information was found that indicated that the vessel was not in service in 2014 or not powered by a diesel combustion engine (e.g. electric powered remotely operated vehicle (ROV)). Detailed results are presented in Appendix D [ref 4]. Summary of research vessel matching activities are provided in Table 4-102.

Table 4-102: Research vessel characteristics matching by reference

Research Vessels Matching	
Original	251
IHS match	77
Online search	109
Annual schedule	23
Removed	35

For research vessels without engine power ratings, the matched vessel data were averaged to provide a default of 732 kW which was used to gap fill missing research vessel power data.

For the 2014 inventory, the duration of each research mission was used when available. For the vessels with no activity data, an average value (220 days converted to 5,280 hours) was obtained from the previous Category 1 and 2 Census report. This default duration data was used to when vessel schedule data were not available. The vessel power data were applied to the duration data to calculate kW-hrs for the research vessels.

Coast Guard

A roster of U.S. Coast Guard vessels was provided by the US Coast Guard's (USCG) External Coordination Division [ref 15]. Among the data given were vessel name, horsepower, and annual underway hours for 246 USCG cutters (Appendix E, ref 4) and over 1,600 smaller boats. Fifty-eight percent of the smaller vessels were gas powered and excluded from this analysis. Also boats which were flagged as retired were also excluded from this analysis. This reduced the Coast Guard Boat list to 652 vessels.

All vessel power ratings were converted from horsepower to kW using the conversion factor 1 HP = 0.7457 kW. The vessel power ratings were multiplied by underway hours also provided by the U.S. Coast Guard to estimate kW-hrs per vessel. As Table 4-103 indicates, approximately 95 percent of activity is related to cutter operations and 5 percent is associated with the smaller boats. The Coast Guard data also included general information about where the vessels operated; for the 2014 NEI inventory, each vessel's kW-hrs were associated with the area of operation and summarized in Table 4-104.

Table 4-103: Summary of Coast Guard underway activity

Vessel Type	Number of Vessels	Total kW-hrs
Cutter	267	2,125,794,310
Boats	652	117,895,003
Total	**919**	**2,243,689,313**

Table 4-104: General location of Coast Guard underway activities

Area	Total kW-hrs
Arkansas River	1,025,173
Atlantic	643,954,356
Elizabeth River	92,689,163
Great Lakes	53,675,432
Gulf	129,482,530
Illinois River	343,721
Lower Atchafalaya River	625,932
Mississippi River	3,349,678
Ohio River	1,276,438
Pacific	1,311,967,588

Area	Total kW-hrs
Puget Sound	3,793,450
Tennessee River	1,115,487
Willamette River	354,849
Lake Champlain	35,515
Total	**2,243,689,312**

As the vessel fleet roster quantified at sea hours of operation, an inquiry was sent to the Coast Guard to ask specifically about in-port activities for the cutters. The Coast Guard staff indicated that cutters generally use shore power whenever it is available. There are some instances where maintenance, testing, or training could necessitate the need to run on ship's power. Because of these exceptions, it is estimated that the time on ship's power is no more than 10 hours per 30 days of in-port time. This means that while in-port, a Coast Guard cutter is estimated to be on shore power "99% of the time" [ref 16]. As this response indicates, in-port ship activity is relatively small, so it was not included in this version of the NEI.

Note, currently the NEI does not include emission estimates from U.S. Naval exercises in U.S. waters. It is anticipated that data may be available in 2016 that will allow inclusion of these vessels.

Commercial Fishing

To obtain the most accurate survey of commercial fishing vessels operating in the United States, regional offices of the National Oceanic and Atmosphere Administration (NOAA) were contacted. Of the offices contacted, only Northeast, Southeast (including the Gulf of Mexico), West Coast, and Alaska provided data. Data for the Great Lakes, Puerto Rico, and the U.S. Virgin Islands were not obtained. Upon further research, it was found that fishing vessels in Puerto Rico and the Virgin Islands are almost all powered by small single engines, diesels too small to be considered C1 vessels or gasoline powered vessels not included in this inventory effort.

Due to confidentiality concerns, the responding NOAA regions were not able to provide specific vessel information. The Northeast [ref 17] and Southeast [ref 18] region provided the data on annual number of trips, vessel count, and days absent by port or county, which were used to estimate and spatially allocate annual hours of operation.

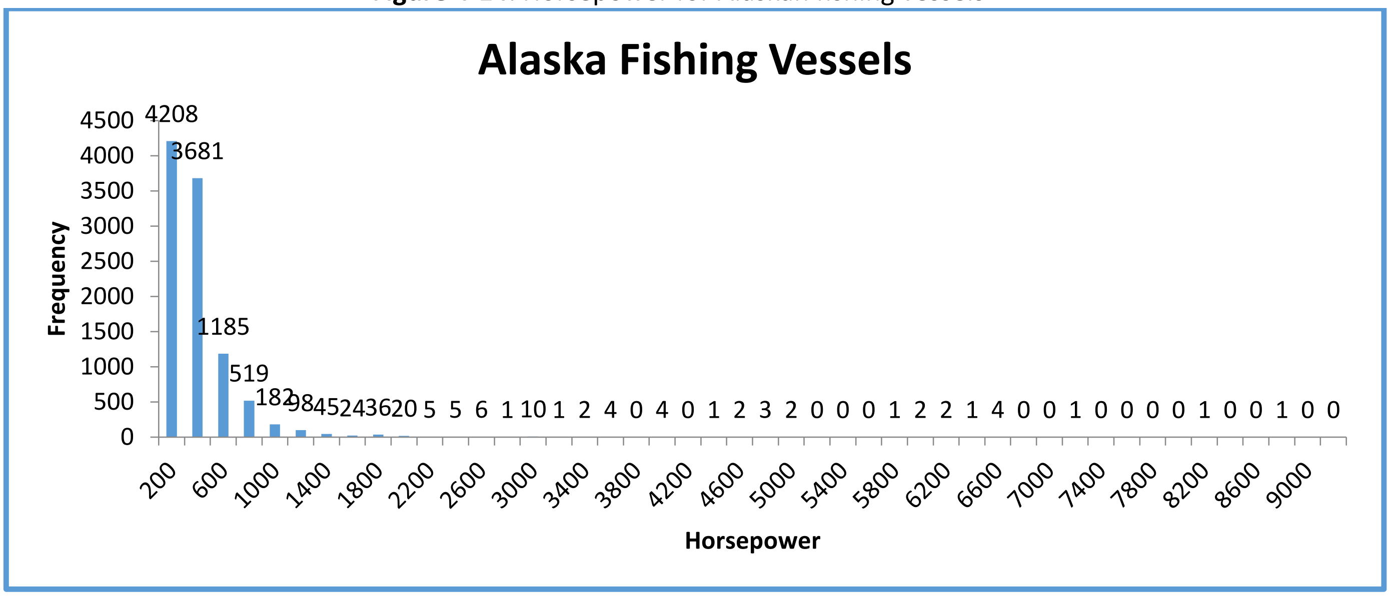
Data obtained from the West Coast regional office [ref 19] were not used in this inventory because the data provided only quantified the number of vessels operating and amount of fish caught by port. Data to quantify hours of operation were not provided. To gap fill the West Coast and the Great Lakes hours of operation, the NOAA website's commercial fishery landings by state [ref 20] were used to calculate a percent change between 2006 and 2013 commercial fish landings in pounds. It should be noted that data for 2014 was not available at the time, so 2013 data were used. Fishing vessel activity values in terms of kW-hrs developed in the original Category 1 and 2 Census Study [ref 14] for the West Coast and Great Lakes were extrapolated using the percent change summarized in Table 4-105.

Table 4-105: State fish landing data for Great Lakes and Pacific States

Year (lbs)	Great Lakes					Pacific				
	MI	MN	OH	WI	Total	CA	HI	OR	WA	Total
2006	9,350,764	308,409	4,241,973	4,449,476	18,350,622	341,660,769	26,020,904	282,846,344	241,606,439	892,134,456
2013	9,487,700	457,374	4,812,541	3,850,262	18,607,877	363,798,075	32,447,284	339,589,404	273,796,328	1,009,631,091
Percent Change	1.5	48.3	13.5	-13.5	1.4	6.5	24.7	20.1	13.3	13.2

It is expected that the Alaska fishing vessel activity data would be significant as it represents about half of the U.S. fish landings. But the NOAA data [ref 21] obtained from the Alaska region was problematic as it documented the fleet size to be 2,267 vessels, noting the average duration at-sea per trip was 3 days, but could not provide an estimate of the number of trips these vessels made. Data from the Alaska Commercial Fisheries Entry Commission (CFEC) website which tracked Alaskan fishing vessels for the year 2014 [ref 22] was used to evaluate the state's fishing fleet. The database included build date, horsepower rating, and duration at sea for 10,058 individual vessels. As seen in Figure 4-14, assessing the horsepower of the vessels included in the database revealed that many of the vessels had very small or had no kW ratings. It was uncertain whether these smaller vessels were powered by recreational gasoline marine engines.

Figure 4-14: Horsepower for Alaskan fishing vessels



For this version of the NEI, vessels in the CFEC with a rating of 400 horsepower or less were omitted, leaving 2,169 vessels with horsepower ratings between 402 and 8,800. A study of active commercial Alaskan fishing vessels implemented by the North Pacific Fishery Management Council estimated the commercial fishing vessel fleet operating in state and federal waters around Alaska to be 1,646 unique vessels [ref 23]. Unfortunately, vessel characteristics of the fleet were not included in the report. Therefore, the 2,169 larger vessels identified in the CFEC database were evaluated selecting the largest 1,646 vessels for inclusion into the 2014 NEI.

The days of operation for the vessels in the CFEC database seemed inflated and may indicate potential periods for operation, but not actual periods of operation. For example, many vessels were shown to operate year round, while most of the regulated fishing seasons in Alaska are restricted to the period from May to September [ref 24], which is about 150 days. The value of 3,600 hours per year (150 days/year x 24 hours = 3,600 hours) was used for Alaska vessels, which may over estimate emissions as it is assumed to be a maximum value for the fishing season. Future versions of the NEI marine vessel inventory should review available AIS data to better quantify Alaskan fishing vessel operations.

For the Northeast and Southeast regions where vessel power was not provided, an average fishing vessel kW power rating (1,000 kW) was obtained from the Category 1 and Category 2 Census [ref 14] to estimate kW-hrs.

For the Alaska regions, horsepower ratings were converted to kW ratings, and applied to the hours of operation to estimate kW-hrs.

Where fishing vessel in-port and underway activities were not distinguished, activity was split to 95% underway and 5% in-port based on the Category 1 and Category 2 Census [ref 14]. Underway activity was also divided between state and federal waters using percentages derived from data on commercial landings of fish and shellfish in the Pacific Ocean for 2013 [ref 20]; landings less than 3 miles from the coast were assumed to be in state waters and landings greater than 3 miles were assumed to be in federal waters. This approach will underestimate some states' activities such as Texas, Florida's Gulf coast, and Puerto Rico where the federal/state water boundary is 9 nautical miles.

It should be noted that additional study of fishing vessel activities is necessary to get a more accurate estimate of the fleet and its vessel characteristics and activity levels in Alaska, Pacific, and Great Lake Areas.

Ferries

The U.S. Department of Transportation's Bureau of Transportation Statistics maintains a database of ferry vessels and activity [ref 26]. This database includes ferry vessels characteristics by operator, trip segment, and terminal information. Individual vessels were linked to operators to develop operator fleet profiles which could be matched to trip segments. The operator fleet profiles included average vessel power and speed. The trip segments did not include travel distance or time information, so GIS tools were used to determine the distance between originating and destination terminals for each segment. During the process, duplicate trip segments were consolidated. Segment travel time was calculated using the segment distances and typical vessel speeds. Each segment had a season start date, as well as a count of trips. Total kW-hrs for each segment that an operator used were calculated using the following equation.

$$\text{kW-hrs} = (D_S / S_V) \times (SL \times [WT_V / 7]) \times kW_V$$

Where:

D_S	=	distance of segment S in nautical miles between the start and end ports
S_V	=	typical speed of vessel V in knots
SL	=	length of the ferry season in days
WT_V	=	number of trips made in a week for vessel V
kW_V	=	kW rating of main engines for vessel V

Offshore oil and gas support vessels:

For the purpose of this inventory, 2011 estimates for the offshore oil and gas support vessels operating in the Gulf of Mexico were obtained from the Bureau of Ocean Energy Management [ref 25]. These vessels include:

- Seismic survey vessels
- Crew boats
- Supply boats
- Drilling rigs
- Anchor handling tugs
- Offshore tugs
- Pipelaying vessels

The 2011 estimates were adjusted to 2014 based on changes in the Gulf of Mexico's annual crude oil production. BOEM anticipates that the 2014 Gulf of Mexico emission inventory will be available in later 2016.

4.19.3.4 *Engine operating loads*

Because the activity data used to develop the 2014 NEI did not include engine operating load data or actual vessel speeds, typical operating loads were compiled for each vessel type based on published reports. Initially engine operating load assumptions were taken from the EPA's Current Methodologies in Preparing Port Emission Inventories [ref 27]. This guidance document provided a typical cruising load factor of 0.83. Engine load data from the most recent IMO GHG study [ref 6] were also evaluated. The data in the IMO study included an assessment of bulk carriers, containerships, and tanker speed and engine loads, which accounted for the practice of slow steaming. The IMO data were weighed based on the fleet composition of the E&C data linked up to the IHS vessel characteristics, as provided in Table 4-106.

Table 4-106: IMO underway cruising vessel speed and engine load factors for bulk carriers, containerships, and tankers

Ship Type	Size Category	Size Units	Average at-sea Main Engine Load Factor (% MCR)	Percent of Total Pop.	Engine Load Weight Fraction	Weighted Load Factor
Bulk Carrier	0-9999	dwt	70	0.9	0.0062	0.5893
	10000-34999		59	25.1	0.1480	
	35000-59999		58	36.0	0.2089	
	60000-99999		60	31.7	0.1902	
	100000-199999		57	6.2	0.0353	
	200000+		62	0.1	0.0008	
Container	0-999	TEU	52	4.9	0.0257	0.3672
	1000-1999		45	11.8	0.0531	
	2000-2999		39	12.5	0.0489	
	3000-4999		36	32.8	0.1181	
	5000-7999		32	28.6	0.0915	
	8000-11999		32	9.0	0.0288	
	12000-14500		34	0.3	0.0011	
	14500+		28	0.0	0.0000	
Oil Tanker	0-4999	dwt	67	0.1	0.0009	0.5158
	5000-9999		49	0.3	0.0013	
	10000-19999		49	0.0	0.0000	
	20000-59999		55	3.6	0.0196	
	60000-79999		57	15.6	0.0889	
	80000-11999		51	43.4	0.2212	
	120000-199999		49	32.6	0.1595	
	200000+		54	4.5	0.0244	

dwt = dead weight tonnage; TEU = twenty foot equivalent units

Load factors for RSZ were developed based on vessel speed which was either the maximum speed of the RSZ or the cruising speed of the vessel, which ever value was the smaller. The vessel speed was used in conjunction with the vessel's maximum speed and the propeller rule to estimate the propulsion engine operating load while in the RSZ.

$$LF = (AS/MS)^3$$

Where:

LF = Load Factor (percent)

AS = Actual Speed (knots)
MS = Maximum Speed (knots)

Propulsion engine load factor for maneuvering was assumed to be 0.2, based on Entec's European emission inventory [ref 7]. It is recommended that future versions of this inventory consider reviewing AIS in port data to more accurately quantify maneuvering loads. It was also assumed that the auxiliary engines would be operating during maneuvering based on EPA port guidance [ref 27] as summarized in Table 4-107.

Table 4-107: Auxiliary operating loads

Vessel Types	Maneuver	Hotel
Bulk Carrier	0.45	0.1
Bulk Carrier, Laker	0.45	0.1
Buoy Tender	0.45	0.22
Container	0.48	0.19
Crude Oil Tanker	0.33	0.26
Drilling	0.45	0.22
Fishing	0.45	0.22
FPSO	0.45	0.22
General Cargo	0.45	0.22
Icebreaker	0.45	0.22
Jackup	0.45	0.22
LNG Tanker	0.33	0.26
LPG Tanker	0.33	0.26
Misc.	0.45	0.22
Passenger	0.8	0.64
Pipelaying	0.45	0.22
Reefer	0.67	0.32
Research	0.45	0.22
RORO	0.45	0.26
Supply	0.45	0.22
Support	0.45	0.22
Tanker	0.33	0.26
Tug	0.45	0.22
Vehicle Carrier	0.45	0.22
Well Stimulation	0.45	0.22

While the vessel is dockside, it was assumed that propulsion engines would not be operating and the auxiliary engines were operating at the loads noted in Table 4-17. For vessels equipped with C 1 and C2 propulsion engines it was assumed that neither the propulsion nor the auxiliary engines would be operating while dockside to conserve fuel. This version of the NEI also did not include activity or emissions associated with boilers used to generate steam or to run cargo handling equipment and pumps.

4.19.3.5 *Emission factors and HAP speciation profiles*

Vessels equipped with Category 3 propulsion engines

As the dominant propulsion engine configuration for large Category 3 vessels is the slow speed diesel (SSD) engine, the following SSD emission factors were used for Category 3 propulsion engines. Medium speed diesel (MSD) emission factors were used for auxiliary engines associated with these larger vessels. For the 2014 inventory, it was assumed that Emission Control Area (ECA) compliant fuels were used while transiting U.S. waters. Emission factors for vessels equipped with Category 3 propulsion engines [ref 28] are presented in Table 4-108.

Table 4-108: Category 3 emission factors (g/kW-hrs)

Type	Engine	Fuel	NO_X	VOC_a	HC	CO	SO_2	CO_2	PM_{10}	$PM_{2.5\ b}$
SSD	Main	1% Sulfur	14.7	0.6318	0.6	1.4	3.62	588.86	0.45	0.42
MSD	Aux	1% Sulfur	12.1	0.4212	0.4	1.1	3.91	636.6	0.47	0.43

From: U.S. EPA/OTAQ, Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder, March 2008 [ref 28].

[a] Hydrocarbon (HC) was converted to VOC using a conversion factor of 1.053 as provided in [ref 28]

[b] $PM_{2.5}$ was assumed to be 97 percent of PM_{10} using [ref 28]

Note that this approach assumes that all large vessels will implement fuel switching before 2014 to comply with the 1% fuel sulfur standard, and use of controls such as scrubbing of high sulfur fuels, which is also an option to meet regulations, will be minimal.

If an engine load factor is less than 20 percent of the engine operating load, the emission factors were adjusted to account for operations outside the engines typical optimal load. For this 2014 inventory, these low load periods tend to occur during vessel movements in the RSZ. The low load adjustment factors used in this inventory were obtained from the EPA port guidance [ref 27] and are provided in Table 4-109.

Table 4-109: Calculated low load multiplicative adjustment factors

Load	NO_x	HC	CO	PM	SO_2	CO_2
1%	11.47	59.28	19.32	19.17	5.99	5.82
2%	4.63	21.18	9.68	7.29	3.36	3.28
3%	2.92	11.68	6.46	4.33	2.49	2.44
4%	2.21	7.71	4.86	3.09	2.05	2.01
5%	1.83	5.61	3.89	2.44	1.79	1.76
6%	1.60	4.35	3.25	2.04	1.61	1.59
7%	1.45	3.52	2.79	1.79	1.49	1.47
8%	1.35	2.95	2.45	1.61	1.39	1.38
9%	1.27	2.52	2.18	1.48	1.32	1.31
10%	1.22	2.20	1.96	1.38	1.26	1.25
11%	1.17	1.96	1.79	1.30	1.21	1.21
12%	1.14	1.76	1.64	1.24	1.18	1.17
13%	1.11	1.60	1.52	1.19	1.14	1.14
14%	1.08	1.47	1.41	1.15	1.11	1.11
15%	1.06	1.36	1.32	1.11	1.09	1.08
16%	1.05	1.26	1.24	1.08	1.07	1.06
17%	1.03	1.18	1.17	1.06	1.05	1.04
18%	1.02	1.11	1.11	1.04	1.03	1.03
19%	1.01	1.05	1.05	1.02	1.01	1.01
20%	1.00	1.00	1.00	1.00	1.00	1.00

Vessels equipped with Category 1 / Category 2 propulsion engine

Activity data for smaller vessels equipped with C1 and C2 engines are aggregated together, therefore Category 2 emission factors (Table 4-110) were used for these vessels as these factors tended to provide more conservative emission estimates.

Table 4-110: Tier emission factors for vessels equipped with Category 2 propulsion engines (g/kW-hrs)

Tier	PM_{10}	NO_x	HC	CO	VOC [a]	PM_{25} [b]	SO_2	CO_2
0	0.32	13.36	0.134	2.48	0.141102	0.3104	0.006	648.16
1	0.32	10.55	0.134	2.48	0.141102	0.3104	0.006	648.16
2	0.32	8.33	0.134	2.00	0.141102	0.3104	0.006	648.16
3	0.11	5.97	0.07	2.00	0.073710	0.1067	0.006	648.16

From: U.S. EPA/OTAQ, Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters per Cylinder, March 2008 [ref 28].

[a] HC was converted to VOC using a conversion factor of 1.053 as provided in the above reference.

[b] $PM_{2.5}$ was assumed to be 97 percent of PM_{10} using the above reference.

The Tier emission factors noted in Table 4-111 were weighted relative to the vessel type based on the year the vessel was manufactured. Table 4-112 shows the vessel age distribution by Tier.

Table 4-111: Vessel tier population by type for vessels equipped with C1 or C2 propulsion engines

Trip Count	Vessel Count	Vessel Type	Total*	Tier Level				Percent Tier			
				0	1	2	3	0	1	2	3
5,330	51	Bulk Carrier	51	46		5		90.2	0	9.8	0
932	23	Bulk Carrier, Laker	23	23				100	0	0	0
5	3	Buoy Tender	3	3				100	0	0	0
200	2	Container	2	2				100	0	0	0
2,421	25	Containership	25	22	3			88	12	0	0
140,767	426	Crewboat / Supply / Utility Vessel	425	298	37	87	3	70.1	8.7	20.5	0.7
7	5	Drilling	5	2		3		40	0	60	0
19,026	13	Excursion / Sightseeing Vessel	13	12		1		92.3	0	7.7	0
276	45	Fishing	45	43	2			95.6	4.4	0	0
29,660	153	General Cargo	152	93	11	48		61.2	7.2	31.6	0
8	2	Icebreaker	2	2				100	0	0	0
10	3	Jackup	3	2		1		66.7	0	33.3	0
8	2	LPG Tanker	2			2		0	0	100	0
247,369	35	Misc.	33	28	2	3		84.8	6.1	9.1	0
749	26	Passenger	26	24	1	1		92.3	3.8	3.8	0
4,666	18	Passenger Carrier	18	15	3			83.3	16.7	0	0
61	10	Pipelaying	10	10				100	0	0	0
344,540	1,626	Pushboat	1,625	1,348	43	214	20	83	2.6	13.2	1.2
63	12	Reefer	12	12				100	0	0	0
346	42	Research	42	35	1	6		83.3	2.4	14.3	0
1,771	19	RORO	19	17	1	1		89.5	5.3	5.3	0

Trip Count	Vessel Count	Vessel Type	Total*	Tier Level				Percent Tier			
				0	1	2	3	0	1	2	3
230	3	RO-RO Vessel	3	3				100	0	0	0
4,778	243	Supply	243	126	31	86		51.9	12.8	35.4	0
808	66	Support	66	28	7	31		42.4	10.6	47	0

Table 4-112: Vessel tier population by type for vessels equipped with C1 or C2 propulsion engines

Trip Count	Vessel Count	Vessel Type	Total*	Tier Level				Percent Tier			
				0	1	2	3	0	1	2	3
5553	102	Tanker	101	47	11	43		46.5	10.9	42.6	0
3962	336	Tug	336	286	13	35	2	85.1	3.9	10.4	0.6
14251	867	Tugboat	867	630	48	172	17	72.7	5.5	19.8	2
2	1	Well Stimulation	1	1				100	0	0	0
95606	4159	Total / Average Percent Tier	4,153	3,158	214	739	42	76	5.2	17.8	1

Note this approach does not account for early introduction of controls by vessel operators, compliance with more stringent local standards, or participation in voluntary emission reduction programs such as California's Carl Moyer Program or the Texas Emission Reduction Plan (TERP).

Hazardous air pollutant emissions were estimated by applying speciation profiles (Appendix F, ref 4) to the VOC estimates for organic HAPs and PM estimates for metal HAPs using the following equation:

$$E = A \times SF$$

Where:

E	=	Annual emissions for HAP (tons)
A	=	Annual emissions for speciation base (tons)
SF	=	Speciation factor (unit less fraction)

Emission Summaries

Based on the approach documented above, Table 4-113 summarizes activity and emissions by vessel propulsion engine category and mode. Table 4-114 also summaries emissions by vessel type.

Table 4-113: 2014 EPA-estimated vessel activity (kW-hrs) and emissions (tons) by propulsion engine and mode

Category	Source	SCC	Mode	Total Activity (kW-hr)	NO_X	PM_{10}	PM_{25}	SO_2	VOC
Cat1/2	E&C	2280002100	Maneuvering	742,228,543	1,179	44	40	333	39
Cat1/2	E&C	2280002200	Cruising	945,222,365	9,648	255	247	5	113
Cat1/2	Misc-C1/C2	2280002100	Maneuvering	4,086,763,051	11,316	285	276	5	126
Cat1/2	Misc-C1/C2	2280002200	Cruising	13,348,660,561	336,909	10,409	10,097	2,258	5,785
Cat1/2	WBD	2280002100	Maneuvering	2,090,680,129	5,754	147	143	3	65
Cat1/2	WBD	2280002200	Cruising	19,795,947,087	196,657	5,049	4,898	94	2,228
Cat3	E&C	2280003100	Dock	27,735,673,393	39,098	1,540	1,409	12,665	1,503
Cat3	E&C	2280003100	Maneuvering	7,217,499,394	6,568	216	200	1,758	267

Category	Source	SCC	Mode	Total Activity (kW-hr)	NO_X	PM_{10}	PM_{25}	SO_2	VOC
Cat3	E&C	2280003200	Cruising	64,474,040,733	586,555	17,956	16,759	144,444	25,210
Cat3	E&C	2280003200	Reduced Speed Zone	7,055,981,077	22,034	713	666	5,492	1,319
			Total	**147,492,696,332**	**1,215,718**	**36,614**	**34,735**	**167,058**	**36,654**

Note: Misc C1/C2 includes: Coast Guard, dredging, ferries, fishing, offshore oil & gas support, and research.

Table 4-114: 2014 EPA CMV emissions by vessel type

Vessel Type	Total Activity (kW-hr)	NO_X	PM_{10}	PM_{25}	SO_2	VOC
Bulk Carrier	16,502,188,704	108,528	3,278	3,070	23,396	4,264
Bulk Carrier, Laker	591,085,436	4,349	129	121	865	161
Buoy Tender	2,647,731	32	1	1	0	0
Coast Guard	2,150,964,635	26,292	630	611	12	278
Containership	53,193,329,151	220,943	6,808	6,359	50,912	9,048
Dredging	1,041,726,442	12,273	294	285	5	130
Excursion / Sightseeing Vessel	4,319,972	50	1	1	0	1
Ferries	5,641,357,376	32,678	825	800	16	365
Fishing	6,585,566,278	76,606	1,852	1,797	34	817
General Cargo	4,462,901,347	36,436	1,126	1,052	8,522	1,472
Misc	1,101,196,066	4,247	108	105	53	53
Offshore Oil & Gas*	669,380,168	182,540	6,653	6,454	2,188	4,128
Passenger	11,886,827,285	123,561	3,835	3,576	30,586	5,254
Reefer	1,082,375,467	9,645	303	282	2,425	406
Research	2,015,808,882	22,507	573	556	11	253
RO-RO	2,369,916,464	20,995	574	547	1,998	469
Tanker, Crude Oil	7,192,697,038	42,670	1,329	1,238	10,710	1,819
Tanker, LNG/LPG	1,461,972,434	13,291	412	384	3,314	567
Tanker, Misc	14,088,889,926	121,580	3,725	3,508	22,470	4,221
Tug	11,197,514,271	119,306	3,005	2,913	250	1,343
Vehicle Carrier	4,250,031,261	37,187	1,154	1,076	9,291	1,608
Total	**147,492,696,332**	**1,215,718**	**36,614**	**34,735**	**167,058**	**36,654**

* Note: Some Offshore Oil & Gas emissions were derived from the BOEM Emission Inventory which did not include activity data.

4.19.3.6 *Allocation of port and underway emissions*

Ports and underway activity and emissions are summarized in Table 4-115. Note that in this version of the marine vessel component of the NEI, auxiliary emissions for underway operations were considered less significant than other modes and were not included in this version of the NEI marine vessel inventory, such that actual underway emissions may be slightly higher than the values presented in Table 4-115.

Table 4-115: 2014 vessel activity (kW-hrs) and EPA emissions (tons) by propulsion engine and SCC

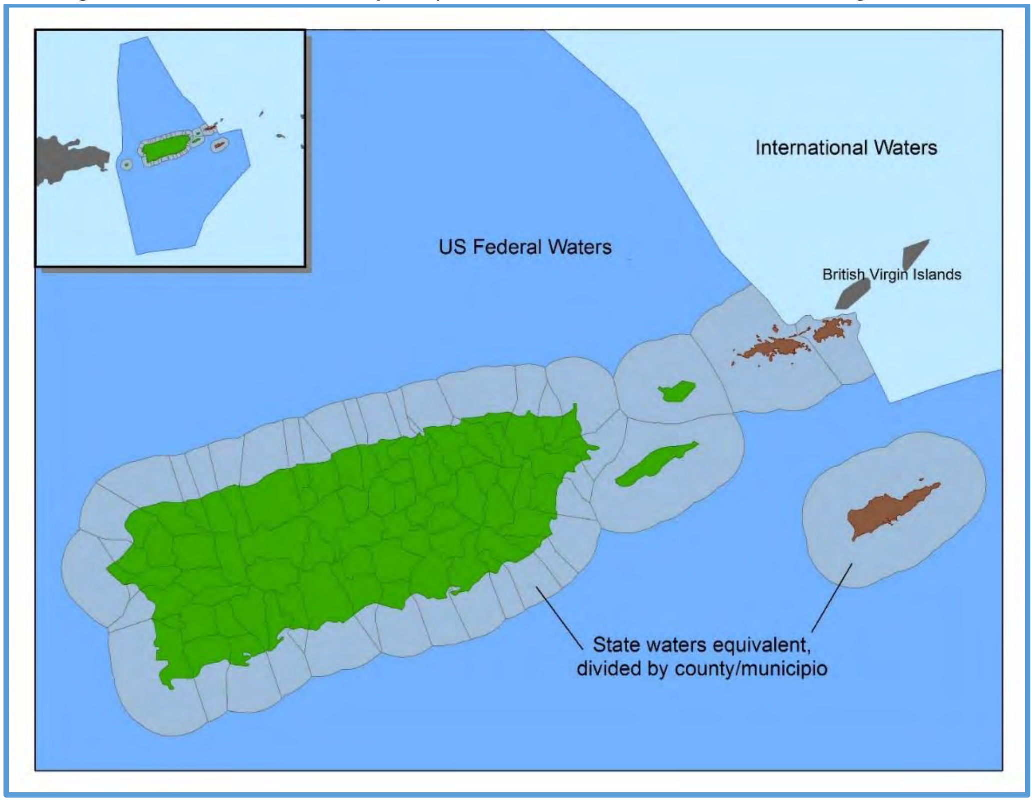
SCC Description	SCC	Total Activity (kW-hr)	NO_X	PM_{10}	PM_{25}	SO_2	VOC
Diesel Port	2280002100	6,919,671,722	18,250	476	459	341	230
Diesel Underway	2280002200	34,089,830,013	543,214	15,713	15,242	2,357	8,125
Residual Port	2280003100	34,953,172,787	45,666	1,756	1,609	14,423	1,770
Residual Underway	2280003200	71,530,021,810	608,589	18,669	17,425	149,936	26,529
Total		**147,492,696,332**	**1,215,718**	**36,614**	**34,735**	**167,058**	**36,654**

EPA has continued to develop and improve port shapes using a variety of resources. First, GIS data or maps provided directly from the ports were used to delineate port boundaries. Next, maps or port descriptions from local port authorities and port districts were used in combination with existing GIS data to identify port boundaries. Finally, satellite imagery from tools such as Google Earth and street layers from StreetMap USA were used to delineate port areas. Originally, primary emphasis was placed on mapping the 117 ports with C3 vessel activity using available shapefiles of the port area. As the availability of C1 and C2 activity improved, additional port shapes were required to represent their emissions. The NEI port shapefiles were revised to include 114 additional ports from the 2014 inventory. Further revisions over the years have increased the count of the current 5,649 port shapes for the 2014 inventory.

In all cases, port shapes were split by county boundary, such that no shape crosses county lines, to facilitate totaling of emissions to the state or county level. Each port shape was identified by the port name and state and county FIPS in addition to a unique Shape ID. In most cases, port shapes were created on land bordering waterways and coastal areas. However, the additional port shapes created in this effort were generated as small circles with a radius of 0.25 miles that cover both land and water. Additionally, activity data such as Automatic Identification System (AIS) indicated that vessels frequently have maneuvering/hoteling activities further offshore than previously anticipated. As such, the underway shapes were duplicated, given new IDs, and added to the port shapefile to provide a place to put these activities if state or local agencies wish to include them.

Underway shapes remain unchanged with the exception of new shapes added to represent state and federal waters around Puerto Rico and the U.S. Virgin Islands as shown in Figure 4-15.

Figure 4-15: New underway shapes for Puerto Rico and the U.S. Virgin Islands



Spatial allocation of the activity data varied by data source. Port activity was allocated to the origin and destination port shapes. E&C data and the WCD were routed along a waterway network, then the routes were intersected with EPA's shapefiles shipping lanes for NEI. For the E&C data, underway activity for each vessel trip was divided among the NEI shapes based on the portion of the route that passed through each shape. The length of the waterway segment passing through each shape was divided by the total trip length to calculate the percentage of the trip's activity to assign to each shape.

$$V = (L/T)* A$$

Where:

V = Activity for shape V
L = Length of waterway segment within shape V
T = Total trip length
A = Total trip activity

For WCD, hoteling and maneuvering activity was allocated to the nearest water-based port shapes for each origin and destination. For underway activity, the length of the waterway through each shape was calculated and multiplied by the number of trips in that shape. This value was divided by the national total for trips multiplied by length to determine the percentage of the national total activity to allocate to each shape.

$$P = (T * L)/(NT*NL)$$

Where:

P = Percentage of national activity

T = Total trips for the NEI underway shape
L = Waterway segment length within underway shape
NT = National trip total
LN = National waterway network length total

Offshore oil and gas support vessel data derived from AIS data used by BOEM was limited to federal waters and was assigned to the associated shape, though the more refined activity can be seen in Figure 4-16. Research vessel activity was allocated to shapes based on the spatial allocation from the Category 1 and Category 2 Census [ref 14]. Dredging activities were spatially apportioned to ship channels based on the job name. The job names indicated general location, such as a bay area or a waterway portion; however, they did not provide sufficient information to precisely locate the dredging activities or even extent of the project. Best effort was given to identify the waterway segments in GIS that most closely match the limited location information. Ferry activity was split to 65% port and 35% underway, and all terminals were mapped using the coordinates available in the National Census of Ferry Operators [ref 26]. Activity was then allocated to the port or underway shape nearest each ferry terminal. The underway spatial allocation can be seen in Figure 4-17. U.S. Coast Guard activity was provided by region, NEI shapes in each region were identified, and underway activity was allocated to individual shapes as a fraction of the total region's area as shown in Figure 4-18.

Figure 4-16: Spatial allocation of 2014 support vessel activity

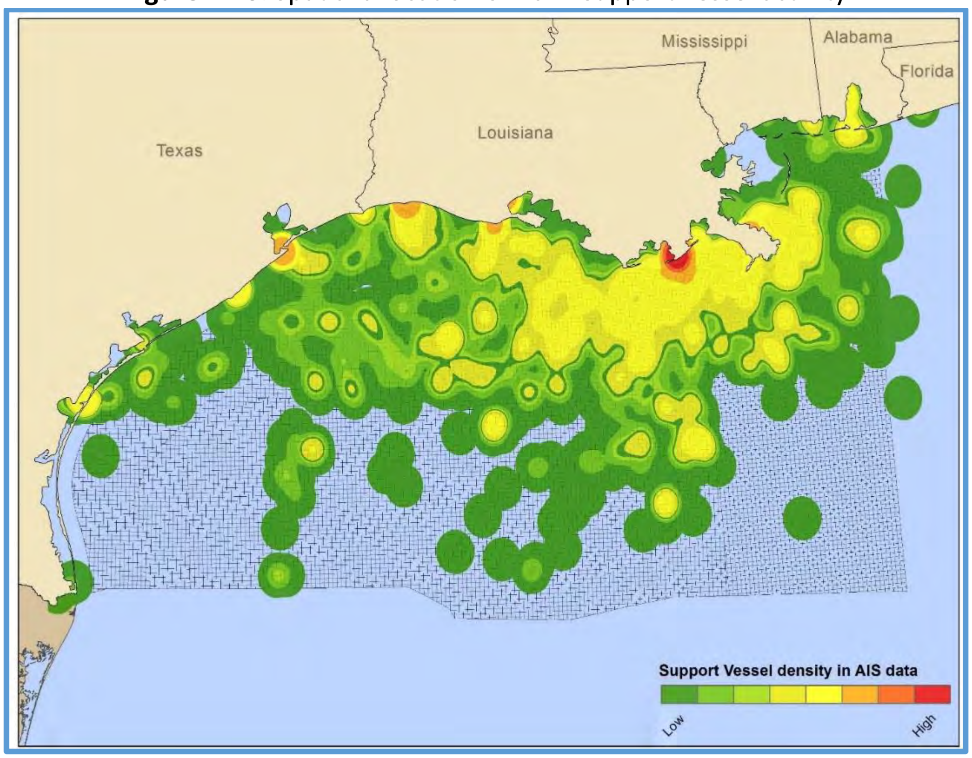


Figure 4-17: Spatial allocation of 2014 ferry activity

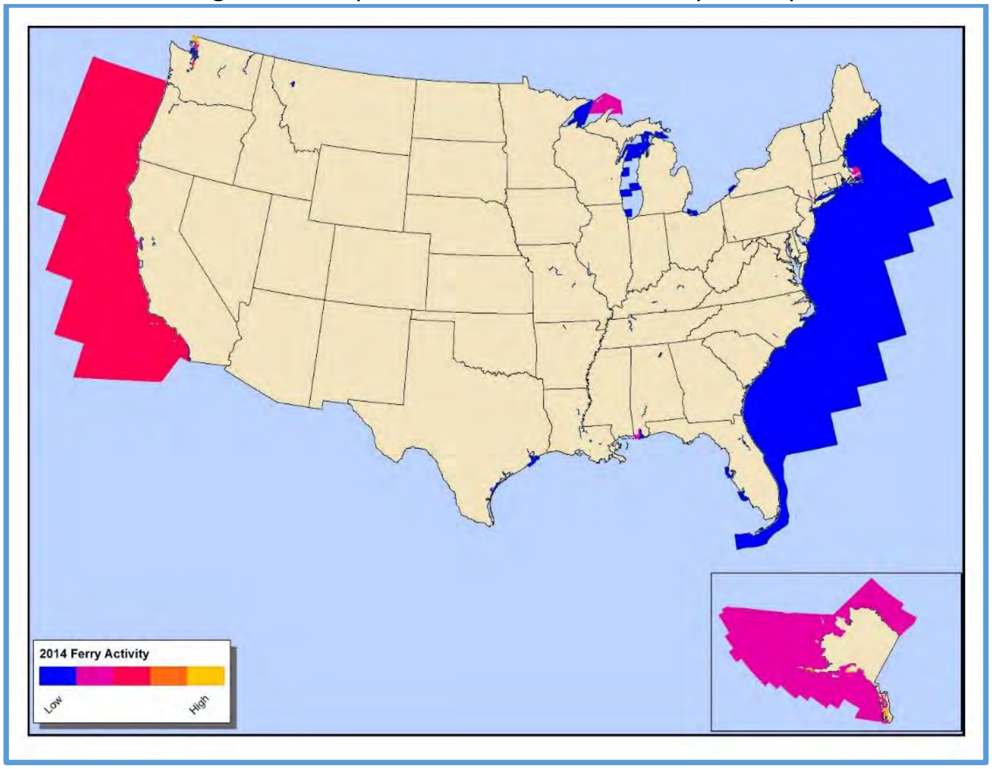
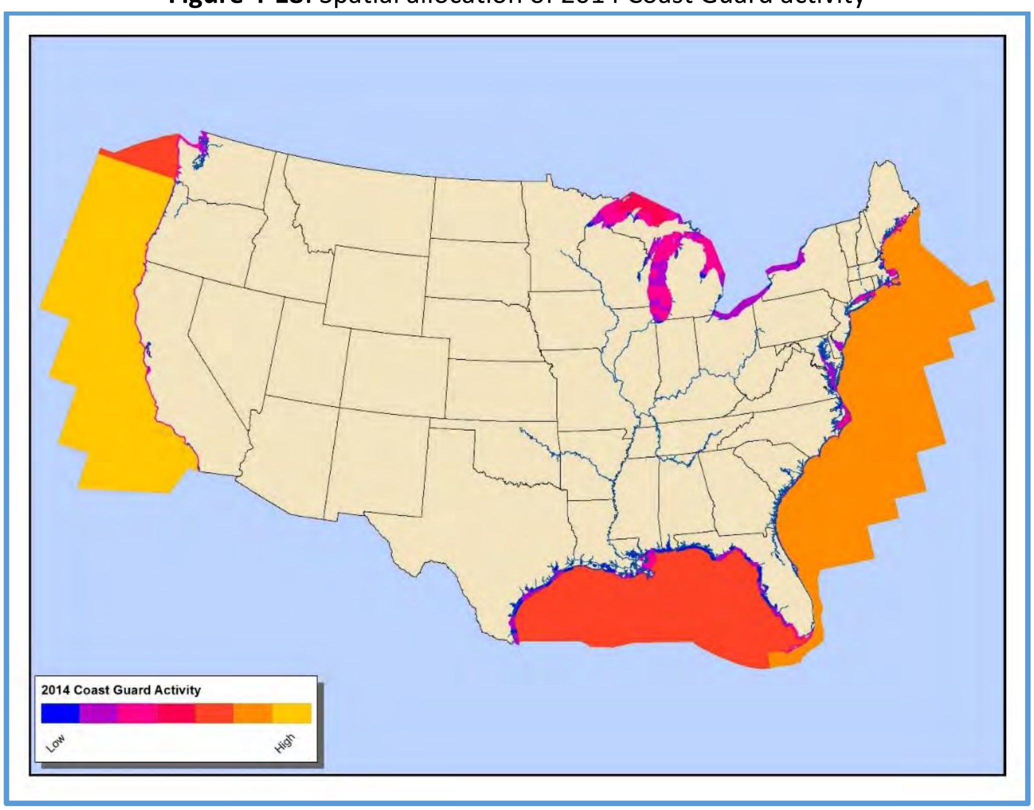


Figure 4-18: Spatial allocation of 2014 Coast Guard activity



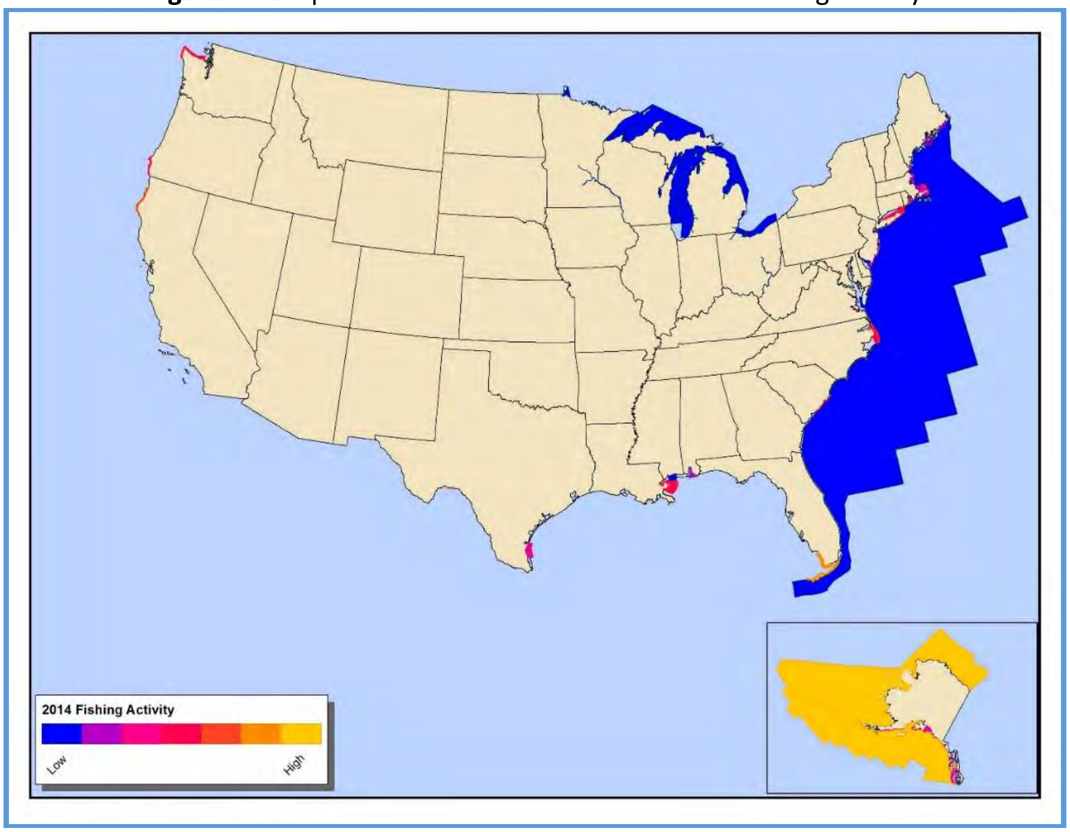
Fishing vessel activity was spatially allocated using different methods based on available regional data. Alaska fishing activity was spatially apportioned based on NOAA data that listed the number of catcher vessels by region for the Aleutian Islands, Western Alaska, Central Gulf of Alaska, and Eastern Gulf of Alaska as shown in Table 4-116. The NEI shapes were assigned to these regions in GIS, and then emissions were spatially allocated by region based on shape area.

Table 4-116: Alaska commercial fishing catcher vessel count

Area	Catcher Vessels	Percent
Aleutian Islands	494	23
Western Alaska	64	3
Central Gulf of Alaska	728	34
Eastern Gulf of Alaska	854	40

The Northeast NOAA data provided fishing activity by city or by state [ref 17]. Cities were mapped, and activity values were assigned to the nearest port and underway shape ID. In some cases, the city name was unknown, so the activity was divided between other known ports within that state proportionate to their activity values. For the southeast and the west coast, total activity was provided by state. Statewide activity was divided as 95% underway and 5% in-port and then allocated to shapes based on the previous fishing allocation in the Category 1 and Category 2 Census [ref 14]. The final fishing allocation can be seen in Figure 4-19.

Figure 4-19: Spatial allocation of 2014 commercial fishing activity



4.19.3.7 *Summary of quality assurance methods for EPA-developed emissions*

- While developing the EPA 2014 marine vessel inventory, data quality checks were implemented at critical points; this included comparison with earlier data sets used to develop the C1 and C2 inventory, published emission factors, and previous NEI emission estimates for all engine categories.
- All calculations were checked by experience staff members of the team.

- During data transfers into the project database, quality assurance checks were implemented and data summary tables generated to ensure that no corrupted data were transferred and the record count was consistent with the transfer.
- All assumptions were documented and discussed with team members to ensure that the assumptions were reasonable and consistent with other known data points.
- Microsoft Access data queries were documented and reviewed by experience staff who were not directly involved in developing the current databases.
- GIS imagery were reviewed to identify any spatial anomalies in the data.
- Where anomalies were found during these checks, additional research was implemented to determine whether the identified issue was correct or whether there was an error in developing the estimate.

EPA compared shape-, state-, and county-level sums in (1) EPA default data, (2) state/local/tribal (S/L/T) agency submittals, and (3) the resultant 2011 NEI selection by:

- Pollutants, SCCs, and SCC-emission types
- Emissions summed to agency and SCC level.

4.19.4 Summary of quality assurance between EPA and S/L/T submittals

- Submitted EPA estimates were compared to EPA's. In particular, these checks were performed: Shape files used. Because CMV estimates must be allocated to port and underway GIS polygons (shape files), it was important to check for potentially erroneous double counting where EPA and states used different shapes. Where necessary, EPA estimates were tagged, for example in Texas where the state provided all emissions to be included in the NEI. In other areas, like Washington, only certain ports had been studied and provided and thus EPA estimates in other areas were used.
- Reasonableness comparisons of pollutant totals. This check led to replacing California's provided HAPs with EPA-augmented ones.
- Individual pollutants compared to pollutant groups to avoid including both.
- Where HAPs were not submitted, HAP-Aug was applied to estimate HAPs from submitted criteria pollutants.
- Chromium compounds were split into hex- and tri-valent chromium.
- Missing criteria estimates. This check found that California did not provide NH_3 for all processes. In these cases, EPA NH_3 records are used in the NEI if they exist for the same processes.

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4.20 Mobile - Locomotives (Nonpoint)

This section documents locomotives (rail) emissions in the nonpoint data category. For information on rail yard emissions in the point data category, refer to Section 3.3.

4.20.1 Sector description

The locomotive sector includes railroad locomotives powered by diesel-electric engines. A diesel-electric locomotive uses 2-stroke or 4-stroke diesel engines and an alternator or a generator to produce the electricity required to power its traction motors. The locomotive source category is further divided up into categories: Class I line haul, Class II/III line haul, Passenger, Commuter, and Yard. Table 4-117 below indicates locomotive SCCs and whether EPA estimated emissions. If EPA did not estimate the emissions, then all emissions from that SCC that appear in the inventory are from S/L/T agencies.

Table 4-117: Locomotives SCCs, descriptions and EPA estimation status

SCC	Description	EPA Estimated?	Data Category
2285002006	Mobile Sources; Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	Yes – in shape files	Nonpoint
2285002007	Mobile Sources; Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	Yes-in shape files	Nonpoint
2285002008	Mobile Sources; Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	No	Nonpoint
2285002009	Mobile Sources; Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	No	Nonpoint
2285002010	Mobile Sources; Railroad Equipment; Diesel; Yard Locomotives	No	Nonpoint
28500201	Internal Combustion Engines; Railroad Equipment; Diesel; Yard Locomotives	Yes – as point sources	Point

4.20.2 Sources of data

The nonpoint component of this source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. The state agencies listed in Table 4-118 submitted at least $PM_{2.5}$, NO_X and VOC emissions; agencies not listed used EPA estimates for all CMV sources. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-118: Percentage of locomotives $PM_{2.5}$, NO_X and VOC emissions submitted by reporting agency

Region	Agency	S/L/T	$PM_{2.5}$	NO_X	VOC
1	Massachusetts Department of Environmental Protection	State	70	67	69
3	Maryland Department of the Environment	State	95	94	95

Region	Agency	S/L/T	$PM_{2.5}$	NO_X	VOC
3	Virginia Department of Environmental Quality	State	4	4	4
4	North Carolina Department of Environment and Natural Resources	State	6	5	6
5	Illinois Environmental Protection Agency	State	100	100	100
6	Texas Commission on Environmental Quality	State	100	100	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100	100	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	100	100	100
9	California Air Resources Board	State	98	98	99
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	100	100	100
9	Washoe County Health District	Local	100	100	100
10	Alaska Department of Environmental Conservation	State	58	54	62
10	Washington State Department of Ecology	State	91	91	92

4.20.3 EPA-developed emissions for nonpoint locomotives

EPA used EPA's 2011 national rail estimates for 2014 v1. They were not adjusted by growth, nor were 2011 submitted estimates included. The EPA 2011 rail estimates were developed by applying growth factors to the 2008NEI values based on railroad freight traffic data from the 2008 and 2011 R-1 reports submitted by all Class I rail lines to the Surface Transportation Board and employment statistics from the American Short Lines and Regional Railroad Association for class II and III. For more information on the development of the 2008 and 2011 EPA estimates, refer to the 2008 NEI Documentation and 2011 NEI Documentation web pages available here: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. The emissions were allocated to line haul shape IDs and yard locations based on 2008 allocations.

4.20.3.1 *Hazardous Air Pollutant Emissions Estimates*

HAP emissions were estimated by applying speciation profiles to the VOC or PM estimates. Because California uses low sulfur diesel fuel and emission factors specific for California railroad fuels were available, calculations of California's emissions were done separately from the other reporting agencies. HAP estimates were calculated at the yard and link level, after the criteria emissions had been allocated. Where submitting agencies did not supply HAPs, those estimates were also derived via this VOC/PM speciation method.

4.20.4 Summary of quality assurance

EPA and S/L/T agency-submitted values were compared to find instances where:

- Point and nonpoint rail yard SCCs may duplicate. This occurs when agencies submitted nonpoint in the same counties where EPA had point yards. In this case, EPA point yard records were tagged.
- Different shapes within a county were used by EPA and agencies. These were reviewed by agencies and corrected as needed to avoid double counting.
- Different variations of the same pollutant were used by agencies and EPA. For instance, individual xylenes versus mixed xylene compounds. When agencies submitted total chromium, the value was apportioned to hex- and trivalent chromium
- Suspiciously high or low emissions. As advised by California, all CA HAPs were tagged and EPA values used instead.

4.21 Solvent – Consumer & Commercial Solvent Use: Agricultural Pesticides

There are three sections in this documentation that discuss nonpoint sources of Consumer and Commercial Solvent Use. This section discusses agricultural pesticides; the following section discusses asphalt paving, and the third section discusses all other Solvent sources, including the remaining sources in the Consumer and Commercial Solvent Use sector. The reason these sources are broken up within this EIS sector is because the EPA methodologies for estimating the emissions are different.

4.21.1 Source category description

While Agricultural Pesticide Application is part of Consumer and Commercial Solvents sector, the nature of its methodology is significantly different from most of the other sources in this sector. Pesticides are substances used to control nuisance species and can be classified by targeted pest group: weeds (herbicides), insects (insecticides), fungi (fungicides), and rodents (rodenticides). They can be further described by their chemical characteristics: synthetics, non-synthetics (petroleum products), and inorganics. Different pesticides are made through various combinations of the pest-killing material, also called the active ingredient (AI), and various solvents (which serve as carriers for the AI). Both types of ingredients contain volatile organic compounds (VOC) that may be emitted to the air during application or after application as a result of evaporation [ref 1].

4.21.2 Sources of data

As seen in Table 4-119, this source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. EPA estimates emissions for only Agricultural application (SCC=2461850000). New Jersey and Maryland also reported emissions for Surface Application (2461800001) and Maryland also reported estimates for Soil Incorporation (2461800002). The leading SCC description is "Solvent Utilization; Miscellaneous Non-industrial: Commercial" for all SCCs.

Table 4-119: Agricultural Pesticide Application SCCs estimated by EPA and S/L/Ts

SCC	Description	EPA	State	Local	Tribe
2461800001	Pesticide Application: All Processes; Surface Application		X		
2461800002	Pesticide Application: All Processes; Soil Incorporation		X		
2461850000	Pesticide Application: Agricultural; All Processes	X	X		X

The agencies listed in Table 4-120 submitted 100% of their VOC emissions for agricultural pesticide application; agencies not listed used EPA estimates for the entire sector.

Table 4-120: Percentage of Agricultural Pesticide Application VOC emissions submitted by reporting agency

Region	Agency	S/L/T	VOC
1	New Hampshire Department of Environmental Services	State	100
2	New Jersey Department of Environment Protection	State	100
5	Illinois Environmental Protection Agency	State	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100
9	California Air Resources Board	State	100
10	Coeur d'Alene Tribe	Tribe	100
10	Idaho Department of Environmental Quality	State	100
10	Kootenai Tribe of Idaho	Tribe	100
10	Nez Perce Tribe	Tribe	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100

4.21.3 EPA-developed emissions for agricultural pesticide application

This is the first time that EPA has provided estimates for this source category; therefore, these emissions are new for the 2014 NEI, and were not covered on a national basis for previous inventory years. Members of the NOMAD Committee (Idaho and Texas) were instrumental in developing this methodology. An inventory developer in Idaho developed the method, based on one used in Idaho for many years. An inventory developer from TCEQ (TX) then created a tool in MS Access, and also provided instructions, which makes the method easy to use for all reporting agencies.

Approximately 68 to 75 percent of pesticides used in the United States are applied to agricultural lands, both cropland and pasture. Agricultural pesticides continue to be a cost-effective means of controlling weeds, insects, and other threats to the quality and yield of food production. Since application rates for a particular pesticide may vary from region to region, the regional application rates should be considered when estimating potential VOC emissions.

4.21.3.1 *Emission factors*

The VOC emission factor is derived for each active ingredient based on the pesticide profiles database maintained by the California Department of Pesticide Regulation [ref 2]. The California Department of Pesticide Regulation's (CA DPR) database contains the chemical formulation for pesticides registered in the State of California and provides key inputs for the development of VOC emission factors. These key inputs include mass fraction of each active ingredient and the emission potential (EP) of registered pesticide products. The EP value represents the VOC content of the pesticide product and it is determined empirically through thermogravimetric analysis (TGA). Because the CA DPR database lists both agricultural and non-agricultural pesticide products, it was necessary to screen out entries that were likely formulated as a consumer product. Pesticide products that contained terms suggesting non-agricultural applications were excluded. Terms used to screen out likely consumer products are listed in Table 4-121.

Table 4-121: Terms used to screen out consumer products

ALGAE	DEODORIZING	GERM	MRSA	STAIN
ANT	DETERGENT	HAMSTER	ORNAMENTAL	SWIM
BATHROOM	DISHWASHER	HOME	POND	TICK
BEDBUG	DISINFECT	HORNET	POTTY	TURF
BEE	DOG	HORSE	PRESCRIPTION	WASP
CAT	DRAIN	HOUSE	RAT	WIPES
CATTLE	EQUINE	INDOOR	ROACH	YARD
CLEANER	FLEA	KLEEN	RODENTICIDE	
DECK	FLY	LANDSCAPE	ROOF	
DEGREASER	FOGGER	LAWN	SANI	
DEODORIZER	GERBIL	MOUSE	SPA	

Each record in the DPR database is for a specific pesticide product, and provides product name, primary active ingredient, the mass percent of active ingredient, emission potential (EP), registration number, and method used to estimate the EP. The pesticide specific EP of reactive organic gases (i.e., the mass percentage of product that contributes to VOC emissions) and the mass percent of active ingredient were used to calculate pesticide-specific VOC emission factors.

$$EF_{pesticide} = 1/(AI\%/100) \times (EP_{rog}/100)$$

where:

$EF_{pesticide}$ = pesticide-specific emissions factor (lb VOC / lb AI)
AI% = average mass percent of active ingredient in pesticide
EP_{rog} = emissions potential of reactive organic gases (expressed as % of pesticide mass)

For active ingredients not in the DPR database, a weighted average emission factor (EF_{avg}) was calculated. This weighted average was estimated by weighting the emission factors from the DPR database using the total pounds of active ingredient reported in the USGS report "Estimated Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2008-2012" [ref 3]. A crosswalk between compound name in the USGS database and the chemical name in the CA DPR database is provided in Table 4-122.

$$EF_{avg} = \Sigma_{pesticides}(EF_{pesticide} \times AI/T)$$

where:

EF_{avg} = average emissions factor (lb VOC / lb AI)
$EF_{pesticide}$ = pesticide-specific emissions factor (lb VOC / lb AI)
AI = active ingredient applied (lb)
T = total mass of all active ingredients applied (lb)

This resulted in an EF_{avg} value of 0.4 pounds of VOC per pound of active ingredient. The VOC emission factors by active ingredient are shown in Table 4-123.

For the estimation of HAP emissions, a variation of the EIIP's preferred method (9-4.1) based on vapor pressure of the active ingredient was implemented. The subset of HAPs was extracted from the list of active ingredients and is shown in Table 4-124 along with the HAP emission factors. Note that these HAPs are also VOCs and are therefore included in the pesticide-specific VOC emission factors calculated above.

The HAP emissions are based on the quantity of active ingredient applied and are estimated as follows:

$$E_{HAP} = AI \times EF_{HAP}$$

where:

E_{HAP} = HAP emissions from pesticide active ingredient applications in pounds;
EF_{HAP} = emission factor in pounds of emission per pound of active ingredient from EIIP Table 9.4-4 based on vapor pressure of HAP. If the EIIP method resulted in HAP emissions exceeding VOC emissions, then the emissions factor was set to the pesticide-specific VOC emissions factor calculated above for total VOC emissions.

Table 4-122: Crosswalk between USGS compound name and CA DPR chemical name

USGS_Compound_Name	CA_DPR_chemname
2,4-D	2,4-D
2,4-DB	2,4-DB ACID
6-BENZYLADENINE	AVERAGE
ABAMECTIN	ABAMECTIN
ACEPHATE	ACEPHATE
ACEQUINOCYL	ACEQUINOCYL
ACETAMIPRID	ACETAMIPRID

USGS_Compound_Name	CA_DPR_chemname
ACETOCHLOR	AVERAGE
ACIBENZOLAR	ACIBENZOLAR-S-METHYL
ACIFLUORFEN	ACIFLUORFEN, SODIUM SALT
ALACHLOR	ALACHLOR
ALDICARB	ALDICARB
ALUMINUM PHOSPHIDE	ALUMINUM PHOSPHIDE
AMECTOCTRADIN	AMETOCTRADIN
AMETRYN	AMETRYNE
AMINOPYRALID	AMINOPYRALID, TRIISOPROPANOLAMINE SALT
ASULAM	ASULAM, SODIUM SALT
ATRAZINE	ATRAZINE
AVIGLYCINE	AVERAGE
AZADIRACHTIN	AZADIRACHTIN
AZINPHOS-METHYL	AZINPHOS-METHYL
AZOXYSTROBIN	AZOXYSTROBIN
BACILLUS AMYLOLIQUIFACIEN	BACILLUS AMYLOLIQUEFACIENS STRAIN D747
BACILLUS CEREUS	BACILLUS CEREUS, STRAIN BP01
BACILLUS FIRMUS	BACILLUS FIRMUS (STRAIN I-1582)
BACILLUS PUMILIS	BACILLUS PUMILUS GHA 180
BACILLUS SUBTILIS	BACILLUS SUBTILIS GB03
BACILLUS THURINGIENSIS	BACILLUS THURINGIENSIS (BERLINER)
BENFLURALIN	AVERAGE
BENOMYL	BENOMYL
BENSULFURON	BENSULFURON METHYL
BENSULIDE	BENSULIDE
BENTAZONE	BENTAZON, SODIUM SALT
BIFENAZATE	BIFENAZATE
BIFENTHRIN	BIFENTHRIN
BISPYRIBAC	BISPYRIBAC-SODIUM
BOSCALID	BOSCALID
BROMACIL	BROMACIL
BROMOXYNIL	BROMOXYNIL BUTYRATE
BUPROFEZIN	BUPROFEZIN
BUTRALIN	AVERAGE
CALCIUM POLYSULFIDE	AVERAGE
CAPTAN	CAPTAN
CARBARYL	CARBARYL
CARBOPHENOTHION	CARBOPHENOTHION
CARBOXIN	CARBOXIN
CARFENTRAZONE-ETHYL	CARFENTRAZONE-ETHYL
CHINOMETHIONAT	AVERAGE
CHLORANTRANILIPROLE	CHLORANTRANILIPROLE

USGS_Compound_Name	CA_DPR_chemname
CHLORETHOXYFOS	AVERAGE
CHLORFENAPYR	CHLORFENAPYR
CHLORIMURON	AVERAGE
CHLORMEQUAT	CHLORMEQUAT CHLORIDE
CHLORONEB	CHLORONEB
CHLOROPICRIN	CHLOROPICRIN
CHLOROPICRIN	CHLOROPICRIN
CHLOROPICRIN	CHLOROPICRIN
CHLOROPICRIN	CHLOROPICRIN
CHLOROPICRIN	CHLOROPICRIN
CHLOROTHALONIL	CHLOROTHALONIL
CHLORPROPHAM	CHLORPROPHAM
CHLORPYRIFOS	CHLORPYRIFOS
CHLORSULFURON	CHLORSULFURON
CLETHODIM	CLETHODIM
CLODINAFOP	AVERAGE
CLOFENTEZINE	CLOFENTEZINE
CLOMAZONE	CLOMAZONE
CLOPYRALID	CLOPYRALID
CLORANSULAM-METHYL	AVERAGE
CLOTHIANIDIN	CLOTHIANIDIN
CONIOTHYRIUM MINITANS	CONIOTHYRIUM MINITANS STRAIN CON/M/91-08
COPPER	COPPER
COPPER HYDROXIDE	COPPER HYDROXIDE
COPPER OCTANOATE	COPPER OCTANOATE
COPPER OXYCHLORIDE	COPPER OXYCHLORIDE
COPPER OXYCHLORIDE S	COPPER OXYCHLORIDE SULFATE
COPPER SULF TRIBASIC	COPPER SULFATE (BASIC)
COPPER SULFATE	COPPER SULFATE (PENTAHYDRATE)
CPPU	AVERAGE
CRYOLITE	CRYOLITE
CUPROUS OXIDE	COPPER OXIDE (OUS)
CYANAMIDE	AVERAGE
CYAZOFAMID	CYAZOFAMID
CYCLANILIDE	CYCLANILIDE
CYCLOATE	CYCLOATE
CYDIA POMONELLA	AVERAGE
CYFLUFENAMID	CYFLUFENAMID
CYFLUTHRIN	CYFLUTHRIN
CYHALOFOP	CYHALOFOP-BUTYL
CYHALOTHRIN-GAMMA	AVERAGE
CYHALOTHRIN-LAMBDA	AVERAGE

USGS_Compound_Name	CA_DPR_chemname
CYMOXANIL	CYMOXANIL
CYPERMETHRIN	CYPERMETHRIN
CYPROCONAZOLE	AVERAGE
CYPRODINIL	CYPRODINIL
CYROMAZINE	CYROMAZINE
CYTOKININ	CYTOKININ
DAMINOZIDE	DAMINOZIDE
DAZOMET	DAZOMET
DCPA	AVERAGE
DECAN-1-OL	AVERAGE
DELTAMETHRIN	DELTAMETHRIN
DESMEDIPHAM	DESMEDIPHAM
DIAZINON	DIAZINON
DICAMBA	DICAMBA
DICHLOBENIL	DICHLOBENIL
DICHLOROPROPENE	AVERAGE
DICHLORPROP	DICHLORPROP, BUTOXYETHANOL ESTER
DICLOFOP	DICLOFOP-METHYL
DICLORAN	DICLORAN
DICLOSULAM	AVERAGE
DICOFOL	DICOFOL
DICROTOPHOS	DICROTOPHOS
DIENOCHLOR	DIENOCHLOR
DIETHATYL	DIETHATYL-ETHYL
DIFENOCONAZOLE	DIFENOCONAZOLE
DIFLUBENZURON	DIFLUBENZURON
DIFLUFENZOPYR	DIFLUBENZURON
DIMETHENAMID	DIMETHENAMID-P
DIMETHENAMID-P	DIMETHENAMID-P
DIMETHIPIN	DIMETHIPIN
DIMETHOATE	DIMETHOATE
DIMETHOMORPH	DIMETHOMORPH
DIMETHYL DISULFIDE	AVERAGE
DINOSEB	DINOSEB
DINOTEFURAN	DINOTEFURAN
DIQUAT	DIQUAT DIBROMIDE
DISULFOTON	DISULFOTON
DITHIOPYR	DITHIOPYR
DIURON	DIURON
DODINE	DODINE
EMAMECTIN	EMAMECTIN BENZOATE
ENDOSULFAN	ENDOSULFAN

USGS_Compound_Name	CA_DPR_chemname
ENDOTHAL	ENDOTHALL, DISODIUM SALT
EPTC	EPTC
ESFENVALERATE	ESFENVALERATE
ETHALFLURALIN	ETHALFLURALIN
ETHEPHON	ETHEPHON
ETHION	ETHION
ETHOFUMESATE	ETHOFUMESATE
ETHOPROPHOS	ETHOPROP
ETOXAZOLE	ETOXAZOLE
ETRIDIAZOLE	AVERAGE
FAMOXADONE	AVERAGE
FATTY ALCOHOLS	AVERAGE
FENAMIDONE	FENAMIDONE
FENAMIPHOS	FENAMIPHOS
FENARIMOL	FENARIMOL
FENBUCONAZOLE	FENBUCONAZOLE
FENBUTATIN OXIDE	FENBUTATIN-OXIDE
FENHEXAMID	FENHEXAMID
FENOXAPROP	FENOXAPROP-ETHYL
FENOXYCARB	FENOXYCARB
FENPROPATHRIN	FENPROPATHRIN
FENPYROXIMATE	FENPYROXIMATE
FENTIN	FENTIN HYDROXIDE
FERBAM	FERBAM
FIPRONIL	FIPRONIL
FLAZASULFURON	FLAZASULFURON
FLONICAMID	FLONICAMID
FLORASULAM	FLORASULAM
FLUAZIFOP	FLUAZIFOP-BUTYL
FLUAZINAM	FLUAZINAM
FLUBENDIAMIDE	FLUBENDIAMIDE
FLUCARBAZONE	AVERAGE
FLUDIOXONIL	FLUDIOXONIL
FLUFENACET	AVERAGE
FLUMETRALIN	FLUOMETURON
FLUMETSULAM	AVERAGE
FLUMICLORAC	FLUMICLORAC-PENTYL
FLUMIOXAZIN	FLUMIOXAZIN
FLUOMETURON	FLUOMETURON
FLUOPICOLIDE	FLUOPICOLIDE
FLUOPYRAM	FLUOPYRAM
FLUOXASTROBIN	FLUOXASTROBIN

USGS_Compound_Name	CA_DPR_chemname
FLURIDONE	FLURIDONE
FLUROXYPYR	FLUROXYPYR
FLUTHIACET-METHYL	AVERAGE
FLUTOLANIL	FLUTOLANIL
FLUTRIAFOL	FLUTRIAFOL
FLUVALINATE-TAU	AVERAGE
FLUXAPYROXAD	FLUXAPYROXAD
FOMESAFEN	AVERAGE
FORAMSULFURON	FORAMSULFURON
FORMETANATE	FORMETANATE HYDROCHLORIDE
FOSETYL	FOSETYL-AL
GALLEX	META-CRESOL
GAMMA AMINOBUTYRIC ACID	AVERAGE
GIBBERELLIC ACID	GIBBERELLINS
GLUFOSINATE	GLUFOSINATE-AMMONIUM
GLYPHOSATE	GLYPHOSATE
HALOSULFURON	HALOSULFURON-METHYL
HARPIN PROTEIN	HARPIN PROTEIN
HEXAZINONE	HEXAZINONE
HEXYTHIAZOX	HEXYTHIAZOX
HYDRAMETHYLNON	HYDRAMETHYLNON
HYDRATED LIME	CALCIUM HYDROXIDE
HYDROGEN PEROXIDE	HYDROGEN PEROXIDE
HYMEXAZOL	AVERAGE
IBA	IBA
IMAZALIL	IMAZALIL
IMAZAMETHABENZ	IMAZAMETHABENZ
IMAZAMOX	IMAZAMOX
IMAZAPIC	IMAZAPIC
IMAZAPYR	IMAZAPYR
IMAZAQUIN	AVERAGE
IMAZETHAPYR	IMAZETHAPYR
IMAZOSULFURON	IMAZOSULFURON
IMIDACLOPRID	IMIDACLOPRID
INDAZIFLAM	INDAZIFLAM
INDOXACARB	INDOXACARB
IODOSULFURON	AVERAGE
IPCONAZOLE	IPCONAZOLE
IPRODIONE	IPRODIONE
ISOXABEN	ISOXABEN
ISOXAFLUTOLE	AVERAGE
KAOLIN CLAY	KAOLIN

USGS_Compound_Name	CA_DPR_chemname
KINOPRENE	KINOPRENE
KRESOXIM-METHYL	KRESOXIM-METHYL
LACTOFEN	AVERAGE
L-GLUTAMIC ACID	GLUTAMIC ACID
LINURON	LINURON
MALATHION	MALATHION
MALEIC HYDRAZIDE	MALEIC HYDRAZIDE
MANCOZEB	MANCOZEB
MANDIPROPAMID	MANDIPROPAMID
MANEB	MANEB
MCPA	MCPA
MCPB	MCPB, SODIUM SALT
MECOPROP	MECOPROP-P
MEFENOXAM	MEFENOXAM
MEPIQUAT	MEPIQUAT CHLORIDE
MESOSULFURON	MESOSULFURON-METHYL
MESOTRIONE	MESOTRIONE
METALAXYL	METALAXYL
METALDEHYDE	METALDEHYDE
METAM	METAM-SODIUM
METAM POTASSIUM	METAM-SODIUM
METCONAZOLE	METCONAZOLE
METHAMIDOPHOS	METHAMIDOPHOS
METHIDATHION	METHIDATHION
METHIOCARB	METHIOCARB
METHOMYL	METHOMYL
METHOXYFENOZIDE	METHOXYFENOZIDE
METHYL BROMIDE	METHYL BROMIDE
METHYL BROMIDE	METHYL BROMIDE
METHYL IODIDE	METHYL IODIDE
METHYL PARATHION	METHYL PARATHION
METIRAM	METIRAM
METOLACHLOR	METOLACHLOR
METOLACHLOR-S	METOLACHLOR
METRAFENONE	METRAFENONE
METRIBUZIN	METRIBUZIN
METSULFURON	METSULFURON-METHYL
MEVINPHOS	MEVINPHOS
MSMA	MSMA
MYCLOBUTANIL	MYCLOBUTANIL
MYROTHECIUM VERRUCARIA	MYROTHECIUM VERRUCARIA, DRIED FERMENTATION SOLIDS
NALED	NALED

USGS_Compound_Name	CA_DPR_chemname
NAPHTHYLACETAMIDE	AVERAGE
NAPHTHYLACETIC ACID	AVERAGE
NAPROPAMIDE	NAPROPAMIDE
NAPTALAM	NAPTALAM, SODIUM SALT
NEEM OIL	AVERAGE
NICOSULFURON	NICOSULFURON
NORFLURAZON	NORFLURAZON
NOSEMA LOCUSTAE CANN	NOSEMA LOCUSTAE SPORES
NOVALURON	NOVALURON
ORTHOSULFAMURON	ORTHOSULFAMURON
ORYZALIN	ORYZALIN
OXADIAZON	OXADIAZON
OXAMYL	OXAMYL
OXYDEMETON-METHYL	OXYDEMETON-METHYL
OXYFLUORFEN	OXYFLUORFEN
OXYTETRACYCLINE	OXYTETRACYCLINE HYDROCHLORIDE
PACLOBUTRAZOL	PACLOBUTRAZOL
PARAQUAT	PARAQUAT DICHLORIDE
PARATHION	PARATHION
PELARGONIC ACID	AVERAGE
PENDIMETHALIN	PENDIMETHALIN
PENOXSULAM	PENOXSULAM
PENTHIOPYRAD	PENTHIOPYRAD
PERMETHRIN	PERMETHRIN
PETROLEUM DISTILLATE	PETROLEUM DISTILLATES
PETROLEUM OIL	PETROLEUM NAPHTHENIC OILS
PHENMEDIPHAM	PHENMEDIPHAM
PHORATE	PHORATE
PHOSMET	PHOSMET
PHOSPHORIC ACID	PHOSPHORIC ACID
PICLORAM	PICLORAM
PINOXADEN	PINOXADEN
PIPERONYL BUTOXIDE	PIPERONYL BUTOXIDE
POLYHEDROSIS VIRUS	POLYHEDRAL OCCLUSION BODIES (OB'S) OF THE NUCLEAR
POLYOXORIM	AVERAGE
POTASSIUM BICARBONATE	POTASSIUM BICARBONATE
POTASSIUM OLEATE	AVERAGE
PRIMISULFURON	AVERAGE
PRODIAMINE	PRODIAMINE
PROFENOFOS	PROFENOFOS
PROHEXADIONE	PROHEXADIONE CALCIUM
PROMETRYN	PROMETRYN

USGS_Compound_Name	CA_DPR_chemname
PROPAMOCARB HCL	PROPAMOCARB HYDROCHLORIDE
PROPANIL	PROPANIL
PROPARGITE	PROPARGITE
PROPAZINE	PROPAZINE
PROPICONAZOLE	PROPICONAZOLE
PROPOXYCARBAZONE	AVERAGE
PROPYZAMIDE	PROPYZAMIDE
PROSULFURON	AVERAGE
PROTHIOCONAZOLE	PROTHIOCONAZOLE
PSEUDOMONAS FLUORESCENS	PSEUDOMONAS FLUORESCENS, STRAIN A506
PYMETROZINE	PYMETROZINE
PYRACLOSTROBIN	PYRACLOSTROBIN
PYRAFLUFEN ETHYL	PYRAFLUFEN-ETHYL
PYRASULFOTOLE	AVERAGE
PYRETHRINS	PYRETHRINS
PYRIDABEN	PYRIDABEN
PYRIMETHANIL	PYRIMETHANIL
PYRIPROXYFEN	PYRIPROXYFEN
PYRITHIOBAC-SODIUM	PYRITHIOBAC-SODIUM
PYROXASULFONE	AVERAGE
PYROXSULAM	PYROXSULAM
QUINCLORAC	QUINCLORAC
QUINOXYFEN	QUINOXYFEN
QUINTOZENE	AVERAGE
QUIZALOFOP	QUIZALOFOP-ETHYL
RIMSULFURON	RIMSULFURON
ROTENONE	ROTENONE
SABADILLA	SABADILLA ALKALOIDS
SAFLUFENACIL	SAFLUFENACIL
SETHOXYDIM	SETHOXYDIM
SILICATES	SILICA AEROGEL
SIMAZINE	SIMAZINE
SODIUM CHLORATE	SODIUM CHLORATE
SODIUM CHLORATE	SODIUM CHLORATE
SPINETORAM	SPINETORAM
SPINOSYN	SPINOSAD
SPIRODICLOFEN	SPIRODICLOFEN
SPIROMESIFEN	SPIROMESIFEN
SPIROTETRAMAT	SPIROTETRAMAT
STREPTOMYCIN	STREPTOMYCIN
SULFCARBAMIDE	AVERAGE

USGS_Compound_Name	**CA_DPR_chemname**
SULFENTRAZONE	SULFENTRAZONE
SULFOMETURON	SULFOMETURON-METHYL
SULFOSATE	AVERAGE
SULFOSULFURON	SULFOSULFURON
SULFOXAFLOR	SULFOXAFLOR
SULFUR	SULFUR
SULFURIC ACID	SULFURIC ACID
TCMTB	TCMTB
TEBUCONAZOLE	TEBUCONAZOLE
TEBUFENOZIDE	TEBUFENOZIDE
TEBUPIRIMPHOS	AVERAGE
TEBUTHIURON	TEBUTHIURON
TEFLUTHRIN	AVERAGE
TEMBOTRIONE	TEMBOTRIONE
TERBACIL	TERBACIL
TERBUFOS	AVERAGE
TETRABOROHYDRATE	AVERAGE
TETRACONAZOLE	TETRACONAZOLE
TETRATHIOCARBONATE	AVERAGE
THIABENDAZOLE	THIABENDAZOLE
THIACLOPRID	THIACLOPRID
THIAMETHOXAM	THIAMETHOXAM
THIAZOPYR	THIAZOPYR
THIDIAZURON	THIDIAZURON
THIENCARBAZONE-METHYL	AVERAGE
THIFENSULFURON	THIFENSULFURON-METHYL
THIOBENCARB	THIOBENCARB
THIODICARB	THIODICARB
THIOPHANATE-METHYL	THIOPHANATE-METHYL
THIRAM	THIRAM
TOPRAMEZONE	AVERAGE
TRALKOXYDIM	TRALKOXYDIM
TRIADIMEFON	TRIADIMEFON
TRIADIMENOL	TRIADIMENOL
TRI-ALLATE	TRIALLATE
TRIASULFURON	AVERAGE
TRIBENURON METHYL	TRIBENURON-METHYL
TRIBUFOS	AVERAGE
TRICLOPYR	TRICLOPYR, BUTOXYETHYL ESTER
TRIFLOXYSTROBIN	TRIFLOXYSTROBIN
TRIFLOXYSULFURON	TRIFLOXYSULFURON-SODIUM
TRIFLUMIZOLE	TRIFLUMIZOLE

USGS_Compound_Name	CA_DPR_chemname
TRIFLURALIN	TRIFLURALIN
TRIFLUSULFURON	AVERAGE
TRINEXAPAC	TRINEXAPAC-ETHYL
TRITICONAZOLE	TRITICONAZOLE
UNICONAZOLE	UNICONIZOLE-P
VINCLOZOLIN	VINCLOZOLIN
ZETA-CYPERMETHRIN	AVERAGE
ZINC	ZINC CHLORIDE
ZINEB	ZINEB
ZIRAM	ZIRAM
ZOXAMIDE	AVERAGE

Table 4-123: VOC emission factors for EPA-estimated Agricultural Pesticide Application

PESTICIDE	Average VOC per LB AI (lb)
2,4-D	0.827
2,4-DB ACID	0.067
ABAMECTIN	15.236
ACEPHATE	0.275
ACEQUINOCYL	0.135
ACETAMIPRID	0.207
ACIBENZOLAR-S-METHYL	0.063
ACIFLUORFEN, SODIUM SALT	1.887
ALACHLOR	0.513
ALDICARB	0.064
ALUMINUM PHOSPHIDE	0.055
AMETOCTRADIN	0.041
AMETRYNE	0.024
AMINOPYRALID, TRIISOPROPANOLAMINE SALT	0.16
ASULAM, SODIUM SALT	0.202
ATRAZINE	0.148
AZADIRACHTIN	10.092
AZINPHOS-METHYL	0.464
AZOXYSTROBIN	0.344
BACILLUS AMYLOLIQUEFACIENS STRAIN D747	0.076
BACILLUS CEREUS, STRAIN BP01	0.106
BACILLUS FIRMUS (STRAIN I-1582)	0.052
BACILLUS PUMILUS GHA 180	2,050.00
BACILLUS SUBTILIS GB03	190.333
BACILLUS THURINGIENSIS (BERLINER)	0.487
BENOMYL	0.074
BENSULFURON METHYL	0.031
BENSULIDE	0.553

PESTICIDE	Average VOC per LB AI (lb)
BENTAZON, SODIUM SALT	0.053
BIFENAZATE	0.084
BIFENTHRIN	1.566
BISPYRIBAC-SODIUM	0.038
BOSCALID	0.229
BROMACIL	0.85
BUPROFEZIN	0.164
CALCIUM HYDROXIDE	0.003
CAPTAN	0.144
CARBARYL	0.321
CARBOPHENOTHION	0.446
CARBOXIN	0.437
CARFENTRAZONE-ETHYL	0.653
CHLORANTRANILIPROLE	0.364
CHLORFENAPYR	0.137
CHLORMEQUAT CHLORIDE	0.586
CHLORONEB	0.074
CHLOROPICRIN	1.272
CHLOROTHALONIL	0.113
CHLORPROPHAM	0.325
CHLORPYRIFOS	1.538
CHLORSULFURON	0.028
CLETHODIM	1.84
CLOFENTEZINE	0.147
CLOMAZONE	0.149
CLOPYRALID	0.05
CLOTHIANIDIN	0.153
CONIOTHYRIUM MINITANS STRAIN CON/M/91-08	0.698
COPPER	0.218
COPPER HYDROXIDE	0.06
COPPER OCTANOATE	2.198
COPPER OXIDE (OUS)	0.029
COPPER OXYCHLORIDE	0.023
COPPER OXYCHLORIDE SULFATE	0.026
COPPER SULFATE (BASIC)	0.048
COPPER SULFATE (PENTAHYDRATE)	0.062
CRYOLITE	0.025
CYAZOFAMID	0.166
CYCLANILIDE	2.468
CYCLOATE	0.507
CYFLUFENAMID	0.175
CYFLUTHRIN	1.736

PESTICIDE	Average VOC per LB AI (lb)
CYHALOFOP-BUTYL	0.452
CYMOXANIL	0.044
CYPERMETHRIN	1.521
CYPRODINIL	0.049
CYROMAZINE	0.228
CYTOKININ	0.254
DAMINOZIDE	0.045
DAZOMET	1
DELTAMETHRIN	3.949
DESMEDIPHAM	3.668
DIAZINON	0.76
DICAMBA	0.084
DICHLOBENIL	0.434
DICLOFOP-METHYL	1.042
DICLORAN	0.087
DICOFOL	0.424
DICROTOPHOS	0.258
DIENOCHLOR	0.182
DIFENOCONAZOLE	1.12
DIFLUBENZURON	0.159
DIMETHENAMID-P	0.135
DIMETHIPIN	0.367
DIMETHOATE	0.83
DIMETHOMORPH	0.038
DINOSEB	0.455
DINOTEFURAN	0.191
DIQUAT DIBROMIDE	1.456
DISULFOTON	1.186
DITHIOPYR	0.955
DIURON	0.072
DODINE	0.049
EMAMECTIN BENZOATE	3.055
ENDOSULFAN	0.492
EPTC	0.517
ESFENVALERATE	8.919
ETHALFLURALIN	1.554
ETHEPHON	0.302
ETHION	0.397
ETHOFUMESATE	0.691
ETHOPROP	0.416
ETOXAZOLE	0.059
FENAMIDONE	0.101

PESTICIDE	Average VOC per LB AI (lb)
FENAMIPHOS	1.043
FENARIMOL	1.404
FENBUCONAZOLE	0.049
FENBUTATIN-OXIDE	0.058
FENHEXAMID	0.037
FENOXAPROP-ETHYL	3.132
FENOXYCARB	0.655
FENPROPATHRIN	1.469
FENPYROXIMATE	8.721
FENTIN HYDROXIDE	0.039
FERBAM	0.045
FIPRONIL	6.463
FLAZASULFURON	0.148
FLONICAMID	0.06
FLORASULAM	0.052
FLUAZIFOP-BUTYL	1.464
FLUAZINAM	0.406
FLUBENDIAMIDE	0.102
FLUDIOXONIL	0.308
FLUMICLORAC-PENTYL	0.565
FLUMIOXAZIN	0.075
FLUOMETURON	0.046
FLUOPICOLIDE	0.136
FLUOPYRAM	0.291
FLUOXASTROBIN	0.172
FLURIDONE	0.629
FLUROXYPYR	0.279
FLUTOLANIL	0.031
FLUTRIAFOL	0.331
FLUXAPYROXAD	0.02
FORAMSULFURON	0.252
FORMETANATE HYDROCHLORIDE	0.011
FOSETYL-AL	0.049
GIBBERELLINS	2.819
GLUFOSINATE-AMMONIUM	0.442
GLUTAMIC ACID	0.063
GLYPHOSATE	0.159
HALOSULFURON-METHYL	0.032
HARPIN PROTEIN	1.233
HEXAZINONE	0.142
HEXYTHIAZOX	0.423
HYDRAMETHYLNON	0.614

PESTICIDE	Average VOC per LB AI (lb)
HYDROGEN PEROXIDE	0.356
IBA	0.559
IMAZALIL	0.794
IMAZAMETHABENZ	0.504
IMAZAMOX	0.016
IMAZAPIC	0.016
IMAZAPYR	0.025
IMAZETHAPYR	0.019
IMAZOSULFURON	0.049
IMIDACLOPRID	0.305
INDAZIFLAM	0.416
INDOXACARB	0.453
IPCONAZOLE	0.122
IPRODIONE	0.203
ISOXABEN	0.103
KAOLIN	0.015
KINOPRENE	0.466
KRESOXIM-METHYL	0.034
LINURON	0.077
MALATHION	0.409
MALEIC HYDRAZIDE	0.015
MANCOZEB	0.047
MANDIPROPAMID	0.209
MANEB	0.071
MCPA	0.47
MCPB, SODIUM SALT	1.206
MECOPROP-P	0.622
MEFENOXAM	0.587
MEPIQUAT CHLORIDE	0.661
MESOSULFURON-METHYL	0.822
MESOTRIONE	0.236
META-CRESOL	73.605
METALAXYL	0.506
METALDEHYDE	0.691
METAM-SODIUM	0.566
METCONAZOLE	0.369
METHAMIDOPHOS	0.71
METHIDATHION	1.068
METHIOCARB	0.22
METHOMYL	0.115
METHOXYFENOZIDE	0.223
METHYL BROMIDE	1.159

PESTICIDE	Average VOC per LB AI (lb)
METHYL IODIDE	1.212
METHYL PARATHION	0.502
METIRAM	0.11
METOLACHLOR	0.198
METRAFENONE	0.074
METRIBUZIN	0.087
METSULFURON-METHYL	0.037
MEVINPHOS	0.534
MSMA	0.315
MYCLOBUTANIL	0.451
MYROTHECIUM VERRUCARIA, DRIED FERMENTATION SOLIDS	0.127
NALED	0.494
NAPROPAMIDE	0.385
NAPTALAM, SODIUM SALT	0.588
NICOSULFURON	0.037
NORFLURAZON	0.031
NOSEMA LOCUSTAE SPORES	7.085
NOVALURON	2.273
ORTHOSULFAMURON	0.097
ORYZALIN	0.212
OXADIAZON	0.182
OXAMYL	0.721
OXYDEMETON-METHYL	0.928
OXYFLUORFEN	1.012
OXYTETRACYCLINE HYDROCHLORIDE	0.199
PACLOBUTRAZOL	0.983
PARAQUAT DICHLORIDE	0.311
PARATHION	0.357
PENDIMETHALIN	0.559
PENOXSULAM	0.208
PENTHIOPYRAD	0.054
PERMETHRIN	3.345
PETROLEUM DISTILLATES	1.142
PETROLEUM NAPHTHENIC OILS	0.884
PHENMEDIPHAM	3.129
PHORATE	0.448
PHOSMET	1.162
PHOSPHORIC ACID	0.434
PICLORAM	0.398
PINOXADEN	10.388
PIPERONYL BUTOXIDE	4.504
POLYHEDRAL OCCLUSION BODIES (OB'S) OF THE NUCLEAR	8.922

PESTICIDE	Average VOC per LB AI (lb)
POTASSIUM BICARBONATE	0.027
PRODIAMINE	0.126
PROFENOFOS	0.367
PROMETRYN	0.184
PROPAMOCARB HYDROCHLORIDE	0.18
PROPANIL	0.099
PROPARGITE	0.196
PROPAZINE	0.2
PROPICONAZOLE	1.052
PROPYZAMIDE	0.055
PROTHIOCONAZOLE	0.139
PSEUDOMONAS FLUORESCENS, STRAIN A506	0.022
PYMETROZINE	0.02
PYRACLOSTROBIN	0.549
PYRAFLUFEN-ETHYL	5.343
PYRETHRINS	6.737
PYRIDABEN	0.019
PYRIMETHANIL	0.188
PYRIPROXYFEN	1.387
PYRITHIOBAC-SODIUM	0.193
PYROXSULAM	0.135
QUINCLORAC	0.121
QUINOXYFEN	0.06
QUIZALOFOP-ETHYL	4.121
RIMSULFURON	0.07
ROTENONE	0.808
SABADILLA ALKALOIDS	2.018
SAFLUFENACIL	0.015
SETHOXYDIM	3.751
SILICA AEROGEL	0.381
SIMAZINE	0.089
SODIUM CHLORATE	0.025
SPINETORAM	0.138
SPINOSAD	0.483
SPIRODICLOFEN	0.229
SPIROMESIFEN	0.119
SPIROTETRAMAT	0.101
STREPTOMYCIN	0.133
SULFENTRAZONE	0.128
SULFOMETURON-METHYL	0.076
SULFOSULFURON	0.027
SULFOXAFLOR	0.06

PESTICIDE	Average VOC per LB AI (lb)
SULFUR	0.013
SULFURIC ACID	0.088
TCMTB	0.995
TEBUCONAZOLE	0.178
TEBUFENOZIDE	0.163
TEBUTHIURON	0.075
TEMBOTRIONE	0.096
TERBACIL	0.023
TETRACONAZOLE	0.492
THIABENDAZOLE	0.117
THIACLOPRID	0.119
THIAMETHOXAM	0.178
THIAZOPYR	1.756
THIDIAZURON	0.396
THIFENSULFURON-METHYL	0.049
THIOBENCARB	0.158
THIODICARB	0.133
THIOPHANATE-METHYL	0.118
THIRAM	0.219
TRALKOXYDIM	0.141
TRIADIMEFON	0.162
TRIADIMENOL	0.243
TRIALLATE	0.573
TRIBENURON-METHYL	0.03
TRICLOPYR, BUTOXYETHYL ESTER	0.433
TRIFLOXYSTROBIN	0.083
TRIFLOXYSULFURON-SODIUM	0.014
TRIFLUMIZOLE	0.067
TRIFLURALIN	0.737
TRINEXAPAC-ETHYL	2.386
TRITICONAZOLE	0.24
UNICONIZOLE-P	125.636
VINCLOZOLIN	0.055
ZINC CHLORIDE	0.329
ZINEB	0.082
ZIRAM	0.031

Table 4-124: HAP emission factors for EPA-estimated Agricultural Pesticide Application

Compound	Pollutant Code	Vapor Pressure	Emission Factor	Source
		(mm Hg at 20°C to 25°C)	(lb per lb AI)	
2,4-D	94757	0.000008	0.35	EIIP, Volume 3, Chapter 9, Table 9.4-4 [ref 1]
CAPTAN	133062	0.00000008	0.1441	Set equal to VOC emissions factor calculated from the CA DPR [ref 2]
CARBARYL	63252	0.0000012	0.3208	Set equal to VOC emissions factor calculated from the CA DPR [ref 2]
METHYL BROMIDE	74839	1,420	0.58	EIIP, Volume 3, Chapter 9, Table 9.4-4 [ref 1]
METHYL IODIDE	74884	400	0.58	EIIP, Volume 3, Chapter 9, Table 9.4-4 [ref 1]
PARATHION	56382	0.0000378	0.35	EIIP, Volume 3, Chapter 9, Table 9.4-4 [ref 1]
TRIFLURALIN	1582098	0.00011	0.58	EIIP, Volume 3, Chapter 9, Table 9.4-4 [ref 1]

4.21.3.2 *Activity data*

The activity for pesticide application is the pounds of active ingredient applied per pesticide for the year 2012. These data are available from the USGS report “Estimated Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2008-2012” [ref 3], which gives county-level pesticide data in terms of kg of active ingredient applied. The report estimates annual county-level pesticide use for 423 herbicides, insecticides, and fungicides applied to agricultural crops grown in the conterminous United States during 2008–12. For all States except California, pesticide-use data are compiled from proprietary surveys of farm operations located within U.S. Department of Agriculture Crop Reporting Districts (CRDs). Surveyed pesticide-use data were used in conjunction with county annual harvested-crop acres reported by the U.S. Department of Agriculture 2007 and 2012 Censuses of Agriculture and the 2008–11 County Agricultural Production Survey to calculate use rates per harvested-crop acre, or an “estimated pesticide use” (EPest) rate, for each crop by year. County-use estimates were then calculated by multiplying EPest rates by harvested-crop acres for each pesticide crop combination. Use estimates for California were obtained from annual Department of Pesticide Regulation-Pesticide Use Reports.

The USGS report calculates both EPest-low and EPest-high rates. The EPest-high rates were used here to estimate VOC emissions. Both methods incorporated surveyed and extrapolated rates to estimate pesticide use for counties, but EPest-low and EPest-high estimations differed in how they treated situations when a CRD was surveyed and pesticide use was not reported for a particular pesticide-by-crop combination. If use of a pesticide on a crop was not reported in a surveyed CRD, EPest-low reports zero use in the CRD for that pesticide-by-crop combination. EPest-high, however, treats the unreported use for that pesticide-by-crop combination in the CRD as un-surveyed, and pesticide-by-crop use rates from neighboring CRDs and, in some cases, CRDs within the same Farm Resources Region are used to calculate the pesticide-by-crop EPest-high rate for the CRD.

Due to data limitations in the USGS report, active ingredient usages for Alaska and Hawaii were pulled forward from 2011.

4.21.3.3 *Controls*

No controls were accounted for in the emissions estimation.

4.21.3.4 *Example Calculation*

Emissions were estimated by summing the product of the active ingredient applied and the emissions factor for each pesticide at the county-level:

$$\text{Total VOC Emissions}_{county} = \Sigma_{pesticide} (AI \times EF)$$

Taking Autauga County, Alabama as an example:

2,874.9 kg of active ingredient of 2,4-D was applied
2,874.9 kg × 2.20462 lb/kg = 6,338.1 lb active ingredient.
$EF_{2,4\text{-}D}$ = 0.8273 (lb VOC/lb AI)

Emissions are calculated by multiplying activity data by the emissions factor:

$\text{Emissions}_{Autauga,2,4\text{-}D}$ = 6,338.1 lb AI × 0.8273 lb VOC/lb AI = 5,244 lb VOC

This process was then repeated for all pesticide compounds and summed to the county level, resulting in approximately 39,585 lb, or 19.8 tons, of VOC emitted due to agricultural pesticide application in Autauga County.

4.21.3.5 *Changes from 2011 Methodology*

In the 2011 inventory, data estimating harvested acres per crop in each county was multiplied by the percent of acres treated to yield the number of acres treated for each combination of crop and pesticide compound in a given county. This acreage was multiplied by an application rate of active ingredient applied per treated acre (calculated using Crop Life Foundation Database application rates and 2007 USDA Census of Agriculture harvest acres). The result was the pounds of active ingredient applied for each compound and crop type at the county level. The mass of active ingredient was then multiplied by an average emissions factor derived from the CA DPR pesticide database.

Since the Crop Life Foundation Database was discontinued in 2008, the 2014 inventory uses county-level active ingredient applied for all crop types from the USGS report for year 2012. The amount of active ingredient (kg) applied was available at the county level by pesticide compound, but not by crop. The mass of active ingredient was then multiplied by pesticide-specific emission factors derived from the CA DPR 2015 pesticide database (rather than an average emissions factor). In addition, the 2014 methodology includes HAP emissions estimates for all counties, except those in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands (due to data limitations).

4.21.3.6 *Puerto Rico and US Virgin Islands Emissions Calculations*

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: Broward (state-county FIPS=12011) for Puerto Rico and Monroe (state-county FIPS=12087) for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

4.21.4 References for agricultural pesticides

1. United States Environmental Protection Agency, "*Pesticides - Agricultural and Nonagricultural*", Vol. 3, Ch. 9, Section 5.1, p. 9.5-4, Emissions Inventory Improvement Program, June 2001.

2. California Department of Pesticide Regulation, "CDPR_Emission_Potential_Database_10_2015.xlsx", provided by Pam Wofford, Environmental Program Manager, CA DPR to Jonathan Dorn, Associate, Abt Associates (January 2016).
3. United States Geological Survey, "*Estimated Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2008–12*", http://pubs.usgs.gov/ds/0907/ (accessed December 2015).

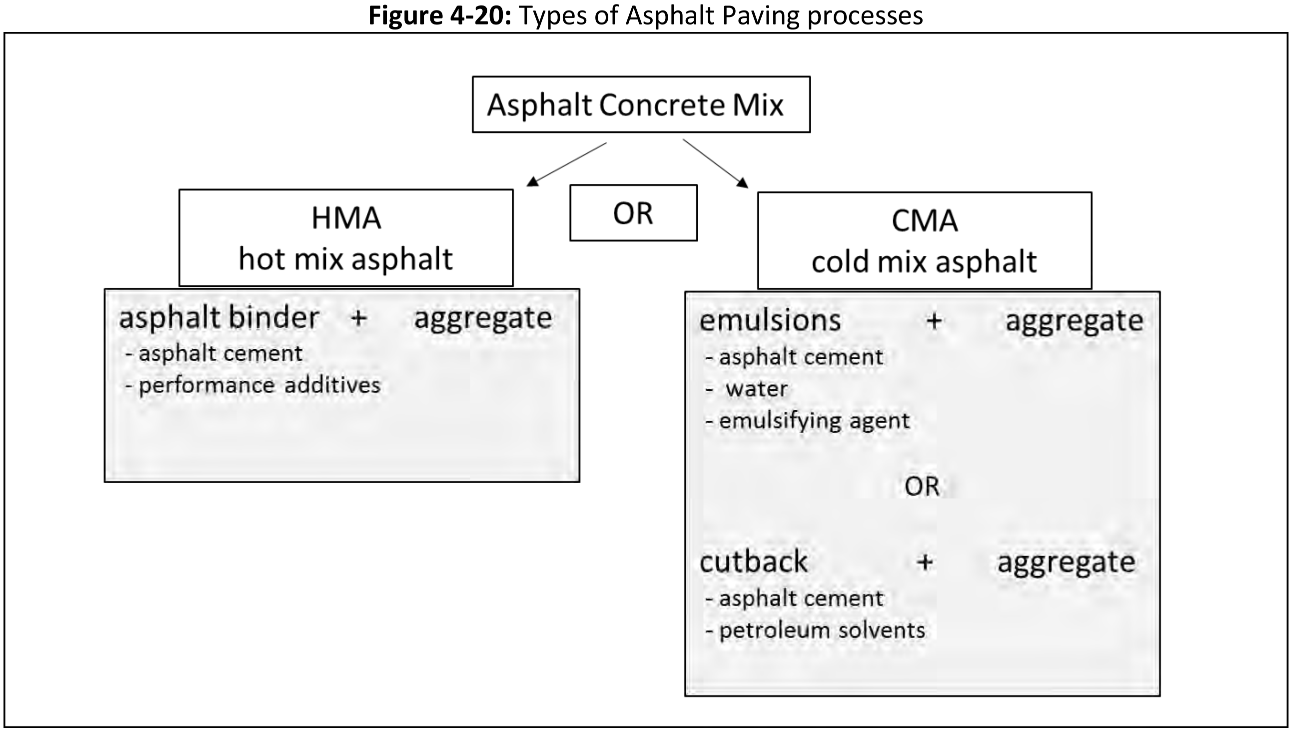
4.22 Solvent – Consumer & Commercial Use: Asphalt Paving - Cutback and Emulsified

4.22.1 Sector description

Asphalts for paving are mainly used in two ways. They are either mixed with aggregates at plants and hauled to the paving site and then compacted on the road, or they are sprayed in relatively thin layers with or without aggregates. Plant mixed asphalt products are called asphalt concrete mix. As seen in Figure 4-20, these can be produced and laid down hot, using asphalt cements, or cold, using emulsions or cutbacks. These mixes usually contain about 5% asphalt and 95% aggregates by weight. Aggregates give the mix most of its ability to carry or resist loads while the asphalt coats and binds the aggregate structure.

Hot laid mixes, also called hot mix asphalt (HMA), are produced by mixing heated aggregates and asphalt cements in special mixing plants. These very strong, stiff mixes are usually used for surface and subsurface layers in highways, airports, parking lots, and other areas which carry heavy or high volume traffic. HMA uses an asphaltic binding agent which includes asphalt cement as well as any material added to modify the original asphalt cement properties. Cold asphalt mixes are produced by mixing damp, cold aggregates with emulsions or cutbacks at mixing plants — either stationary plants or portable ones brought to the site. Although not as strong and stiff as hot mix, cold mixes may be more economical and flexible, and less polluting. They are used for areas with intermediate and low traffic, for open graded mixes, and for patching. Sprayed asphalt applications include asphalt-aggregate applications, usually called surface treatments or seal coats, and asphalt-only applications such as tack coat, prime coat, fog seal, and dust prevention [ref 1].

Figure 4-20: Types of Asphalt Paving processes



A new, third type of mix, warm-mix asphalt (WMA), has become increasingly popular. In this type of mixture, various different methods are used to significantly reduce mix production temperature by 30 to over 100°F. These methods include (1) using chemical additives to lower the high-temperature viscosity of the asphalt binder; (2) techniques involving the addition of water to the binder, causing it to foam; and (3) two-stage processes involving the addition of hard and soft binders at different points during mix production. WMA has several benefits, including lower cost (since significantly less fuel is needed to heat the mix), lower emissions and so improved environmental impact, and potentially improved performance because of decreased age hardening [ref 2].

4.22.2 Sources of data

As seen in Table 4-125, this source category includes data from the S/L/T agency submitted data and the default EPA generated emissions. EPA estimates emissions for both cutback and emulsified asphalt paving. New Jersey and Maryland also reported emissions for "Asphalt Application: All Processes; Total: All Solvent Types" (2461020000). The leading SCC description is "Solvent Utilization; Miscellaneous Non-industrial: Commercial" for all SCCs.

Table 4-125: Asphalt Paving SCCs estimated by EPA and S/L/Ts

SCC	Description	EPA	State	Local	Tribe
2461020000	Asphalt Application: All Processes; Total: All Solvent Types		X		
2461021000	Cutback Asphalt; Total: All Solvent Types	X	X	X	X
2461022000	Emulsified Asphalt; Total: All Solvent Types	X	X	X	X

The agencies listed in Table 4-126 submitted VOC emissions for cutback and/or emulsified asphalt paving; agencies not listed used EPA estimates for the entire sector.

Table 4-126: Percentage of cutback and emulsified Asphalt Paving VOC emissions submitted by reporting agency

Region	Agency	S/L/T	SCC	Description	VOC
2	New Jersey Department of Environment Protection	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
3	Delaware Department of Natural Resources and Environmental Control	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
3	Maryland Department of the Environment	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
5	Illinois Environmental Protection Agency	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
5	Michigan Department of Environmental Quality	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
5	Minnesota Pollution Control Agency	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
6	Texas Commission on Environmental Quality	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	2461021000	Cutback Asphalt; Total: All Solvent Types	100
8	Utah Division of Air Quality	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
9	California Air Resources Board	State	2461021000	Cutback Asphalt; Total: All Solvent Types	64

Region	Agency	S/L/T	SCC	Description	VOC
9	Washoe County Health District	Local	2461021000	Cutback Asphalt; Total: All Solvent Types	100
10	Coeur d'Alene Tribe	Tribe	2461021000	Cutback Asphalt; Total: All Solvent Types	100
10	Idaho Department of Environmental Quality	State	2461021000	Cutback Asphalt; Total: All Solvent Types	100
10	Kootenai Tribe of Idaho	Tribe	2461021000	Cutback Asphalt; Total: All Solvent Types	100
10	Nez Perce Tribe	Tribe	2461021000	Cutback Asphalt; Total: All Solvent Types	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2461021000	Cutback Asphalt; Total: All Solvent Types	100
1	New Hampshire Department of Environmental Services	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
2	New Jersey Department of Environment Protection	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
3	Delaware Department of Natural Resources and Environmental Control	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
3	Maryland Department of the Environment	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
5	Illinois Environmental Protection Agency	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
5	Michigan Department of Environmental Quality	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
5	Minnesota Pollution Control Agency	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
6	Texas Commission on Environmental Quality	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
8	Utah Division of Air Quality	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
9	California Air Resources Board	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	94
9	Washoe County Health District	Local	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
10	Coeur d'Alene Tribe	Tribe	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
10	Idaho Department of Environmental Quality	State	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
10	Kootenai Tribe of Idaho	Tribe	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
10	Nez Perce Tribe	Tribe	2461022000	Emulsified Asphalt; Total: All Solvent Types	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2461022000	Emulsified Asphalt; Total: All Solvent Types	100

4.22.3 EPA-developed emissions for asphalt paving

Additional information about asphalt paving practices and terminology is provided in the nonpoint asphalt paving method development document posted on the 2014 NEI documentation page [ref 3].

EPA estimated emissions from paving processes that use cold mix asphalt – cutback and emulsified, but not from the use of hot mix asphalt or WMA. For the 2014 NEI v1, the EPA could not find readily available information on the composition of HMA asphalt binder or from WMA products. Emission estimates from HMA/WMA paving are not provided at this time.

4.22.3.1 *Activity data*

The EPA's pre-existing emissions estimation method for paving using cutback or emulsified asphalt cement applies 2008 usage data by the Asphalt Institute. The 2008 usage data for cutback and emulsified asphalt is also applied for the 2014 NEI v1. General on-line data searches did not yield more recent and available information on cutback and emulsified asphalt usage though data may be available for purchase from Freedonia. Several information sources indicate that the Asphalt Institute which performed periodic surveys through 2008, stopped surveys efforts of that type after 2008. The EPA contacted the Asphalt Institute to see if more recent activity data is available and was provided the copyright protected 2014 survey report. While that data is not presented here, review indicated little difference between the national-level 2008 and the 2014 use amounts for cutback asphalt and a larger increase in the national 2014 emulsified usage compared to the 2008 use value, i.e., a 20 percent change from 2008. The Asphalt Institute 2008 survey indicated many states had zero usage for cutback asphalt- specifically AK, CT, DE, DC, HI, ME, MD, MA, NH, NJ, NY, NC, RI, SC, VT, and WV. Some of those states also were noted with zero usage for emulsified asphalt. Based on comparison of the 2008 activity with the MANE-VU 2007 inventory [ref 4] and the 2011 NEI v2, it appears that the proposed estimates for the 2014 NEI asphalt emissions may under-estimate (zero out emissions) for the MARAMA states when many of those states have emissions in the 2007 MANE-VU inventory and in the 2011 NEI v2. The use of 2008 activity data as a surrogate for the 2014 NEI likely under-estimates some states' use of cutback and emulsified asphalts, and perhaps more so for emulsified. The survey report acknowledged that manufacturers or resellers in some states may have not reported or under-reported due to confidentiality concerns.

The rate of growth pattern for asphalt use between 2008 and 2014 was also reviewed by looking at several on-line sources such as Freedonia brochures [ref 5] and, as seen in Figure 4-21, the U.S. Energy Information Administration (EIA) State Energy Data System (SEDS) [ref 6]. Freedonia suggests that demand for asphalt in the United States will rebound from the sharp declines in the 2007-2012 period, driven by stronger economic growth and increased construction activity, though demand in 2017 is expected to remain below the 2007 level. The US and Canada are significant consumers of asphalt for roofing products; demand for those products will rise with increased building construction expenditures. The study says demand for asphalt in both paving and roofing applications will be driven by the recovering US economy and increasing construction activity in the country. Review of the EIA SEDs data to determine the trend in asphalt product sales and consumption since 2008, specifically the petroleum end-use industrial sector of asphalt and road oil - indicates that state-level consumption (see Figure 4-22) of asphalt and road oil between the years of 2008-2013 experienced a general decline or approximately flat growth.

Figure 4-21: EIA-based U.S. asphalt road oil consumption estimates

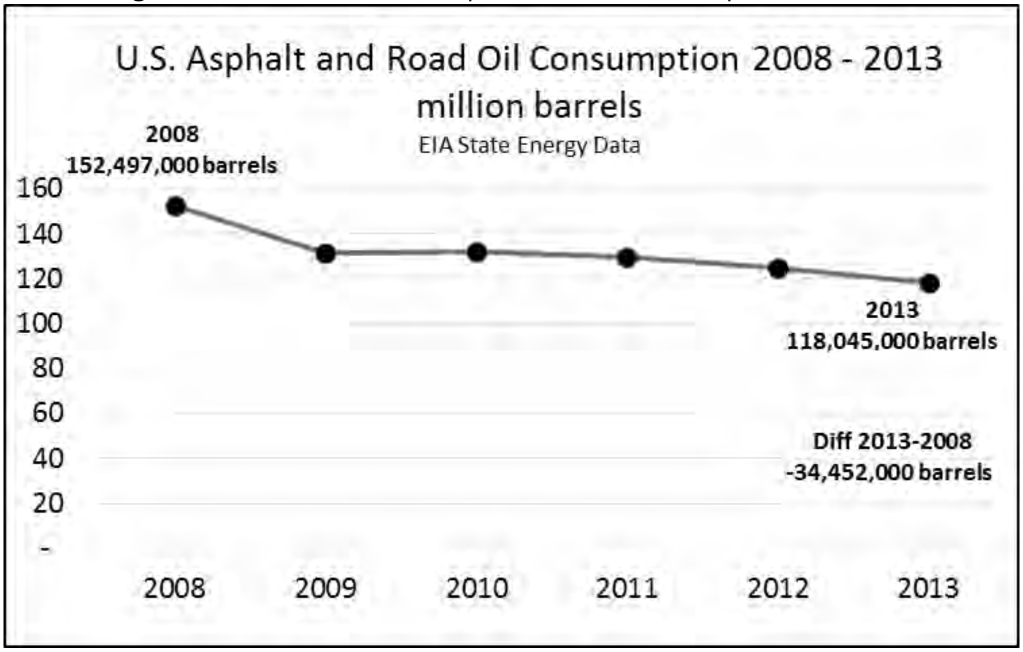
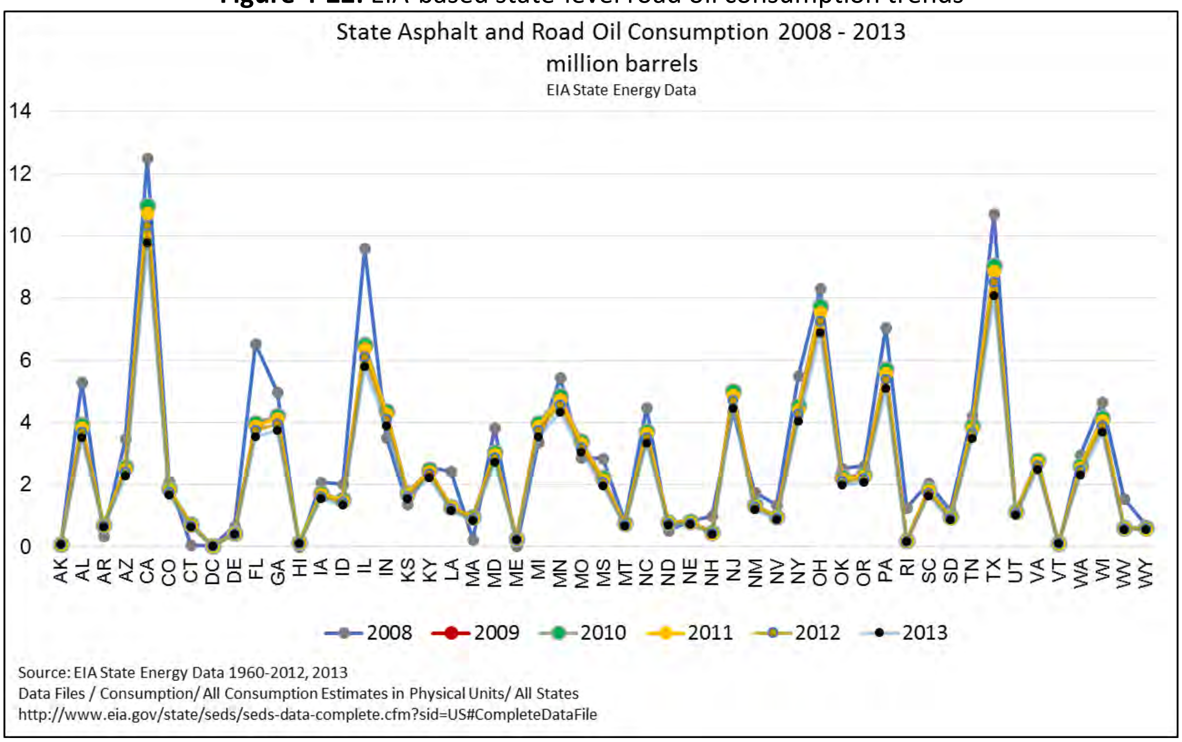


Figure 4-22: EIA-based state-level road oil consumption trends



The FHWA (Federal Highway Administration) is also a potential source of activity data via their contract with the National Paving Association to survey states about their use of asphalt and reclaimed materials. The FWHA and National Paving Association survey of 2013 [ref 7] state-level asphalt usage cites an increased use of warm-mix asphalt and recycled content. *There is no discussion however of the binder composition or the amount of solvent that may be attributed to the HMA (hot-mix) or WMA.* The objective of the survey was to quantify the use of recycled materials and WMA produced by the asphalt pavement industry in each state. The results include an estimate of 351 million tons of HMA/WMA plant mix asphalt produced in 2013, of which WMA is 106 million tons. While the 2008 data usage indicated some states with zero use of cutback and emulsified asphalt for paving, there are no states with an estimated zero HMA/WMA asphalt production for 2013.

Additional discussion and review of the activity data is provided in the nonpoint asphalt paving method development document [ref 3] posted as "*2014_NPt_Asphalt_18nov2015_edit03302016.zip*" at: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint. That discussion includes a comparison of the 2008 *usage* for cutback and emulsified asphalt that EPA last obtained from the Asphalt Institute with the state summary of HMA/WMA asphalt *production* for 2013.

Many state and or local jurisdictions restrict or ban the use of highly evaporative asphalt mixtures such as cutback asphalt during months of potentially poor air quality, i.e., typically in the warmer, sunny months. Paving using cutback asphalt may be scheduled and resume in other parts of the year when evaporation of the VOC content will not influence ozone formation as much. For the purposes of the NEI annual county-level estimate, it may be assumed that the county allocation of asphalt usage will eventually be used at some point during the year, rather than assuming emissions are 'zeroed-out' – unless bans are in place. If agencies are developing an inventory for SIP purposes, a monthly inventory could be calculated to account for monthly variations in process activity, unless restricted use or bans. EPA's processing of the annual emission inventory for regional air quality modeling may not take that into account unless county, SCC-specific spatial and temporal factors can be developed and applied, which is typically outside of the scope of limited resources unless the SCC emissions are particularly significant relative to other emission sources. Table 4-127 summarizes the activity data applied and the sources.

Table 4-127: Sources of activity data and related parameters

Activity Parameters (G = Given; C = Computed)		
	Parameter	**Source Reference Use Note**
G	Quantity of asphalt used by state, by asphalt type – cutback, emulsified Annual 2008 national tons	2008 Asphalt Usage Survey, purchased from Asphalt Institute, www.asphaltinstitute.org The state-level 2008 activity was used for the 2008 and the 2011 NEI. Tons. This asphalt use is assumed to be for asphalt cement, rather than for asphalt concrete which is composed of both aggregate (~95% by wgt) and asphalt cement (~5%by wgt).
G	State $VMT_{2013\ FHWA\ Roads}$	State-level annual vehicle miles traveled (VMT) by FHWA road class, 2013. FHWA Report VM-2, 2013 [ref 8]. http://www.fhwa.dot.gov/policyinformation/statistics/2013
C	County $VMT_{FHWA\ Roads\ for\ 2014\ NEI}$	Estimate of county-level annual VMT by FHWA road class, for 2014 NEI. This approximation of county-level annual VMT for 2014 is based on the equation: County $VMT_{FHWA\ Road\ Type\ for\ 2014\ NEI}$ = 2011NEIv2 $CountyVMT_{MOVES\_NEI\ Road\ Type}$ x (2013 $StateVMT_{FHWA\ Road\ Type}$ /2013 $State_{MOVES\_NEI\ Road\ Type}$) See EIAG's NEI documentation file: <README_VMTfor2014NEInptCals_20150728.docx>
C	County VMT fraction of State VMT	Estimate of county fraction of the state VMT by FHWA road class, for 2014 NEI. This approximation is based on the equation: (2014 County $VMT_{FHWA\ Road}$ / 2013 State $VMT_{FHWA\ Road}$) = $(County\ VMT/\ State\ VMT)_{FHWA\ Road\ for\ 2014\ NEI}$

Activity Parameters (G = Given; C = Computed)		
	Parameter	**Source Reference Use Note**
G	State Lane-Miles$_{2013\ FHWA\ Roads}$	State lane-miles by FHWA road class, 2013. FHWA Report HM-60, 2013. http://www.fhwa.dot.gov/policyinformation/statistics/2013
G	State Paved Road Miles$_{2013\ FHWA\ Roads}$	State paved road miles by FHWA road class, 2013. FHWA Report HM-51, 2013. http://www.fhwa.dot.gov/policyinformation/statistics/2013
C	State Paved Lane-Miles$_{2013\ FHWA\ Roads}$	Estimate of state lane-miles that are paved by FHWA road class, for 2013 based on the equation: [state paved road miles$_{2013\ FHWA\ Road}$ / (state paved + unpaved road miles)$_{2013\ FHWA\ Road}$] x state lane-miles$_{2013\ FHWA\ Road}$ = state paved lane-miles$_{2013\ FHWA\ Road}$
C	State Utilization Paved$_{2013\ FHWA\ Roads}$	Estimate of state-level utilization measure for paved road surface by FHWA road class, for 2013 based on the equation: (stateVMT$_{2013\ FHWA\ Road}$ /state paved lane-miles$_{2013\ FHWA\ Road}$) = state utiliztn paved roads$_{2013\ FHWA\ Road}$
C	County Utilization Paved$_{2013\ FHWA\ Roads}$	Estimate of the county-level utilization measure for paved road surface by FHWA road class is calculated by applying the county/state VMT fraction to the state paved road utilization measure. (county VMT/ state VMT)$_{FHWA\ Road\ for\ 2014\ NEI}$ x (state utilization paved roads$_{2013\ FHWA\ Road}$) = county utilization paved roads$_{2013\ FHWA\ road}$
C	County Utilization Sum$_{2013}$ County-to-State Utiliz Sum$_{2013}$	Sum the county utilization by FHWA roads to county total and sum the county totals to state total.
C	County Utilization Fraction of State Utilization	Estimate of county fraction of the state utilization measure for paved road surface is based on the equation: (county utilization paved$_{2013}$/ CountyToStateSum utilization paved$_{2013}$)
C	County Asphalt Usage $_{for\ 2014NEI}$	County-level cutback asphalt usage estimated by allocating state-level usage data to county based on the estimate of county utilization paved roads$_{2013}$ using the equation: (state-level asphalt usage x (county utilization paved$_{2013}$/ CountyToStateSum utilization paved$_{2013}$) = county asphalt usage $_{for\ 2014NEI}$

Distribution of Activity Data to the County

While the 2008 asphalt usage from the pre-existing method was applied again for the 2014 NEI v1, the procedure for distributing the state asphalt use to county-level usage was updated with the intent to simplify the method by using ready available FHWA data reports to develop a utilization measure for paved roads. The utilization measure focuses on the quantity of travel on paved roads. The pre-existing EPA distribution procedure applies 10+ year old FHWA data no longer published concerning traffic volume with conversion to VMT (vehicle miles travelled) using assumed speeds. The intent of the update was to develop a state-to-county activity distribution factor that is computationally more stream-lined, requires less operating assumptions, and uses current and routinely available FHWA highway statistics reports rather than carry forward and build a factor upon old data (1996) as a surrogate for information no longer published (HM-67 Miles by Surface Type and Average Daily Traffic Volume Group, last published in 1997). The update also intends to allocate paving to areas with the highest travel. This isn't a perfect methodology as all roads get paved at some point in time, even low-usage rural roads on their own maintenance schedule, but it may be a reasonable approximation.

The update considers the following performance measures and definitions that may be applied by state DOTs and MPOs [ref 9].

Dimension	Performance Measure	Definition
Quantity of Travel	Vehicle miles traveled	Average Annual Daily Traffic * Length
Utilization	Vehicles per lane-mile	Average Annual Daily Traffic * Length/lane miles

The operating assumption is that the county-level paved road utilization is similar to the calculated state-level paved road utilization measure, and may be related based on the county VMT fraction of state VMT. The general steps using the activity parameters in the above Table are as follows.

- Step 1. Develop state road utilization measure by road surface.
  Utilization measure = VMT/ lane-miles.
  By FHWA road type, the amount of lane-miles that are paved may be expressed as: (state paved road miles/ state paved + unpaved road miles) x state lane-miles = state paved lane-miles.
  State utilization measure for paved road surface = (state VMT / (state paved lane-miles)
- Step 2. Compute county-to-state fraction for quantity of travel, i.e., vehicle miles traveled.
  By FHWA road type, the county-to-state fraction, vehicle miles traveled = County VMT/ State VMT.
  Estimate of annual county VMT based on MOVES mobile source model is provided by EPA.
- Step 3. Compute county-level utilization measure for paved roads.
  By FHWA road type, apply the county/state VMT fraction (Step 2) to the state road utilization measure by paved road type (Step 1) to obtain the county-level road utilization measure for paved roads.
  County utilization paved roads = (County VMT/state VMT) x (State utilization measure for paved road surface)
- Step 4. Sum the county utilization by FHWA roads to county total and sum the county totals to state total.
- Step 5. Estimate the county fraction of the state utilization measure for paved road surface as: County utilization paved roads / county-to-state sum utilization paved

The county fraction of state utilization measure computed in step 5 is multiplied by the state asphalt usage to distribute the state-level asphalt use to county usage.

4.22.3.2 *Emission Factors*

The annual mass emission rate factors for cutback and emulsified asphalt are updated using the 2008 asphalt consumption data and MSDS (Material Safety Data Sheets) information to reflect the composition of cutback and emulsified paving mixtures used today. Table 4-128 summarizes the sources of emission factors and related parameters.

Table 4-128: Sources of emission factors and related parameters

Emission Factor Parameters (G = Given; C = Computed)		
	Parameter	**Source Reference Use Notes**
C	Emission Factor VOC, HAPs	Emission factors are updated for 2014 NEI. Basis includes: 2008 annual asphalt cement use data from Asphalt Institute; average chemical composition information from available online MSDS – specific diluent, % wgt fraction; and assumed %wgt emitted. See factors in Table 4-129 and equations in method discussion section.

Emission Factor Parameters (G = Given; C = Computed)		
	Parameter	**Source Reference Use Notes**
G	Asphalt cement consumption Annual 2008 national tons	The 2008 activity usage by state (2008 Asphalt Usage Survey, from Asphalt Institute) is summed to national. Cutback usage = 187,328 tons; Emulsified usage = 1,350,999 tons.
G	Diluent(s) and Average pct of each diluent in asphalt cement	Determination that likely multiple diluents are present in asphalt cement (binder) and an average wgt percent of diluent in asphalt cement is assumed based on MSDS information. Specific diluent and properties are referenced in method discussion section.
G	Density of asphalt	The density of asphalt is assumed similar to that of water, 8.34 lbs/gal which seems reasonable based on relative density information in MSDS.
G	Density of diluent (s)	Density measures for each diluent are referenced in method discussion section. While density measures were gathered/recorded, they are not used for wgt % calculations.
G	Pct by wgt of volatile (diluent) emitted in product	95% of total solvent is assumed emitted; with 5% of total solvent assumed retained in the product.
C	Emissions	Emissions = County-Level Asphalt Usage * Emission Factors

Emission factors (lbs pollutant emitted/ ton asphalt, cutback or emulsified) were calculated using parameters in the above table:

- lbs/yr cutback (or emulsified) cement x avg % weight diluent = lbs/yr diluent
- lbs/yr diluent x avg weight % volatile emitted = lbs/yr diluent emitted
- annual mass emission rate: (lbs poll emitted/yr) / (tons asphalt used/yr) = lb/ton

Material Safety Data Sheets (MSDS) for cutback and emulsified asphalt were searched on-line and reviewed as a general way to assess the physical parameters used in the pre-existing emission factor calculation – regarding material composition, percent concentrations, and density measures. The MSDS typically cover a range of graded asphalts and note that petroleum asphalt is mixed with varying proportions of solvent, fuel oils, kerosene, and/or petroleum residues and the composition varies depending on source of crude and specifications of final product. Information from several MSDS are summarized below. Based on the MSDS information, the following values, seen in Table 4-129, were developed and applied as average composite surrogates. The information for cutback is based primarily on rapid cure though ethylbenzene is cited for presence in medium and slow cure mixtures. In the MSDS, the units of the concentration percent is seldom confirmed as whether percent by volume or percent by weight. When it was specified on the emulsified and cutback sheets reviewed, it was percent by weight. References for several ASTM (American Society for Testing and Materials) standard methods for sampling and testing the composition of bituminous paving materials were reviewed to form the assumption that the concentration percentages are mass percentages.

Additional information, including the use of specific MSDS, is provided in the nonpoint asphalt paving method development document [ref 3].

Table 4-129: Cutback asphalt computed average chemical composition information

Chemical Composition, i.e., VOCs, HAPs	Avg % by Weight	Density	Note
Asphalt	60-90	8.34 lb/gal	Relative Density ~ 0.9-.99, water=1
Naptha, i.e., VM&P, Stoddards solv	40	6.3 lb/gal	15C/60F (CDC/NIOSH)
Naphthalene	0.49 (0.58 w PAH)	9.5 lb/gal	20C/68F (CDC/NIOSH), SG 1.16
Toluene	0.59	7.2 lb/gal	20C/68F (CDC/NIOSH)
Xylene	0.99	7.2 lb/gal	20C/68F (CDC/NIOSH)
Benzene	0.19	7.3 lb/gal	20C/68F (CDC/NIOSH)
Ethylbenzene	0.49	7.2 lb/gal	20C/68F (CDC/NIOSH)
Polycyclic Aromatic Hydrocarbons	0.09		Add to wgt % as napthalene
Hydrogen Sulfide	0.09	8.3 lb/ gal	SG 1.19 (gas)

The units of the updated emission factors, seen in Table 4-130 are different than for the pre-existing factors. A conservative conversion of the existing lbs/ barrel value to terms of lbs/ton is done using the conversion factor: 5.5 barrels of road oil / ton [ref 5].

Table 4-130: Updated emission factors and expected pollutants by SCC vs. pre-existing factors

SCC	Description	Pollutant	Pollutant Code	Update lb/ton	Pre-existing lb/barrel
2461021000	Cutback Asphalt, Total: All Solvent Types	VOC	VOC	813.96	88.0
		Benzene	71432	3.6	
		Ethylbenzene	100414	9.3	2.02
		Naphthalene	91203	11.0	
		Toluene	108883	11.2	5.63
		Xylenes (Mixed Isomers)	1330207	18.8	10.74
		Hydrogen Sulfide	7783064	1.7	
2461022000	Emulsified Asphalt, Total: All Solvent Types	VOC	VOC	195.5	9.2
		Naphthalene	91203	5.5	
		Hydrogen Sulfide	7783064	1.7	

Example: 88 lbs VOC/ barrel x 5.5 barrels/ton = 484 lb VOC/ ton

The updated emission factors include (three) additional HAPs (hazardous air pollutants) based on review of some current available MSDS composition information. The pre-existing HAP factors were based on a percent weight of VOC from the EPA 1996 NTI (National Toxics Inventory).

The nonpoint asphalt paving method development document [ref 3] includes a discussion of the basis for the pre-existing emission factors and the specific calculations for the updated factors.

4.22.3.3 *Some Possible Steps for Further Improvement*

This method update for the 2014 NEI v1, involved contacting the FHWA, the Asphalt Institute, and the NAPA. FHWA staff responded that they do not collect nor track information on cutback and emulsified asphalt usage on the National Highway System and that emulsions are generally used in maintenance activities and not new construction or re-construction. Staff from the Asphalt Institute responded to provide their copyright protected 2014 survey report with request that it not be further distributed. As of this writing, response was not received from the NAPA.

FHWA may be able to obtain information from their paving industry partners, i.e., NAPA to help quantify the composition of WMA and HMA. For HMA and WMA, knowing the use amounts that may include solvents with evaporative potential and also whether there are amounts of cutback and emulsified not covered by their annual survey purposes, could improve both activity and composition information to update the emission factor calculations. NAPA also conducts FHWA co-sponsored research of which on-line brochure indicates that NAPA drafted a report[8] comparing criteria air pollutant emissions of warm-mix technologies and hot-mix technologies - available upon request from NAPA and that the report was not released to the public because additional stack emissions testing is needed to determine the extent of criteria air pollutant reduction with the use of warm-mix technologies. Current asphalt use (activity) data may also be available for purchase from Freedonia.

More in-depth on-line literature searches, e.g., Science Direct, could also be conducted to see if research results exist that describe measured volatile composition of asphalt mixtures used today. That could be another way to further assess emission characteristics of the VOC and individual chemical species.

The nonpoint asphalt paving method development document [ref 3] includes a list of some possible contacts for more information.

4.22.4 References for asphalt paving

1. Wisconsin Transportation Bulletin • No. 1, Understanding and Using Asphalt
2. National Cooperative Highway Research Program (NCHRP) Report 673. A Manual for Design of Hot Mix Asphalt with Commentary. 2011
3. U.S. Environmental Protection Agency, 2015. Nonpoint asphalt paving method development document posted as "*2014_NPt_Asphalt_18nov2015_edit03302016.zip*" at: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint.
4. MARAMA 2007 Emissions Inventory. http://www.marama.org/publications_folder/MVEmissionsTrendsRpt_Oct2011.pdf
5. Freedonia Brochure – Asphalt Paving. http://www.freedoniagroup.com/Asphalt.html
6. EIA SEDS. www.eia.gov/state/seds/sep_prices/notes/pr_petrol.pdf
7. Annual Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage: 2009–2013. Information Series 138. National Asphalt Paving Association. https://www.asphaltpavement.org/PDFs/IS138/IS138-2013_RAP-RAS-WMA_Survey_Final.pdf
8. FHWA Traffic Analysis Toolbox Volume VI: Definition, Interpretation, and Calculation of Traffic Analysis Tools Measures of Effectiveness (MOEs), Tables 6 and 7. http://ops.fhwa.dot.gov/publications/fhwahop08054/sect2.htm
9. National Asphalt Pavement Association Research Brochure 2015. http://www.asphaltpavement.org/PDFs/NAPA_Research_Brochure_2015.pdf

4.23 Solvents: All other Solvents

This section includes discussion on all nonpoint solvent sources except for agricultural pesticide application (see 4.21.3Section 4.21) and asphalt paving (see Section 4.22). The reason these sources are discussed separately is because the EPA methodologies for estimating the emissions are different.

4.23.1 Sector description

Solvent usage is covered in the NEI for 2014 by many SCCs and is comprised of industrial, commercial, and residential applications. EPA's solvents category includes architectural surface coatings, industrial surface coatings, degreasing, graphic arts, dry cleaning, consumer and commercial (includes personal care products and household products), automotive aftermarket, adhesives and sealants, and FIFRA related products (pesticides).

4.23.2 Sources of data

Table 4-131 shows, for Solvents, the nonpoint SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 2, 3 and 4 SCC descriptions are also provided. The SCC level 1 description is "Solvent Utilization" for all SCCs. Note that the SCCs in this list are only the SCCs that either the EPA used or the submitting State agencies used in the 2014 NEI, and not a comprehensive list of all "active" Solvent SCCs. Also note the solvent SCCs (see table footnote) that were discussed in previous sections.

Table 4-131: Nonpoint Solvent SCCs with 2014 NEI emissions

SCC	Description	EPA	State	Local	Tribe	Sector
2401001000	Surface Coating; Architectural Coatings; Total: All Solvent Types	X	X	X	X	Solvent - Non-Industrial Surface Coating
2401001050	Surface Coating; Architectural Coatings; All Other Architectural Categories		X			Solvent - Non-Industrial Surface Coating
2401005000	Surface Coating; Auto Refinishing: SIC 7532; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401005700	Surface Coating; Auto Refinishing: SIC 7532; Top Coats		X			Solvent - Industrial Surface Coating & Solvent Use
2401005800	Surface Coating; Auto Refinishing: SIC 7532; Clean-up Solvents		X			Solvent - Industrial Surface Coating & Solvent Use
2401008000	Surface Coating; Traffic Markings; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401010000	Surface Coating; Textile Products: SIC 22; Total: All Solvent Types		X			Solvent - Industrial Surface Coating & Solvent Use
2401015000	Surface Coating; Factory Finished Wood: SIC 2426 thru 242; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401020000	Surface Coating; Wood Furniture: SIC 25; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401025000	Surface Coating; Metal Furniture: SIC 25; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401030000	Surface Coating; Paper: SIC 26; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401035000	Surface Coating; Plastic Products: SIC 308; Total: All Solvent Types		X	X		Solvent - Industrial Surface Coating & Solvent Use
2401040000	Surface Coating; Metal Cans: SIC 341; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401045000	Surface Coating; Metal Coils: SIC 3498; Total: All Solvent Types		X		X	Solvent - Industrial Surface Coating & Solvent Use

SCC	Description	EPA	State	Local	Tribe	Sector
2401050000	Surface Coating; Miscellaneous Finished Metals: SIC 34 - (341 + 3498); Total: All Solvent Types		X			Solvent - Industrial Surface Coating & Solvent Use
2401055000	Surface Coating; Machinery and Equipment: SIC 35; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401060000	Surface Coating; Large Appliances: SIC 363; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401065000	Surface Coating; Electronic and Other Electrical: SIC 36 - 363; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401070000	Surface Coating; Motor Vehicles: SIC 371; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401075000	Surface Coating; Aircraft: SIC 372; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401080000	Surface Coating; Marine: SIC 373; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401085000	Surface Coating; Railroad: SIC 374; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401090000	Surface Coating; Miscellaneous Manufacturing; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401100000	Surface Coating; Industrial Maintenance Coatings; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2401200000	Surface Coating; Other Special Purpose Coatings; Total: All Solvent Types	X	X	X	X	Solvent - Industrial Surface Coating & Solvent Use
2415000000	Degreasing; All Processes/All Industries; Total: All Solvent Types	X	X	X	X	Solvent - Degreasing
2420000000	Dry Cleaning; All Processes; Total: All Solvent Types	X	X	X	X	Solvent - Dry Cleaning
2425000000	Graphic Arts; All Processes; Total: All Solvent Types	X	X	X	X	Solvent - Graphic Arts
2440000000	Miscellaneous Industrial; All Processes; Total: All Solvent Types		X	X		Solvent - Industrial Surface Coating & Solvent Use
2440020000	Miscellaneous Industrial; Adhesive (Industrial) Application; Total: All Solvent Types		X			Solvent - Industrial Surface Coating & Solvent Use
2460000000	Miscellaneous Non-industrial: Consumer and Commercial; All Processes; Total: All Solvent Types		X			Solvent - Consumer & Commercial Solvent Use

SCC	Description	EPA	State	Local	Tribe	Sector
2460100000	Miscellaneous Non-industrial: Consumer and Commercial; All Personal Care Products; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460200000	Miscellaneous Non-industrial: Consumer and Commercial; All Household Products; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460400000	Miscellaneous Non-industrial: Consumer and Commercial; All Automotive Aftermarket Products; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460500000	Miscellaneous Non-industrial: Consumer and Commercial; All Coatings and Related Products; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460600000	Miscellaneous Non-industrial: Consumer and Commercial; All Adhesives and Sealants; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460800000	Miscellaneous Non-industrial: Consumer and Commercial; All FIFRA Related Products; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2460900000	Miscellaneous Non-industrial: Consumer and Commercial; Miscellaneous Products (Not Otherwise Covered); Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2461000000	Miscellaneous Non-industrial: Commercial; All Processes; Total: All Solvent Types			X		Solvent - Consumer & Commercial Solvent Use
2461020000*	Miscellaneous Non-industrial: Commercial; Asphalt Application: All Processes; Total: All Solvent Types		X			Solvent - Consumer & Commercial Solvent Use
2461021000*	Miscellaneous Non-industrial: Commercial; Cutback Asphalt; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2461022000*	Miscellaneous Non-industrial: Commercial; Emulsified Asphalt; Total: All Solvent Types	X	X	X	X	Solvent - Consumer & Commercial Solvent Use
2461023000	Miscellaneous Non-industrial: Commercial; Asphalt Roofing; Total: All Solvent Types		X			Solvent - Consumer & Commercial Solvent Use
2461024000	Miscellaneous Non-industrial: Commercial; Asphalt Pipe Coating; Total: All Solvent Types		X			Solvent - Consumer & Commercial Solvent Use

SCC	Description	EPA	State	Local	Tribe	Sector
2461160000	Miscellaneous Non-industrial: Commercial; Tank/Drum Cleaning: All Processes; Total: All Solvent Types		X			Solvent - Consumer & Commercial Solvent Use
2461800001*	Miscellaneous Non-industrial: Commercial; Pesticide Application: All Processes; Surface Application		X			Solvent - Consumer & Commercial Solvent Use
2461800002*	Miscellaneous Non-industrial: Commercial; Pesticide Application: All Processes; Soil Incorporation		X			Solvent - Consumer & Commercial Solvent Use
2461850000*	Miscellaneous Non-industrial: Commercial; Pesticide Application: Agricultural; All Processes	X	X		X	Solvent - Consumer & Commercial Solvent Use

* These sources are discussed in Section 4.21 (Agricultural Pesticides) and Section 4.22 (Asphalt Paving)

The agencies listed in Table 4-132 submitted at least VOC emissions for all the EIS Solvent sectors discussed in this section: Consumer & Commercial Use, Degreasing, Dry Cleaning, Graphic Arts, Industrial Surface Coating & Solvent Use, and Non-Industrial Surface Coating. Agencies not listed used EPA estimates for the entire sector. Some agencies submitted emissions for the entire sector (100%), while others submitted only a portion of the sector (totals less than 100%).

Table 4-132: EIS sector-specific percentage of Solvent VOC emissions submitted by reporting agency

Region	Agency	S/L/T	Consumer & Commercial *	Degreasing	Dry Cleaning	Graphic Arts	Ind. Sfc. Coating & Solvent Use	Non-Ind. Sfc. Coating
1	Connecticut Department of Energy and Environmental Protection	State	100	100	100	100	100	100
1	Maine Department of Environmental Protection	State	98	100	100	100	100	100
1	Massachusetts Department of Environmental Protection	State		100	100	100	100	100
1	New Hampshire Department of Environmental Services	State	18	100		100	77	100
2	New Jersey Department of Environment Protection	State	100	100	100	100	100	100
2	New York State Department of Environmental Conservation	State	60	100		100	55	100
3	DC-District Department of the Environment	State	99	100	100	100	100	100

Region	Agency	S/L/T	Consumer & Commercial *	Degreasing	Dry Cleaning	Graphic Arts	Ind. Sfc. Coating & Solvent Use	Non-Ind. Sfc. Coating
3	Delaware Department of Natural Resources and Environmental Control	State	92		100	100	14	
3	Maryland Department of the Environment	State	97	99	100	100	98	100
3	Pennsylvania Department of Environmental Protection	State	74	100		100	100	100
3	Virginia Department of Environmental Quality	State	96	100		100	90	100
4	Chattanooga Air Pollution Control Bureau (CHCAPCB)	Local	86	100	100	100	100	100
4	Florida Department of Environmental Protection	State	76	100	100	100	100	100
4	Georgia Department of Natural Resources	State	82	100	100		100	100
4	Knox County Department of Air Quality Management	Local	85	100	100	100	100	100
4	Louisville Metro Air Pollution Control District	Local	87	100	100		48	100
4	Metro Public Health of Nashville/Davidson County	Local	50		100		18	100
4	South Carolina Department of Health and Environmental Control	State	91	100	100	100	100	100
5	Illinois Environmental Protection Agency	State	100	100	100	100	100	100
5	Indiana Department of Environmental Management	State		100			58	
5	Michigan Department of Environmental Quality	State	94	100	100	100	100	100
5	Minnesota Pollution Control Agency	State	82	100	100	99	100	100
5	Ohio Environmental Protection Agency	State	89	100		100	100	100
5	Wisconsin Department of Natural Resources	State	76	100			100	100
6	Louisiana Department of Environmental Quality	State	87	100	100	100	100	100

Region	Agency	S/L/T	Consumer & Commercial *	Degreasing	Dry Cleaning	Graphic Arts	Ind. Sfc. Coating & Solvent Use	Non-Ind. Sfc. Coating
6	Oklahoma Department of Environmental Quality	State	73	100	100	100	100	100
6	Texas Commission on Environmental Quality	State	94	100	100	100	100	100
7	Iowa Department of Natural Resources	State	56			100	100	100
7	Kansas Department of Health and Environment	State	61	100	100	100	100	100
7	Missouri Department of Natural Resources	State		100		100	35	
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	100					
8	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Tribe	100					
8	Northern Cheyenne Tribe	Tribe	100					100
8	Utah Division of Air Quality	State	80	100	100	100	100	100
9	Arizona Department of Environmental Quality	State	71	100	100	100	100	100
9	California Air Resources Board	State	94	100	4	16	64	6
9	Washoe County Health District	Local	55	100	100	100	61	100
10	Coeur d'Alene Tribe	Tribe	100	100	100	100	100	100
10	Idaho Department of Environmental Quality	State	100	100	100	100	100	100
10	Kootenai Tribe of Idaho	Tribe	100	100			100	100
10	Nez Perce Tribe	Tribe	100	100	100	100	100	100
10	Oregon Department of Environmental Quality	State	69	100	100	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100	100	100	100	100	100

* The EIS sector Consumer & Commercial EIS includes agricultural pesticide application and asphalt paving, sources discussed in previous sections.

4.23.3 EPA-developed emissions from the Solvent Tool

New for 2014 is a MS Access tool which calculates emissions for almost all of the solvent categories estimated by EPA. More information on the solvents tool can be found in the documentation entitled, “Solvent Utilization: Documentation for EPA’s Nonpoint Emissions Estimation Tool,” found in zipped files with the documentation and the tool itself on the ftp site: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint. There are three SCCs that are highlighted in Table 4-131 that are not covered by the MS Access Tool, which include Agricultural Pesticide Application and Cutback and Emulsified Asphalt Paving.

The benefits of consolidating the solvent categories into MS Access are twofold. Activity data can be a common thread amongst many of these SCCs, eliminating the need to upload data repeatedly to many different MS Excel workbooks. Also, the tool can export final emissions data to staging table format, making uploading final emissions data to EIS easier and less of a burden to EIS data submitters.

In general, the solvent tool uses activity factors that are based either on employment or population, with a notable exception of Lane Miles for Traffic Marking applications. Most point source data do not rely on these same activity inputs, which makes conducting point source subtraction on an activity basis difficult. Therefore, the tool was developed to accept point source data for subtraction in two ways: either activity or an emissions Point/Nonpoint SCC Crosswalk.

In addition, much work was done to improve the point/nonpoint crosswalk, so that point source subtraction could be done within the tool. The crosswalk was updated with the addition of around 65 SCCs.

States were given the option to accept EPA estimates. However, this premise relies heavily on the assumption that there are no point sources to subtract. Because EPA lacks the resources to complete point source subtraction on behalf of the states, it is possible that this may have led to double-counting of emissions.

4.23.4 Notes about the Solvent Tool for 2014v1

Retired SCCs Unretired for NJ

New Jersey noted late in the submission period that EPA had retired several SCC codes that were meaningful to their inventory. NJ asked that EPA un-retire these codes, with the rationale that the Ozone Transport Commission Stationary and Area Source Committee targets high VOC area source categories for regulation, based on California regulations. Therefore, EPA made the decision to un-retire these codes in a silent fashion. The categories include: Consumer Products, Autobody Refinishing, Pesticide Application, Graphic Arts, and Asphalt Paving. EPA then needed to go back and review the nonpoint survey to make sure that any double-counting didn't occur at this point.

Two Versions/Graphic Arts

It should also be noted that two Versions of the Solvent Tool were released for states to use in version 1 of the 2014 NEI. In the history of the ERTAC committee, two different methodologies have been used for the estimation of Graphic Arts emissions. One is based on employment, using a lb VOC/employee unit, and the other is based on population, using a lb VOC/capita unit. States differed on their preference, so it was decided by the NOMAD Committee to release two versions of the tool, identical in nature except for the graphic arts emission factor and activity. While EPA gave states the allowance to choose which methodology to use, EPA made the final decision to use the employment methodology for EPA estimates.

This did cause issues for Graphic Arts for version 1 of the 2014 NEI. Publishing two tools created disparities; population-based often resulted in emissions a factor of ten or greater than the employment basis. Several states revised their emissions accordingly. One of the improvements for version 2 will be to choose one tool that makes the most sense to use on a national basis.

Incorrect HAPs for Tool

Another disparity that had to be addressed in 2014 v1 was that the HAPs that were published in the Solvent Tool on SharePoint in time for S/L/Ts to utilize in v1 were ones that were EPA had derived from some EPA/SPPD data in the 2011 NEI. These HAPs emission factors had never been reviewed by S/L/Ts, as they were only input into version 2 of the 2011 NEI (due to timing of the development of the HAPs). In retrospect, these HAPs were very different from previous inventories (completely different pollutant sets) and were not extrapolated in a technically-defensible manner. Therefore, because the published tool used faulty HAP emission factors, EPA had to tag out S/L/T-submitted solvent HAPs. These HAPs were then created from S/L/T-submitted VOC emissions via the HAP augmentation file, which used speciation factors from VOC to create VOC HAPs. New HAPs were developed in order to have more correct HAPs included in v1 of the 2014 NEI.

The VOC HAP factors are weight fractions of chemical species comprising total reactive VOCs. The speciation factor, or weight fraction, for each HAP is multiplied by the nonpoint VOC emissions (i.e. after point source subtraction). The speciation factors have historically been based on data from the Freedonia Group which provides information on the amount of solvent demand by solvent type (e.g. toluene, xylene, etc.). The speciation factors are developed by dividing the demand for each solvent type by the total solvent usage (Freedonia Group 2013). Previous editions of the Freedonia data broke this information down by type of solvent and industry; however, the most recent version of the Freedonia data breaks it down by either type of solvent or industry, but not both. For this reason, if a newly calculated speciation factor using 2013 Freedonia data is significantly larger (i.e. by an order of magnitude) than the factor used in the 2011 NEI, then the factor is not changed and the 2011 factor is carried forward.

State Tagged Data

A few states (NH, TX, and VA) requested that we tag out their data after reviewing it in the draft. These were for: NH surface coating (electronic and other electrical, factory finished wood, and machinery and equipment), TX surface coating (special purpose coatings), and VA traffic markings and ag pesticides. As requested by inventory developers in these state air agencies, EPA estimates were used in lieu of the state submitted data.

EPA Tagged Data

Several S/L/Ts, listed in Table 4-133, answered on the nonpoint survey that they did not have specific solvent categories in their area of responsibility, or that these sources were completely covered in their point inventory submittal; therefore, EPA tagged out any emissions from the 2014 EPA Nonpoint Dataset to ensure that EPA emissions did not backfill where S/L/Ts did not submit nonpoint estimates.

Table 4-133: S/L/Ts that requested EPA not backfill nonpoint Solvent estimates with EPA estimates

S/L/T	Solvent category(s)	Reason to not include in NP Inventory
AK	Ag Pesticides, Surface Coating (auto, factory wood, industrial maintenance, motor vehicles, special purpose, wood furniture, arch. coatings)	Do not have this type of source
CA	Consumer & Commercial (adhesives/sealants, personal care products)	Use different SCCs
Chattanooga County	Dry cleaning, Consumer & Commercial (adhesives/sealants, automotive aftermarket, coatings, FIFRA, household, personal care, misc.); Surface Coating (arch. Coating, auto refinishing, electronic, factory wood, ind. Maintenance, marine, metal cans, metal furn, other special purpose, paper, traffic markings, wood furniture)	No to Use EPA estimates
CO	Degreasing, Dry Cleaning, Graphic Arts, All Surface Coating except Arch Coating)	All covered in point source inv.

S/L/T	Solvent category(s)	Reason to not include in NP Inventory
CT	Dry Cleaning, Consumer & Commercial (adhesives/sealants, automotive aftermarket, coatings, FIFRA, household, personal care, misc.); Surface Coating (arch. Coating, auto refinishing, factory wood, ind. Maintenance, appliances, metal cans, metal furn, other special purpose, railroad, traffic markings)	No to Use EPA estimates
NH	Graphic Arts	All covered in point source inv.
DC	Degreasing, Dry Cleaning, Consumer & Commercial (automotive aftermarket, coatings, FIFRA, household personal care, misc. products, adhesives/sealants), Surface Coatings (arch. Coatings, auto refinishing, ind. Maintenance, misc. manuf., special purpose wood furniture, marine)	No to Use EPA estimates
DE	Surface Coating (motor vehicles, special purpose)	Do not have this type of source
IL	Dry Cleaning	No to use EPA estimates
IA	Consumer & Commercial (adhesive/sealant, automotive aftermarket, coatings, FIFRA, household, personal care, misc); Surface Coating (arch. Coatings)	No to use EPA estimates
KY	Degreasing, Dry Cleaning	All covered in point source inv.
KY	Surface Coating (Ind. Maint, machinery, metal cans, special purpose)	Do not have this type of source
KY	Surface Coating (Aircraft, Electronic, Appliances, Marine, Metal Furniture, Misc. Mfg, Motor Vehicles, paper, railroad)	No to use EPA estimates
Knox County	Consumer & Commercial (adhesives/sealants, auto aftermarket, coatings, FIFRA, household, personal care, misc. products, marine)	No to use EPA estimates
MS	Surface Coating (aircraft, auto refinishing, electronic, factory wood, ind. Maintenance, appliances, machinery, marine, metal cans, metal furn, misc. mfg, motor vehicles, other special purpose, paper, traffic markings, wood furniture)	All covered in point source inv.
NV	Surface Coating (marine)	Do not have this type of source
NH	Surface Coating (large appliances)	Do not have this type of source
NJ	Surface Coating (wood furniture)	Do not have this type of source
NJ	Consumer & Commercial (adhesives/sealants, auto aftermarket, coatings, FIFRA, household, personal care, misc. products), Surface Coating (auto refinishing)	No to use EPA estimates
OH	Surface Coating (architectural coatings)	No to use EPA estimates
OK	Consumer & Commercial (adhesives/sealants, auto aftermarket, coatings, FIFRA, household, personal care, misc. products), Surface Coatings (arch. Coatings, auto refinishing, factory wood, ind. Maintenance, metal cans, metal furniture, special purpose coatings, paper, traffic markings, wood furniture)	No to use EPA estimates
PR	Ag Pesticide, Surface Coating (Metal Cans, metal furniture, paper, railroad, arch. Coatings)	Do not have this type of source
RI	Dry Cleaning	All covered in point source inv.
RI	Surface Coating (motor vehicles)	Do not have this type of source

S/L/T	Solvent category(s)	Reason to not include in NP Inventory
SC	Surface Coating (auto refinishing, ind. Maintenance, traffic markings)	No to use EPA estimates
Washoe County	Surface Coating (factory finished wood, ind. Maintenance coatings, metal furniture, special purpose, railroad)	No to use EPA estimates
WI	Consumer & Commercial (adhesives/sealants, auto aftermarket, coatings, FIFRAZ, household, personal care, misc.products), Surface Coating (arch. Coatings)	No to use EPA estimates
WY	Surface Coating (metal can)	Do not have this type of source

4.23.5 Issues found after release of 2014 v1

The Solvent Tool developers realized that when they updated the HAP speciation factors, they used the incorrect codes for two of the HAP pollutants from traffic markings. They accidentally used the code for methyl isobutyl ketone when they should have used toluene, and further, they used the code for toluene when they should have used xylenes. We plan to correct this for 2014 v2. Another issue noted by Virginia concerns traffic marking and will be corrected for v2.

Suggested Improvements for the Solvents Tool (from the NOMAD Committee)

- HAP point inventory subtraction, even if the S/L/T doesn't provide HAPs
- Standardize the sort of counties/SCCs between tools
- Look into whether additional columns added to the excel sheets will foul up the import feature (as Missouri noted)
- Add a warning screen that point source subtraction should be on an "uncontrolled" basis
- Provide a column in the Emission Factor which give the source of the factors
- Provide a column in the Emission Factor table to show the relationship between VOC and HAP
- Population of an emissions comment field, summarizing all mapped-point source SCCs
- Reporting period comment field to update if updating population

4.24 Waste Disposal: Open Burning

There are three sections in this documentation that discuss nonpoint inventory Waste Disposal. This section discusses Open Burning; the next section discusses Publicly-Owned Treatment Works (POTWs), and the third section was a broad discussion of nonpoint non-combustion sources of mercury (see Section 4.2), which included several Waste Disposal sector sources. The reason these sources are broken up within this EIS sector is because the EPA methodologies for estimating the emissions are different.

4.24.1 Source category description

This sector includes several types of intentional burning for waste disposal purposes, with the exception of agricultural purposes. This source category includes open burning of municipal solid waste, land clearing debris, and different types of yard waste.

4.24.2 Sources of data

Table 4-134 shows, for open burning, the nonpoint SCCs in the 2014 NEI as well as SCCs that the EPA estimates. The SCC level 3 and 4 SCC descriptions are also provided. The SCC level 1 and 2 descriptions are "Waste Disposal, Treatment, and Recovery; Open Burning" for all SCCs.

Table 4-134: Open Burning SCCs with 2014 NEI emissions

EPA Estimate?	SCC	Description
Y	2610000100	All Categories; Yard Waste - Leaf Species Unspecified
	2610000300	All Categories; Yard Waste - Weed Species Unspecified (including Grass)
Y	2610000400	All Categories; Yard Waste - Brush Species Unspecified
Y	2610000500	All Categories; Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)
Y	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)

The agencies listed in Table 4-135 submitted VOC emissions for open burning; agencies not listed used EPA estimates for the entire sector.

Table 4-135: Percentage of Open Burning NO_X, $PM_{2.5}$ and VOC emissions submitted by reporting agency

Region	Agency	S/L/T	SCC	Description	NO_X	$PM_{2.5}$	VOC
1	Vermont Department of Environmental Conservation	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100		100
2	New Jersey Department of Environment Protection	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
2	New Jersey Department of Environment Protection	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
2	New Jersey Department of Environment Protection	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
3	Maryland Department of the Environment	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
3	Maryland Department of the Environment	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
3	Maryland Department of the Environment	State	2610000500	All Categories; Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	34	40	34
3	Maryland Department of the Environment	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
4	Georgia Department of Natural Resources	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	89	89	89
4	Georgia Department of Natural Resources	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	89	89	89

Region	Agency	S/L/T	SCC	Description	NO_X	$PM_{2.5}$	VOC
4	Georgia Department of Natural Resources	State	2610000500	All Categories; Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	97	98	97
4	Georgia Department of Natural Resources	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	89	89	89
4	North Carolina Department of Environment and Natural Resources	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
4	North Carolina Department of Environment and Natural Resources	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
4	North Carolina Department of Environment and Natural Resources	State	2610000500	All Categories; Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	100	100	100
4	North Carolina Department of Environment and Natural Resources	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
5	Illinois Environmental Protection Agency	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
5	Illinois Environmental Protection Agency	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
5	Illinois Environmental Protection Agency	State	2610000500	All Categories; Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	100	100	100
5	Illinois Environmental Protection Agency	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
5	Minnesota Pollution Control Agency	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100		100
6	Texas Commission on Environmental Quality	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
6	Texas Commission on Environmental Quality	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
6	Texas Commission on Environmental Quality	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)			100
7	Sac and Fox Nation of Missouri in Kansas and Nebraska Reservation	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100

Region	Agency	S/L/T	SCC	Description	NO_X	$PM_{2.5}$	VOC
8	Northern Cheyenne Tribe	Tribe	2610000100	All Categories; Yard Waste - Leaf Species Unspecified		100	100
8	Northern Cheyenne Tribe	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)		100	100
8	Northern Cheyenne Tribe	Tribe	2610000400	All Categories; Yard Waste - Brush Species Unspecified		100	100
8	Northern Cheyenne Tribe	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
8	Utah Division of Air Quality	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
8	Utah Division of Air Quality	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
8	Utah Division of Air Quality	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
9	California Air Resources Board	State	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
9	Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
9	Washoe County Health District	Local	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Coeur d'Alene Tribe	Tribe	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Coeur d'Alene Tribe	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Coeur d'Alene Tribe	Tribe	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
10	Coeur d'Alene Tribe	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Idaho Department of Environmental Quality	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Idaho Department of Environmental Quality	State	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Idaho Department of Environmental Quality	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100

Region	Agency	S/L/T	SCC	Description	NO_X	$PM_{2.5}$	VOC
10	Idaho Department of Environmental Quality	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Kootenai Tribe of Idaho	Tribe	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Kootenai Tribe of Idaho	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Kootenai Tribe of Idaho	Tribe	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
10	Kootenai Tribe of Idaho	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Nez Perce Tribe	Tribe	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Nez Perce Tribe	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Nez Perce Tribe	Tribe	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
10	Nez Perce Tribe	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100
10	Washington State Department of Ecology	State	2610000100	All Categories; Yard Waste - Leaf Species Unspecified	100	100	100
10	Washington State Department of Ecology	State	2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)	100	100	100
10	Washington State Department of Ecology	State	2610000400	All Categories; Yard Waste - Brush Species Unspecified	100	100	100

Region	Agency	S/L/T	SCC	Description	NO_X	$PM_{2.5}$	VOC
10	Washington State Department of Ecology	State	2610030000	Residential; Household Waste (use 26-10-000-xxx for Yard Wastes)	100	100	100

4.24.3 EPA-developed emissions for open burning

Land Clearing Debris

Open burning of land clearing debris is the purposeful burning of debris, such as trees, shrubs, and brush, from the clearing of land for the construction of new buildings and highways. Criteria air pollutant (CAP) and hazardous air pollutant (HAP) emission estimates from open burning of land clearing debris are a function of the amount of material or fuel subject to burning per year.

Activity data is taken from US Census Bureau and Federal Highway Administration data, and the amount of material burned is estimated using the county-level total number of acres disturbed by residential, non-residential, and road construction. County-level weighted loading factors were applied to the total number of construction acres to convert acres to tons of available fuel. More details on the underlying data can be found in the detailed documentation located on the FTP site.

Control data for land clearing debris burning are generally in the form of a ban on open burning of waste in a given municipality or county. Counties that were more than 80% urban by land area were assumed not to practice any open burning. Emissions from open burning of land clearing debris in all Colorado counties were assumed to be zero.

Emission factors for CAPs were developed by EPA in consultation with ERTAC, and are based primarily on the AP-42. Emission factors for AHPs come from an EPA Control Technology Center report. Emissions from dioxin congeners are also available, but these are excluded from the NEI due to their uncertainty.

There were several significant changes from the 2011 inventory. This included the utilization of a newer information source to determine the spending per mile and acres disturbed per mile for each roadway type. The previous inventory calculations were based on information from the NC DOT from 2000, while this inventory instead uses data obtained from the FL DOT in 2014.

Additionally, the 80% urban no-burn threshold was based on the ratio of urban to rural population in the 2011 NEI methodology. These ratios were replaced with ratios based on urban and rural land area. In both cases, the data are from the 2010 census.

Residential Household Waste

Open burning of residential municipal solid waste (MSW) is the purposeful burning of MSW in outdoor areas. Criteria air pollutant (CAP) and hazardous air pollutant (HAP) emission estimates for MSW burning are a function of the amount of waste burned per year.

The amount of household MSW burned was estimated using data from EPA's report Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012. The report presents the total mass of waste generated from the residential and commercial sectors in the United States by type of waste for the calendar year 2012. According to the 2010 version of the EPA report, residential waste generation accounts for 55-65 percent of the total waste from the residential and commercial sectors. For the calculation of per capita household waste subject to burning, the median value of 60 percent was assumed. This information was used to calculate a daily estimate of the per capita household waste subject to burning of 1.94 lbs/person/day. Non-combustible waste, such as glass and metals, was not considered to be waste subject to burning. Burning of yard waste is included in SCC 2610000100 and SCC 2610000400; therefore, it is not part of residential MSW. Approximately 25 to 32 percent of all waste that is subject to open burning is actually burned. A median value of 28 percent is assumed to be burned in all counties in the United States.

Since open burning is generally not practiced in urban areas, only the rural population in each county was assumed to practice open burning. More details can be found in the detailed documentation found on the FTP site.

Controls for residential MSW burning are generally in the form of a ban on open burning of waste in a given municipality or county. Counties that were more than 80% urban, by land area, determined by the 2010 U.S. Census data, were assumed not to practice any open burning. Therefore, criteria pollutant and HAP emissions from residential municipal solid waste burning are zero in these counties. In addition, the State of Colorado implemented a state-wide ban on open burning. Emissions from open burning of residential waste in all Colorado counties were assumed to be zero.

Emission factors for CAPs were developed by the U.S. Environmental Protection Agency (EPA) in consultation with the Eastern Regional Technical Advisory Committee and based primarily on the AP-42 report. Emission factors for HAPs are from an EPA Control Technology Center report. Emissions from dioxin congeners are also available, but these are excluded from the NEI due to their uncertainty.

Yard Waste- Leaf and Brush Debris

Open burning of yard waste is the purposeful burning of leaf and brush species in outdoor areas. Criteria air pollutant (CAP) and hazardous air pollutant (HAP) emission estimates for leaf and brush waste burning are a function of the amount of waste burned per year.

The amount of household MSW burned was estimated using data from EPA's report Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012. The report presents the total mass of waste generated from the residential and commercial sectors in the United States by type of waste for the calendar year 2012. According to the 2010 version of the EPA report, residential waste generation accounts for 55-65 percent of the total waste from the residential and commercial sectors. For the calculation of per capita yard waste subject to burning, the median value of 60 percent was assumed. This information was used to calculate a daily estimate of the per capita yard waste of 0.36 lbs/person/day. Of the total amount of yard waste generated, the yard waste composition was assumed to be 25 percent leaves, 25 percent brush, and 50 percent grass by weight.

Open burning of grass clippings is not typically practiced by homeowners, and therefore, only estimates for leaf burning and brush burning were developed. Approximately 25 to 32 percent of all waste that is subject to open burning is actually burned. A median value of 28 percent is assumed to be burned in all counties in the United States.

The per capita estimate was then multiplied by the 2014 population in each county that is expected to burn waste. Since open burning is generally not practiced in urban areas, only the rural population in each county was assumed to practice open burning. The ratio of rural to total population was obtained from 2010 U.S. Census data. This ratio was then multiplied by the 2014 U.S. Census Bureau estimate of the population in each county to obtain the county-level rural population for 2014.

The percentage of forested acres used to adjust for variations in vegetation. The percentage of forested acres per county (including rural forest and urban forest) was then determined. To better account for the native vegetation that would likely be occurring in the residential yards of farming States, agricultural land acreage was subtracted before calculating the percentage of forested acres.

Controls for residential MSW burning are generally in the form of a ban on open burning of waste in a given municipality or county. Counties that were more than 80% urban, by land area, determined by the 2010 U.S. Census data. were assumed not to practice any open burning. Therefore, criteria pollutant and HAP emissions from residential yard waste burning are zero in these counties. In addition, the State of Colorado implemented a state-wide ban on open burning. Emissions from open burning of residential yard waste in all Colorado counties were assumed to be zero.

Emission factors for CAPs were developed by the EPA in consultation with the Eastern Regional Technical Advisory Committee. For leaf burning, emission factors for $PM_{2.5}$ were calculated by multiplying the PM_{10} leaf burning emission factors by the $PM_{2.5}$ to PM_{10} emission factor ratio for brush burning (0.7709). Emission factors for HAPs are from an EPA Control Technology Center report. Emissions from dioxin congeners are also available, but these are excluded from the NEI due to their uncertainty.

4.25 Waste Disposal: Nonpoint POTWs

4.25.1 Source category description

This sector, Publicly Owned Treatment Works (POTW), includes treatment works owned by a state, municipality, city, town, special sewer district, or other publicly owned and financed entity, as opposed to a privately (industrial) owned treatment facility. The definition includes intercepting sewers, outfall sewers, sewage collection systems, pumping, power, and other equipment. The wastewater treated by these POTWs is generated by industrial, commercial, and domestic sources. The SCC that EPA uses for estimated nonpoint emissions is 260020000; the SCC description is “Waste Disposal, Treatment, and Recovery; Wastewater Treatment; Public Owned; Total Processed”.

4.25.2 Sources of data

The agencies listed in Table 4-136 submitted VOC emissions for POTWs; agencies not listed used EPA estimates for the entire sector.

Table 4-136: Percentage of nonpoint POTW VOC and $PM_{2.5}$ emissions submitted by reporting agency

Region	Agency	S/L/T	VOC	$PM_{2.5}$
1	Maine Department of Environmental Protection	State	100	
1	Vermont Department of Environmental Conservation	State	100	
2	New York State Department of Environmental Conservation	State	100	
3	Maryland Department of the Environment	State	100	
4	Knox County Department of Air Quality Management	Local	100	
4	Metro Public Health of Nashville/Davidson County	Local	100	
5	Illinois Environmental Protection Agency	State	100	
5	Michigan Department of Environmental Quality	State	100	
5	Ohio Environmental Protection Agency	State	100	
6	Texas Commission on Environmental Quality	State	100	

Region	Agency	S/L/T	VOC	$PM_{2.5}$
8	Utah Division of Air Quality	State	100	
9	Clark County Department of Air Quality and Environmental Management	Local		100
9	Washoe County Health District	Local	100	
10	Coeur d'Alene Tribe	Tribe	100	
10	Idaho Department of Environmental Quality	State	100	
10	Kootenai Tribe of Idaho	Tribe	100	
10	Nez Perce Tribe	Tribe	100	
10	Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	Tribe	100	
10	Washington State Department of Ecology	State	100	

4.25.3 EPA-developed emissions for nonpoint POTWs

The general approach to calculating 2014 emissions for POTWs is to multiply the 2012 flow rate by the emission factors for VOCs, ammonia, and 53 HAPs. The emissions are allocated to the county level using methods described below. More details including references to the documentation can be found at ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint.

4.25.3.1 *Activity data*

The EPA Clean Watersheds Needs Survey reports the existing flow rate in 2012 for POTWs as 28,296 million gallons per day (MMGD). The nationwide flow rate includes Puerto Rico and the U.S. Virgin Islands. Flow rates were allocated to each county by the county proportion of the U.S. population.

It should be noted that the derivation of the nationwide flow rate for the 2014 nonpoint POTW emissions inventory differs from the derivation of the nationwide flow rate used to estimate year 2011 nonpoint POTW emissions. The methodology for the 2011 nonpoint POTW emissions inventory used a projected 2010 nationwide flow rate of 39,780 MMGD that was available from an EPA report. The projection was based on Needs Surveys from 1984 to 1996. The 2012 nationwide flow rate used for the 2014 inventory is not a projection, but a value directly reported by the 2012 Needs Survey.

4.25.3.2 *Emission Factors*

The ammonia emission factor was obtained from a report to EPA, while the VOC emission factor was based on a TriTAC study. Emission factors for the 52 HAPs were derived using 1996 area source emissions estimates that were provided by ESD and the 1996 nationwide flow rate. These HAP emission factors were then multiplied by the 2008 to 2002 VOC emission factor ratio (0.85/9.9) to obtain the final HAP emission factors applied in the 2014 inventory.

4.25.3.3 *Emissions calculation*

Emissions per county for a given pollutant were computed by multiplying the pollutant emission factor (lb/million gallon) by the county flow rate (million gallons). This process was repeated for all counties in the U.S., Puerto Rico, and the U.S. Virgin Islands, and the result was pollutant specific nonpoint POTW county-level emissions.

The next step was to determine whether there are POTW point source emissions and to subtract those point source emissions from the total nonpoint emissions. The EIS was queried for POTW point sources, and the resulting output contained facility-level HAP and CAP emissions in fifteen states. The fifteen states were: CA,

CO, FL, IA, IL, MA, MD, MI, MN, NC, NJ, NY, PA, TN, and TX. The facility-level point source emissions were summed to county and pollutant, and then were subtracted from the nonpoint POTW emissions by county and pollutant. For counties where the point source emissions were larger than the corresponding nonpoint emissions, the nonpoint emissions were set to zero.

5 Nonroad Equipment – Diesel, Gasoline and Other

Although "nonroad" is used to refer to all transportation sources that are not on-highway, this section addresses nonroad equipment other than locomotives, aircraft, or commercial marine vessels. Locomotive emissions from railyards and aircraft and associated ground support equipment are described in Section 3. Section 4 includes descriptions of the nonpoint portion of locomotives and the commercial marine vessel emissions.

5.1 Sector Description

This section deals specifically with emissions processes calculated by the EPA's NONROAD2008 model [ref 1] and the family of off-road models used by California [ref 2]. They include nonroad engines and equipment, such as lawn and garden equipment, construction equipment, engines used in recreational activities, portable industrial, commercial, and agricultural engines. Nonroad equipment emissions are included in every state, the District of Columbia, Puerto Rico, and the Virgin Islands.

Nonroad mobile source emissions are generated by a diverse collection of equipment from lawn mowers to locomotive support. NONROAD estimates emissions from nonroad mobile sources using a variety of fuel types as shown in Table 5-1.

Table 5-1: MOVES-NONROAD equipment and fuel types

Equipment Types	Fuel Types
Recreational Construction Industrial Lawn and Garden Agriculture Commercial Logging Airport Ground Support Equipment (GSE) (excludes aircraft)* Underground Mining Oilfield Pleasure Craft (recreational marine) (excludes commercial marine vessels) Railroad (excludes locomotives)	Compressed Natural Gas (CNG) Diesel Gasoline Liquified Petroleum Gas (LPG)

*Although NONROAD2008 estimates GSE, the results are not used in the NEI. NEI GSE estimates are instead calculated via the Federal Aviation Administration's Emission and Dispersion Modeling System (EDMS).

5.2 MOVES-NONROAD

NONROAD2008, the latest public release of EPA's NONROAD Model, estimates daily emissions for total hydrocarbons (THC), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), particulate matter 10 microns and less (PM_{10}), and sulfur dioxide (SO_2), as well as calculating fuel consumption. MOVES2014a (version 20151201) [ref 2] uses ratios from some of these emissions to calculate emissions for particular matter 2.5 microns and less ($PM_{2.5}$), methane, ammonia (NH_3), 4 more aggregate hydrocarbon groups (NMHC, NMOG, TOG, and VOC), 14 hazardous air pollutants (HAPs), 17 dioxin/furan congeners, 32 polycyclic aromatic hydrocarbons, and 6 metals. For a complete list of these pollutants, see Table 5-2. All of the input and activity data required to run MOVES-NONROAD are contained within the Motor Vehicle Emissions Simulator (MOVES) default database, which is distributed with the model. State- and county-specific data can be used by creating a supplemental database known as a county database (CDB) and specifying it in the MOVES run specification (runspec). State, local and tribal (S/L/T) agencies can update the data within the CDBs to produce emissions estimates that accurately reflect local conditions and equipment usage. MOVES first uses the data in the CDBs and fills in any missing data from the MOVES default database.

MOVES-NONROAD is the new way of running NONROAD2008. Nonroad emissions for previous NEIs have been produced by running NONROAD2008 for all U.S. counties using the National Mobile Inventory Model (NMIM) [ref 4]. Now superseded by MOVES, NMIM was the EPA's consolidated mobile emissions estimation system that allowed the EPA to produce nonroad mobile emissions in a consistent and automated way for the entire country. NMIM was basically a user interface for NONROAD2008. It took data from the NMIM County Database (NCD) and used it to write input files for NONROAD2008 (called "opt" files), executed NONROAD2008, picked up the output, and put it into a MySQL database. It also generated additional pollutant estimates as ratios to those produced by NONROAD. As part of the EPA's continuing efforts to upgrade the NONROAD model, it was moved from NMIM into MOVES2014. Although MOVES is primarily a user interface for NONROAD, just as NMIM was, data are now stored in standard MySQL tables, the same as for the onroad sources, which are much easier to access and update than the original NONROAD ASCII files. The transfer to MOVES was tested by verifying that the NONROAD model and MOVES2014 produced identical results for the species produced by stand-alone NONROAD (THC, CO, CO_2, NOx, SO_2, PM_{10}, and fuel consumption). MOVES-NONROAD also includes improved estimation of HAPs, which are creating by post-processing NONROAD2008 output. MOVES2014-NONROAD produced THC, NOx, PM_{10}, $PM_{2.5}$, CO, SO_2, NH_3, CO_2, and fuel consumption. MOVES2014a added the ability to calculate all of the species mentioned above and listed in Table 5-2. At the same time, it based these calculations on much newer and better data than had been used in NMIM [refs 5,6].

Table 5-2: Pollutants produced by MOVES-NONROAD for 2014 NEI

Pollutant ID	Pollutant Name	Pollutant ID	Pollutant Name
1	Total Gaseous Hydrocarbons	83	Phenanthrene particle
2	Carbon Monoxide (CO)	84	Pyrene particle
3	Oxides of Nitrogen (NOx)	86	Total Organic Gases
5	Methane (CH_4)	87	Volatile Organic Compounds
20	Benzene	88	NonHAPTOG
21	Ethanol	90	Atmospheric CO_2
22	MTBE	99	Brake Specific Fuel Consumption (BSFC)
23	Naphthalene particle	100	Primary Exhaust PM_{10} - Total
24	1,3-Butadiene	110	Primary Exhaust $PM_{2.5}$ - Total
25	Formaldehyde	130	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin
26	Acetaldehyde	131	Octachlorodibenzo-p-dioxin
27	Acrolein	132	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin
30	Ammonia (NH_3)	133	Octachlorodibenzofuran
31	Sulfur Dioxide (SO_2)	134	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin
40	2,2,4-Trimethylpentane	135	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin
41	Ethyl Benzene	136	2,3,7,8-Tetrachlorodibenzofuran
42	Hexane	137	1,2,3,4,7,8,9-Heptachlorodibenzofuran
43	Propionaldehyde	138	2,3,4,7,8-Pentachlorodibenzofuran

Pollutant ID	Pollutant Name	Pollutant ID	Pollutant Name
44	Styrene	139	1,2,3,7,8-Pentachlorodibenzofuran
45	Toluene	140	1,2,3,6,7,8-Hexachlorodibenzofuran
46	Xylene	141	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin
60	Mercury Elemental Gaseous	142	2,3,7,8-Tetrachlorodibenzo-p-Dioxin
61	Mercury Divalent Gaseous	143	2,3,4,6,7,8-Hexachlorodibenzofuran
62	Mercury Particulate	144	1,2,3,4,6,7,8-Heptachlorodibenzofuran
63	Arsenic Compounds	145	1,2,3,4,7,8-Hexachlorodibenzofuran
65	Chromium 6+	146	1,2,3,7,8,9-Hexachlorodibenzofuran
66	Manganese Compounds	168	Dibenzo(a,h)anthracene gas
67	Nickel Compounds	169	Fluoranthene gas
68	Dibenzo(a,h)anthracene particle	170	Acenaphthene gas
69	Fluoranthene particle	171	Acenaphthylene gas
70	Acenaphthene particle	172	Anthracene gas
71	Acenaphthylene particle	173	Benz(a)anthracene gas
72	Anthracene particle	174	Benzo(a)pyrene gas
73	Benz(a)anthracene particle	175	Benzo(b)fluoranthene gas
74	Benzo(a)pyrene particle	176	Benzo(g,h,i)perylene gas
75	Benzo(b)fluoranthene particle	177	Benzo(k)fluoranthene gas
76	Benzo(g,h,i)perylene particle	178	Chrysene gas
77	Benzo(k)fluoranthene particle	181	Fluorene gas
78	Chrysene particle	182	Indeno(1,2,3,c,d)pyrene gas
79	Non-Methane Hydrocarbons	183	Phenanthrene gas
80	Non-Methane Organic Gases	184	Pyrene gas
81	Fluorene particle	185	Naphthalene gas
82	Indeno(1,2,3,c,d)pyrene particle		

5.3 Default MOVES code and database

The nonroad runs were executed using MOVES2014a, the most current publically-released version of MOVES available at the time. The code version for this release is moves20151201. A modification was made to one Java class (ApplicationRunner) to allow MOVES to run NONROAD2008 on a Linux distributed processing system. This change had no effect on the modeling output and will be included in all future versions of MOVES. The code with the change is referred to as moves20151201a. The default database is movesdb20151201, the same one released publically with MOVES2014a. When NONROAD2008 was incorporated into MOVES, the default data built into NONROAD2008 was converted to MySQL tables and included in movesdb20151201.

5.4 Additional Data: NONROAD County Databases (CDBs)

MOVES uses county databases (CDBs) to provide detailed local information for developing nonroad emissions. The EPA encouraged S/L/T agencies to submit MOVES-NONROAD CDBs to the Emission Inventory System (EIS) for the 2014 NEI. To facilitate the transition from NMIM to MOVES, the EPA also accepted NONROAD inputs in the old format of the NCD. The NCD inputs were converted to CDBs in MOVES format. Data not provided in CDBs is automatically supplied from the MOVES default database. As is also true for MOVES onroad runs, even if an agency submitted fuel or meteorological data, the EPA's values for these data parameters were used. The fuels were those in the MOVES default database for MOVES2014a, movesdb20151201 (see also Section 6.6.2.3). The meteorological data were provided by OAQPS and were derived from a Weather Research and Forecasting Model (WRF) [ref 7] run.

Table 5-3 shows the selection hierarchy for the nonroad data category. The MOVES default database for MOVES2014a (movesdb20151201) and state-submitted inputs in CDBs were used to run MOVES-NONROAD to produce emissions for all states other than California. California-submitted emissions were used.

Table 5-3: Selection hierarchy for the Nonroad Mobile data category

Priority	Dataset	Notes
1	S/L/T-supplied emissions	Several tribes submitted NONROAD emissions. California used their own model, OFFROAD. (Texas ran NONROAD2008 using their data. These data are present in EIS, but were not selected for the 2014NEI. Texas also supplied NCD inputs which were converted and used in MOVESNONROAD)
2	S/L/T-supplied input data from 2014 NEI process	
3	S/L/T-supplied input data from previous NEIs	
4	Movesdb20151201	All data from Movesdb20151201

The EPA asked S/L/T agencies to provide model inputs (CDBs or NCDs) instead of emissions for 2014. However, some agencies also submitted nonroad emissions. Table 5-4 shows the S/L/T agencies that submitted nonroad emissions and/or activity data for the 2014 NEI via the EIS Gateway. The NCDs all went into the database NCD20160513_nei2014v1, which was used to run NMIM to compare with the MOVES-NONROAD runs. Most of the state- and county-specific data in this NCD was converted to CDBs for the MOVES run. The NCD20160513_nei2014v1 database also contained data which had been submitted by S/L/Ts previously, primarily for the 2011 NEI. This S/L/T data were also converted to CDBs for the MOVES-NONROAD runs. Table 5-4 shows all the states for which either CDBs were submitted or created from the NCD20160513_nei2014v1 database. The latter includes those submitted for 2014 and those submitted in earlier NEI processes. If a CDB was supplied as part of the 2014 NEI process, earlier data from NCD20160513_nei2014v1 that was converted to CDBs was not used. Only Texas submitted valid NCD data for 2014. Florida submitted a nonroad NCD, but it contained only onroad data. Several allocation files were submitted for Pima County (Arizona) that assigned all of the state's activity to that county, so it was not used. The user-supplied allocation files incorrectly have set the state total surrogates the same as Pima. Since equipment activity and population was not supplied with the Pima submission, the result is that the whole state population is assigned to Pima County. Our solution to this problem was to use the MOVES results for Arizona without rerunning. Although there is probably some good information in the Pima submission, timing prohibited its use. Their submission is for 2014, whereas the default data that was included was for 2002, so changing state totals to match 2002 would not be correct and therefore it was not used.

Table 5-4: Nonroad Mobile S/L/T submissions for the 2014 NEI

Agency Organization	State
2014 Nonroad Emissions	
California Air Resources Board	CA
Coeur d'Alene Tribe	ID

Agency Organization	**State**
Kootenai Tribe of Idaho	ID
Metro Public Health of Nashville/Davidson County	TN
Nez Perce Tribe	ID
Northern Cheyenne Tribe	MT
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho	ID
Texas Commission on Environmental Quality	TX
2014 Nonroad CDB	
Illinois Environmental Protection Agency	IL
New York State Department of Environmental Conservation	NY
North Carolina Department of Environment and Natural Resources	NC
Washington State Department of Ecology	WA
Washoe County Health District	NV
2014 Nonroad NCD*	
Texas Commission on Environmental Quality	TX

* Florida submitted a Nonroad NCD, but it contained only onroad data. Several allocation files were submitted for Pima County that assigned all of the state's activity to that county, so it was not used.

Table 5-5: States for which one or more CDBs were created from NCD20160513_nei2014v1 and for which NONROAD files were included

Name	**FIPS**	**Pop**	**Act**	**Alo***	**Grw**	**Sea**
Colorado	08			1		
Connecticut	09	X				
Delaware	10	X		17		
Georgia	13			10		
Illinois	17	X	X	2	X	X
Indiana	18	X	X	2	X	X
Iowa	19		X	2		X
Maryland	24	X				
Michigan	26	X	X	2	X	X
Minnesota	27		X	3	X	X
Nevada	32			10		
New Hampshire	33	X				
New Jersey	34	X				
New York	36			1		
North Carolina	37					X
Ohio	39	X	X	2	X	X
Rhode Island	44	X				
Texas	48	X	X	19	X	X
Washington	53			2		
Wisconsin	55	X	X	2	X	X

Name	FIPS	Pop	Act	Alo*	Grw	Sea
* "Alo" is allocation of equipment population from state to county, based on one of 19 possible surrogates. The number in the "Alo" column is the number of files, one for each surrogate. "Act" is activity in hours per year. "Pop" is equipment population. "Grw" is growth of population from a number of base years. MOVES will use the correct surrogate and closest base year. "Sea" (seasonality) is temporal allocation of activity to different seasons. In MOVES, this allocation is by month and state. "FIPS" is the 2-digit Federal Information Processing Standard state code.						

The 320 submitted CDBs used for the MOVES-NONROAD run are collected together in NonroadCDBs.zip in the NRSupplementalData folder. CDBs were used only for states/counties that submitted CDBs or NCDs, including submissions prior to 2014. The rest were run using the MOVES default database, which does not require CDBs. A list of all 3,224 U.S. counties and their corresponding CDBs, if any, is available in nonroad_counties_nei2014v1_FinalList.xlsx. The contents of the NRSupplementalData folder are listed in Table 5-6.

Table 5-6: Contents of the Nonroad Mobile supplemental folder

File or Folder	Description
2014v1_NonroadCDBs.zip	Submitted CDBs used to run MOVES-NONROAD.
2014v1_nonroad_counties_nei2014v1_FinalList.xlsx	List of all counties and their CDBs.
2014v1_zonemonthhour2014.zip	Zonemonthhour table (meteorology data).
2014v1_NonroadRunspecs.zip	6,448 runspecs.
2014v1_NmimToMovesConversion.zip	Folder containing two subfolders corresponding to the two steps of the NMIM to MOVES conversion.
TextFilesToIntermediateTables\	Folder containing documentation for the first step of the NMIM to MOVES conversion.
SeparateNRExtFiles.plx	Separates the external files from the NCD into county or state FIPS on which the Python script operates.
RunProcessNRTxtFiles.bat	Runs ProcessNRTxtFiles.exe (Python program) on NONROAD text files.
NonroadProcessTextFilesDist.zip	The Python program that converts NONROAD2008 ASCII data files to MySQL tables. This zip file contains all of the python code needed to run the tool from the command line (in addition the script used to create the .EXE and unit test scripts that prove the code works as intended).
IntermediateTablesToMovesTables\	Folder containing documentation for the second step of the NMIM to MOVES conversion.
SQLScripts\	Scripts to convert the intermediate MySQL tables to MOVES tables. These are called by the Perl script below.
GenerateMovesNrCDBs.plx	Perl script that generates the NR CDBs and calls the SQL scripts above to populate them.
2014v1_NCD20160513_nei2014v1_nrextfiles.zip	The NONROAD files from the external files folder of NCD20160513_nei2014v1.
2014v1_postprocess_nrnei_20160523.jar	Post-processing scripts for MOVES runs.
2014v1_EICtoEPA_SCCmapping.xlsx	File mapping California emission inventory codes (EICs) to EPA SCCs.
2014v1_tribes_moblie.xlsx	Tribal mobile emissions submittal summary.

5.5 Conversion of NMIM NCDs to MOVES CDBs

Conversion from NMIM NCDs to MOVES CDBs was done in two steps. First, the data packets in the NCD ASCII files were converted into intermediate MySQL tables with the same column headings. Second, the resulting MySQL tables were converted into MOVES tables and stored in the correct CDB.

The state- and county-specific custom data files that NONROAD2008 uses are text files that are stored in a folder called ExternalFiles within the NCD. It is these text files that the S/L/T agencies submit. The files are activity (hours per year by SCC and horsepower category), allocation files (allocation of equipment population from state to county level), growth, population, and seasonality (how equipment usage varies with season). These data files may be found in the NCD20160513_nei2014v1_nrextfiles folder in the online NRSupplementalData folder. All the NRSupplemental data and scripts are listed in Table 5-6. The NR external files contain one or more "packets" of data. Table 5-7 shows the data files and the packets they contain. These packets were converted by a Python program (ProcessNRTxtFiles.py) into Intermediate MySQL tables, as shown in Table 5-8.

Table 5-7: Conversion of NONROAD data files to MOVES tables

NR data file	NONROAD data file packet	Intermediate MySQL tables	MOVES tables
Pop	Population	Population*	nrbaseyearequippopulation
Act	Activity	Activity*	nrsourceusetype
Alo	Indicators	Allocation*	nrstatesurrogate
Grw	Indicators Growth Scrappage Alternate scrappage	Growthindicators Growth* Growthscrappage Growthaltscrappage	Nrgrowthindex
Sea	Regions Monthly Daily	Region Monthlyadjfactors* Dailyadjfactors*	 nrmonthallocation nrdayallocation

*These are the intermediate MySQL tables that were converted into MOVES tables by the scripts listed in Table 5-8.

Table 5-8: MySQL scripts to convert intermediate to MOVES tables

Script	Comment
GenerateMovesNr_activity.sql	If pop is provided
GenerateMovesNR_activity_nopop.sql	If pop is not provided
GenerateMovesNr_allocation.sql	
GenerateMovesNr_dailyadjfactors.sql	
GenerateMovesNr_growth.sql	Converts only the "Growth" packet
GenerateMovesNr_monthlyadjfactors.sql	
GenerateMovesNr_population.sql	

The intention was to convert all intermediate tables to MOVES tables, but time and resource limitations restricted us to the most important tables. Only Texas submitted NCDs for 2014.

5.6 MOVES runs

In the online NRSupplementalData folder, the Excel® file nonroad_counties_nei2014v1_FinalList.xlsx lists all 3,224 counties and their corresponding CDBs. If no CDB was listed for a county, that county was run with the MOVES default database for MOVES2014a (movesdb20151201). The NRSupplemental Data is listed in Table 5-6.

There were 16 unique state CDBs and 304 unique county CDBs from five states. We constructed the MOVES runspecs so that if a state CDB existed, it was included first, followed by a county CDB. There was only one county with both state and county CDBs. There were 16+304 = 320 CDBs used in the full MOVES-NONROAD run. The CDBs that were used are in nei2014v1_CDBs in the online NRSupplementatalData folder

MOVES was run for each county, using two runspecs: one for diesel equipment, which included horsepower output, and one for all other fuels without horsepower output. All the runspecs are in the NonroadRunspecs folder in the online NRSupplementatalData folder. The MOVES-NONROAD runs were checked for completeness and absence of error messages in the run logs. The output was post-processed to consolidate each county into a single database and to produce SMOKE-ready output. The scripts that performed these processes are in postprocess_nrnei_20160523.jar in the online NRSupplementatalData folder. The MOVES runs created monthly inventories for every U.S. county and post-processing was also done on these monthly outputs.

The following additional steps were taken on the monthly MOVES nonroad outputs to prepare data for loading into EIS:

1. The gas and particle components of PAHs (e.g., Chrysene, Fluorene) were combined.
2. The individual mercury species were combined into total mercury (i.e., pollutant 7439976).
3. Modes for exhaust and evaporative were removed from pollutant names and separated out into the emis_type data field in flat file 2010 files that were then loaded into EIS.
4. Pollutants produced by MOVES but not accepted in the NEI were removed (e.g., ethanol, NONHAPTOG, and total hydrocarbons).
5. Five speciated $PM_{2.5}$ species were added based on speciation profiles (i.e., elemental carbon, organic carbon, nitrate, sulfate and other $PM_{2.5}$). See Section 2.2.5.
6. DIESEL-PM10 and DIESEL-PM25 were added by copying the PM_{10} and $PM_{2.5}$ pollutants (respectively) as DIESEL-PM pollutants for all diesel SCCs. See Section 2.2.5.
7. Airport ground support equipment emissions were removed.
8. Bedford City, Virginia emissions were combined with Bedford County, Virginia emissions.
9. Incorporated California-submitted nonroad emissions.

5.7 NMIM Runs

For comparison purposes, NMIM was run using the NCD20160513_nei2014v1 database. We checked to ensure that no error messages were created during the runs for each geographical area. Furthermore, NMIM generates the same number of output records for each RunID-FIPSCountyID-FIPSStateID-Year-Month combination. Therefore, we confirmed that each output table included the correct number of records for this combination of fields. As with the MOVES runs, the NMIM runs were post-processed to produce monthly inventories for every U.S. county in SMOKE-ready format.

5.8 Quality Assurance: Comparison with NMIM

We compared the MOVES-NONROAD results to the NMIM results. SO_2 was valuable as a comparison species because nearly zero differences in results were expected if activity inputs were the same. Thirty-nine states showed SO_2 differences less than 0.01 percent. Table 5-9 shows the fourteen states that had SO_2 differences greater than 0.01 percent.

Table 5-9: States with absolute percent difference (MOVES-NMIM) > 0.01% for SO_2 exhaust*

State FIPS Code	State	MOVES - NMIM % diff	2014 CDB	NCD
36	New York	-29.743%	X	
4	Arizona	-29.684%		
53	Washington	-24.787%	X	
37	North Carolina	-10.399%	X	
17	Illinois	-9.956%	X	
39	Ohio	7.696%		grw
2	Alaska	6.248%		
27	Minnesota	5.819%		grw
55	Wisconsin	5.145%		grw
26	Michigan	1.637%		grw
24	Maryland	1.376%		pop
48	Texas	-0.040%		grw
18	Indiana	-0.039%		grw
33	New Hampshire	-0.019%		pop

* Sorted in order of decreasing absolute difference

We investigated the reasons behind the larger observed SO_2 differences. The large differences for states that submitted CDBs (-10 percent to -30 percent, in Illinois, New York, North Carolina, and Washington) are attributed to those submittals. Submitted CDBs were expected to contain different data than NCD20160513_nei2014v1. Some states with differences of 2 percent to 8 percent (Michigan, Minnesota, Ohio, and Wisconsin) are attributed to NCD growth files that were only partially converted to CDBs. There are four data packets in the NONROAD growth file. Due to resource limitations, a conversion script was written for only one of them (see Section 5.5). The region packet in the seasonality file did not require conversion because in MOVES, every state has its own seasonality, as defined in the nrmonthallocation table. The growth packets that were not converted for 2014NEIv1 will be converted for the 2014NEIv2.

A NCD for Pima County, Arizona, was submitted, which was used to produce the NMIM results. However, this NCD included allocation files with Pima County allocation surrogates set equal to the state total. The result was that all of the state's emissions were assigned to Pima county, while reasonable allocations were assigned to other counties. Because of this error, the MOVES run was performed without using data from the submittal. As a result, the differences between the MOVES-NONROAD and NMIM-based runs were nearly 30 percent.

In Alaska, between 2007 and 2008, three counties were eliminated and five new ones formed. The eliminated county FIPS codes were 02201, 02232, and 02280. The newly formed county FIPS codes were 02105, 02195, 02230, 02195, and 02198. The NMIM counties were correct, but produced zero emissions for the five new counties. Therefore, MOVES was 6 percent higher. The 24 Alaska counties for which NMIM produced SO_2 emissions agreed exactly with MOVES.

Comparing MOVES and NMIM for states with good agreement in SO_2 (Table 5-10) demonstrates differences due to effects other than activity. Differences in VOC and HAPs were expected since they are both post-processed from THC, and MOVES uses newer emission factor data than NMIM [ref 8]. The HAPs generally increased dramatically, which is reflected in the overall increase shown in the table (the sum of 52 species). NOx increased slightly and CO decreased slightly due to a change in the conversion factor of ethanol volume percent to oxygen weight percent from 0.3448 in NMIM [ref 9] to 0.3653 in MOVES. The direction and small size of these changes was expected. Overall, the changes in criteria air pollutants (CAPs) are small, and provide confidence that the transfer of NONROAD2008 from NMIM to MOVES was successful. We have examined the large changes in HAPs individually and confirmed that these changes agree with our updates.

In addition to the comparison of NMIM and MOVES, county plots of NOx, SO_2, and VOC for of 2014 MOVES were compared and reviewed, along with comparison plots and spreadsheets of 2014 NMIM versus 2011NEIv2. County plots of MOVES nonroad activity hours and population along with plots of NOx emissions per unit activity by nonroad category (agriculture, industrial, lawn and garden, etc) were also developed and reviewed.

Table 5-10: Comparison of NMIM to MOVES-NONROAD*

Pollutant Code	Pollutant Name	Percent Difference
CO	CO	-1.28%
CO2	CO2	0.98%
NH3	NH3	0.00%
NOX	NOx	0.34%
PM10-PRI	PM10-PRI	0.00%
PM25-PRI	PM25-PRI	0.00%
SO2	SO_2	0.00%
VOC	VOC	-1.68%
200	Mercury Elemental Gaseous	23.64%
201	Mercury Divalent Gaseous	14.58%
202	Mercury Particulate	2.02%
50000	Formaldehyde	103.17%
50328	Benzo(a)pyrene	1122.47%
53703	Dibenzo(a,h)anthracene	1383.69%
56553	Benz(a)anthracene	612.21%
71432	Benzene	26.70%
75070	Acetaldehyde	63.19%
83329	Acenaphthene	675.35%
85018	Phenanthrene	702.97%
86737	Fluorene	494.41%
91203	Naphthalene	300.49%
100414	Ethyl Benzene	61.64%
100425	Styrene	182.84%
106990	1,3-Butadiene	61.39%
107028	Acrolein	306.56%
108883	Toluene	32.78%
110543	Hexane	31.90%
120127	Anthracene	419.28%
123386	Propionaldehyde	49.94%
129000	Pyrene	269.93%
191242	Benzo(g,h,i)perylene	841.48%
193395	Indeno(1,2,3,c,d)pyrene	1065.88%
205992	Benzo(b)fluoranthene	928.25%

Pollutant Code	Pollutant Name	Percent Difference
206440	Fluoranthene	273.50%
207089	Benzo(k)fluoranthene	989.73%
208968	Acenaphthylene	574.35%
218019	Chrysene	777.29%
540841	2,2,4-Trimethylpentane	149.54%
1330207	Xylene	5.59%
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	-96.58%
3268879	Octachlorodibenzo-p-dioxin	-100.00%
7439965	Manganese Compounds	-0.13%
7440020	Nickel Compounds	-4.50%
7440382	Arsenic Compounds	-84.51%
18540299	Chromium 6+	-97.18%
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	-99.93%
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	-99.99%
39001020	Octachlorodibenzofuran	-100.00%
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	-99.88%
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	-98.45%
51207319	2,3,7,8-Tetrachlorodibenzofuran	-99.01%
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran	-99.98%
57117314	2,3,4,7,8-Pentachlorodibenzofuran	-98.72%
57117416	1,2,3,7,8-Pentachlorodibenzofuran	-99.76%
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran	-99.67%
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	-99.31%
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran	-99.81%
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran	-99.94%
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran	-99.83%
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran	-99.77%

* Differences from the 39 states for which SO_2 was within 0.01%. Positive values mean MOVES is larger.

5.9 Use of California Submitted Emissions

California submitted nonroad emissions for EPA's use in the NEI, and we used these emissions directly. Prior to preparing the emissions for submission, the California Air Resources Board (CARB) updated the mapping of their EICs to EPA's detailed SCCs used for emissions modeling that include the off network, on-network, and brake and tire wear categories. CARB provided their HAP and CAP emissions by county using these more detailed SCCs. The updated version of the mapping is posted with the supplemental data in the Excel file 2014v1_EICtoEPA_SCCmapping.xlsx. In addition, CO_2 data were added to the California data based on EPA estimates, because CO_2 emissions were not provided in the submission. We also speciated CARB total $PM_{2.5}$ and PM_{10} using the same approach as for other states (see Section 5.6) and copied the $PM_{2.5}$ and PM_{10} to DIESEL-PM "pollutants" for all diesel SCCs.

5.10 References for nonroad mobile

1. NONROAD2008, its documentation and technical reports can be found here: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.
2. CARB's group of models for off-road equipment may be linked to from this site: https://www.arb.ca.gov/msei/categories.htm.
3. MOVES2014a, its default database, documentation and technical reports can be found here: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.
4. NMIM, its documentation and tech reports can be found here: https://www.epa.gov/moves/national-mobile-inventory-model-nmim.
5. Speciation Profiles and Toxic Emission Factors for Nonroad Engines, EPA-420-R-15-019, November 2015 (https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NOC7.pdf).
6. Lawrence Reichle, Rich Cook, Catherine Yanca, and Darrell Sonntag. Development of Organic Gas Exhaust Speciation Profiles for Nonroad Spark Ignition and Compression Ignition Engines and Equipment. 2015. *Journal of the Air and Waste Management Association*, 65: 1185-1193.
7. Detailed information on The Weather Research & Forecasting Model (WRF) may be found here: http://www.wrf-model.org/index.php and here: Skamarock, W.C., et al., National Center for Atmospheric Research, Mesoscale and Microscale Meteorology Division, Boulder CO, June 2008, NCAR/TN-475+STR, A Description of the Advanced Research WRF Version 3, http://www2.mmm.ucar.edu/wrf/users/docs/arw_v3.pdf.
8. Speciation of Total Organic Gas and Particulate Matter Emissions from On-road Vehicles in MOVES2014 (PDF) (75 pp, 1.2MB, EPA-420-R-15-022, November 2015). This document is available at https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NOJG.pdf.
9. *EPA's National Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD,* EPA420-R-05-024, December 2005. This document is available at https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10023FZ.pdf.

6 MobileOnroad – All Vehicles and Refueling

6.1 Sector description

Onroad mobile sources include emissions from motorized vehicles that are normally operated on public roadways. This includes passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses. The sector includes emissions generated from parking areas as well as emissions while the vehicles are moving. The sector also includes "hoteling" emissions, which refers to the time spent idling in a diesel long-haul combination truck during federally-mandated rest periods of long-haul trips.

The 2014 NEI v1 is comprised of emission estimates calculated based on the MOVES model run with S/L/T-submitted activity data when provided, except for California and tribes, for which the NEI includes submitted emissions.

6.2 Sources of data and selection hierarchy

The EPA calculated the onroad emissions for 2014 v1 for all states using the most recently released version of MOVES, MOVES2014a (code version: 20151201, database version: movesdb20151028). The sources of MOVES input data vary by area, representing a mix of local data, past NEI data, and some MOVES defaults. More state and local agencies than ever before submitted local input data for MOVES. The S/L/T agencies that submitted data for 2014 are listed below in Section 6.8. The EPA used programs within the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system that integrate with MOVES to generate the emission inventories in the lower 48 states for each hour of the year. These emissions are summed over all hours and across road types to develop the emissions for the NEI. For areas outside the continental U.S. (AK, HI, Virgin Islands, and Puerto Rico), the EPA ran MOVES in *Inventory Mode* (rather than with SMOKE-MOVES) to directly estimate emissions[15]. For the state of California, the EPA used onroad emissions provided by California based on the EMFAC model.

As in past NEIs, the data selection hierarchy for 2014 v1 favored local input data over default information. For areas that did not submit a MOVES CDB for this NEI, the EPA projected the corresponding CDB from the most recent version (2011 v2) from year 2011 to 2014. In all projected CDBs, the EPA updated the older 2011 vehicle miles travelled (VMT), population, and hoteling activity with new activity specific to 2014, described in Section 6.6.4.

6.3 California-submitted onroad emissions

California is the only state agency for which an onroad emissions submittal was used in the 2014 NEI v1. California uses their own emission model, EMFAC, which uses EICs instead of SCCs. The EPA and California worked together to develop a code mapping to better match EMFAC's EICs to EPA MOVES' detailed set of SCCs that distinguish between off-network and on-network and brake and tire wear emissions. This detail is needed for modeling but not for the NEI, because the NEI uses simplified/more aggregated SCCs than used in modeling. This code mapping is provided in "2014v1_EICtoEPA_SCCmapping.xlxs." California provided their CAP and HAP emissions by county using EPA SCCs after applying the mapping. The California-submitted emissions data provided CAPs (including NH_3), HAPs and methane, but did not include CO_2. Therefore, the 2014 v1 includes MOVES-based CO_2 estimates for California. There was one vehicle/fuel type combination included in the CARB

[15] More information on the Inventory Mode for MOVES2014a is available in the MOVES2014a User Guide.

data, gas intercity buses (first 6 digits of the SCC = 220141), that did not match to an SCC generated using MOVES, so we mapped it to gasoline single unit short-haul trucks (220152).

CARB estimates onroad refueling emissions outside of the EMFAC model; they provided these to the EPA, and we assigned them to the onroad refueling SCC 2201000062 (Mobile Sources**;** Highway Vehicles - Gasoline; Refueling; Total Spillage and Displacement). The two EIC codes mapped to this SCC are: EIC 33037811000000 (Petroleum Marketing / Vehicle Refueling – Vapor Displacement Losses / Gasoline (Unspecified)) and EIC 33038011000000 (Petroleum Marketing / Vehicle Refueling – Spillage / Gasoline (Unspecified)).

6.4 Agency-submitted MOVES inputs

Many state and local agencies provided county-level MOVES inputs in the form of CDBs. This established format requirement enables the EPA to more efficiently scan for errors and manage input datasets. The EPA screened all submitted data using several quality assurance scripts that analyze the individual tables in each CDB to look for missing or unrealistic data values.

6.4.1 Overview of MOVES input submissions

State and local agencies prepare complete sets of MOVES input data in the form of one CDB per county. One way agencies can ensure a correctly-formatted CDB is to use the MOVES graphical user interface (GUI) county data manger (CDM) importer. With a proper template created for a single county, a larger set of counties (e.g., statewide) can be updated systematically with county-specific information if the preparer has well-organized county data and familiarity with MySQL queries. However, there is no requirement of MySQL experience to prepare the NEI submittal because the user can instead rely on the CDM to help build the individual CDBs one at a time. Table 6-1 lists each table in a CDB and describes its content or purpose. Note that several of the tables are optional, which means that they may be left blank without consequence to a MOVES run's completeness of results. If an optional CDB table is populated, the data override MOVES internal calculations and produce a different result that may better represent local conditions.

Table 6-1: MOVES2014a CDB tables

Table Name	**Description of Content**
auditlog	Information about the creation of the database
avft	Fuel type fractions
avgspeeddistribution	Average speed distributions
county	Description of the county
countyyear	Description of the Stage 2 refueling control program
dayvmtfraction	Fractions to distribute VMT between day types
fuelformulation	Fuel properties
fuelsupply	Fuel differences by month of year
fuelusagefraction	Fraction of the time that E85 vs. gasoline is used in flex-fuel engine vehicles
hotellingactivitydistribution	***Optional table*** – fraction of hoteling hours in which the power source is the main engine, diesel APU, electric APU, or engine-off
hotellinghours	***Optional table*** – total hoteling hours
hourvmtfraction	Fractions to distribute VMT across hours in a day
hpmsvtypeday	VMT input by HPMS vehicle group, month, and day type (1 of 4 options)

Table Name	Description of Content
hpmsvtypeyear	VMT input by HPMS vehicle group, as annual total (2 of 4 options)
imcoverage	Description of the inspection and maintenance program
importstartsopmodedistribution	***Optional table*** – engine soak distributions
monthvmtfraction	Fractions to distribute VMT across 12 months of the year
roadtype	***Optional table*** – fraction of highway driving time spent on ramps
roadtypedistribution	Fractions to distribute VMT across the road types
sourcetypeagedistribution	Distribution of vehicle population by age
sourcetypedayvmt	VMT input by source use type, month, and day type (3 of 4 options)
sourcetypeyear	Vehicle populations
sourcetypeyearvmt	VMT input by source use type, as annual total (4 of 4 options)
starts	***Optional table*** – starts activity, replacing the MOVES-generated starts table
startshourfraction	***Optional table*** – fractions to distribute starts across hours in a day
startsmonthadjust	***Optional table*** – fractions to vary the vehicle starts by month of year
startsperday	***Optional table*** – total number of starts in a day
startssourcetypefraction	***Optional table*** – fractions to distribute starts among MOVES source types
state	Description of the state
year	Year of the database
zone	Allocations of starts, extended idle and vehicle hours parked to the county
zonemonthhour	Temperature and relative humidity values
zoneroadtype	Allocation of source hours operating to the county
emissionratebyage	Implementation of California standards [not normally part of a CDB but included for NEI because state-specific data is applicable]

S/L/T agencies submitted a total of 1,815 CDBs for the 2014 v1. Previously for the 2011 NEI, the number of submitted CDBs totaled 1,363 and 1,426 in v1 and v2, respectively. Agencies submitting data through the EIS, provided completed CDBs (i.e., each table populated), along with documentation and a submission checklist indicating which of the CDB tables contained local data. summarizes these submission checklists, showing the number of counties within each submittal for which the information was local data, as opposed to a default. Empty slots in the table indicate that the state or county did not provide local data for that particular CDB table. The grand totals of counties across all states show that VMT and population (‘HPMSVtypeYear’ and ‘SourceTypeYear’ tables, respectively) were the most commonly provided local data types.

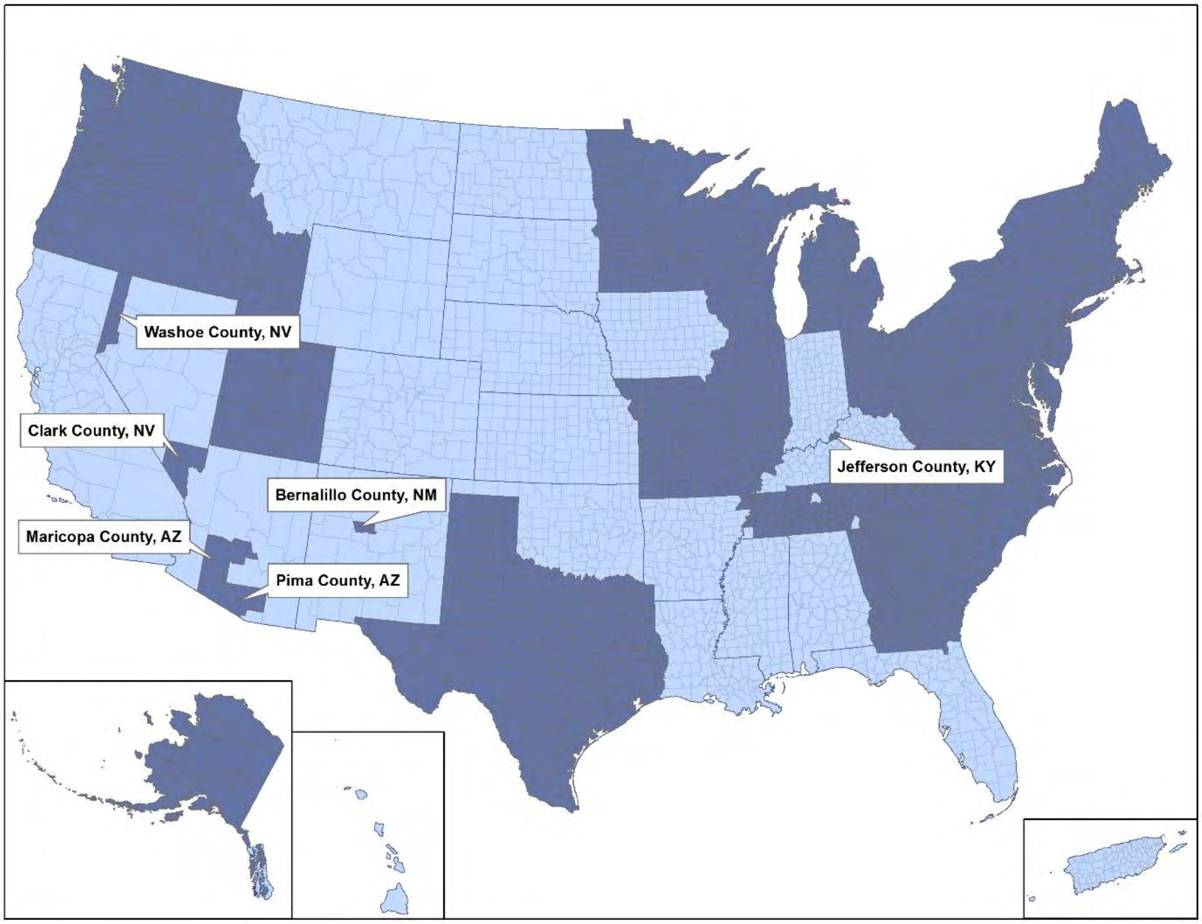
Figure 6-1 shows the geographic coverage of CDB submissions where the state or local agency submitted data that was used for at least one table (dark blue). The light blue areas are counties for which the CDBs were developed by EPA based on the 2011 v2 NEI.

Table 6-2: Number of counties with submitted data, by state and key MOVES CDB table

State/County	avft	avgspeeddistribution	countyyear	dayvmtfraction	emissionratebyage	fuelformulation	fuelsupply	fuelusagefraction	hotellingactivitydistribution	hotellinghours	hourvmtfraction	hpmsvtypeyear	imcoverage	monthvmtfraction	onroadretrofit	roadtype	roadtypedistribution	sourcetypeagedistribution	sourcetypedayvmt	sourcetypeyear	starts	startsperday
Alaska	29											29	1				29	29		29		
Arizona (Maricopa)	1	1	1	1		1	1				1	1	1	1			1	1		1		
Arizona (Pima)	1	1		1							1	1	1	1			1	1		1		
Connecticut	8	8	8	8	8	8	8	8	8	8	8	8	8	8			8	8		8		
Delaware	3		3		3	3	3	3	3	3		3			3						3	3
District of Columbia		1		1							1	1	1	1			1	1		1		
Georgia		24	13	159							24	159	13	159			159	159		159		20
Idaho	44	44		44				44			44	44	2	44			44	44		44		
Illinois		102	102	102		102	102	102			102	102	11	102			102	102		102		
Kentucky (Jefferson)	1	1										1	1				1	1		1		
Maine												16	1					16		16		
Maryland	24	24	24	24	24	24	24	24			24	24	24	24			24	24		24		
Massachusetts	14	14		14	14	14	14	14	14	14	14	14		14	14					14	14	14
Michigan	7	83		83		7	7	7			83	83	83	83			83	83		83		
Minnesota		87		87							87	87		87			87	87		87		
Missouri	115											115	5					115		115		
Nevada (Clark)											1	1	1	1			1	1		1		
Nevada (Washoe)		1		1		1	1	1			1		1				1	1	1			
New Hampshire			10									10					10	10		10		
New Jersey	21	21	21	21		21	21	21	21	21	21	21	21	21	21		21	21		21		
New Mexico												1						1		1		
New York	62	62	62	62		62	62	62	62	62	62	62	62	62			62	62		62		

State/County	avft	avgspeeddistribution	countyyear	dayvmtfraction	emissionratebyage	fuelformulation	fuelsupply	fuelusagefraction	hotellingactivitydistribution	hotellinghours	hourvmtfraction	hpmsvtypeyear	imcoverage	monthvmtfraction	onroadretrofit	roadtype	roadtypedistribution	sourcetypeagedistribution	sourcetypedayvmt	sourcetypeyear	starts	startsperday
North Carolina		20				1	1				20	100	48				100	100		100		
Ohio	88	88	88	88		1	1	88			88	88	14	88			88	88		88		
Oregon			36				36			36		36	6					36		36		
Pennsylvania		67		67	67	67	67	67			67	67	67	67			67	67		67		
Rhode Island				5							5	5	5	5			5	5		5		
South Carolina												46					46			46		
Tennessee (Knox)		1		1							1	1		1			1	1		1		
Tennessee												91					91	91		91		
Texas	254	254	254	254		254	254		254	254	254	254	254	254		254	254	254		254	254	
Utah	29	29										29	29			29	29	29		29		
Vermont												14		14				14		14		
Virginia			17				134					134	10	134			134	134		134		
Washington	1			39			1	1			39	39	5	39			39	39		39		
West Virginia												55		55			55	55		55		
Wisconsin		8	9								7	72	7				72	72		72		
Total	**702**	**941**	**648**	**1062**	**116**	**566**	**737**	**442**	**362**	**398**	**955**	**1814**	**682**	**1265**	**38**	**283**	**1616**	**1752**	**1**	**1811**	**271**	**37**

Figure 6-1: Counties for which agencies submitted local data for at least 1 CDB table are shown in dark blue



6.4.2 QA checks on MOVES CDB Tables

The EPA used two separate quality assurance scripts to scan submitted CDBs and flag potential data errors. The scripts report the potential errors by compiling a list into a summary quality assurance database table. The list of potential errors includes the CDB name, table name, a numeric error code, and in some cases the suspect data value or sum of values that caused the script to flag the particular table. EPA then reviewed all of the potential errors, identified which ones needed to be addressed in coordination with the EPA staff, and the EPA coordinated with the responsible state/local agency to verify or revise the needed data clarifications.

The first quality assurance script is one that the EPA updates for each version of the NEI for which states are asked to submit CDBs through the EIS. The EPA designed this script to catch errors that would cause MOVES to fail during a run. The second script was designed to catch unreasonable data values. These wouldn't necessarily cause MOVES to fail, but would produce unreasonable model outputs. Examples of suspected unreasonable values include (a) a mix of vehicle type population or VMT that shows more heavy-duty (HD) vehicles or VMT than shown for light-duty (LD), (b) age distributions that are skewed to older vehicles rather than newer, or (c) atypical VMT temporal patterns such as higher VMT in winter than summer or higher VMT overnight than during daytime.

Nearly 90 percent of the submitted 1,815 CDBs required at least one update due to missing or incorrect data, incorrect table formatting, or excess data (more than required), which was removed prior to use. The missing or incorrect data included the following problems:

- Missing age distributions for some HD source types (most commonly buses)
- Age distribution for some source types not summing to 1 (e.g., 0.93 or 3.5)
- Negative values in the Hoteling Activity Distribution table
- Missing weekend (day type 2) activity across one or more CDB tables: VMT (via the \`SourceTypeDayVMT\` table), average speed distributions, hourly VMT fractions, and/or starts per day
- Completely empty or missing source types in the Hour, Day, or Month VMT fractions
- Old inspection and maintenance (I/M) programs included as active, but known to have previously ended
- Incorrect year (e.g., 2013, but should be 2014) in the population table
- Fleet mix too large for HD vehicles (e.g., combination truck population 100 times larger than that of passenger cars)
- All freeways in a state have zero ramps

The EPA resolved each of the above data problems by coordinating with state/local agencies individually. In some cases, the agency preferred to submit a corrected CDB, which the EPA contractor reviewed again to verify the intended correction. In other cases, the agency provided the EPA with instructions for a “spot correction” to a table or simply accepted the EPA’s proposed update. ERG also corrected formatting problems with the database tables. In some cases, tables had missing data fields and/or table keys; the missing fields did not house important content, but their presence is required for MOVES2014a to run. One state’s table formatting problems were so widespread that we rebuilt the states’ databases using a template MOVES CDB and filled them with the content from the submittal. We also removed the following unnecessary, excess data content from several tables in several states’ submissions:

- 2011 entries for vehicle population, age distribution, and year tables (presumably carried over from 2011 NEI, presented in addition to 2014 data).
- Invalid input road types in the \`roadType\` CDB table including road types 6, 7, 8, 9 (associated with separating ramps from freeways) and 100 (associated with the MOVES nonroad model) generated by the County Data Manager template.

6.5 EPA default MOVES inputs

6.5.1 Sources of default data by MOVES CDB table

The EPA developed the CDBs for counties where agencies did not submit them for the 2014 v1 NEI. We started with the final set of CDBs from the 2011 v2 NEI. We projected the 2011 age distributions and I/M programs to calendar year 2014 and updated the yearID to 2014 in multiple tables in the CDB. The EPA developed 2014 estimates of VMT, vehicle population, and hoteling at the county- and SCC-level for use in the subsequent SMOKE-MOVES processing step. In the CDBs, we used these 2014 activity estimates to overwrite 2011 data. States and counties with CDBs that included 2014 EPA-generated activity and projected CDBs are those indicated by light blue shading in Figure 6-1. Table 6-3 below lists the sources of default information by MOVES CDB table. In some counties, the content for the 2014 v1 NEI was from the previous submittal (for 2011 NEI v2) that did not require 2014-specific updates, or an empty table that causes MOVES to use the default MOVES methodology.

Table 6-3: Source of defaults for key data tables in MOVES CDBs

CDB Table	Default content for 2014 NEI v1
avft	2011 NEI v2, or MOVES2014a fuel type mix (if table is empty)
avgspeeddistribution	2011 NEI v2
dayvmtfraction	2011 NEI v2
fuelformulation	Based on EPA estimates for each county from 2014 refinery data
fuelsupply	Based on EPA estimates for each county from 2014 refinery data
fuelusagefraction	MOVES2014a default E85 usage
hotellingactivitydistribution	MOVES2014a default APU vs. Main Engine fractions
hotellinghours	2014 EPA estimates of hoteling based on 2014 VMT
hourvmtfraction	2011 NEI v2
hpmsvtypeday	Empty by default
hpmsvtypeyear	Empty by default
imcoverage	2011 NEI v2
importstartsopmodedistribution	Empty by default
monthvmtfraction	2011 NEI v2
roadtype	2011 NEI v2 (fraction of 0.08 is default value if table empty)
roadtypedistribution	2011 NEI v2
sourcetypeagedistribution	2011 NEI v2
sourcetypedayvmt	Empty by default
sourcetypeyear	2014 EPA estimates of population based on 2014 VMT and FHWA data
sourcetypeyearvmt	2014 EPA estimates of VMT based on FHWA data
starts	Empty by default
startshourfraction	Empty by default
startsmonthadjust	Empty by default
startsperday	Empty by default
startssourcetypefraction	Empty by default
zonemonthhour	2014 meteorology data averaged by county
emissionratebyage	The \`emissionratebyage\` tables for some counties were populated using appropriate data described in the guidance for states adopting California emission standards

6.5.2 Default California emission standards

The EPA populated an alternative MOVES database table 'EmissionRateByAge' in the CDBs for some counties in the states that have adopted emission standards from California's Low Emission Vehicle (LEV) program. Table 6-4 shows which states adopted the California standards and the year the program began in each state. We developed these tables to be consistent with the EPA guidance for LEV modeling provided on the EPA web site [ref 1].

Table 6-4: States adopting California LEV standards and start year

FIPS State ID	State Name	LEV Program Start Year
06	California	1994
09	Connecticut	2008
10	Delaware	2014
23	Maine	2001
24	Maryland	2011
25	Massachusetts	1995
34	New Jersey	2009
36	New York	1996
41	Oregon	2009
42	Pennsylvania	2008
44	Rhode Island	2008
50	Vermont	2000
53	Washington	2009

6.6 Calculation of EPA Emissions

6.6.1 EPA-developed onroad emissions data for the continental U.S.

For the 2014 NEI v1, the EPA estimated emissions for every county. For the continental U.S., the EPA the EPA used county-specific inputs and programs that integrate inputs and outputs for the MOVES model with the SMOKE modeling system (i.e., SMOKE-MOVES) to take advantage of the gridded hourly temperature information available from meteorology modeling used for air quality modeling. This set of programs was developed by the EPA and also is used by states and regional planning organizations to compute onroad mobile source emissions for regional air quality modeling. SMOKE-MOVES requires emission rate “lookup” tables generated by MOVES that differentiate emissions by process (running, start, vapor venting, etc.), vehicle type, road type, temperature, speed, hour of day, etc.

To generate the MOVES emission rates for counties in each state across the U.S., the EPA used an automated process to run MOVES to produce emission factors by temperature and speed for a set of “representative counties,” to which every other county could be mapped, as detailed below. Using the calculated MOVES emission rates, SMOKE selected appropriate emissions rates for each county, hourly temperature, SCC, and speed bin and multiplied the emission rate by activity (VMT, vehicle population, or hoteling hours) to produce emissions. These calculations were done for every county, grid cell, and hour in the continental U.S. and aggregated by county and SCC for use in the 2014 v1 NEI. The MOVES “RunSpec” files (that provide MOVES input data for each representative county) are provided in the supplementary materials (see Table 6-6 for access information).

The EPA used a different approach for states and territories outside the lower 48 states. For Alaska, the EPA ran MOVES in Inventory Mode, during which MOVES computes the emissions instead of emission rates, for every county and month, using county-specific inputs and meteorological data. For Hawaii, Puerto Rico and the Virgin Islands, MOVES was run in Inventory Mode for the months of January and August, with the months of May through September using the August emissions and the other months using January emissions. More information is provided Section 6.6.11.

SMOKE-MOVES tools are incorporated into recent versions of SMOKE and can be used with different versions of the MOVES model. For the 2014 NEI v1, the EPA used the latest publically released version: MOVES2014a (version 20151201) [ref 2]. Creating the NEI onroad mobile source emissions with SMOKE-MOVES requires numerous steps, as described in the sections below:

- Determine which counties will be used to represent other counties in the MOVES runs (see Section 6.6.2.1)
- Determine which months will be used to represent other month's fuel characteristics (see Section 6.6.2.2)
- Create MOVES inputs needed only for the MOVES runs (see Section 6.5). For example, MOVES requires county-specific information on age distributions and inspection-maintenance programs for each of the representative counties.
- Create inputs needed both by MOVES and by SMOKE, including a list of temperatures and activity data (see Section 6.6.4)
- Run MOVES to create emission factor tables (see Section 6.6.8)
- Run SMOKE to apply the emission factors to activity data to calculate emissions (see Section 6.6.9)
- Aggregate the results at the county-SCC level for the NEI, summaries, and quality assurance (see Section 6.6.10)

Some things to note about the 2014 NEI v1 that are different from the 2011 NEI v2 are:

- Manganese/7439965 now includes the brake and tire contribution, whereas in 2011 NEI v2, manganese did not include brake and tire contributions.
- Gasoline with 85 percent ethanol (E85) was tracked as a separate fuel in the 2014 NEI v1, while in the 2011 NEI v2, it was combined with regular gasoline.
- Five speciated $PM_{2.5}$ species were added based on speciation profiles (i.e., elemental carbon, organic carbon, nitrate, sulfate and other $PM_{2.5}$). See Section 2.2.5.
- DIESEL-PM10 and DIESEL-PM25 were added by copying the PM_{10} and $PM_{2.5}$ pollutants (respectively) as DIESEL-PM pollutants for all diesel SCCs. See Section 2.2.5.
- Brake and tire PM was tracked separately from exhaust processes, although all non-refueling processes were combined into broader SCCs prior to loading into EIS.
- For Colorado, refueling emissions were removed from all counties for which Colorado reported refueling in the point source data category.

6.6.2 Representative counties and fuel months

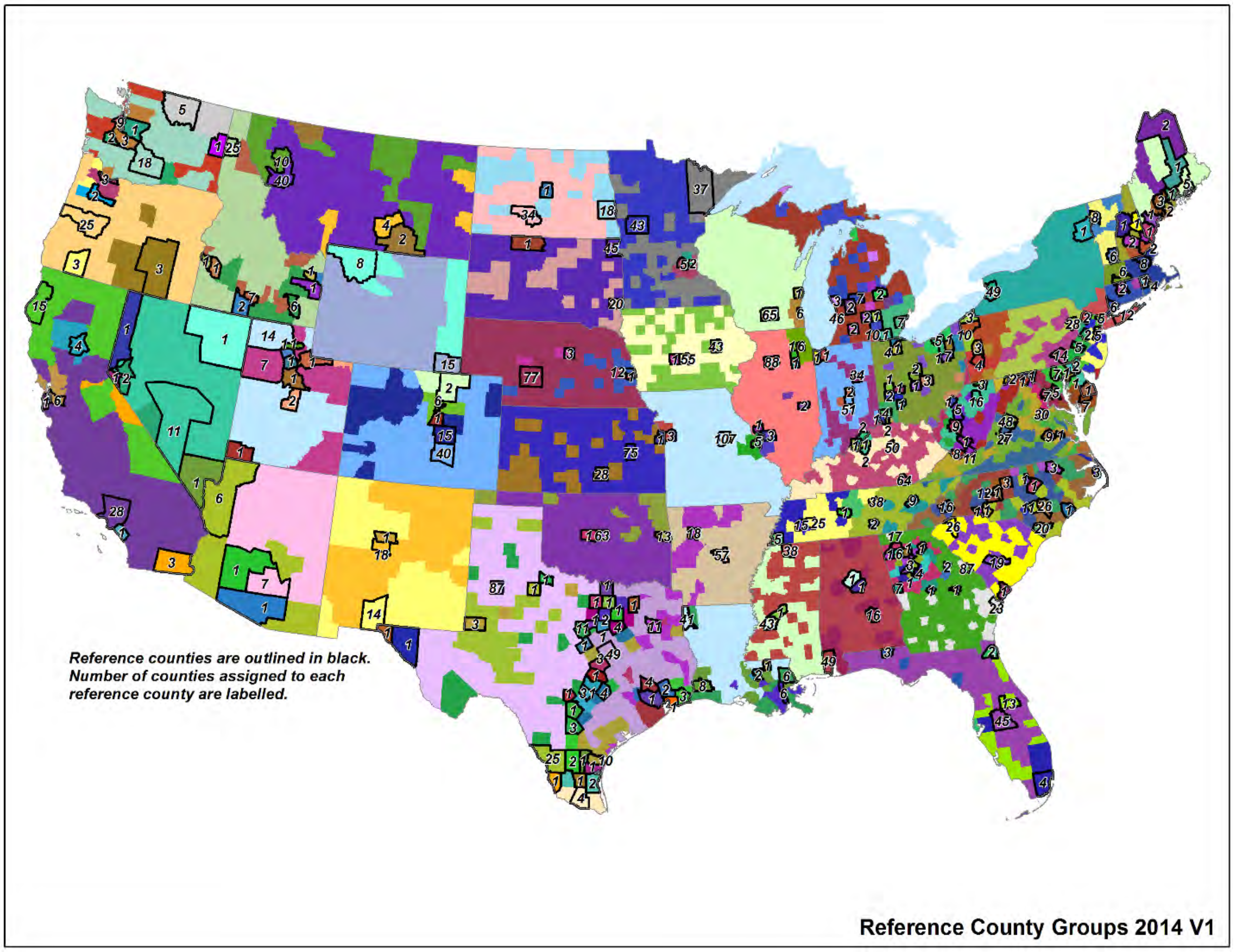
6.6.2.1 *Representative counties*

Although the EPA develops a CDB for each county in the nation, only a subset of these were run with MOVES based on an assumption that most of the important emissions-determining differences among counties can be accounted for by assigning counties to groups with similar properties such as fleet age, a shared I/M program, and shared fuel controls (e.g., low RVP for summer gasoline). The county used to provide emission rates to other counties is called the "representative county." This approach of running MOVES for representative counties helps reduce computation time by reducing the number of MOVES runs to generate a nationwide inventory. The MCXREF file listed in Table 6-5 provides the mapping of each county to its representative county.

In the SMOKE-MOVES framework, temperature- and speed-specific data from the lookup tables generated for the representative counties are multiplied with the county-level activity data for all counties within the corresponding county group. The activity data specific to individual counties in the inventory includes VMT, vehicle population, hoteling hours, and hourly speeds.

The EPA slightly increased the number of representative counties in the 2014 NEI v1 compared to 2011 NEI v2. In the 2011 NEI v2, 284 counties represented the approximately 3,000 counties in the continental U.S. (excludes Alaska, Hawaii, Virgin Islands, and Puerto Rico). For the 2014 NEI v1, the EPA increased the number to 297 based on the EPA's analysis of state/local-provided CDBs and other factors including comments from states. NEI is a map of the representative counties by state and their corresponding county groups. The MCXREF file listed in Table 6-6 provides the mapping of each specific county to its representative county.

Figure 6-2: Representative county groups for the 2014 NEI



6.6.2.2 *Fuel Months*

A "fuel month" indicates when a particular set of fuel properties should be used in a MOVES simulation. Similar to the representative county, the fuel month reduces the computational time of MOVES by using a single month to represent a set of months during which a specific fuel has been used in a representative county. Because there are winter fuels and summer fuels, the EPA used January to represent October through April and July to represent May through September. For example, if the grams/mile exhaust emission rates in January are identical to February's rates for a given representative county, and temperature (as well as other factors), then we use a single fuel month to represent January and February. In other words, only one of the months needs to be modeled through MOVES to obtain the necessary emission factors. The hour-specific VMT, temperature and other factors for February are still used to calculate emissions in February, but the emission factors themselves do not need to be created, since one month can sufficiently represent the other month. The fuel months used for each representative county are provided in the MFMREF file in the supplementary materials (see Table 6-6 for access information).

6.6.2.3 *Fuels*

Although state/local-submitted CDBs may have included information about fuel properties, this fuel information was replaced for the MOVES runs for the 2014 NEI v1 fuel properties for a set of fuel regions generated by the EPA. The EPA developed these data using a combination of purchased fuel survey data, proprietary fuel refinery information and known federal and local regulatory constraints. Our past analyses of state/local-submitted fuel information has led us to conclude that our replacement of the data is more accurate and the best way to treat all parts of the country consistently with respect to fuel use and the fuel impacts on emission rates.

The steps used to determine the fuel properties in each fuel region are as follows:

1. Fuel properties from proprietary refinery certification data were compiled on a regional basis (based on typical pipeline delivery areas).
2. Properties within a region for finished fuel batches (e.g., no conventional blendstock for oxygenate blending (CBOB), reformulated blendstock for oxygenate blending (RBOB) or oxygen backout (OBO) fuel batches) produced in 2010, excluding reformulated gasoline (RFG), were averaged to generate non-ethanol conventional gasoline fuel properties within that region, for a given month.
3. RFG fuel properties were based on RFG fuel compliance survey data, and oxygenate levels were assumed to be 10 percent ethanol (E10, no MTBE).
4. Refinery modeling results generated for the Renewable Fuel Standard were used to adjust the regional conventional gasoline fuel properties to account for ethanol blending up to E10, for a given month.
5. Additional adjustments to fuel properties were performed on individual counties within a region, based on refinery modeling, for known local regulatory constraints such as low-RVP or oxygenate level mandates.
6. Appropriate E10 and conventional gasoline fuel market shares were calculated on a regional basis for the level of ethanol produced in 2014, after ethanol required for RFG compliance was taken into account.
7. Gasoline fuel properties and ethanol market shares were applied to each county regionally and accounting for known local regulatory constraints.
8. Diesel properties were assumed to be 15 parts per million nationally with no significant biodiesel penetration.

The regional fuel supply database used for the 2014 NEI v1 is available as part of the default database provided with MOVES2014a. A detailed description of the development of the default national fuel supply is provided in the documentation for the MOVES model and on the MOVES Technical Reports webpage [ref 3].

6.6.3 Temperature and humidity

Ambient temperature can have a large impact on emissions. Low temperatures are associated with high start emissions for many pollutants. High temperatures and high relative humidity are associated with greater running emissions due to the increase in the heat index and resulting higher engine load for air conditioning. High temperatures also are associated with higher evaporative emissions.

The 12-km gridded meteorological input data for the entire year of 2014 covering the continental U.S. were derived from simulations of version 3.4 of the Weather Research and Forecasting Model (WRF) [ref 4], Advanced Research WRF core [ref 5]. The WRF Model is a mesoscale numerical weather prediction system developed for both operational forecasting and atmospheric research applications. The Meteorology-Chemistry Interface Processor (MCIP) [ref 6] was used as the software for maintaining dynamic consistency between the meteorological model, the emissions model, and air quality chemistry model.

The EPA applied the SMOKE program Met4moves [ref 7] to the gridded, hourly meteorological data (output from MCIP version 4.3) to generate a list of the maximum temperature ranges, average relative humidity, and temperature profiles that are needed for MOVES to create the emission-factor lookup tables. “Temperature profiles” are arrays of 24 temperatures that describe how temperatures change over a day, and they are used by MOVES to estimate vapor venting emissions. The hourly gridded meteorological data (output from MCIP) was also used directly by SMOKE (see Section 6.6.9).

The temperature lists were organized based on the representative counties and fuel months as described in Section 6.6.2. Temperatures were analyzed for all of the counties that are mapped to the representative counties, i.e., for the county groups, and for all the months that were mapped to the fuel months. The EPA used Met4moves to determine the minimum and maximum temperatures in a county group for the January fuel month and for the July fuel month, and the minimum and maximum temperatures for each hour of the day. Met4moves also generated temperature profiles using the minimum and maximum temperatures and 10 °F intervals. In addition to the meteorological data, the representative counties and the fuel months, Met4moves uses spatial surrogates to determine which grid cells from the meteorological data have roads and uses the WRF temperature and relative humidity data from those areas. For example, if a county had a mountainous area with no roads, the grid cells with no roads would be excluded from the meteorological processing. We updated the spatial surrogates used for the 2014 NEI v1 from those used in the 2011 NEI with 2014 activity such as VMT with the goal of better characterizing the spatial variability of the onroad mobile source emissions. The use of these new spatial surrogates required updates to the cross reference of surrogate assignments by vehicle type and process.

To account for changes in relative humidity, there is a pairing of relative humidity to temperature bins. Met4moves calculated an average relative humidity for the county group for all grid cells that make up that temperature bin. In other words, for all grid cells and hours within a single temperature bin and county group, it extracts and averages the corresponding relative humidity. Met4moves repeats this calculation for each temperature bin and county group, and finally repeats the whole process for each fuel month. When the emission factors are applied by SMOKE, the appropriate temperature bin and fuel month specific relative humidity was used for all runs of the county group. The EPA used a 5 °F temperature bin size for RatePerDistance (RPD), RatePerVehicle (RPV), and RatePerHour (RPH).

Met4moves can be run in daily or monthly mode for producing SMOKE input. In monthly mode, the temperature range is determined by looking at the range of temperatures over the whole month for that specific grid cell. Therefore, there is one temperature range per grid cell per month. While in daily mode, the temperature range is determined by evaluating the range of temperatures in that grid cell for each day. The output for the daily mode is one temperature range per grid cell per day and is a more detailed approach for modeling the vapor venting RatePerProfil (RPP) based emissions. The EPA ran Met4moves in daily mode for the 2014 NEI v1.

The resulting temperatures for the representative counties are provided in the supplementary materials (see Table 6-6 for access information). The gridded, hourly temperature data used are publicly available only upon request and with provision of a disk media to copy these very large datasets (contact info.chief@epa.gov).

6.6.4 VMT, vehicle population, speed, and hoteling activity data

The activity data used to compute onroad mobile source emissions for the 2014 NEI uses EPA defaults where state/local agencies did not provide their own data. These default (but county-specific) data were derived from Federal Highway Administration Data (FHWA) information including the published *Highway Statistics 2014* [ref 8], along with county-level VMT data allocated to vehicle type, fuel type, and road type. Some additional data sources were also used. The development of the default data is described in detail in 2014v1_2014_Default_Onroad_Activity_Data_Documentation.pdf, which is provided with the supporting data in Table 6-6.

As discussed above, SMOKE combines the MOVES emission factors for each representative county with county-specific VMT, population, and hoteling data to compute the emissions for each individual county. These activity data are provided to SMOKE in a flat format, and the source of the data varies according to area of the country and depending on whether the state/local agency submitted data for 2014 NEI v1.

For the 1,815 counties for which an agency submitted a CDB (the dark blue areas shown previously in Figure 6-1), the EPA contractor ran scripts to extract the agency-submitted data from the CDBs and reformat it into the flat file 2014 (FF10) text file format that can be input to SMOKE. For the non-submitting areas of the U.S. (light blue areas in Figure 6-1), the EPA VMT, population, and hoteling were used. The 2014 v1 default speeds in non-submitting areas are based on the MOVES2014a national average speed distribution, reformatted for input to SMOKE. Note that some updated speed and other activity data are expected to become available in time for the development of version 2 of the 2014 NEI.

The FF10 creation scripts that read submitted CDBs are described separately by activity type below, followed by discussion on how the EPA created the default 2014 activity data for VMT, population, and hoteling for non-submitting areas.

6.6.4.1 *VMT FF10 file creation*

The FF10-generation scripts read VMT from the MOVES CDB table `HPMSVtypeYear,` which contains 2014 annual VMT organized by the Highway Performance Monitoring System (HPMS) vehicle groups. The scripts disaggregate the VMT into source type, fuel type, model year, and road type using a combination of other CDB tables as well as some MOVES default tables. First, the annual VMT by HPMS groups is divided into source type and model year using the CDB tables with population by source type and age distribution, in combination with the MOVES default table containing default annual mileage accumulation by model year. The scripts use these three sources to create travel fractions for each source type and model year that sums to one (1) by HPMS vehicle type.

Next, the VMT (by source type and model year) is further divided into fuel type categories of gasoline, diesel, CNG, E85, and electric vehicles – preferentially by using submitted MOVES CDB tables `AVFT` to determine the split of engine-fuel types by model year and `FuelUsageFraction` to determine the percent of flex-fuel engines that actually use E85. Flex-fuel engines refer to those capable of operating on either E85 or conventional gasoline, the percentage of which could be a function of local availability of the alternative fuel. Because the AVFT and FuelUsageFraction tables are optional tables in a MOVES CDB, they were not always populated in a submitted database. In cases where data was not provided, the FF10-generation scripts automatically default to

MOVES national distributions of fuel types and/or E85 availability, using the `SampleVehiclePopulation` and `FuelUsageFraction` tables of the model default database to fill the missing data. It is worth noting that several states do not have any VMT (or vehicle population) associated with flex-fuel vehicles because they submitted data indicating either no flex-fuel vehicle population or zero E85 fuel supply in the CDB tables. States without E85 in the 2014 v1 NEI include Connecticut, New Jersey, New York, Texas, and Utah. In the past 2011 NEI, all counties had some E85 vehicles because the FF10 script read only MOVES national data, rather than CDB fuel split and E85 availability information.

Finally, the FF10-generation scripts read the CDB table `RoadTypeDistribution` to further split VMT (by fuel type) into the four MOVES road types (urban and rural, restricted and unrestricted access). The scripts aggregate VMT across model years to the SCC level (i.e., MOVES source type, fuel type, and road type) and reports annual and monthly VMT (using the `MonthVMTFraction` CDB table) for each SCC in each county into a consolidated list.

6.6.4.2 *Population FF10 file creation*

The FF10-generation scripts that creates the SMOKE vehicle population (i.e., VPOP) data operates similarly to the VMT script just described, except that the calculations do not use travel fractions to disaggregate population by model year. First, the script reads the CDB `SourceTypeYear` table, which contains 2014 population by MOVES source type and divides it into model years based on the submitted CDB `SourceTypeAgeDistribution` table. For each vehicle model year, the scripts apportion vehicle populations to fuel types using the submitted CDB tables `AVFT' and `FuelUsageFraction,' or, if no data was provided, uses the national default corresponding data tables described in Section 6.6.4.1.

The FF10 scripts then aggregate population from the model year level back up to the SCC level (MOVES source type and fuel type, and the road type 1). As with the 2014 v1 FF10 VMT by SCC, there is no E85 vehicle population in Connecticut, New Jersey, New York, Texas, or Utah due to agency-submitted data describing the registered populations of flex-fuel vehicles and local E85 supply.

6.6.4.3 *Speed FF10 file creation*

SMOKE uses speed data for all counties to lookup the appropriate VMT-based emission factors by speed bin and SCC. The FF10 "SPD" input for SMOKE is one of two speed-related inputs; the other, described below, contains hourly speeds by SCC and county, separately for weekdays and weekends. The FF10 speed file for SMOKE contains a single daily average speed by SCC and county for the annual average and each of the 12 months.

The FF10-generation scripts read the CDB table `avgSpeedDistribution,' which contains the fraction of VMT by 16 speed bins for each source type, day type (weekday/weekend), and hour. The scripts calculate a weighted average to arrive at the average day values.

6.6.4.4 *Speed Profile creation*

The speed profile (SPDPRO) input for SMOKE is optional and supersedes the FF10SPD input. "FF10SPD" contains average speed data by county and SCC with no time variation, while the SPDPRO contains average speed data by county, SCC, hour, and weekday/weekend. So basically, the SPDPRO is a more detailed version of the FF10SPD, where one has time variation and one does not. The FF10SPD is read by Smkinven, and the SPDPRO is read by Movesmrg. The values in the FF10SPD are only used by SMOKE-MOVES if a SPDPRO is not available. However, regardless of whether or not you have an SPDPRO, SMOKE-MOVES requires that you have an FF10SPD. SMOKE uses speed data for all counties in order to lookup the appropriate VMT-based emission factors by speed bin and SCC. The scripts read the same MOVES CDB tables as it does for FF10SPD, though instead of aggregating to a daily average, the scripts preserve the hourly detail. The scripts compile SPDPRO data listing one average speed per hour of day by SCC and county for weekday/weekend day types Hoteling FF10 file creation.

Hoteling activity refers to the time spent idling in a diesel long-haul combination truck during federally-mandated rest periods of long-haul trips. Drivers may spend these rest periods with the main engine on, a smaller auxiliary power unit (APU) engine on, plugged into an electric source if available, or simply leave the engine off. MOVES and the NEI track the emissions from hoteling using the main engine idling versus those from APUs separately. SMOKE reads each type of hoteling hours by SCC and matches them to the appropriate MOVES emission factor from the `RatePerHour' lookup table.

Because the 2014 v1 NEI is the first to use the 2014a version of MOVES, it is the first NEI to have a new option for agencies to directly provide MOVES with the number of hoteling hours (via the 'hotellingHours' table) and the percent of trucks by model year that use APUs (the 'hotellingActivityDistribution' table). These CDB tables are optional. When they are present, the FF10-generation scripts read them and translates them into the FF10 formats for SMOKE. If they are empty, the FF10-generation scripts calculate the hoteling consistently with the MOVES internal methodology when these tables are empty. Thus, the scripts multiply the VMT for diesel-fueled long-haul combination truck VMT on restricted access roads (urban and rural together) and with the national average rate of hoteling, which in year 2014 is estimated by EPA to be 0.027337 hours per mile. The scripts use the MOVES default fractions of APU usage, which in MOVES2014a is zero percent APU usage through model year 2009, and 30 percent APU usage in model years 2010 and later. The remaining hoteling hours are assumed to occur with the main engine on.

6.6.5 Public release of the NEI county databases

Two sets of 2014 v1 CDBs are available for download: (1) seeded CDBs, which have been altered to produce emission rates for all sources, roads and processes, and (2) unseeded CDBs. Both types of CDBs are available for all U.S. counties, except that the seeded CDBs are not available for Alaska, Hawaii, Puerto Rico, and the Virgin Islands. See Table 6-6 for access details.

6.6.6 Seeded CDBs

The seeded county databases can be used with MOVES to generate emission factor lookup tables for SMOKE-MOVES. In order to create them for SMOKE-MOVES modeling, the EPA performed a "seeding" step, whereby values of zero (0) were updated to a small value of 1e-15. This seeding ensures that the lookup tables will be fully populated regardless of whether the representative county itself had activity for all of the categories covered. Seeding is necessary because counties mapping to the representative county may require an emission factor that would otherwise be missing.

6.6.7 Unseeded CDBs

In contrast to the seeded CDBs, the unseeded CDBs do not have any seeding performed on them. This set of CDBs is true to the local conditions. The unseeded CDBs merge the 1,815 databases that were agency-submitted with the 1,409 default CDBs that were projected from the 2011 NEI v2 and use 2014 EPA estimates of default VMT, population, and hoteling.

The CDBs created by EPA (i.e., ones for which there was no submittal by S/L/T agencies) include the 2014 default VMT in the 'SourceTypeYearVMT' tables rather than the 'HPMSVtypeYear' tables (used in the past EPA defaults), which are now empty. The 2014 default hoteling information is included in the CDB tables 'HotellingHours' and

'HotellingActivityDistribution.' As in the past NEI, the 2014 EPA-default vehicle populations are included in the 'SourceTypeYear' tables in the non-submitted CDBs.

6.6.8 Run MOVES to create emission factors

The EPA ran MOVES for each representative county using January fuels and July fuels for the range of temperatures spanned by the represented county group and set of months associated with each fuel set (January and July). A runspec generator script created a series of runspecs (MOVES jobs) based on the outputs from Met4moves temperature information for all months of the year. Specifically, the script used a 5-degree temperature bin with the minimum and maximum temperature ranges from Met4moves and used the idealized diurnal profiles from Met4moves to generate a series of MOVES runs that captured the full range of temperatures for the county group for the months assigned to each fuel. The MOVES runs resulted in four emission factors tables for each representative county and fuel month: rate per distance (RPD), rate per vehicle (RPV), rate per hour (RPH), and rate per profile (RPP). After the MOVES runs were completed, the post-processor script Moves2smk converted the MySQL tables into EF files that can be read by SMOKE. For more details, see the SMOKE documentation [ref 9].

6.6.9 Run SMOKE to create emissions

To prepare the NEI emissions, the EPA first generated emissions at an hourly resolution using more detailed SCCs than are found in the NEI (i.e., by road type and aggregate processes). The Movesmrg SMOKE-MOVES program performs this function by combining activity data, meteorological data, and emission factors to produce gridded, hourly emissions. The EPA ran Movesmrg for each of the four sets of emission factor tables (RPD, RPV, RPH, and RPP). During the Movesmrg run, the program used the hourly, gridded temperature (for RPD, RPV, and RPH) or daily, gridded temperature profile (for RPP) to select the proper emissions rates and compute emissions. These calculations were done for all counties and SCCs in the SMOKE inputs, covering the continental U.S.

The emissions process RPD is for modeling the driving emissions. This includes the following modes (i.e., processes): vehicle exhaust, evaporation, evaporative permeation, refueling, brake wear, and tire wear. For RPD, the activity data is monthly VMT, monthly speed (i.e., SMOKE variable of SPEED), and hourly speed profiles for weekday versus weekend (i.e., SPDPRO in SMOKE). The SMOKE program Temporal takes temporal profiles specific to vehicle type and road type and distributes the monthly VMT to day of the week and hour. Movesmrg reads the speed data for that county and SCC and the temperature from the gridded hourly (MCIP) data and uses these values to look-up the appropriate emission factors (EFs) from the representative county's EF table. It then multiplies this EF by temporalized and gridded VMT for that SCC to calculate the emissions for that grid cell and hour. This is repeated for each pollutant and SCC in that grid cell. The temporal profiles were updated for the 2014 NEI v1 based on state submissions.

The emission process RPV is for modeling the parked emissions. This includes the following modes: vehicle exhaust, evaporative, evaporative permeation, and refueling. For RPV, the activity data is vehicle population (VPOP). Movesmrg reads the temperature from the gridded hourly data and uses the temperature plus SCC and the hour of the day to look up the appropriate EF from the representative county's EF table. It then multiplies this EF by the gridded VPOP for that SCC to calculate the emissions for that grid cell and hour. This repeats for each pollutant and SCC in that grid cell.

The emissions process RPH is for modeling the parked emissions for combination long-haul trucks (source type 62) that are hoteling. This includes the following modes: extended idle and APUs. For RPH, the activity data is monthly hoteling hours. The SMOKE program Temporal takes a temporal profile and distributes the monthly hoteling hours to day of the week and hour. Movesmrg reads the temperature from the gridded hourly (MCIP) data and uses these values to look-up the appropriate emission factors from the representative county's EF table. It then multiplies this EF by temporalized and gridded HOTELING hours for that SCC to calculate the emissions for that grid cell and hour. This is repeated for each pollutant and SCC in that grid cell.

The emission process RPP is for modeling the parked emissions for vehicles that are key-off. This includes the mode vehicle evaporative (fuel vapor venting). For RPP, the activity data is VPOP. Movesmrg reads the gridded diurnal temperature range (Met4moves' output for SMOKE). It uses this temperature range to determine a similar idealized diurnal profile from the EF table using the temperature min and max, SCC, and hour of the day. It then multiplies this EF by the gridded VPOP for that SCC to calculate the emissions for that grid cell and hour. This repeats for each pollutant and SCC in that grid cell.

The result of the Movesmrg processing is hourly data as well as daily reports for the four processing streams (RPD, RPV, RPH, and RPP). The results include emissions for every county in the continental U.S.

6.6.10 Post-processing to create annual inventory

For the purposes of the NEI, the EPA needed emissions data by county, SCC and pollutant. The EPA ran SMOKE-MOVES at a more detailed level including road type and emission processes (e.g. extended idle) and summed over road types and processes to create the more aggregate NEI SCCs. The EPA developed and used a set of scripts to combine the emissions from the four sets of reports and from all days to create the annual inventory.

The onroad emissions for Alaska, Hawaii, Puerto Rico and the Virgin Islands, which the EPA generated via MOVES in Inventory Mode were appended to the onroad inventory generated from SMOKE-MOVES to create the final emissions. This complete inventory was loaded into the EIS dataset "2014_EPA_MOVES "as the EPA estimates for the onroad sector.

Five speciated $PM_{2.5}$ species were added based on speciation profiles (i.e., elemental carbon, organic carbon, nitrate, sulfate and other $PM_{2.5}$). DIESEL-PM10 and DIESEL-PM25 were also added by copying the PM_{10} and $PM_{2.5}$ pollutants (respectively) as DIESEL-PM pollutants for all diesel SCCs. See Section 2.2.5 for more details.

6.6.11 Onroad mobile emissions data for Alaska, Hawaii, Puerto Rico, and the Virgin Islands

Since the meteorological data used by the EPA for running SMOKE-MOVES covers only the continental U.S., the EPA used the MOVES Inventory Mode to create emissions for Alaska, Hawaii, Puerto Rico and the Virgin Islands. These runs used the average monthly hourly temperatures and humidity values derived from the National Climatic Data Center temperature and humidity data for calendar year 2014. The emissions generated by the Inventory Mode MOVES runs characterized all pollutants, including a full set of metals and dioxins.

These emission inventory estimates were not derived using the same SMOKE-MOVES process used for the other counties. Instead, each county was run independently using the Inventory Mode of the MOVES2014a model. This approach directly calculates the inventory in each county using the inputs provided in each of the county databases. For Hawaii, Puerto Rico, and the Virgin Islands, MOVES was run for only January and July due to the relatively modest temperature variation over the year for these islands. All other months were mapped to those months to create an annual estimate of the emissions. Due to the greater meteorological variation in Alaska, MOVES was run for every month of the year.

The MOVES inputs used for these emissions are:

- The MOVES CDM databases,
- The run specifications used to run MOVES, and
- The MySQL database containing the tables that describe the temperatures and relative humidity values used for these states and territories.

These inputs are provided in the supplementary materials (see Table 6-6 for access information).

6.7 Summary of quality assurance methods

The EPA performed a series of checks and comparisons against both the inputs and the resulting emissions to quality assure the onroad inventory. These checks are in addition to the ones described on the underlying CDBs. The following is a list of the more significant checks that were performed:

- The 2014 emissions were compared to the 2011 NEI v2 emissions to make sure that all SCCs, counties, and pollutants were covered and as a general quality assurance of the emissions.
- Comparisons of 2014 and 2011 emissions were done using spreadsheets that compared emissions from the two years using (a) groupings at the first 6 digits of the SCC (fuel + MOVES source type) and (b) grouping by light-duty and heavy-duty.
- Maps of county-level NOx, $PM_{2.5}$ and VOC were prepared for each fuel + MOVES source type combination, total light-duty, total heavy-duty, that included maps of the difference between 2014 v1 emissions versus 2011NEIv2.

The maps and spreadsheets helped to identify areas with suspect activity data or emission factors, and the EPA followed up on any suspect areas to investigate further and resolve problems if any were found. For example, New Castle County, Delaware and Vermont were identified to have particularly high emission factors, but the source of the problem could not be diagnosed. To prevent unrealistically high emissions in 2014NEIv1, all counties in Delaware were assigned to Sussex County, Delaware and counties in Vermont were assigned to counties in nearby states.

6.8 Supporting data

Onroad 2014 v1 emissions came from EPA estimates, except for the state of California. As discussed previously, more than half the CDBs were submitted by state or local agencies. Table 6-5 provides the submittal history of these databases. The onroad scripts and data files used in the calculations are listed in Table 6-6. The files and datasets listed in Table 6-6 are all available at:

ftp://ftp.epa.gov/EmisInventory/2014/doc/onroad/2014v1_supportingdata/

Table 6-5: Agency submittal history for Onroad Mobile inputs and emissions

Agency Organization	Onroad CDB Submission Date (MM/DD/YYYY)	Onroad Emissions Submission Date (MM/DD/YYYY)	Notes
Alaska Department of Environmental Conservation	01/14/2016		

Agency Organization	Onroad CDB Submission Date (MM/DD/YYYY)	Onroad Emissions Submission Date (MM/DD/YYYY)	Notes
City of Albuquerque (New Mexico) Environmental Health Department	01/14/2016		
Clark County Department of Air Quality	01/22/2016		
Coeur d'Alene Tribe*		01/07/2016	
Connecticut Bureau of Air Management	01/14/2016		
Department of Energy and Environment (Washington D.C.)	12/17/2015		
Delaware Department of Natural Resources	01/15/2016		
Georgia Department of Natural Resources	First: 12/21/2015 Final: 05/17/2016		GA requested that EPA truncate the submitted hoteling CDB tables and replace the content with 2014 default data.
Idaho Department of Environmental Quality	12/17/2015		
Illinois EPA	12/01/2015		
Knox County (Tennessee) Department of Air Quality Management	12/29/2015		
Kootenai Tribe of Idaho*		01/07/2016	
Louisville (Kentucky) Metro Air Pollution Control District	06/03/2015		
Maine Department of Environmental Protection	01/26/2016		
Maricopa County (Arizona) Air Quality Department	12/07/2015		
Maryland Department of the Environment	01/07/2016		
Massachusetts Department of Environmental Protection	11/23/2015		
Metro Public Health of Nashville/Davidson County		01/15/2016	Agency sent VPOP and VMT via email on 6/7/2016.

Agency Organization	Onroad CDB Submission Date (MM/DD/YYYY)	Onroad Emissions Submission Date (MM/DD/YYYY)	Notes
Michigan Department of Environmental Quality	01/13/2016		
Minnesota Pollution Control Agency	First: 12/17/2015 Final: 04/08/2016		
Missouri Department of Natural Resources	First: 03/07/2016 Final: 06/08/2016		
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation, California*		12/14/2015	
New Hampshire Department of Environmental Services	First: 12/18/2015 Final: 04/15/2016		
New Jersey Department of Environment Protection	01/14/2016		
New York Department of Environmental Conservation	03/14/2016		
Nez Perce Tribe*	01/07/2016		
North Carolina DEQ, Division of Air Quality	01/14/2016		
Northern Cheyenne Tribe		12/01/2015	
Ohio EPA	First: 01/12/2016 Final: 03/18/2016		
Oregon Department of Environmental Quality	01/13/2016		
Pennsylvania Department of Environmental Protection	03/04/2016		
Pima Association of Governments (Tuscon, Arizona)	01/27/2016		EPA imported the submittal into MySQL tables and renamed the database (to match the NEI naming convention) and removed the empty non-CDB tables.
Rhode Island Department of Environmental Management	02/11/2016		
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho*		01/07/2016	

Agency Organization	Onroad CDB Submission Date (MM/DD/YYYY)	Onroad Emissions Submission Date (MM/DD/YYYY)	Notes
South Carolina Department of Health and Environmental Control	12/01/2015		
Tennessee Department of Environment and Conservation	12/15/2015		
Texas Commission on Environmental Quality	01/28/2016	01/07/2016	Texas emissions are available in EIS, but Texas' inputs are reflected in EPAMOVES results and in the NEI.
Utah Division of Air Quality	First: 12/01/2016 Final: 04/01/2016		
Vermont Department of Environmental Conservation	01/15/2016		
Virginia Department of Environmental Quality	12/21/2015		
Washington State Department of Ecology	12/01/2015		
Washoe County (Nevada) Health District, Air Quality Management Division	First: 01/11/2016 Final: 05/13/2016	05/13/2016	Texas emissions are available in EIS, but Texas' inputs are reflected in EPAMOVES results and in the NEI.
West Virginia Division of Air Quality	12/16/2015		
Wisconsin Department of Natural Resources	01/15/2016		

* Tribal emissions data submitted to EIS were inadvertently not included in the 2014v1 NEI but will be in version 2 Tribal territory emissions are not calculated by EPA, because they are not in the county databases.

Table 6-6: Onroad Mobile data file references for the 2014 NEI

	File Name	Description
1	2014v1_Default_Onroad_Activity_ Data_Documentation.pdf	Describes method used for EPA default VMT, VPOP, and hoteling hours data used in counties for which data were not submitted by S/L/T agencies.
2	Folder 2014v1_CDBs/unseeded contains 2014NEIv1_MOVES2014a_ CDBs_unseeded_stateXX.zip where XX = 2-digit state FIPS	"*Unseeded*" CDBs for all counties in the U.S. archived separately by state. These may not produce fully populated emission rates tables across all categories without "seeding".
3	Folder 2014Iv1_CDBs/seeded contains 2014NEIv1_MOVES2014a_CDBs_ seeded_stateXX.zip where XX = 2-digit state FIPS. The set does not include AK, HI, VI, or PR.	"*Seeded*" CDBs for all counties in the continental U.S., archived separately by state. These should produce fully populated rates tables because values of zero in the MOVES input tables have been updated to small numbers (1e-15). In the past, ERG only provided these for the ~300 representative counties, but this set covers all continental U.S. counties to provide flexibility in choosing the representative counties. It does not include AK, HI, VI, or PR.
4	2014v1_merged_activity.zip	All three data types are in FF10 format for SMOKE and are a combination of EPA estimates, agency submittals, and corrections: 1. Vehicle population by county and SCC covering every county in the U.S., 2. VMT annual and monthly by county and SCC covering every county in the U.S., and 3. Hoteling hours annual and monthly by county covering every county in the U.S. including hours of extended idle and hours of auxiliary power units for combination long-haul trucks only.
5	2014v1_RepCounty_Runspecs.zip	The MOVES2014a run specifications (runspecs) for the representative counties for running MOVES in emissions rate mode (used for SMOKE-MOVES).
6	2014NEIv1_RepCounty_Temperatures .zip	The temperature and relative humidity bins for running MOVES to create the full range of emissions factors necessary to run SMOKE-MOVES. Generated by running the SMOKE Met4moves program.
7	MFMREF_2014v1_29jun2016_v1	Fuels cross reference (MFMREF) is a table that maps representative fuel months to calendar months for each representative county. The MFMREF file is an input to SMOKE.

	File Name	Description
8	2014v1_AKHIPRVI_Runspecs.zip	The MOVES2014 run specifications (runspecs) for all counties in Alaska, Hawaii, Puerto Rico and the Virgin Islands. These are for running MOVES in Inventory Mode.
9	MCXREF_2014v1_05aug2016_nf_v3	County cross reference file (MCXREF) is a table that shows every US county along with the representative county used as its surrogate. The MCXREF is an input to SMOKE.
10	2014NEIv1_speed_spdpro.zip	These data are in FF10 format for SMOKE and are a combination of EPA estimates, agency submittals, and corrections: 1. Average speed in miles per hour, annual and monthly values, by county and SCC covering every county in the U.S. and 2. Weekend and weekday hourly speed profiles (SPDPRO) in miles per hour, by county and SCC covering every county in the U.S.
11	2014v1_CDB_QA_Checks_ MOVES2014a_v1 2014v1_QA_Checks_v8_ 2December2015.sql	Scripts designed to catch errors that would cause MOVES to fail during a run and to identify unreasonable data values.
12	2014v1_Scripts_GenerateFF10: • Process_ManyCDBs_README.txt • Process_ManyCDBs.plx • Create_FF10_EmptyTables.sql • Populate_FF10_fromMOVES2014 CDB_v6.sql 2014v1_Scripts_ReverseFF10: • activityUpdates_README.txt • activityUpdates.py • Load_FF10_datasets.sql • Populate_CDBs_from_FF10.sql • hotellinghours.sql	FF10 generation scripts read CDB tables and produce SMOKE-formatted activity input files for use in SMOKE-MOVES. The SMOKE files include VMT, vehicle population, hotelling hours, speed, and SPDPRO. Also includes reverse-FF10 scripts to read SMOKE-formatted activity files VMT, vehicle population, and hoteling hours, and then update the MOVES CDB tables SourceTypeYearVMT, SourceTypeYear, HotellingHours, and HotellingActivityDistribution.
13	2014v1_EICtoEPA_SCCmapping.xlxs	Maps California EMFAC codes to MOVES SCCs

6.9 References for onroad mobile

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7 Wildland Fires (Wild and Prescribed Fires) in the 2014 NEI

7.1 Sector description and overview

Wildfires and prescribed burns (Wildland Fires in sum, WLFs) that occur during the inventory year are included in the NEI as event sources. Emissions from these fires, as well as agricultural fires, make up the National Fire Emissions Inventory (NFEI). For the 2014 NFEI, the EPA calculated emissions from agricultural fires separately from WLF emissions as described separately in Section 4.11. This portion of the document describes the calculation of WLF emissions portion of the 2014 NEI. The reader is referred to a draft report [ref 1] for more information, details, and website information for the EPA estimates described in this section.

Estimated emissions from wildfires and prescribed burns in the 2014 NEI (termed in the remainder of this section as the "2014 NEI"—as this section only pertains to WLFs) are calculated from burned area data. Input data sets are collected from S/L/T agencies and from national agencies and organizations. S/L/T agencies that provide input data were also asked to complete the NEI Wildland Fire Inventory Database Questionnaire, which consists of a self-assessment of data completeness. Raw burned area data compiled from S/L/T agencies and national data sources are cleaned and combined to produce a comprehensive burned area data set. Emissions are then calculated using fire emission models that rely on burned area as well as fuel and weather information. The resulting emissions are compiled by date and location.

For purposes of emission inventory preparation, wildland fire (WLF) is defined as "any non-structure fire that occurs in the wildland (an area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities). Wildland fire activity is categorized by the conditions under which the fire occurs. These conditions influence important aspects of fire behavior, including smoke emissions. In the 2014 NEI, data processing is conducted differently depending on the fire type, as defined below:

Wildfire (WF): "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire."

Prescribed (Rx) fire: "any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulations to meet specific land or resource management objectives." Prescribed fire is one type of fuels treatment. Fuels treatments are vegetation management activities intended to modify or reduce hazardous fuels. Fuels treatments include prescribed fires, wildland fire use, and mechanical treatment.

Agricultural burning is a type of prescribed fire, specifically used on land used or intended to be used for raising crops or grazing. This is dealt with in a different section of this document.

Pile burning is a type of prescribed fire in which fuels are gathered into piles before burning. In this type of burning, individual piles are ignited separately. Pile burn emissions are not currently included in the NEI due to lack of usable data and methods. EPA continues to work to develop methods for estimating emissions of this source type.

Table 7-1 lists the Source Classification Codes (SCCs) that define the different types of WLFs in the 2011 NEI, both for EPA data and for S/L/T agency data. The leading SCC description for these SCCs is "Miscellaneous Area Sources; Other Combustion - as Event". In the 2014 NEI, the EPA has compiled WLF emissions by smoldering and flaming phases. The SCCs shown in are used to denote this differentiation. There are six valid SCCs for events in

EIS. The four rows with "EPA Generated?" equals "Yes" are the SCCs into which EPA and S/L/Ts generally compile their data in the 2014 NEI. EPA only generates estimates for these four SCCs.

Table 7-1: SCCs for wildland fires

SCC	Description	EPA Generated?
2810001000	Forest Wildfires; Total (Smoldering + Flaming) for Wildfires	
2810001001	Forest Wildfires; Smoldering	Yes
2810001002	Forest Wildfires; Flaming	Yes
2811015000	Managed Burning, Slash (Logging Debris); Pile Burning	
2811015001	Prescribed Forest Burning; Smoldering	Yes
2811015002	Prescribed Forest Burning; Flaming	Yes

7.2 Sources of data

The WLF EIS sectors include data only from two components: S/L/T agency-provided emissions data for Georgia (day-specific data in Events format), and the EPA dataset created from SmartFire version 2 (SF2), which used available state inputs. This merged information is the basis of the WLF 2014 NEI. The hierarchy of data used to compile the 2014 NEI was very straightforward: Georgia's data comes first, followed by EPA's dataset, as shown in Table 7-2. The NEI includes only Georgia-provided data for that S/L/T; in other words, there were no additions with any EPA-based data. Georgia used the same new hazardous air pollutant (HAP) emission factors to calculate emissions, so that these emissions calculations were used consistent with what was used for the remainder of the U.S. via the EPA methods.

In 2014, no tribes submitted WLF emissions data, and the EPA did not assign any fires based on the tribal land boundaries. These fires were assigned to the states within which the tribal lands fall.

Table 7-2: 2014 NEI Wildfire and Prescribed Fires selection hierarchy

Priority	Dataset Name	Dataset Content	Is Dataset in EIS?
1	State/Local/Tribal Data	Submitted data as discussed above	Yes
2	2014EPA_EVENT	Emissions from SFv2	Yes

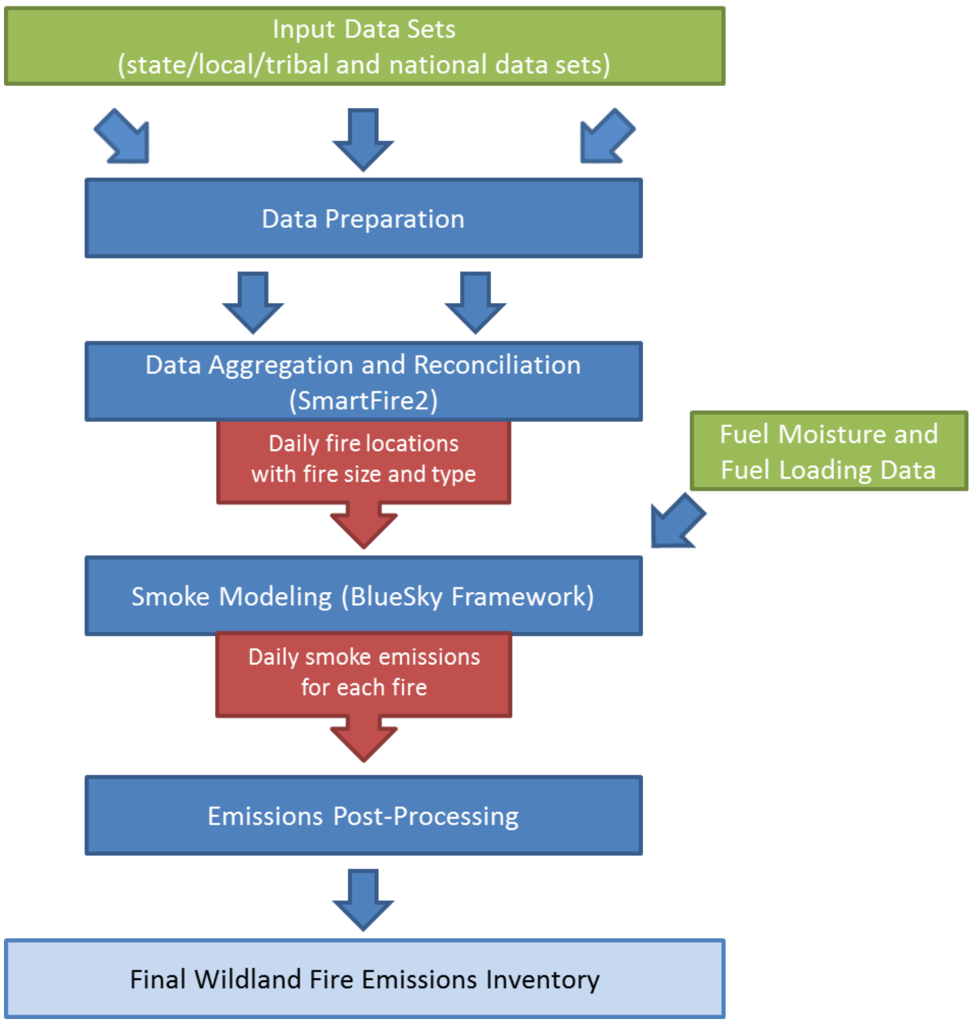
7.3 EPA methods summary

Preparation of the EPA WLF emissions begins with raw input data and ends with daily estimates of emissions from flaming combustion and smoldering combustion phases. Flaming combustion is combustion that occurs with a flame. Flaming combustion is more complete combustion and is more prevalent with fuels that have a high surface-to-volume ratio, a low bulk density, and low moisture content. Smoldering combustion is combustion that occurs without a flame. Smoldering combustion is less complete and produces some pollutants, such as $PM_{2.5}$, VOCs, and CO at higher rates than flaming combustion. Smoldering combustion is more prevalent with fuels that have low surface–to-volume ratios, high bulk density, and high moisture content. Models sometimes differentiate between smoldering emissions that are lofted with a smoke plume and those that remain near the ground (residual emissions), but for purposes of the 2014 NEI v1 those emissions are combined under smoldering emissions of fire. The emissions estimates were estimated and compiled separately for flaming and smoldering combustion phases of fire to facilitate climate modeling and fine-scale research in areas such as health impacts of smoke emissions.

Figure 7-1 shows the sequence of processing steps. First, input data sets are obtained from S/L/T agencies and national sources. The data sets are cleaned to eliminate errors and to standardize formatting for the data. Data sets submitted by various S/L/T agencies are appended together for subsequent processing. Appropriate cleaned data sets from S/L/T agencies and national sources are selected on the basis of data availability, data completeness, and geographic area; they are then reconciled into a single, comprehensive daily fire location data set using SmartFire2. These daily fire locations, along with fuel moisture and fuel loading data, are used by the BlueSky Framework [ref 2] to estimate fuel consumption and smoke emissions. Emissions are then computed for use in the 2014 NEI.

While Figure 7-1 shows a single processing stream, the 2014 NEI for wildland fires was prepared using six separate streams that covered different geographic areas [ref 1]. Each of the streams was processed in a similar manner, with some modification of the smoke modeling approach for fires in Hawaii and Puerto Rico (these modifications are discussed later in this section). Finally, the outputs from all of the streams were compiled into the NEI.

Figure 7-1: Processing flow for wildland fire emission estimates in the NEI



7.3.1 Activity data

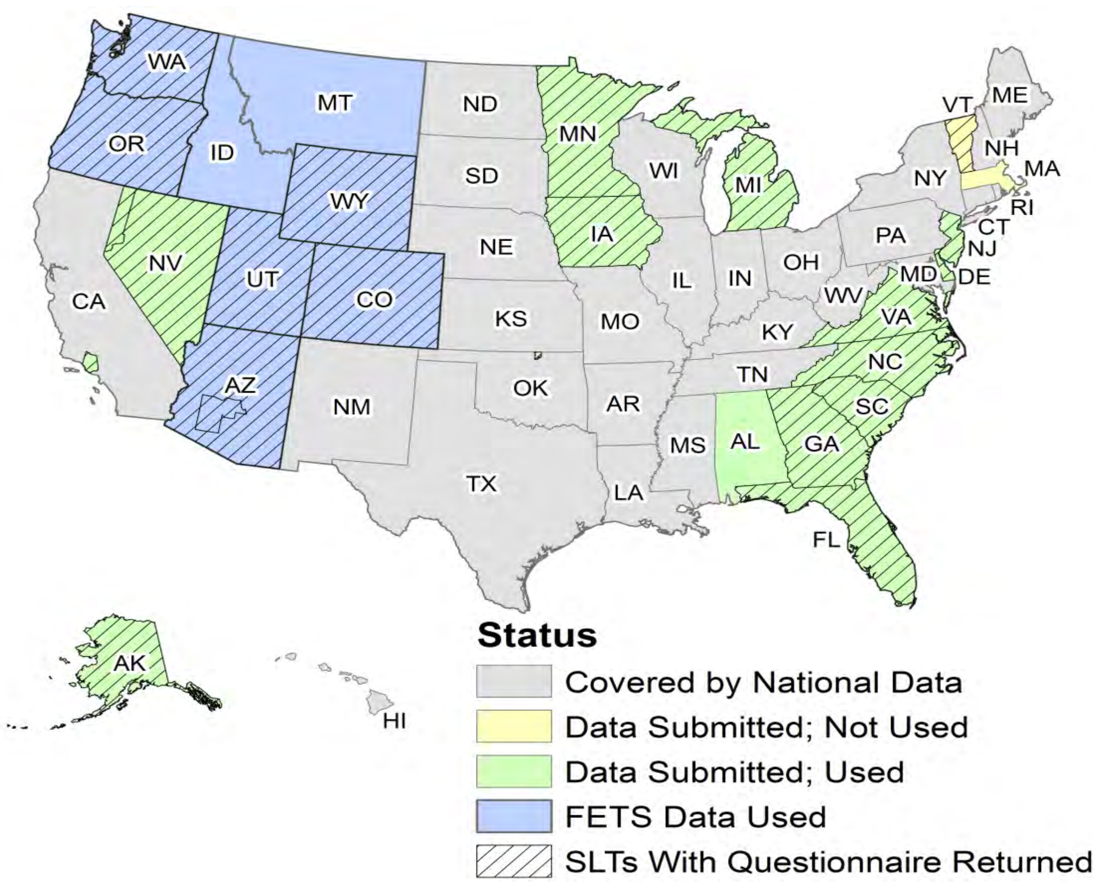
In addition to S/L/T submitted data and national default data sets, auxiliary data for fuel loading and fuel moisture were obtained [ref 1] to support emission calculations.

7.3.2 State, Local, and Tribal fire activity

In spring 2015, S/L/T agencies were invited by EPA and USFS to submit all fire occurrence data in any format for use in developing the 2014 NEI. In winter 2015, the submitting agencies were asked to self-assess the completeness of their data by completing the NEI Wildland Fire Inventory Database Questionnaire [Appendix A in ref 1] Overall, the EPA used a total of 54 data sets from 22 individual states and one Indian Nation. Twenty of the 22 states and the Indian Nation responded to the questionnaire. At a minimum, input data were required to include information about the date, location, fire type, and size of individual fires. Of the 54 data sets, eight were excluded from the NEI because they were determined to lack the minimum descriptive information necessary. Fourteen additional data sets were not used because they were duplicated by regional data from the Fire Emissions Tracking System (FETS). FETS wildland fire information was obtained from the Western Regional Air Partnership (WRAP) through EPA. The FETS data set included fire activity for eight states: Arizona, Colorado, Idaho, Montana, Oregon, Utah, Washington, and Wyoming.

As a result of the data collected and assessed, fire activity data from 22 states and one Indian Nation (32 individual data sets and FETS data) were included in the 2014 NEI. Figure 7-2 shows the states that submitted fire activity data and questionnaire responses, and identifies states where data were incorporated into the 2014 NEI v1. In the figure, states shown in green (as well as the Kaw Nation in Oklahoma and counties in California, Nevada, and Arizona) submitted usable data; blue colored states provided usable data via FETS; yellow colored states submitted unusable data; gray colored states did not provide data; and states shown with lines responded to the database questionnaire.

Figure 7-2: The coverage of state-submitted fire activity data sets



7.3.2.1 National fire activity data sources

In addition to the data provided by S/L/T agencies, fire data sets with national coverage from the following sources were also used to develop the 2014 WLF NEI:

- **Hazard Mapping System (HMS) data** published by the National Oceanic and Atmospheric Administration (NOAA)were acquired and agricultural fires were removed. See Section 4.11 on agricultural fires for more a description as to what was done and why.
- **Incident Status Summary (ICS-209) Reports** in application (.exe) format were acquired via the National Fire and Aviation Management Web Applications website. Upon execution, the application file created a Microsoft Access database containing the fire activity data. Data from two tables in the database were merged and used: the *SIT209_HISTORY_INCIDENT_209_REPORTS* table contained daily 209 data records for large fires, and the *SIT209_HISTORY_INCIDENTS* table contained summary data for additional smaller fires.
- **U.S. Fish and Wildlife Service (USFWS) fire information data** were provided by the USFWS.
- **National Association of State Foresters (NASF) fire information data** were downloaded from the National Fire and Aviation Management Web Applications website. Only wildfire data were included.
- **Forest Service Activity Tracking System (FACTS) fire information data** were supplied by the USFS. Only fuel treatment data were included.
- **Geospatial Multi-Agency Coordination (GeoMAC) fire perimeter data** were downloaded via the USGS GeoMAC wildland fire support website.
- **U.S. Department of the Interior (DOI) prescribed fire data** were extracted from the National Fire Plan Operations and Reporting System (NFPORS) and supplied by the USFS. This is a new data source that was not used in previous efforts. See [ref 1] for more details.

7.3.2.2 Ancillary activity data sources

The fire emission modeling framework used in processing the NEI requires information about burned fuels to estimate emissions. Two key parameters for computing burned fuel, fuel moisture observations and fuel loading were obtained for use in subsequent processing:

- **Fuel moisture:** Fire weather observation files (fdr_obs.dat) were downloaded for each analysis day from the USFS archive on 2/19/2016 and used as inputs to the Fuel_Moisture_WIMS module in the BlueSky Framework [ref 3].
- **Fuel loading:** The Fuel Characteristic Classification System (FCCS) 1-km fuels shapefile and lookup table for the contiguous United States were provided by the USFS AirFire Team. The Alaskan FCCS 1-km fuels shapefile and lookup table were acquired from the USFS Fire and Environmental Research Applications Team's website. Fuels information for Hawaii and Puerto Rico were not required as estimated fuel loadings available in the Fire Inventory from the National Center for Atmospheric Research (FINN) module [ref 4] were used.

7.4 Data preparation and processing

The raw input data were reviewed to determine whether the necessary information was included in each data set. At a minimum, input data were required to include information about the date, location, fire type, and size of individual fires. At a minimum, valid input data were required. Data sets that included at least the minimum required information were examined for data quality and, in cases where the minimum data quality criteria were not met, the invalid data points were modified or removed [see ref 1 for more details on these algorithms].

Agricultural and pile burns were removed from data sets during data preparation or after emission estimation because agricultural burns were processed separately by EPA, and usable pile burn data and a general method for estimating pile burn emissions for the purpose of the NEI were lacking.

7.4.1 S/L/T data preparation

Each S/L/T data set and any accompanying metadata were reviewed to determine its coverage and included information. Eight data sets were excluded from subsequent processing because the data sets lacked the required minimum information (see Appendix B in ref 1). Data sets containing a valid end date value for fires were also noted, and fire durations were calculated when available. All S/L/T data sets were cleaned to:

- include only fires falling within the relevant geographic boundary,
- include only fires with valid start dates falling within 2014 (unless end date is in 2014, in which case fires that started in 2013 were retained),
- include only fires with a valid area greater than 0 acres,
- remove agricultural fires,
- remove pile burns,
- modify invalid end dates by changing invalid end dates to be the same as the start date (end dates were considered to be invalid if they fell before the start date, if they fell more than three weeks after the start date for prescribed fires, or if they fell more than one week after the start data and had an area less than 10 acres),
- standardize column names,
- add a unique ID field and populate the field with unique IDs,
- transform point locations provided in projected coordinate systems to geographic coordinates,
- combine all data sets for each state into a single state data set.

Besides these cleaning steps, data sets were visually reviewed and, where warranted, further adjusted. Adjustments included changing the sign of longitude values for Alabama data to ensure that fires fell in the western hemisphere, and manually cleaning various issues with location information for the Iowa data set. Additional minor adjustments to individual fire records were made to correct assumed typos in key fields, including latitude, longitude, and date. An example of such an adjustment would be changing the start date of a fire from 04/05/2015 to 04/05/2014 where the end date was provided as 04/06/2014. Manual review of the data sets was assisted by the creation of an automated report for each data set showing the number of valid fire records that was located within the relevant geographic boundary and occurred during 2014, the geographic distribution of fires and fire types, the distribution of fire start date, the distribution of fire end date and duration where applicable, and the distribution of fire size.

The FETS regional data set was adjusted using the steps outlined above. However, additional preparation was required for the Oregon fire data sets. First, the Oregon wildfire data set was found to have a large number of fires outside the state. The locations of these fires were corrected. Second, the locations of prescribed fires statewide were reported in township/range/section format rather than as geographic coordinates. To identify an approximate location for these fires, we used the Bureau of Land Management GeoCommunicator Township Geocoder Web Service to assign an approximate geographic location for these fires based on the description of the fire location that was supplied in township/range/section format.

Six states and one local agency submitted data independently but were also covered by FETS regional data. Each submitted state or local data set was compared to the available FETS data. The state and local data duplicated the FETS data exactly in all cases. For these jurisdictions, we used FETS data in place of state- or local-submitted data.

S/L/T data sets were assessed for completeness based on the information included on the Database Questionnaire. Data submitters reported the data inclusion level (e.g., always or sometimes) and estimated percent completeness of data sets in categories based on fire types, primary agencies or actors, and land ownerships. The responses, along with any additional input from data submitters, were used to determine which national data sets would best supplement the S/L/T data, if any.

Data sets representing 14 states and one Indian Nation were reported as incomplete across multiple categories, and subsequent processing included all available national data sets as supplemental data. These S/L/T data sets were merged into a “supplement with all” data set for subsequent processing. Also included in the “supplement with all” category were three states that did not respond to the data questionnaire but submitted data that met the minimum requirements for necessary fire information.

The following five states included either no national data sets or only a subset of available national data sets as supplementary data, according to state feedback

- South Carolina. The South Carolina data sets were reported as 100% complete for all categories and as a result, the data sets were not supplemented with any national data sets.
- Alaska. Similarly, Alaska reported 100% completeness for its data set. However, because each raw data record represented a single wildfire over its entire spatial and temporal extent, we supplemented the data for Alaska with the HMS data set to provide improved fire growth and location information. Any resulting fires that were solely based on HMS data were removed in subsequent processing.
- Georgia. The Georgia questionnaire reported that fires associated with a federal primary agency were not included, so only federal data (USFWS, FACTS, NFPORS, and federally reported GeoMAC) were used to supplement the state’s data. However, the EPA-estimated emissions through this approach were ultimately not used in the NEI because Georgia elected to submit their own emissions.
- Florida. On the basis of Florida’s questionnaire response, its data set was supplemented with federally reported wildfires only in the USFWS and GeoMAC data sets.
- North Carolina. At the state’s request, the North Carolina data set was supplemented with only the FACTS data and USFWS data for Pee Dee and Great Dismal Swamp National Wildlife Refuges.

7.4.2 National data preparation

National data sets were prepared in a process similar to the state data set processing: data sets were checked to ensure the minimum necessary information was included, data sets were cleaned, and data set formats were standardized. Some data set-specific cleaning was also performed. Typical cleaning steps included correcting or removing fire locations outside the United States, correcting poorly formatted dates, and correcting end dates that fell either before the start date or an implausible length of time after the start date.

7.4.3 Event reconciliation and emissions calculations

Once S/L/T and national fire activity data were reviewed and cleaned, they were imported into the SF2 data platform for association and reconciliation to remove duplicate fires and assimilate into daily fire locations with fire size and type information. In addition, to develop the 2014 EPA estimates, comments received from all of the states that submitted comments on the 2014 draft emission estimates were addressed to the extent possible. The final step was that the SF2 output was then processed through the BlueSky Framework to estimate fuel loading, fuel consumption, and ultimately smoke emissions for each daily fire location. These smoke estimates were post-processed and compiled into the final wildland fire emissions inventory. Please consult the STI documentation [ref 1] for more details on these steps and how the hierarchy and reconciliation was implemented.

7.4.4 BlueSky Framework emissions modeling

Daily fire emissions were calculated from daily fire location files using the BlueSky Framework. The framework supports the calculation of emissions using various models depending on the available inputs as well as the desired results. Data for the NEI was calculated by using two different model chains based on the location of the fire. The contiguous United States and Alaska, where FCCS fuel loading data are available, were processed using the modeling chain described in Figure 7-3. Hawaii and Puerto Rico, which do not have FCCS fuel loading information available, were processed using a different modeling chain (Table 7-3Figure 7-3). See Appendix C in ref 1 for a full description of the Bluesky Framework modeling process.

Figure 7-3: Model chain for the contiguous United States and Alaska portion of the 2014 national wildland fire emissions inventory development

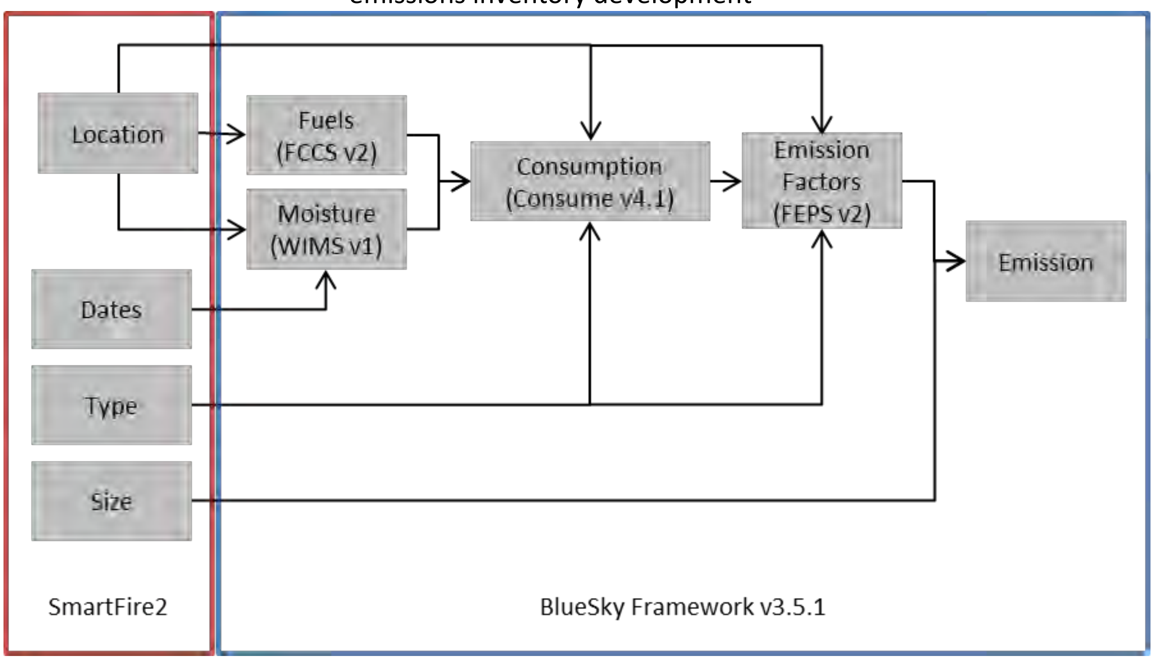


Table 7-3: Model chain for the Hawaii and Puerto Rico portion of the 2014 national wildland fire emissions inventory development

Data Type	Model Used	Version Information
Fire activity data	SmartFire2	Version 2.0, Build 42022
Fuel loading	FINN v1	As implemented in BlueSky Framework 3.5.1, revision 47693
Fuel consumption	FINN v1	
Emissions	FINN v1	

The Fire Emissions Production Simulator (FEPS) in the Bluesky Framework generates all the CAP emission factors for WLFs used in the NEI. However, for the 2014 NEI, the FEPS module has been updated to calculate emissions of HAPs and to calculate the smoldering and flaming components of emissions. In addition, the module was modified to compute emissions using regionalized HAP emission factors developed for this effort, which reflect differences in fire emissions in different parts of the country. The reader is referred to the FEPS module of the

Bluesky model for CAP emission factors (see FEPS link listed above). The HAP emission factors used in this work came from Urbanski, 2015 [ref 5]. These emission factors were regionalized and handled differently by wild and prescribed fire. Table 7-4 outlines the regionalization scheme used while Table 7-5 and Table 7-6 show the HAP EFs employed in this work separately for wild and prescribed fires. Note the differences, in bold in Table 7-4, for wildfires and prescribed burning region assignments for Alaska and Wisconsin.

Table 7-4: Emission factor regions used to assign HAP emission factors for the 2014 NWLFEI v1

Region	Wildfires	Prescribed burning
Region 1	AZ, CA, IA, IL, IN, KS, MO, NM, NV, OH, OK, TX	AZ, CA, IA, IL, IN, KS, MO, NM, NV, OH, OK, TX
Region 2	**AK**, AL, AR, CT, DC, DE, FL, GA, HI, KY, LA, MA, MD, ME, MI, MN, MS, NC, NH, NJ, NY, PA, PR, RI, SC, TN, VA, VI, VT, **WI**, WV	AL, AR, CT, DC, DE, FL, GA, HI, KY, LA, MA, MD, ME, MI, MN, MS, NC, NH, NJ, NY, PA, PR, RI, SC, TN, VA, VI, VT, WV
Region 3	CO, ID, MT, ND, NE, OR, SD, UT, WA, WY	**AK**, CO, ID, MT, ND, NE, OR, SD, UT, WA, **WI**, WY

Table 7-5: Prescribed fire HAP emission factors (lb/ton fuel consumed) for the 2014 NEI

HAP	Flaming			Smoldering		
	Region 1	**Region 2**	**Region 3**	**Region 1**	**Region 2**	**Region 3**
1,3-Butadiene (HAP 106990)	0.272326792	0.516619944	0.362434922	0.272326792	0.516619944	0.362434922
Acetaldehyde (HAP 75070)	1.678013616	1.283540248	2.240688827	1.678013616	1.283540248	2.240688827
Acetonitrile (HAP 75058)	0.322386864	0.064076892	0.43051662	0.322386864	0.064076892	0.43051662
Acrolein (HAP 107028)	0.512615138	0.646776131	0.684821786	0.512615138	0.646776131	0.684821786
Acrylic Acid (HAP 79107)	0.070084101	0.058069684	0.094112936	0.070084101	0.058069684	0.094112936
Anthracene (HAP 120127)	0.005	0.005	0.005	0.005	0.005	0.005
Benz(a)anthracene (HAP 56553)	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062
Benzene (HAP 71432)	0.450540649	0.566680016	0.600720865	0.450540649	0.566680016	0.600720865
Benzo(a)fluoranthene (HAP 203338)	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Benzo(a)pyrene (HAP 50328)	0.00148	0.00148	0.00148	0.00148	0.00148	0.00148
Benzo(c)phenanthrene (HAP 195197)	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
Benzo(e)pyrene (HAP 192972)	0.00266	0.00266	0.00266	0.00266	0.00266	0.00266
Benzo(ghi)perylene (HAP 191242)	0.00508	0.00508	0.00508	0.00508	0.00508	0.00508
Benzo(k)fluoranthene (HAP 207089)	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Benzofluoranthenes (HAP 56832736)	0.00514	0.00514	0.00514	0.00514	0.00514	0.00514
Carbonyl Sulfide (HAP 463581)	0.000534	0.000534	0.000534	0.000534	0.000534	0.000534
Chrysene (HAP 218019)	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062
Fluoranthene (HAP 206440)	0.00673	0.00673	0.00673	0.00673	0.00673	0.00673
Formaldehyde (HAP 50000)	2.515018022	3.366039247	4.475370445	2.515018022	3.366039247	4.475370445
Indeno(1,2,3-cd)pyrene (HAP 193395)	0.00341	0.00341	0.00341	0.00341	0.00341	0.00341
m,p-Xylenes (HAP 1330207)	0.216259511	0.160192231	0.288346015	0.216259511	0.160192231	0.288346015
Methanol (HAP 67561)	2.306768122	1.974369243	5.036043252	2.306768122	1.974369243	5.036043252

HAP	Flaming			Smoldering		
	Region 1	Region 2	Region 3	Region 1	Region 2	Region 3
Methyl Chloride (HAP 74873)	0.128325	0.128325	0.128325	0.128325	0.128325	0.128325
Methylanthracene (HAP 26914181)	0.00823	0.00823	0.00823	0.00823	0.00823	0.00823
Methylbenzopyrenes (HAP 65357699)	0.00296	0.00296	0.00296	0.00296	0.00296	0.00296
Methylchrysene (HAP 41637905)	0.0079	0.0079	0.0079	0.0079	0.0079	0.0079
Methylpyrene,-fluoranthene (HAP 2381217)	0.00905	0.00905	0.00905	0.00905	0.00905	0.00905
n-Hexane (HAP 110543)	0.048057669	0.024028835	0.064076892	0.048057669	0.024028835	0.064076892
Naphthalene (HAP 91203)	0.486583901	0.398478174	0.650780937	0.486583901	0.398478174	0.650780937
o-Xylene (HAP 95476)	0.07609131	0.050060072	0.100120144	0.07609131	0.050060072	0.100120144
Perylene (HAP 198550)	0.000856	0.000856	0.000856	0.000856	0.000856	0.000856
Phenanthrene (HAP 85018)	0.005	0.005	0.005	0.005	0.005	0.005
Pyrene (HAP 129000)	0.00929	0.00929	0.00929	0.00929	0.00929	0.00929
Styrene (HAP 100425)	0.10412495	0.080096115	0.138165799	0.10412495	0.080096115	0.138165799
Toluene (HAP 108883)	0.344413296	0.398478174	0.45855026	0.344413296	0.398478174	0.45855026

Table 7-6: Wild fire HAP emission factors (lbs/ton fuel consumed) for the 2014 NEI

HAP	Flaming			Smoldering		
	Region 1	Region 2	Region 3	Region 1	Region 2	Region 3
1,3-Butadiene (HAP 106990)	0.272326792	0.140168202	0.362434922	0.272326792	0.140168202	0.362434922
Acetaldehyde (HAP 75070)	1.678013616	1.908289948	2.240688827	1.678013616	1.908289948	2.240688827
Acetonitrile (HAP 75058)	0.322386864	0.600720865	0.43051662	0.322386864	0.600720865	0.43051662
Acrolein (HAP 107028)	0.512615138	0.582699239	0.684821786	0.512615138	0.582699239	0.684821786
Acrylic Acid (HAP 79107)	0.070084101	0.080096115	0.094112936	0.070084101	0.080096115	0.094112936
Anthracene (HAP 120127)	0.005	0.005	0.005	0.005	0.005	0.005
benz(a)anthracene (HAP 56553)	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062
Benzene (HAP 71432)	0.450540649	1.101321586	0.600720865	0.450540649	1.101321586	0.600720865
Benzo(a)fluoranthene (HAP 203338)	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Benzo(a)pyrene (HAP 50328)	0.00148	0.00148	0.00148	0.00148	0.00148	0.00148
Benzo(c)phenanthrene (HAP 195197)	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
Benzo(e)pyrene (HAP 192972)	0.00266	0.00266	0.00266	0.00266	0.00266	0.00266
Benzo(ghi)perylene (HAP 191242)	0.00508	0.00508	0.00508	0.00508	0.00508	0.00508
Benzo(k)fluoranthene (HAP 207089)	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Benzofluoranthenes (HAP 56832736)	0.00514	0.00514	0.00514	0.00514	0.00514	0.00514
Carbonyl Sulfide (HAP 463581)	0.000534	0.000534	0.000534	0.000534	0.000534	0.000534
Chrysene (HAP 218019)	0.0062	0.0062	0.0062	0.0062	0.0062	0.0062
Fluoranthene (HAP 206440)	0.00673	0.00673	0.00673	0.00673	0.00673	0.00673

HAP	Flaming			Smoldering		
	Region 1	Region 2	Region 3	Region 1	Region 2	Region 3
Formaldehyde (HAP 50000)	2.515018022	3.954745695	4.475370445	2.515018022	3.954745695	4.475370445
Indeno(1,2,3-cd)pyrene (HAP 193395)	0.00341	0.00341	0.00341	0.00341	0.00341	0.00341
m,p-Xylenes (HAP 1330207)	0.216259511	0.120144173	0.288346015	0.216259511	0.120144173	0.288346015
Methanol (HAP 67561)	2.306768122	2.613135763	5.036043252	2.306768122	2.613135763	5.036043252
Methyl Chloride (HAP 74873)	0.128325	0.128325	0.128325	0.128325	0.128325	0.128325
Methylanthracene (HAP 26914181)	0.00823	0.00823	0.00823	0.00823	0.00823	0.00823
Methylbenzopyrenes (HAP 65357699)	0.00296	0.00296	0.00296	0.00296	0.00296	0.00296
Methylchrysene (HAP 41637905)	0.0079	0.0079	0.0079	0.0079	0.0079	0.0079
Methylpyrene,-fluoranthene (HAP 2381217)	0.00905	0.00905	0.00905	0.00905	0.00905	0.00905
n-Hexane (HAP 110543)	0.048057669	0.054064878	0.064076892	0.048057669	0.054064878	0.064076892
Naphthalene (HAP 91203)	0.486583901	0.554665599	0.650780937	0.486583901	0.554665599	0.650780937
o-Xylene (HAP 95476)	0.07609131	0.054064878	0.100120144	0.07609131	0.054064878	0.100120144
Perylene (HAP 198550)	0.000856	0.000856	0.000856	0.000856	0.000856	0.000856
Phenanthrene (HAP 85018)	0.005	0.005	0.005	0.005	0.005	0.005
Pyrene (HAP 129000)	0.00929	0.00929	0.00929	0.00929	0.00929	0.00929
Styrene (HAP 100425)	0.10412495	0.11814177	0.138165799	0.10412495	0.11814177	0.138165799
Toluene (HAP 108883)	0.344413296	0.480576692	0.45855026	0.344413296	0.480576692	0.45855026

The FINN module (not BlueSky) was used for Hawaii and Puerto Rico, since FCCS data were not available for these regions, and FINN is capable of calculating emissions globally. FINN uses satellite-derived land cover data, estimated fuel loadings, and emission factors to model smoke emissions.

However, the FINN module does not compute emissions for VOCs or HAPs. Estimates of emissions of these species for Hawaii and Puerto Rico were based on the CO_2 outputs from FINN. The average ratios of VOCs and HAPs to CO_2 for wildland fires in grassland/herbaceous land cover, which is most similar to the vegetation type that burned in Hawaii and Puerto Rico, were calculated for the contiguous United States and applied to the CO_2 emissions of Hawaii and Puerto Rico fires to estimate VOC and HAP emissions.

7.4.5 Dataset post-processing

Daily fire emission estimates from BlueSky Framework were post-processed to address known issues and prepare data for final use [ref 6]. Post-processing included adjustment of the calculated duff consumption for certain fires, removal of agriculture and pile burns, speciation of $PM_{2.5}$ emissions, and final formatting.

The FEPS emission estimates for the contiguous United States and Alaska were corrected to address a known issue with emission estimates for prescribed fires in areas with large duff depths [ref 6]. To address overestimation of duff consumption in these fires, a scaling factor was calculated and applied to each fire to reduce phase-specific consumption and emissions. This adjustment was applied as follows:

1. New duff consumption of each prescribed burn was recalculated by setting a “cap” value for the duff consumption. For burns in western states (all states west of Texas, plus the Dakotas), the duff consumption cap was set to 20 tons per acre. For eastern states, the duff consumption cap was set to 5

tons per acre. These caps were developed in consultation with USFS and U.S. DOI experts. For each fire, the exceedance in duff consumption was calculated by subtracting capped duff consumption from the original duff consumption.

2. The new total consumption of each prescribed burn was calculated by removing the exceedance in duff consumption from the original total consumption.
3. The scaling factor for each prescribed burn was calculated as the ratio of the new total consumption over the original total consumption.
4. Finally, the burn-specific scaling factor was applied to phase-specific consumption (flaming, smoldering, and residual) and daily emissions of all pollutants to compute new fuel consumption and emissions.

Emissions from agricultural and pile burns are not accounted for in the 2014 NEI. Any fires that were identified as agricultural or pile burns in the modeling output were removed from the WLF NEI.

The 2014 NEI includes speciated components of $PM_{2.5}$ for the first time. $PM_{2.5}$ components were calculated as a fraction of total $PM_{2.5}$ by multiplying emissions by the speciation factors provided by EPA based on EPA's modeling platforms and SPECIATE 4.0. Table 7-7 provides the speciation factors used for the 2014 NEI.

Table 7-7: $PM_{2.5}$ speciation factors used to calculate $PM_{2.5}$ components for wildfires and prescribed fires

Pollutant	Wildfires	Prescribed burning
EC	0.09490	0.10930
OC	0.46180	0.50190
SO_4	0.01260	0.00330
NO_3	0.00132	0.01070
Other	0.42938	0.37480

Some updates to the outputs were made at the request of data providers, based on comments on the draft WLF EPA inventory. Four wildfires in the state of Delaware, representing all calculated wildfire activity for the state, were removed because it was known that no wildfires had occurred in 2014. The names of some fires in Michigan were also updated.

7.5 Development of the NEI

As stated previously, only Georgia submitted emissions for this data category. For all the other states, the emissions developed as outlined above by EPA methods were the basis for the inventory. In Georgia's case, their data was accepted as submitted, and no additions were made with EPA data. Georgia also used the same new HAP emission factors as shown above (so no HAP augmentation was therefore necessary).

Georgia's methods were very similar to EPA's methods. Georgia provided the following documentation on their methods:

> *Georgia Environmental Protection Division (EPD) has developed 2014 Georgia wildland fire emission inventory using the same fuel consumption and emission factors as was used to develop 2011 Georgia wildland fire emission inventory, which has been included as part of NEI 2011. Such fuel consumption and emission factors are developed as part of the Southeastern Modeling, Analysis, and Planning (SEMAP) fire emission inventory project and were considered as the best knowledge from fire and forest managers in the Southeast. Burned area* [estimates] *are based on*

2014 burning records obtained from Georgia Forestry Commission and three military bases, as well as burning records of wildland fires on federal lands. No satellite fire detection data were used in Georgia EPD estimates. To fulfill the requirement of separating emission by flaming and smoldering combustion phases for NEI 2014, Georgia EPD ran CONSUME to generate separate emissions by flaming, smoldering and residual smoldering and calculated emission fractions by combustion phases assuming that flaming and smoldering in CONSUME corresponds to flaming, and residual smoldering in CONSUME corresponds to smoldering. This assumption is made based on the fact that the emissions during flaming and smoldering often coexist.

7.6 Quality assurance

Quality assurance steps were implemented at each step of processing of the 2014 NEI to ensure the integrity of the product. In general, quality control involved review of data sets to ensure that data did not contain errors and reflected the most accurate available information. Quality control was performed on input fire information data sets, SF2 daily fire location output, and BlueSky Framework emissions estimates.

7.6.1 Input Fire Information Data Sets

Input data set quality control is described in the data preparation section above. In general, the following steps were followed.

- Reviewed input data sets to identify data gaps.
- Identified fire incidents that appeared to be double-counted in individual data sets and removed duplicate records.
- Examined fires with long durations or conflicts between date fields such as start date and report date to identify fires that may have erroneous dates, and made necessary corrections.
- Reviewed fire locations to ensure that they fell within the United States. Obvious errors in data entry such as the reversal of latitude and longitude were corrected where possible.
- Reviewed large and small fires in each data set for validity.
- Modified distant fires (in different states) with the same names to ensure that the events were not associated.

7.6.2 Daily Fire Locations from SmartFire2

Quality assurance actions applied to daily fire locations from SmartFire2 included:

- Checked the location, fire type, duration, underlying fire activity input data, final shape, and final size for large fire events (i.e., area burned >20,000 acres) to ensure that the results were reasonable.
- Checked large fire events by state and by name, removed duplicate events, and renamed fires as needed.
- Reviewed large fire events with multiple data sources to ensure that SmartFire2 reconciliation rankings were correct and produced sensible results.
- Identified and removed fire event duplicates incorrectly created by the SmartFire2 reconciliation process.
- Checked fire events with large differences between the calculated fire area and the geometric fire area. Since the shape and area are calculated separately in SmartFire2, a large discrepancy can indicate errors in reconciliation. For the 2014 NWLFEI, no errors of this sort were identified.

7.6.3 Emissions Estimates

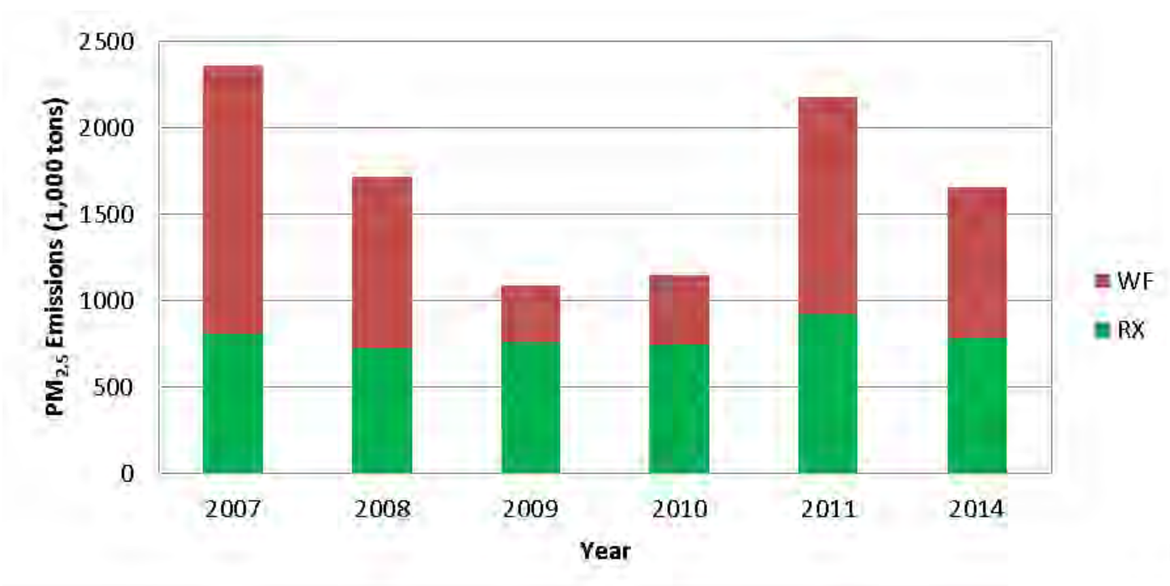
Quality assurance actions applied to resulting emissions estimates included:

- Checked the location of all final fires and emission estimates. Fires falling outside of the United States were removed. Some fires near the border were retained if fuel information was available in that location.
- Identified fire records that were incorrectly associated and adjusted fire event size and emissions proportionally.
- Removed any fires in Alaska that had only HMS as a source.
- Produced and reviewed summary tables and plots of the 2014 fire inventory data.
- Compared acres burned by state to National Interagency Fire Center data as well as the 2015 National Prescribed Fire Use Survey Report (of 2014 data) to ensure the summary values were within reasonable range.

7.6.4 Additional quality assurance on final results

WLF emissions developed using the methods described above were compared to EPA's 2011 estimates, since the models used are similar. The spatial (and temporal) patterns seen in the data correspond to what was expected in 2014, and how the domains changed from 2011 –In general, 2014 was a "better" fire year than 2011 as fewer acres were burned (about 30% less), so the emissions are expected to be lower in 2014 compared to 2011. The trends graphic in Figure 7-4 shows how the 2014 PM2.5 estimates compare to other years (using similar methods). These trends represent only the lower 48 states.

Figure 7-4: $PM_{2.5}$ WLF emissions trends from 2007-2014 using SF2 (for the lower 48 states).



In comparing the 2014 estimates to previous years, the following points of QA that were made should also be noted:

- 2011 emissions are much lower than 2014. However, it is within the range of the previous 5 inventories. The average wildland fire $PM_{2.5}$ emissions for 2007-2010 and 2011 is 1.66 million tons, while 2014 total emission is 1.47 million tons (excluding Alaska, Hawaii, and Puerto Rico).

- The major difference between 2014 and previous years is in wildfires because prescribed burn emissions stay relatively consistent over the years, averaging 792 thousand tons for previous years vs. 770 thousand tons for 2014 (excluding Alaska, Hawaii, and Puerto Rico). Wildfire activity is driven by the state of the climate, which varies greatly from year to year and from region to region, as well as by other factors such as fuel accumulation, human activity, lightning storm, etc. Many of the checks made on these parameters match what would be expected to happen to WLF emissions in 2014 in that domain.
- Examples of this type of QA include: 2014 was one of the wettest years for AK, which explains the decrease in wildfire activity in Alaska. The opposite was seen in California where it had suffered a few consecutive years of drought and experienced greater wildfire activity in 2014 than in 2011. Yet another example is 2011 was the driest year on record for Texas so it made sense that Texas had higher emissions in 2011 than in 2014.

Georgia was the only state to submit emissions data. A comparison of the data between the Georgia-submitted emissions and SF2-generated emissions for Georgia showed a very good match for wildfires, but a marginal match for prescribed fires. Due to that concern and some concerns that Georgia had on the spatial extent of emissions estimate on a county basis for Georgia in SF2 and on VOC emissions being too high with EPA methods, they submitted their own emissions in 2014.

7.7 Summary of results

In the 2014 NEI estimates, wildland fires burned about 15.2 million acres in the United States and emitted almost 1.7 million tons of $PM_{2.5}$. Of this area, about 4.2 million acres (24%) were burned by wildfires and 10.9 million acres (76%) by prescribed fires. Wildfire $PM_{2.5}$ emissions account for 53% and prescribed burns account for 47% of the total emissions in this emissions inventory. Table 7-8 summarizes acres burned and $PM_{2.5}$ emissions by state, fire type, and combustion phase. Additional details can be found in the STI documentation referenced below. Note that the GA numbers listed below are from the S/L/T submission they made to this data category.

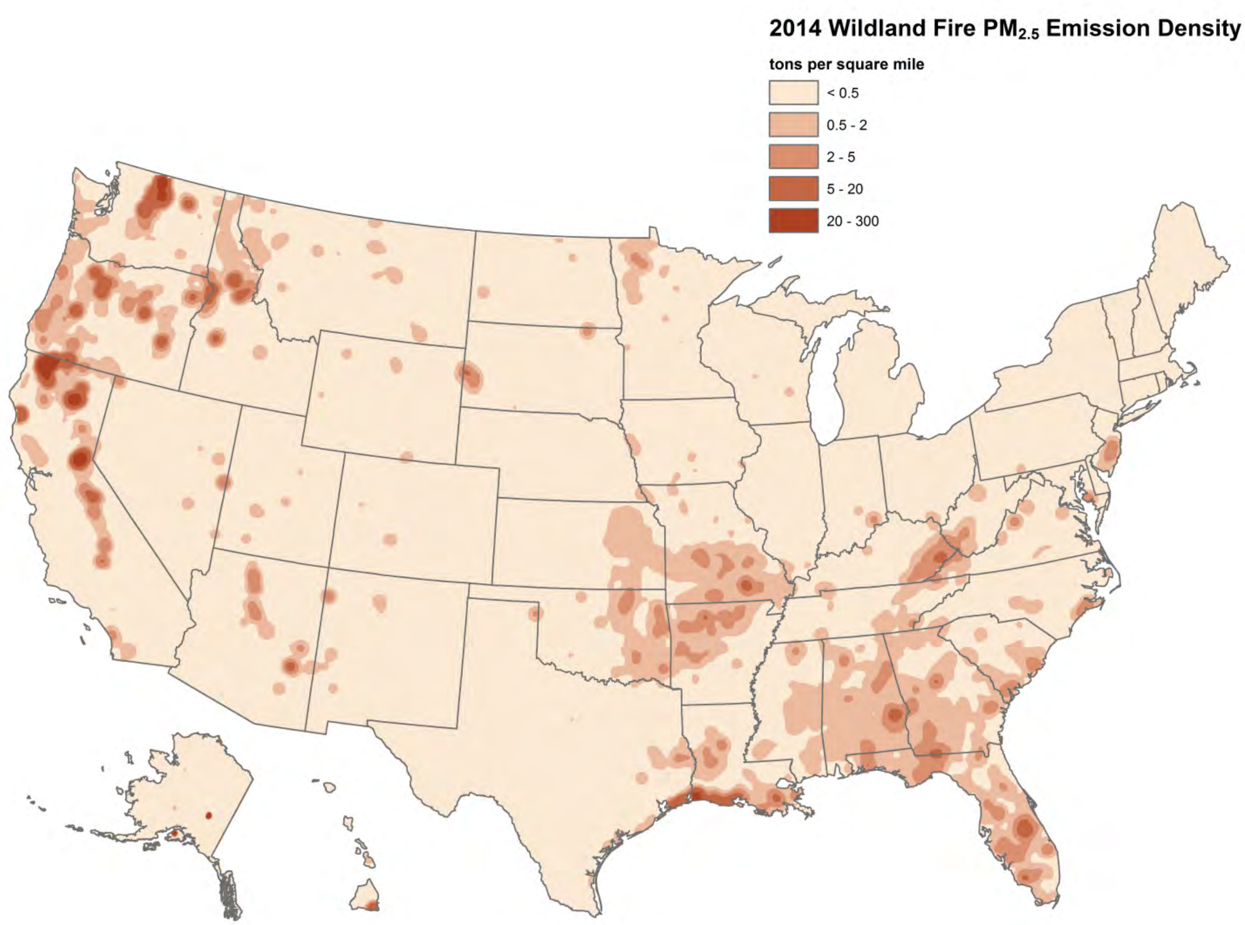
Table 7-8: Summary of NEI acres burned and $PM_{2.5}$ emissions by state, fire type, and combustion phase

State	Area (Acres)			$PM_{2.5}$ (Tons)						
	Total	Wildfire	Prescribed Fire	Total $PM_{2.5}$ Emissions	Wildfire			Prescribed Fire		
					Subtotal	Flaming	Smoldering	Sub total	Flaming	Smoldering
Alabama	1,140,870	74,433	1,066,437	69,117	9,001	2,882	6,119	60,116	20,528	39,588
Alaska	294,644	290,177	4,467	173,411	172,420	141,490	30,929	991	717	274
Arizona	367,897	249,873	118,023	26,939	20,557	10,525	10,032	6,381	4,279	2,102
Arkansas	449,046	21,713	427,333	48,493	4,112	2,400	1,712	44,380	26,567	17,814
California	788,143	635,494	152,649	295,438	271,220	203,701	67,519	24,218	16,483	7,735
Colorado	88,950	33,803	55,147	6,312	805	359	446	5,507	3,686	1,821
Connecticut	606	118	488	68	15	6	9	53	14	39
Delaware	3,013	0	3,013	160	0	0	0	160	57	104
Florida	1,802,824	110,910	1,691,914	97,306	6,377	1,949	4,428	90,929	29,297	61,631
Georgia (S/L/T)	1,380,782	23,176	1,357,606	56,281	1,142	1,032	110	55,141	48,319	6,821
Hawaii	56,920	0	56,920	11,150	0	0	0	11,150	0	11,150
Idaho	374,339	229,963	144,375	54,357	35,133	23,186	11,948	19,224	13,524	5,700
Illinois	139,138	2,816	136,322	9,901	303	153	150	9,598	4,505	5,092

State	Area (Acres)			PM2.5 (Tons)						
	Total	Wildfire	Prescribed Fire	Total PM2.5 Emissions	Wildfire			Prescribed Fire		
					Subtotal	Flaming	Smoldering	Sub total	Flaming	Smoldering
Indiana	55,577	1,190	54,387	5,306	141	69	72	5,165	2,949	2,216
Iowa	212,266	12,761	199,506	12,396	987	432	555	11,409	4,521	6,888
Kansas	490,050	124,687	365,363	24,405	6,843	2,254	4,589	17,562	5,244	12,318
Kentucky	113,246	48,999	64,247	30,106	22,464	13,888	8,576	7,642	3,978	3,664
Louisiana	711,525	44,039	667,486	86,691	26,711	24,764	1,947	59,980	43,931	16,049
Maine	3,038	216	2,822	477	53	39	14	424	305	119
Maryland	19,076	3,168	15,909	2,836	1,487	1,334	153	1,349	986	363
Massachusetts	2,858	1,284	1,575	284	133	47	86	152	89	63
Michigan	33,478	3,287	30,191	2,710	331	147	184	2,379	1,342	1,036
Minnesota	297,587	4,934	292,653	22,630	850	473	376	21,780	12,150	9,630
Mississippi	562,702	41,745	520,956	26,913	3,284	1,123	2,161	23,629	8,921	14,708
Missouri	501,719	31,394	470,324	63,143	7,057	4,748	2,309	56,086	36,992	19,094
Montana	226,966	35,729	191,237	27,392	6,008	4,951	1,057	21,384	15,494	5,890
Nebraska	160,720	23,796	136,924	7,530	1,135	476	658	6,395	2,599	3,796
Nevada	100,586	85,116	15,470	9,466	8,672	5,180	3,492	794	562	232
New Hamp.	447	79	369	56	16	8	8	40	17	22
New Jersey	32,359	8,953	23,406	7,327	3,966	3,286	680	3,361	2,728	633
New Mexico	142,832	56,547	86,285	9,005	5,676	3,531	2,145	3,329	2,035	1,295
New York	9,788	2,945	6,843	1,207	464	255	209	743	443	299
N. Carolina	153,600	25,053	128,547	13,881	3,008	1,898	1,110	10,872	6,750	4,123
N. Dakota	135,184	1,383	133,802	9,870	87	35	52	9,783	5,085	4,699
Ohio	27,726	4,003	23,723	3,511	1,378	802	575	2,133	1,164	969
Oklahoma	541,760	163,871	377,888	41,022	14,244	5,607	8,637	26,778	13,047	13,731
Oregon	1,311,203	1,005,701	305,501	135,085	94,823	63,336	31,487	40,262	30,512	9,750
Pennsylvania	21,382	5,384	15,998	3,338	1,499	888	611	1,839	1,169	669
Puerto Rico	21,593	193	21,400	576	2	0	2	574	0	574
Rhode Island	246	24	222	16	5	3	3	11	3	7
S. Carolina	401,805	14,722	387,083	22,180	1,664	540	1,124	20,516	8,519	11,997
S. Dakota	96,903	15,262	81,642	15,265	2,049	1,325	724	13,216	9,026	4,190
Tennessee	127,020	22,836	104,184	16,576	5,592	2,492	3,100	10,984	4,492	6,492
Texas	804,389	159,399	644,990	50,670	22,768	17,540	5,228	27,902	11,637	16,265
Utah	118,434	48,240	70,194	6,486	2,591	1,295	1,296	3,896	2,238	1,658
Vermont	1,345	163	1,181	112	27	11	16	85	52	33
Virginia	117,354	16,774	100,580	16,682	5,395	2,957	2,439	11,287	6,248	5,038
Washington	626,616	505,212	121,403	105,577	91,594	63,173	28,421	13,983	9,860	4,123
West Virginia	47,657	15,397	32,259	12,676	7,103	4,372	2,731	5,573	3,721	1,851
Wisconsin	69,246	2,868	66,378	4,314	196	72	124	4,118	2,005	2,113
Wyoming	62,704	15,763	46,941	6,863	1,502	1,072	430	5,361	3,999	1,361
Grand Total	**15,177,838**	**4,239,624**	**10,938,214**	**1,658,014**	**875,230**	**622,039**	**253,191**	**782,784**	**402,698**	**380,086**

In the 2014 NEI, the table above and Figure 7-5 (Puerto Rico data is not shown) shows that the bulk of emissions originate from two regions: The West and the Southeast. This spatial distribution of emissions is consistent with previous national fire inventories. Spring and winter emissions are mostly from the southeastern states, where prescribed burning is a common land management practice in spring, and, to a lesser extent, at the end of the year. Summer/fall emissions occur primarily in the West, particularly in California, Oregon, Washington, and Idaho.

Figure 7-5: 2014 NEI wildland fire $PM_{2.5}$ emission density



7.8 Improvements in the 2014 NEI v1 compared to the 2011 NEI

The methods used to develop the 2014 WLF NEI included several changes and improvements over methods used in the previous NEI cycle (2011).

7.8.1 Fire activity data

The 2014 NEI incorporates a total of 30 S/L/T and national fire activity data sets (23 S/L/T and 7 national data sets), similar to the breadth of the data used for the 2011 NEI (31 total, 24 S/L/T and 7 national data sets). However, in the 2014 effort, S/L/T data submitters were asked to respond to a data questionnaire by providing data completeness information for their data. We were able to use this self-assessed information from 21 S/L/T agencies to better understand their data and make an informed decision about how their fire activity data should be supplemented with national data sets (Table 7-2). Instead of applying the national fire activity data sets universally to all S/L/T entities, as was done for the 2011 NEI, data supplement policies were directly guided by S/L/T input to ensure the final fire activity data best represented S/L/T knowledge.

In addition, the FACTS dataset for 2014 was obtained in polygon format, an improvement over the point data used in the 2011 NEI. Polygons provide more accurate fire location, shape, and size information. Also, NFPORS fire activity data for the DOI was added to the national data sets that helped improve the fire emissions estimates.

7.8.2 SmartFire2 processing

During SF2 processing of fire activity data, two software issues were identified and workarounds to address these issues were made. First, some daily fire records were lost when daily exports were created (saving one export file per day). In previous years, daily export was the preferable export method due to system performance concerns. However, upgraded computing resources for SF2 allowed for exporting all of 2014's data at once, eliminating the inadvertent loss of some daily fire records.

Second, it was found that some input fires were incorrectly associated with two separate fire events, resulting in double counting of acres burned. This issue was caused by reconciling fire events twice in an effort to prevent double counting caused by another reason, namely, fires that intersect within spatial and temporal uncertainties are not associated and reconciled. The issue was resolved by developing a standalone R script to sift through SF2 inputs and outputs to identify the duplicated fire events. The duplicates were removed from subsequent processing. Refer to the STI documentation [ref 1] for further details.

7.8.3 Emission factors

As previously mentioned, updated HAP emission factors were provided by EPA based on a peer reviewed publication [ref 5]. The new emission factors were region- and fire-type-specific and were based on the latest research carried out by the Missoula Fire Sciences Laboratory at the USFS. A complete list of these emission factors was provided earlier and is available in the literature.

7.9 Future areas of improvement

7.9.1 More accurate fuel loading

A limitation of the BlueSky Framework v3.5.1 is that it only accepts fire location point input. For a given fire location, the fuel bed assignment is based upon the point location. When a fire is small, the fuel bed at a single point may be representative of the primary fuels burned. However, for large fires, basing the fuel loading within the fire perimeter on a single point could result in significant over- or under-estimation of fuels consumed, possibly biasing the emission estimate. We recommend exploring options to provide more accurate fuel loading information for large fires. Potentially, this could be achieved by modifying SF2 and BlueSky Framework so that a given fire could be represented by multiple points or a polygon instead of one single point.

7.9.2 Pile burn emissions

During the data collection process, we received pile burn data sets from 13 S/L/T data submitters. In addition, pile burn data were included in the data we acquired from two national sources, NFPORS and FACTS. In order to reasonably estimate emissions from pile burns, two pieces of pile information are required: count and fuel loading of the piles (fuel loading may also be estimated from pile volume and composition). There was only one state whose pile burn data provided the minimum amount of information. In cases where the minimum required information is not provided, estimating pile burn emissions requires the use of default values for either pile count or pile fuel loading. However, due to time and budgetary constraints, it was not feasible to request missing information from data submitters or develop default values collectively with both the research community and S/L/T agencies for the 2014 NEI v1.

Most of the pile burn data sets for 2014 included hundreds or thousands of records, suggesting that the emissions from pile burning practices are not trivial. For future EI development, we recommend that methods for estimating pile burn emissions be considered. Inclusion of pile burns in future EIs would provide a more complete estimation of emissions from wildland fires. To do this with more confidence requires default information to be available on pile burns in the Bluesky framework.

7.9.3 SmartFire2 improvements

Two issues were identified with SF2 during the development of the 2014 NEI. First, daily fire records may be lost when daily exports are created. Second, input fires can be incorrectly associated into two separate fire events, resulting in double counting of acres burned. Although corrective steps were adopted to mitigate the impacts the issues had on the data, these bugs should be addressed before future SF2 development.

7.9.4 VOC emission factors

At least two states, Georgia and Alaska, have noted that the emission factor for VOC used for the NEI is too high as default from Bluesky. It is recommended that a literature review of VOC emission factors be conducted and that the most up-to-date value(s) be utilized for future emission inventory development.

7.9.5 Centralized fire information database

Beginning with the 2011 version, the NEI has incorporated S/L/T fire activity data sets. The collection, review, cleaning, and standardization of a few dozen data sets require a significant amount of time and labor. This process could be streamlined if there were a centralized fire activity database where S/L/T agencies could store all of their fire activity data. All of the data would be stored in one place and in one universal format. Such a centralized database would not only save both time and money for future emission inventory development, but also potentially serve other purposes such as prescribed burn planning, permitting, and tracking. Loading and quality assuring these data in EIS could be investigated for future NEIs.

7.10 References

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8 Biogenics – Vegetation and Soil

Biogenic emissions are emissions that come from natural sources. They need to be accounted for in photochemical grid models, as most types are widespread and ubiquitous contributors to background air chemistry. In the NEI, only the emissions from vegetation and soils are included, but other relevant sources include volcanic emissions, lightning oxides of nitrogen (NOx), and sea salt.

Biogenic emissions from vegetation and soils are computed using a model that utilizes spatial information on vegetation, land use and environmental conditions of temperature and solar radiation. The model inputs are typically horizontally allocated (gridded) data, and the outputs are gridded biogenic emissions, which can then be speciated and utilized as input to photochemical grid models.

8.1 Sector description

In the 2014 NEI, biogenic emissions are included in the nonpoint data category, in the EIS sector "Biogenics – Vegetation and Soil." Table 8-1 lists the two source classification codes (SCCs) used in the 2014 NEI that comprise this sector. The level 1 and 2 SCC description for both SCCs is "Natural Sources; Biogenic" and the full Tier 3 description for both SCCs is "Natural Resources; Biogenic; Vegetation". These two SCCs have distinct pollutants: SCC 2701220000 has only NO_X emissions, and SCC 2701200000 has emissions for carbon monoxide (CO), volatile organic compounds (VOC) and three VOC hazardous air pollutants (HAPs): formaldehyde, acetaldehyde and methanol.

Table 8-1: SCCs for Biogenics – Vegetation and Soil

SCC	SCC Level 3	SCC Level 4
2701200000	Vegetation	Total
2701220000	Vegetation/Agriculture	Total

The biogenic emissions for the 2014 National Emissions Inventory (NEI) were computed based on 2014 meteorology data from the Weather Research and Forecasting (WRF) model version 3.8 (WRFv3.8) and using the Biogenic Emission Inventory System, version 3.61 (BEIS3.61) model within the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. The BEIS3.61 model creates gridded, hourly, model-species emissions from vegetation and soils. The 12-kilometer gridded hourly data are summed to monthly and annual level, and are mapped from 12-kilometer grid cells to counties using a standard mapping file. BEIS produces biogenic emissions for a modeling domain which includes the contiguous 48 states in the U.S., parts of Mexico, and Canada. The NEI uses the biogenic emissions from counties from the contiguous 48 states and Washington, DC.

The model-species are those associated with the carbon bond 2005 chemical mechanism (CB05). The NEI pollutants produced are: CO, VOC, NOx, methanol, formaldehyde and acetaldehyde. VOC is the sum of all biogenic species except CO, nitrogen oxide (NO), and sesquiterpene (SESQ). Mapping of BEIS pollutants to NEI pollutants is as follows:

- NO maps to NO_X
- FORM maps to formaldehyde
- ALD2 maps to acetaldehyde
- MEOH maps to methanol
- VOC is the sum of all biogenic species except CO, NO, SESQ

BEIS3.61 has some important updates from BEIS 3.14. These include the incorporation of Version 4.1 of the Biogenic Emissions Land Use Database (BELD4) for the 2011v6.3 platform, and the incorporation of a canopy model to estimate leaf-level temperatures [ref 1]. BEIS3.61 includes a two-layer canopy model. Layer structure varies with light intensity and solar zenith angle. Both layers of the canopy model include estimates of sunlit and shaded leaf area based on solar zenith angle and light intensity, direct and diffuse solar radiation, and leaf temperature [ref 2].

The new algorithm requires additional meteorological inputs as compared to previous versions of BEIS, and these meteorology inputs must be in a data file format that is output from the Meteorology-Chemistry Interface Processor (MCIP). MCIP is also used to convert WRF outputs to inputs for the Community Multi-scale Air Quality (CMAQ) model. The meteorology input data fields used by BEIS are shown in Table 8-2.

Table 8-2: Meteorological variables required by BEIS 3.61

Variable	Description
LAI	leaf-area index
PRSFC	surface pressure
Q2	mixing ratio at 2 m
RC	convective precipitation per met TSTEP
RGRND	solar rad reaching surface
RN	non-convective precipitation per met TSTEP
RSTOMI	inverse of bulk stomatal resistance
SLYTP	soil texture type by USDA category
SOIM1	volumetric soil moisture in top cm
SOIT1	soil temperature in top cm
TEMPG	skin temperature at ground
USTAR	cell averaged friction velocity
RADYNI	inverse of aerodynamic resistance
TEMP2	temperature at 2 m

BELD version 4.1 is based on an updated version of the U.S. Department of Agriculture (USDA) and U.S. Forest Service (USFS) Forest Inventory and Analysis (FIA) database (http://www.fia.fs.fed.us/). FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. The FIA database version 5.1 includes recent updates of these data through the year 2014 (from 2001). Earlier versions of BELD used an older version of the FIA database that had included data only through the year 2012. Canopy coverage is based on the Landsat satellite National Land Cover Database (NLCD) product from 2011. The FIA includes approximately 250,000 representative plots of species fraction data that are within approximately 75 km of one another in areas identified as forest by the NLCD canopy coverage. The 2011 NLCD provides land cover information with a native data grid spacing of 30 meters. For land areas outside the conterminous United States, 500-meter grid spacing land cover data from the Moderate Resolution Imaging Spectroradiometer (MODIS) is used.

Other improvements to the BELDv4.1 data included the following:

- Used 30-meter NASA's Shuttle Radar Topography Mission (SRTM) elevation data (http://www2.jpl.nasa.gov/srtm/) which will more accurately define the elevation ranges of the vegetation species.
- Used the 2011 30-meter USDA Cropland Data Layer (CDL) data (http://www.nass.usda.gov/research/Cropland/Release/) to improve the BELD4 agricultural categories.

8.2 Sources of data overview and selection hierarchy

The only source of data for this sector is the EPA-estimated emissions from BEIS3.61. States are neither required nor encouraged to report biogenic emissions, and no state has done this. The name of the EPA dataset in the EIS is: 2014EPA_biogenics.

8.3 Spatial coverage and data sources for the sector

The spatial coverage of the biogenics emissions is governed by the "2011 platform" modeling domain which covers all counties in the lower 48 states. More information on this modeling platform is available at https://www.epa.gov/air-emissions-modeling/2011-version-6-air-emissions-modeling-platforms.

8.4 References

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