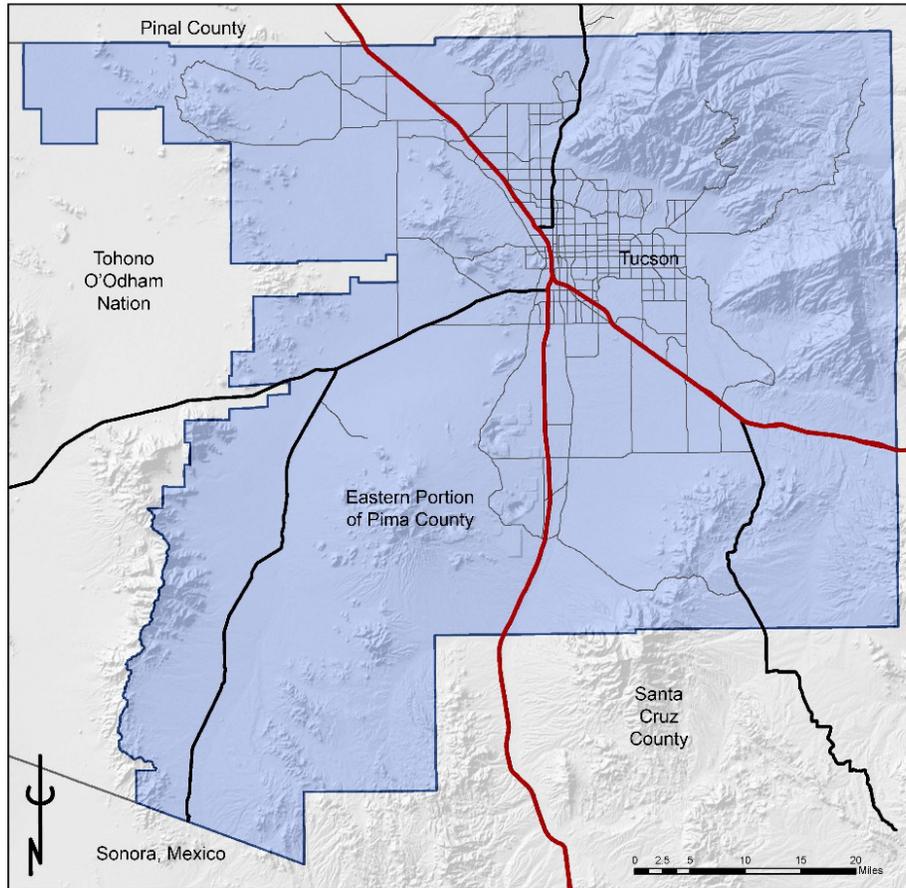


Pima County Emissions Inventory: Final Report



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List of Acronyms

ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AFB	Air Force Base
BEIS	Biogenic Emission Inventory System
CANA	Cremation Association of North America
CNG	compressed natural gas
EIIP	Emissions Inventory Improvement Program
ERG	Eastern Research Group, Inc.
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FF10	Flat File 2010
HAP	hazardous air pollutant
HDD	heating degree day
LPG	liquefied petroleum gas
MMcf	million cubic feet
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standard
NEI	National Emissions Inventory
NO _x	nitrogen oxides
OSD	ozone season day
PAG	Pima Association of Governments
PDEQ	Pima County Department of Environmental Quality
POTW	public owned treatment works
PTE	potential to emit
SEDS	State Energy Data Systems
SMOKE	Sparse Matrix Operator Kernel Emissions (modeling system)
tpy	tons per year
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecasting (model)

1.0 Introduction

In anticipation of possible future nonattainment with the 2015 National Ambient Air Quality Standard (NAAQS) for 8-hour ozone (i.e., 0.070 parts per million), the Pima County Department of Environmental Quality (PDEQ) requires a comprehensive annual and ozone season day (OSD) emissions inventory for the portion of Pima County likely to be classified as a nonattainment area (NAA). PDEQ contracted with Eastern Research Group, Inc. (ERG) to develop the emissions inventory under Pima County Contract No. PO-PO-17-032.

This draft emissions inventory report includes a complete and detailed description of all emission inventory methods, assumptions, and data used to develop the emissions inventory. In addition, supporting example calculations are provided.

It should be noted that this is a ‘first time’ inventory for Pima County. As such, some data were not available (e.g., daily or monthly operational data for point sources) which contribute to inventory uncertainty. These types of uncertainty are discussed in this report, along with recommendations for improvement when revising the inventory in the future.

The remainder of this report is organized as follows:

- Section 2.0 discusses the emissions inventory scope, including inventory year, pollutants, source types, geographic domain, temporal resolution, and spatial resolution;
- Sections 3.0 through 8.0 describes the methods, data, and assumptions used to develop emission estimates for point sources (Section 3.0), area sources (Section 4.0), on-road motor vehicles (Section 5.0), nonroad mobile sources (Section 6.0), aircraft and locomotives (Section 7.0), and biogenic sources (Section 8.0);
- Section 9.0 presents a summary of the comprehensive Pima County emissions inventory;
- Section 10.0 describes the development of model ready files;
- Section 11.0 discusses recommendations for future emissions inventory development; and
- Section 12.0 lists the references that were used to develop the inventory.

2.0 Emissions Inventory Scope

The emissions inventory scope describes the inventory year, pollutants, source types, geographic domain, temporal resolution, and spatial resolution of the estimates.

2.1 Inventory Year

ERG developed the Pima County Emissions Inventory for the calendar year 2014. The selection of the year 2014 coincides with the most recent U.S. Environmental Protection Agency (U.S. EPA) National Emissions Inventory (NEI), which is on a triennial development cycle.

2.2 Pollutants

Since the Pima County Emissions Inventory was developed in anticipation of future nonattainment with the 2015 NAAQS for 8-hour ozone, the inventory focuses on ozone precursors – specifically, nitrogen oxides (NO_x) and volatile organic compounds (VOC).

2.3 Source Types

The Pima County Emissions Inventory is comprehensive and includes estimates of emissions from industrial point sources, nonpoint (i.e., area) sources, on-road motor vehicle, nonroad mobile sources, aircraft and locomotives, and biogenic sources. The Pima Association of Governments (PAG) developed the on-road motor vehicle and nonroad mobile source emissions, and ERG developed emissions from the other sources.

2.4 Geographic Domain

The geographic domain of the Pima County Emissions Inventory consists of the eastern portion of Pima County (see Figure 2-1). This domain was previously designated by PAG as the “PAG Model Study Area”.

The inventory domain includes the Tucson metropolitan area and is bounded by Pinal County on the north, Cochise County on the east, and Santa Cruz County and Mexico on the south. The western boundary of the inventory domain is the boundary of the Tohono O’odham Nation (Schuk Toak District). Although most of the Tohono O’odham Nation and some western areas (i.e., Ajo and Organ Pipe Cactus National Monument) are in Pima County, these areas are not included in the inventory domain. Two smaller tribal areas (i.e., Tohono O’odham Nation [San Xavier District] and Pascua Yaqui Tribe) located within the Tucson metropolitan area are included in the emissions inventory domain.

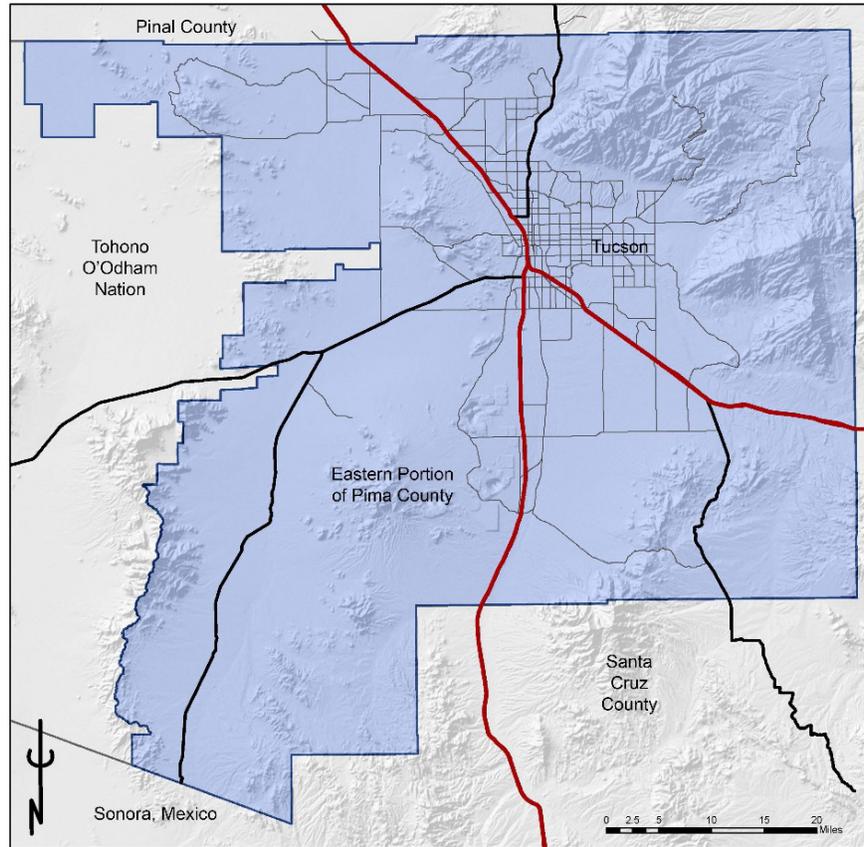


Figure 2-1. Pima County Emissions Inventory Domain (Source: PAG)

2.5 Temporal Resolution

In addition to the 2014 annual Pima County Emissions Inventory, ERG also developed ozone season day (OSD) emissions for the ozone season (i.e., April 1 through October 31). The OSD emissions were developed using temporal profiles that represent how annual emissions are temporally distributed throughout the year. Additional information regarding OSD emission calculations is provided in the documentation for specific source types.

2.6 Spatial Resolution

For compatibility with possible future air quality modeling efforts by PAG, the Western Regional Air Partnership (WRAP), and other entities, ERG developed spatial surrogates for the emissions inventory. These spatial surrogates are useful for allocating county-level emissions to the emissions inventory domain. Additional discussion of spatial surrogate development is provided in Section 10.0.

3.0 Point Sources

Industrial point sources are facilities emitting air emissions great enough to be identified as a single source. In some inventories, point sources are defined as such because they emit pollutants greater than specific quantities, or a threshold. Many point sources have an operating permit that specifies their maximum allowable and/or potential emissions, some facilities annually report their actual emissions.

3.1 Identification of Point Sources in the Pima County Emissions Inventory Domain

Point sources operating within the inventory domain were identified with the assistance of the PDEQ Air Quality Permitting Section. PDEQ issues operating permits to three different classes of air pollution sources:

- Class I Sources:
 - Federal major source program (i.e., Title V) sources that have potential to emit (PTE) quantities greater than the following:
 - 100 tons per year (tpy) of any criteria pollutant (excluding lead);
 - 10 tpy of any single hazardous air pollutant (HAP) or 25 tpy of a combination of HAPs; or
 - 5 tpy of lead.
 - Solid waste incineration unit required to obtain a permit pursuant to Section 129(e) of the Act;
 - Affected source; or
 - In a source category designated by the administrator pursuant to 40 CFR 70.3.
- Class II Sources: Minor sources that meet at least one of the following criteria:
 - PTE quantities above Class I emission levels;
 - Federally enforceable limits are taken to keep emissions below Class I emission levels; and
 - Sources subject to a standard, limitation, or other requirement under Section 11 (NSPS) or 112 (NESHAP) of the Act.
- Class III Sources: True minor sources that meet the following criteria:
 - PTE above significant quantities of regulated air pollutants; and
 - Not subject to a standard, limitation, or other requirement under Section 11 (NSPS) or 112 (NESHAP) of the Act.

Currently, there are 13 Class I Sources actively operating point sources located within the Pima County inventory domain. These point sources include the following:

- Three electricity generating stations owned by Tucson Electric Power Company:
 - Irvington Generating Station
 - DeMoss Petrie Generating Station
 - North Loop Generating Station
- Three landfills:
 - Los Reales Municipal Solid Waste Landfill (City of Tucson Environmental Services)
 - Tangerine Landfill (PDEQ – Solid Waste Management)
 - Marana Regional Landfill (Waste Management of Arizona, Inc.)
- Two mining and processing facilities:
 - ASARCO LLC – Mission Complex
 - Freeport-McMoRan Sierrita, Inc.
- Vail Compressor Station (El Paso Natural Gas Company, LLC)
- Tucson Terminal (SFPP, L.P.)
- University of Arizona
- Tucson Facility (Learjet, Inc.)
- Inter-Fab, Inc.

There is one inactive Class I source located in Pima County (i.e., Southwest Fiberglass) that was not included in the emission inventory.

All Class I sources are required to submit annual emission statements to PDEQ; PDEQ staff provided annual VOC and NO_x emissions for the 13 Class I sources based upon the submitted emission statements early in the inventory development process (PDEQ, 2017a). In addition to the 13 Class I sources, PDEQ staff also provided 2014 annual VOC and NO_x emissions from the three other non-Class I sources (i.e., Davis-Monthan Air Force Base [AFB], Raytheon, and Poly Print) (PDEQ, 2017b).

In addition to the 16 PDEQ permitted point source facilities, there is an additional point source facility that is permitted by the Arizona Department of Environmental Quality (ADEQ) (i.e., the CalPortland cement plant located in Rillito). Annual 2014 VOC and NO_x emissions for this facility were provided by ADEQ staff (ADEQ, 2017).

The point sources in the Pima County emissions inventory only included emissions from the 17 permitted sources identified above. Emissions from the other Class II and Class III permitted

sources, as well as any industrial point sources located in the San Xavier District of the Tohono O’odham National (none of which are under PDEQ jurisdiction), were not be estimated explicitly; however, fuel combustion emissions from these sources are accounted for as part of the area source inventory.

Because actual point source operating schedules are not known, OSD emissions were assumed to be average daily emissions (i.e., annual emissions divided by 365 days). This is a reasonable assumption, unless facility operation is seasonal or if the facility was off-line for significant periods of time during 2014. Seasonal differences or facility off-line periods are a potential source of inventory uncertainty and will be discussed in Section 11.0.

A summary of the point source NO_x and VOC annual and OSD emissions is provided in Table 3-1.

Table 3-1. Point Source Emissions Summary

Source	Permit Number	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
CalPortland - Rillito Plant	65021	2,201.8	5.3	12,064.8	28.8
Tucson Electric Power Company - Irvington Generating Station	1052	1,331.2	28.7	7,294.2	157.3
Freeport-McMoRan Sierrita, Inc.	6067	134.7	37.9	738.2	207.5
ASARCO LLC, Mission Complex - Mission Complex	2026	88.0	1.0	482.2	5.5
University of Arizona	2371	49.6	3.1	271.9	17.0
Raytheon	1978	41.2	7.9	225.6	43.2
Davis-Monthan AFB, AZ	1701	27.2	16.3	149.0	89.3
SFPP, L.P. - Tucson Terminal	1674	4.4	64.0	23.9	350.7
El Paso Natural Gas Company LLC (EPNG) - Vail Compressor Station	425	4.2	0.6	23.0	3.2
Tucson Electric Power Company - North Loop Generating Station	1053	3.7	0.1	20.1	0.3
Learjet, Inc. - Tucson Facility	825	2.0	38.3	10.8	209.9
Tucson Electric Power Company - DeMoss Petrie Generating Station	910	1.6	0.1	8.6	0.7
City of Tucson Environmental Services - Los Reales Municipal Solid Waste Landfill	3618	1.4	9.7	7.7	53.3
Waste Management of Arizona, Inc. - Marana Regional Landfill	6133	0.2	0.9	0.9	5.2
Pima County Dept. of Environmental Quality - Solid Waste Management - Tangerine Landfill	5011		2.0		11.2
Inter-Fab, Inc.	2905		6.5		35.8
Poly Print	671		41.6		228.1
Total		3,891.0	264.1	21,320.8	1,446.8

4.0 Area Sources

Area sources include all activities which are too numerous and dispersed to estimate emissions as point sources. Also, in some cases, area sources occur over a wide area and do not have a true “point” where emissions occur. The area source categories that were included in the Pima County emissions inventory domain are presented in Table 4-1. Table 4-1 presents the estimation method and the data used to develop the area source emissions for each area source category within the inventory domain. When available, ERG used local data (i.e., either county- or domain-specific); if local data were not available, then national- or state-level data were used to estimate emissions. In a few instances, ERG used emission estimates directly from the U.S. EPA’s 2014 NEI (U.S. EPA, 2016). Emission factors used for area source category estimates developed by ERG are presented in Appendix A.

Table 4-1. Methods and Data Used to Estimate Area Source Emissions

Source Category	Pollutants	Estimation Method	Activity Data
Industrial Fuel Combustion	NO _x , VOC	Emission factors from ICI Tool	State-level industrial fuel consumption data
Commercial/ Institutional Fuel Combustion	NO _x , VOC	Emission factors from ICI Tool	State-level commercial fuel consumption data
Residential Fuel Combustion (excluding wood)	NO _x , VOC	Emission factors from WebFIRE	State-level residential fuel consumption data
Residential Wood Combustion	NO _x , VOC	2014 NEI estimates	NA
Architectural Surface Coating	VOC	Emission factors from Solvent Tool	Domain-level population
Industrial Surface Coating	VOC	Emission factors from Solvent Tool	Domain-level employee population
Autobody Refinishing	VOC	Emission factors from Solvent Tool	Domain-level employee population
Traffic Markings	VOC	2014 NEI estimates	NA
Degreasing	VOC	Emission factors from Solvent Tool	Domain-level employee population
Dry Cleaning	VOC	Emission factors from Solvent Tool	Domain-level employee population
Graphic Arts	VOC	Emission factors from Solvent Tool	Domain-level population
Consumer Solvent Use	VOC	Emission factors from Solvent Tool	Domain-level population
Asphalt Application	VOC	2014 NEI estimates	NA
Petroleum Transport and Distribution (including aviation gasoline)	VOC	Emission factors from EIIP and 2014 NEI	Local fuel throughput
Residential and Commercial Portable Gas Cans	VOC	2014 NEI estimates	NA
Wastewater Treatment Plant	VOC	2014 NEI estimates	NA
Agricultural Pesticides	VOC	2014 NEI estimates	NA
Commercial Cooking	VOC	2014 NEI estimates	NA
Structural Fires	NO _x , VOC	Emission factors from EIIP	National estimates on fire incidents – FEMA
Vehicle Fires	NO _x , VOC	Emission factors from EIIP	National estimates on fire incidents – FEMA

Table 4-1. Methods and Data Used to Estimate Area Source Emissions

Source Category	Pollutants	Estimation Method	Activity Data
Bakeries	VOC	Emission factors from EIIP	Domain-level population
Cremation	NO _x , VOC	Emission factors from 2011 NEI	County-level deaths and national-level cremations data

EIIP = U.S. EPA’s *Emissions Inventory Improvement Program*

FEMA = Federal Emergency Management Agency

NA = Not applicable

NEI = National Emissions Inventory

4.1 Area Source Fuel Combustion

Area source fuel combustion includes three discrete sectors (i.e., industrial, commercial/institutional, and residential) and several fuel types (e.g., coal, natural gas, distillate fuel oil, liquefied petroleum gas [LPG], and kerosene). Residential wood combustion is treated as a separate area source category because the method and data used are very different from the other area source fuel combustion categories.

ERG estimated emissions from area source fuel combustion categories by using emission factors and state-level fuel consumption data. ERG obtained state-level fuel consumption data from U.S. Energy Information Administration’s (EIA) *State Energy Data System* (SEDS). These data consisted of state-level consumption quantities, by sector and by fuel type for Arizona for the calendar year 2014 (EIA, 2017). ERG obtained emission factors for industrial and commercial fuel combustion categories from U.S. EPA’s *ICI Tool* documentation (U.S. EPA, 2015a). Emission factors for the residential fuel combustion categories were obtained from U.S. EPA’s WebFIRE database (U.S. EPA, 2017). Emission factors for the area source fuel combustion categories are listed in Appendix A.

To obtain fuel consumption for the inventory domain, several steps were followed. ERG apportioned state-level fuel consumption data to Pima County based on the ratio of county-level employees to state-level employees. Employee data were obtained from U.S. Census Bureau’s *County Business Patterns* (U.S. Census, 2016). The PAG provided local employee data, but these were not used because there were only available at the county-level, while the U.S. Census data were available at both the state- and county-level. For apportioning industrial fuel use, ERG used the ratio of county- and state-level employee population in the manufacturing sector (NAICS 31-33). For apportioning commercial/institutional fuel use, ERG used the ratio of county- and state-level employee population in the service industries (NAICS 42-92). For apportioning residential fuel use, ERG used county- and state-level household fuel use data obtained from U.S. Census’ *American Community Survey* (U.S. Census, 2017).

Local population data (both Pima County and inventory domain) obtained from PAG indicate that approximately 98 percent of the county population resides within the inventory domain (PAG, 2017a). Therefore, ERG multiplied county-level residential fuel combustion emissions by a factor of 0.98 to estimate emissions for the inventory domain. It was assumed that all industrial and commercial/institutional fuel combustion in Pima County occurs within the inventory

domain. The original source for the Pima County population data is the U.S. Census Bureau's *American Community Survey* (U.S. Census Bureau, 2017).

Example calculations for estimating annual NO_x emissions from industrial and residential combustion of natural gas are shown below:

SCC 2102006000 – Industrial/Natural Gas/Total: Boilers & IC Engines:

State-level natural gas consumption in the industrial sector = 22,492 MMcf

Employee population in the manufacturing sector (NAICS 31-33) for Arizona = 262,492
Employee population in the manufacturing sector (NAICS 31-33) for Pima County = 42,613
Ratio of county- and state-level employee population = 42,613/262,492 = 0.16234

County-level estimated natural gas consumption in the industrial sector = 22,492 MMcf × 0.16234 = 3,651.4 MMcf

NO_x emission factor = 100 lb/MMcf

$$NOx \text{ Emissions} = (3651.4 \text{ MMcf} \times 100 \text{ lb/MMcf}) \times \frac{1 \text{ ton}}{2,000 \text{ lbs}} = 182.6 \text{ tons}$$

SCC 2104006000 – Residential/Natural Gas/Total: All Combustor Types:

State-level natural gas consumption in the residential sector = 32,397 MMcf

Households using utility gas for heating in Arizona = 819,618
Households using utility gas for heating in Pima = 209,745
Domain adjustment factor = 0.98 (98 percent of county population resides within the domain)
Households using utility gas for heating in the domain = 209,745 × 0.98 = 205,550
Ratio of domain- and state-level households using utility gas = 205,550/819,618 = 0.25079

Domain-level estimated natural gas consumption in the residential sector = 32,397 MMcf × 0.25079 = 8,124.8 MMcf

NO_x emission factor = 94 lb/MMcf

$$NOx \text{ Emissions} = (8124.8 \text{ MMcf} \times 94 \text{ lb/MMcf}) \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = 381.9 \text{ tons}$$

4.2 Solvent Evaporation

ERG estimated VOC emissions from various solvent evaporation categories, including architectural coatings, consumer solvent use, industrial surface coatings, miscellaneous coatings, dry cleaning, graphic arts, degreasing, autobody refinishing, traffic markings, and asphalt application. ERG used population-based and employee-based emission factors to estimate VOC emissions from the solvent evaporation categories as local solvent usage data (i.e., quantity of solvent used and VOC content of solvent) were not available.

ERG compiled population-based and employee-based emission factors from U.S. EPA's *Solvent Tool* documentation (U.S. EPA, 2015b). Local employee and population data for the inventory domain were obtained from PAG (PAG, 2017a; PAG, 2017b). Emission factors for the solvent evaporation categories are listed in Appendix A.

Example calculations for estimating annual VOC emissions from dry cleaning and graphic arts are shown below:

SCC 2420000000 – Dry Cleaning (employee-based emission factor approach):

VOC emission factor for dry cleaning operations = 10 lb VOC/employee
Local employee population for NAICS 812320 (Dry cleaning & laundry services, except coin-operated) = 509

$$VOC\ emissions = \left(509\ employees \times \frac{10\ lb}{employee} \right) \times \frac{1\ ton}{2,000\ lbs} = 2.6\ tons$$

SCC 2425000000 – Graphic Arts (population-based emission factor approach):

VOC emission factor for graphic arts operations = 3.7 lb VOC per-capita population
Inventory domain area population = 984,426

$$VOC\ emissions = \left(984,426 \times \frac{3.7\ lb}{person} \right) \times \frac{1\ ton}{2,000\ lbs} = 1,821.2\ tons$$

For the traffic markings and asphalt application categories, emissions were obtained directly from U.S. EPA's 2014 NEI (U.S. EPA, 2016).

4.3 Petroleum Product Transport and Distribution

ERG estimated VOC emissions from automotive gasoline and aviation gasoline storage, transport, and distribution categories. This category also includes VOC emissions from residential and commercial portable gas cans (automotive gasoline). For portable gas can categories (residential and commercial), emissions were directly taken from U.S. EPA's 2014 NEI (U.S. EPA, 2016).

For automotive gasoline Stage I and underground storage operations, ERG estimated VOC emissions using emission factors obtained from U.S. EPA (U.S. EPA, 2001a). Stage II emissions from refueling of motor vehicles were estimated as are included under the on-road motor vehicles source type and are part of the MOVES model output. County-level automotive gasoline consumption data were provided by PAG. The original data source for the county-level automotive gasoline consumption data is Arizona Department of Transportation (ADOT) (ADOT, 2017). Due to lack of availability of local data on underground tank filling operations (splash filling, submerged filling, or balanced submerged filling), it was assumed that all underground tank filling operations in the domain are done using balanced submerged filling.

For aviation gasoline categories, emission factors were obtained from U.S. EPA’s 2014 NEI documentation (U.S. EPA, 2016) and domain-level aviation gasoline consumption data were obtained from PAG (ADOT, 2017).

Example calculations for estimating annual VOC emissions from underground tank breathing and emptying operations at retail gasoline dispensing stations are shown below:

SCC 2501060201 – Gasoline Service Stations/Underground Tank: Breathing & Emptying:

VOC emission factor for underground tank breathing and emptying losses = 1 lb/1000 gallons
 Motor gasoline consumption for Pima county (in 2014) = 217,640,739 gallons
 Domain adjustment factor = 0.98 (98 percent of county population resides within the domain)
 Motor gasoline consumption for domain area = 0.98 × 217,640,739 = 213,287,924 gallons

$$VOC\ emissions = \left(213,287,924\ gallons \times \frac{1\ lb}{1000\ gallons} \right) \times \frac{1\ ton}{2,000\ lbs} = 106.7\ tons$$

4.4 Accidental Structure and Vehicle Fires

ERG estimated VOC and NO_x emissions from accidental fires (i.e., structure and vehicle fires) using emission factors and average fuel loading factors from U.S. EPA (U.S. EPA, 2001b; U.S. EPA, 2000). National-level activity data (i.e., number of fire incidents, by type) were obtained from the Federal Emergency Management Agency’s U.S. Fire Administration (FEMA, 2017). Data for structural fires includes residential structural fires and non-residential structural fires. The national-level activity data were apportioned to the inventory domain area using the ratio of domain- to national-level population.

Example calculations for estimating annual VOC emissions from accidental vehicle fires are shown below:

SCC 2810050000 – Accidental Motor Vehicle Fires:

National-level vehicle fires reported in 2014 = 193,500

U.S. national population (2014) = 318,857,056

Inventory domain population (2014) = 984,426

Ratio of domain- to national-level population = 984,426/318,857,056 = 0.00309 (0.309%)

Estimated vehicle fires reported in domain area = 193,500 × 0.0031 = 597

VOC emission factor for vehicle fires = 32 lb/ton burned

Average fuel loading = 500 lbs/vehicle = 0.25 tons/vehicle

$$VOC\ emissions = \left(597\ vehicles \times \frac{0.25\ ton}{vehicle} \times \frac{32\ lb}{ton\ burned} \right) \times \frac{1\ ton}{2,000\ lbs} = 2.4\ tons$$

4.5 Miscellaneous Area Source Categories

Miscellaneous area source categories include: residential wood combustion, public wastewater treatment, agricultural pesticide application, commercial cooking, bakeries, and human cremations. Emissions were not estimated for landfills, open burning, and agricultural burning. Emissions for residential wood combustion, public wastewater treatment plants, agricultural pesticide application, and commercial cooking categories were obtained directly from U.S. EPA's 2014 NEI (U.S. EPA, 2016).

VOC emissions from bakeries were estimated using emission factor and per-capita bread consumption factor obtained from U.S. EPA (U.S. EPA, 1999). Domain-level population data were obtained from PAG (PAG 2017a).

Example calculations for estimating annual VOC emissions from bakeries are shown below.

SCC 2302050000 – Bakeries:

Per-capita bread consumption factor = 70 lb/person
 Pima inventory domain population (2014) = 984,426
 Estimated bread consumption in the domain area = 70 lb/person × 984,426 = 68,909,820 lbs
 VOC emission factor = 5 lb VOC/1000 lb bread

$$VOC\ emissions = \left(68,909,820\ lbs \times \frac{5\ lbs\ VOC}{1000\ lb\ bread} \right) \times \frac{1\ ton}{2,000\ lbs} = 172.3\ tons$$

VOC and NO_x emissions from human cremations were estimated based on emission factors and average body weight data obtained from U.S. EPA's 2011 NEI (U.S. EPA, 2015c). Data on the number of deaths in Pima County in 2014 were obtained from the U.S. Census Bureau (U.S. Census Bureau, 2015). These data were apportioned to the inventory domain area using a factor of 0.98 (i.e., 98 percent of Pima County population is assumed to be located within the inventory domain). Data on cremations were obtained from the Cremation Association of North America (CANA) (CANA, 2017). Example calculations for VOC emissions from human cremations for 2014 are shown below:

Example calculations for estimating annual VOC emissions from human cremations are shown below.

SCC 2810060100 – Human Cremations

Annual deaths in Pima County (2014) = 9,087
 Estimated deaths in the domain area = 0.98 × 9,087 = 8,905
 % Cremations in 2010 (US) = 40.8% (or 0.408)
 % Cremations in 2015 (US) = 48.6% (or 0.486)

$$Estimated\ \% \ cremations\ in\ 2014 = 0.408 + \left(4 \times \left(\frac{0.486 - 0.408}{2015 - 2010} \right) \right) = 0.4704$$

VOC emission factor = 0.083 lb/ton cremated

Average body weight = 168 lb = 0.084 tons

$$VOC\ emissions = [(8,905 \times 0.4704 \times 0.084) \times 0.083] \times \frac{1\ ton}{2,000\ lbs} = 0.02\ tons$$

Three landfills (Los Reales, Marana, and Tangerine) are included in the point source inventory. It was assumed that there are no other landfills in the inventory domain that should be included in the area source inventory. This assumption is a potential source of inventory uncertainty and will be discussed in Section 11.0.

Review of open burning regulations for Pima County indicated that open burning of household waste and agricultural burning requires a permit issued by Pima County (Pima County Code of Ordinances §17.12.480.D.1 and §17.12.480.F). A listing of burning permits was not requested by PDEQ and the 2014 NEI did not contain any emissions data for these source categories. Therefore, it was assumed that open burning of household waste and agricultural burning did not occur within the inventory domain. This assumption is also a potential source of inventory uncertainty and will be discussed in Section 11.0.

4.6 Area Source Emissions Results

Based upon the methods described above, ERG estimated annual NO_x and VOC emissions for the area source categories located within the Pima County inventory domain. The annual emission totals, by SCC, are presented in Table 4-2.

It should be noted that a potential source of uncertainty exists in the industrial fuel combustion, industrial surface coating, and degreasing area source categories. In particular, some double-counting of emissions may have occurred between these area source categories and the point sources discussed in Section 3.0. Typically, the quantity of materials used as area source activity data (e.g., fuel, coating, solvent) are reduced by the corresponding amount of material used by point sources. This process is called “reconciliation”; however, reconciliation requires detailed information regarding the quantity of materials used. Since the annual emission statements provided to PDEQ do not include the quantity of materials, it was not possible to reconcile the point sources and the industrial fuel combustion, industrial surface coating, and degreasing area source categories. This potential source of uncertainty is discussed further in Section 11.0.

In order to estimate OSD emissions, for all area source categories except residential fuel combustion ERG assumed that OSD emissions were equal to average daily emissions (i.e., annual emissions divided by 365 days). For estimating residential fuel combustion (including residential wood combustion) OSD emissions, ERG assumed these are proportional to heating degree days (HDDs). Total ozone season emissions were calculated by multiplying annual emissions by the fraction of total annual HDDs that occurred during the ozone season (i.e., April 1 through October 31). Based on historical weather data for the Tucson International Airport (Weather Station WTUS), there were 900 HDD in 2014, of which only 24 occurred during the ozone season (Weather Underground, 2017). The total ozone season emissions were then divided by the number of days in the ozone season (i.e., 214 days) to obtain OSD emissions.

$$OSD\ Emissions = Annual\ Emissions \times \frac{24\ HDD}{900\ HDD} \times \frac{1}{214\ days}$$

The OSD emission totals, by SCC, are also presented in Table 4-2 below.

Table 4-2. Area Source Emissions Summary

Area Source SCC	Category Description	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2102002000	Industrial Fuel Combustion - Coal	197.3	0.9	1,081.2	4.9
2102004000	Industrial Fuel Combustion - Distillate Oil	354.6	3.5	1,943.1	19.4
2102006000	Industrial Fuel Combustion - Natural Gas	182.6	10.0	1,000.4	55.0
2102007000	Industrial Fuel Combustion - Liquefied Petroleum Gas	11.1	0.4	60.9	2.2
2103004000	Commercial/Institutional Fuel Combustion - Distillate Oil	59.6	1.0	326.8	5.6
2103006000	Commercial/Institutional Fuel Combustion - Natural Gas	211.0	11.6	1,156.1	63.6
2103007000	Commercial/Institutional Fuel Combustion - Liquefied Petroleum Gas	17.8	0.7	97.6	3.6
2104004000	Residential Fuel Combustion - Distillate Oil	0.1	0.0	0.0	0.0
2104006000	Residential Fuel Combustion - Natural Gas	381.9	22.3	95.2	5.6
2104007000	Residential Fuel Combustion - Liquefied Petroleum Gas	37.3	1.5	9.3	0.4
2104008100	Residential Wood Combustion - Fireplace	5.8	42.1	1.4	10.5
2104008210	Residential Wood Combustion - Woodstoves, non-EPA certified fireplace inserts	3.1	58.2	0.8	14.5
2104008220	Residential Wood Combustion - Woodstoves, non-catalytic EPA certified fireplace inserts	1.6	8.6	0.4	2.2
2104008230	Residential Wood Combustion - Woodstoves, catalytic EPA certified fireplace inserts	0.4	3.2	0.1	0.8
2104008310	Residential Wood Combustion - Freestanding Woodstoves, non-EPA certified	11.7	221.3	2.9	55.2
2104008320	Residential Wood Combustion - Freestanding Woodstoves, EPA certified, non-catalytic	11.8	62.1	2.9	15.5
2104008330	Residential Wood Combustion - Freestanding Woodstoves, EPA certified, catalytic	6.9	51.8	1.7	12.9
2104008400	Residential Wood Combustion - Woodstoves, pellet-fired	6.7	3.9	1.7	1.0
2104008510	Residential Wood Combustion - non-EPA certified Indoor Furnaces, cordwood-fired	0.3	1.9	0.1	0.5
2104008610	Residential Wood Combustion - Outdoor Hydronic Heaters	1.3	47.6	0.3	11.9
2104008700	Residential Wood Combustion - Outdoor Wood Burning Devices, NEC	0.1	0.6	0.5	3.3
2104009000	Residential Wood Combustion - Residential Firelog	3.9	19.8	1.0	4.9
2302002100	Commercial Cooking - Conveyorized Charbroiling		6.8		37.5
2302002200	Commercial Cooking - Under-fired Charbroiling		24.9		136.6
2302003000	Commercial Cooking - Deep Fat Frying		3.7		20.1
2302003100	Commercial Cooking - Flat Griddle Frying		3.2		17.8
2302003200	Commercial Cooking - Clamshell Griddle Frying		0.1		0.6
2302050000	Bakeries		172.3		944.0

Table 4-2. Area Source Emissions Summary

Area Source SCC	Category Description	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2401001000	Architectural Surface Coatings		1,151.8		6,311.1
2401005000	Autobody Refinishing		310.2		1,700.0
2401008000	Traffic Markings		107.5		589.0
2401015000	Industrial Surface Coating - Factory Finished Wood		14.9		81.4
2401020000	Industrial Surface Coating - Wood Furniture		158.8		870.4
2401025000	Industrial Surface Coating - Metal Furniture		21.2		116.2
2401040000	Industrial Surface Coating - Metal Cans		18.7		102.5
2401055000	Industrial Surface Coating - Machinery & Equipment		22.9		125.4
2401065000	Industrial Surface Coating - Electronic & Other Electrical		2.4		13.3
2401070000	Industrial Surface Coating - Motor Vehicles		14.3		78.2
2401075000	Industrial Surface Coating - Aircraft		75.8		415.1
2401090000	Industrial Surface Coating - Miscellaneous Manufacturing		135.6		742.8
2401100000	Industrial Surface Coating - Maintenance Coatings		296.9		1,626.6
2401200000	Industrial Surface Coating - Other Special Purpose Coatings		3.0		16.2
2415000000	Degreasing		790.8		4,333.4
2420000000	Dry Cleaning		2.5		13.9
2425000000	Graphic Arts		1,821.2		9,979.1
2460100000	Consumer Solvent Use - All Personal Care Products		984.4		5,394.1
2460200000	Consumer Solvent Use - All Household Products		1,082.9		5,933.5
2460400000	Consumer Solvent Use - All Auto Aftermarket Products		669.4		3,668.0
2460500000	Consumer Solvent Use - All Coatings & Related Products		467.6		2,562.2
2460600000	Consumer Solvent Use - All Adhesives & Sealants		280.6		1,537.3
2460800000	Consumer Solvent Use - All FIFRA Related Products		876.1		4,800.8
2460900000	Consumer Solvent Use - Miscellaneous Products (Not Otherwise Covered)		34.5		188.8
2461021000	Asphalt Paving Operations - Cutback Asphalt		385.2		2,110.8
2461022000	Asphalt Paving Operations - Emulsified Asphalt		729.5		3,997.1
2461850000	Agricultural Pesticide Application		26.9		147.7
2501011011	Residential Portable Gas Cans, Permeation		23.9		131.2
2501011012	Residential Portable Gas Cans, Evaporation (includes Diurnal losses)		26.9		147.2
2501011013	Residential Portable Gas Cans, Spillage During Transport		46.6		255.3
2501011014	Residential Portable Gas Cans, Refilling at the Pump - Vapor Displacement		8.5		46.3
2501011015	Residential Portable Gas Cans, Refilling at the Pump - Spillage		1.4		7.5

Table 4-2. Area Source Emissions Summary

Area Source SCC	Category Description	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2501012011	Commercial Portable Gas Cans, Permeation		1.0		5.7
2501012012	Commercial Portable Gas Cans, Evaporation (includes Diurnal losses)		0.9		4.7
2501012013	Commercial Portable Gas Cans, Spillage During Transport		63.6		348.3
2501012014	Commercial Portable Gas Cans, Refilling at the Pump - Vapor Displacement		24.4		133.4
2501012015	Commercial Portable Gas Cans, Refilling at the Pump - Spillage		2.6		14.3
2501050120	Bulk Terminals - All Gasoline Evaporative Losses		28.6		156.6
2501055120	Bulk Plants - All Gasoline Evaporative Losses		24.3		133.1
2501060053	Gasoline Service Stations - Stage 1 (Balanced Submerged Filling)		32.0		175.3
2501060201	Gasoline Service Stations - Underground Tank Losses		106.6		584.4
2501080050	Aviation Gasoline - Stage 1		4.9		27.0
2501080100	Aviation Gasoline - Stage 2		2.7		14.9
2505030120	Gasoline Truck Transport		13.0		71.0
2505040120	Gasoline Pipeline Transport		6.2		34.2
2630020000	Public Owned Treatment Works (POTW)		0.0		0.3
2810030000	Accidental Structural Fires	1.2	9.4	6.5	51.3
2810050000	Accidental Motor Vehicle Fires	0.3	2.4	1.6	13.1
2810060100	Human Cremations	4.2	0.0	23.0	0.1
Area Source Total		1,512.6	11,699.6	5,815.5	61,259.9

5.0 On-Road Motor Vehicles

ERG compiled on-road motor vehicle emissions data developed by PAG for inclusion in the Pima County Emissions Inventory. On-road motor vehicle emission estimates were developed by PAG using the MOVES2014a model (PAG, 2017c). Emissions were disaggregated as follows:

- Month – 1 (January) to 12 (December)
- Source type – motorcycle, passenger car, passenger truck, light commercial truck, intercity bus, transit bus, school bus, refuse truck, single unit short-haul truck, single unit long-haul truck, motor home, combination short-haul truck, and combination long-haul truck
- Road type – urban restricted (highway), urban unrestricted, rural restricted (highway), rural unrestricted, and off network
- Fuel type – gasoline, diesel, compressed natural gas (CNG), and E-85
- Process type – running exhaust, start exhaust, brake wear, tire wear, evaporative permeation, evaporative fuel vapor venting, evaporative fuel leaks, crankcase running exhaust, crankcase start exhaust, crankcase extended idle exhaust, refueling displacement vapor loss, refueling spillage loss, extended idle exhaust, and auxiliary power exhaust

The PAG on-road emission estimates were developed by month for the Pima County inventory domain area. Annual emissions were estimated by summing up the monthly totals for the entire year. Ozone season day emissions were estimated by summing up the monthly emissions for April through October and then dividing by the number of days in the ozone season (214 days).

The annual and OSD on-road motor vehicle emission totals are presented in Table 5-1.

Table 5-1. On-Road Motor Vehicle Emissions Summary

Source Type	Fuel Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
Motorcycle	Gasoline	40.0	188.2	209.4	1,132.5
Passenger Car	Gasoline	2,340.7	2,254.0	12,768.2	13,189.0
Passenger Car	Diesel	8.3	5.5	46.2	28.0
Passenger Car	E-85	0.7	1.1	3.9	6.0
Passenger Truck	Gasoline	1,311.6	1,004.4	7,154.9	5,828.8
Passenger Truck	Diesel	48.4	11.1	269.8	59.7
Passenger Truck	E-85	0.6	0.8	3.4	4.3
Light Commercial Truck	Gasoline	348.5	257.0	1,902.2	1,482.1
Light Commercial Truck	Diesel	38.7	9.5	216.4	51.1

Table 5-1. On-Road Motor Vehicle Emissions Summary

Source Type	Fuel Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
Light Commercial Truck	E-85	0.1	0.2	0.8	1.0
Intercity Bus	Diesel	41.7	2.8	220.4	15.2
Transit Bus	Gasoline	0.3	0.2	1.8	1.3
Transit Bus	Diesel	57.0	4.4	301.2	23.8
Transit Bus	CNG	5.0	0.7	27.0	4.0
School Bus	Gasoline	6.0	4.8	31.6	27.2
School Bus	Diesel	132.3	16.5	698.9	87.2
Refuse Truck	Gasoline	1.3	0.6	6.6	3.7
Refuse Truck	Diesel	79.9	4.3	421.8	23.3
Single Unit Short-haul Truck	Gasoline	185.1	86.4	971.6	494.3
Single Unit Short-haul Truck	Diesel	644.1	76.2	3,402.4	408.8
Single Unit Long-haul Truck	Gasoline	2.9	1.6	15.0	9.1
Single Unit Long-haul Truck	Diesel	45.9	5.6	242.2	30.2
Motor Home	Gasoline	22.0	15.5	114.8	92.1
Motor Home	Diesel	17.5	2.2	92.4	12.0
Combination Short-haul Truck	Gasoline	0.1	0.1	0.6	0.3
Combination Short-haul Truck	Diesel	765.0	40.9	4,040.1	221.7
Combination Long-haul Truck	Diesel	2,984.0	236.8	15,758.5	1,285.3
Total		9,127.9	4,231.4	48,921.9	24,521.9

6.0 Nonroad Mobile Sources

As with on-road motor vehicles, ERG compiled nonroad mobile source emissions data developed by PAG for inclusion in the Pima County Emissions Inventory. Nonroad mobile source emission estimates were developed by PAG using the NONROAD module of MOVES2014a (PAG, 2017d). Emissions were disaggregated as follows:

- Day type – weekend and weekday
- Equipment type – recreational, construction, industrial, lawn and garden, agriculture, commercial, logging, underground mining, oilfield, recreational marine (excluding commercial marine vessels), railroads (excluding locomotives)
- Fuel type – gasoline, diesel, CNG, and liquefied petroleum gas (LPG)

The PAG weekday and weekend day nonroad mobile source emission estimates were developed on a monthly basis for the entire county. Annual emissions were estimated by multiplying monthly weekday emissions by the number of weekdays in a particular month and multiplying monthly weekend day emissions by the number of weekend days in a particular month and then summing up the monthly totals for the entire year. As mentioned in previous sections, it is estimated that 98 percent of the county population resides within the inventory domain and so the annual county-level emissions were multiplied by 0.98 to generate domain-level nonroad emission estimates.

Table 6-1 presents the number of weekdays and weekend days in each month for the 2014 inventory year.

Table 6-1. Number of Weekdays and Weekend Days in 2014 Inventory Year

Month	Weekdays	Weekend Days	Total Days
January	23	8	31
February	20	8	28
March	21	10	31
April	22	8	30
May	22	9	31
June	21	9	30
July	23	8	31
August	21	10	31
September	22	8	30
October	23	8	31
November	20	10	30
December	23	8	31

An example calculation of annual nonroad mobile source emissions is shown below.

$$E = \left\{ \sum_{m=1}^{12} [(EmisWD_m \times WD_m) + (EmisWE_m \times WE_m)] \right\} \times \left(\frac{1 \text{ ton}}{907.2 \text{ kg}} \right)$$

- Where E = Annual emissions (tpy);
- EmisWD_m = Daily weekday emissions for month *m* (kg/day);
- WD_m = Number of weekdays in month *m*;
- EmisWE_m = Daily weekend day emissions for month *m* (kg/day);
- WE_m = Number of weekend days in month *m*; and
- m* = Number of months (1 through 12)

Ozone season day emissions were estimated by summing up the monthly emissions for April through October and then dividing by the number of days in the ozone season (214 days). The annual and OSD nonroad mobile source emission totals by equipment type are presented in Appendix B. Summarized nonroad mobile source emission total by fuel and general equipment category are presented in Table 6-2.

Table 6-2. Nonroad Mobile Source Emissions Summary

Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
CNG - Agricultural	0.0	0.0	0.0	0.0
CNG - Commercial	5.5	3.1	30.2	16.9
CNG - Construction & Mining	0.0	0.0	0.1	0.1
CNG - Industrial	7.4	4.9	40.3	27.0
Diesel - Agricultural	38.5	3.5	267.5	24.4
Diesel - Airport Ground Support Equipment	21.3	1.7	116.1	9.4
Diesel - Commercial	132.1	16.6	722.2	91.0
Diesel - Construction & Mining	1,730.1	192.7	9,855.5	1,097.5
Diesel - Industrial	202.8	17.6	1,106.9	95.8
Diesel - Lawn & Garden	133.5	13.4	926.4	92.6
Diesel - Logging	0.0	0.0	0.0	0.0
Diesel - Pleasure Craft	3.4	0.2	24.7	1.3
Diesel - Railway Maintenance	3.0	0.5	16.3	2.8
Diesel - Recreational	2.4	0.6	16.1	3.9
Gasoline - Agricultural	0.3	0.9	2.3	6.4

Table 6-2. Nonroad Mobile Source Emissions Summary

Fuel Type – Equipment Type	NO_x (tpy)	VOC (tpy)	NO_x (lbs/OSD)	VOC (lbs/OSD)
Gasoline - Airport Ground Support Equipment	0.1	0.2	0.7	1.1
Gasoline - Commercial	50.9	227.3	257.8	1,328.1
Gasoline - Construction & Mining	11.5	81.6	61.5	474.4
Gasoline - Industrial	3.9	4.6	19.8	25.8
Gasoline - Lawn & Garden	216.1	1,694.6	1,425.2	11,215.1
Gasoline - Logging	0.0	0.0	0.0	0.0
Gasoline - Pleasure Craft	7.4	44.4	52.5	313.7
Gasoline - Railway Maintenance	0.0	0.1	0.2	0.8
Gasoline - Recreational	21.0	608.4	133.1	4,029.7
LPG - Agricultural	0.0	0.0	0.0	0.0
LPG - Airport Ground Support Equipment	0.2	0.0	0.8	0.1
LPG - Commercial	17.5	2.9	95.5	16.0
LPG - Construction & Mining	3.3	0.7	19.1	3.9
LPG - Industrial	106.2	20.0	580.8	109.6
LPG - Lawn & Garden	1.6	0.3	10.9	1.9
LPG - Railway Maintenance	0.0	0.0	0.0	0.0
LPG - Recreational	0.2	0.0	1.1	0.2
Total	2,720.4	2,941.0	15,783.5	18,989.6

7.0 Aircraft and Locomotives

In addition to the nonroad mobile sources estimated by PAG using the MOVES model, there are two additional types of nonroad mobile sources that were estimated outside of MOVES: aircraft and locomotives.

7.1 Aircraft

ERG determined that using airport-specific aircraft emissions data from the 2014 NEI (U.S. EPA, 2016) was an appropriate method due to the intensive nature of aircraft activity data collection (i.e., engine types, landings and takeoffs, time in modes, etc.) at individual airports and landing strips used in the NEI.

As shown in Table 7-1, the 2014 NEI includes emissions for 22 airports located in Pima County, all of which officially reported by the Federal Aviation Administration (FAA) to U.S. EPA for the 2014 NEI. Through geographic analysis, ERG determined that two of the Pima County airports originally included in the NEI (i.e., Ajo Municipal and Sells) are located outside of the inventory domain; thus emissions from these two airports were not included in the inventory.

Table 7-1. Pima County Aircraft Emissions in 2014 NEI

Airport	ID	City	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)	In Domain?
Ajo Municipal	P01	Ajo	0.01	0.02	0.06	0.12	
C & L Ranch	AZ19	Sonoita	0.00	0.01	0.03	0.06	✓
Continental	35AZ	Continental	0.00	0.01	0.02	0.06	✓
Davis-Monthan AFB	DMA	Tucson	0.04	0.00	0.21	0.01	✓
El Tiro	AZ67	Tucson	0.01	0.02	0.04	0.09	✓
Flying Diamond	6AZ8	Tucson	0.01	0.01	0.03	0.07	✓
Horizon	2AZ6	Oro Valley	0.01	0.01	0.03	0.07	✓
Ina Road	3AZ9	Tucson	0.01	0.01	0.03	0.07	✓
La Cholla Airpark	57AZ	Tucson	0.14	0.30	0.75	1.65	✓
Marana Northwest Region	AVQ	Marana	32.85	22.94	179.99	125.68	✓
Palm Valley Tucson			0.00	0.00	0.00	0.00	✓
Pima County Sheriff's	AZ84	Tucson	0.01	0.01	0.03	0.07	✓
Regional Public Safety Training Academy	70AZ	Tucson	0.01	0.01	0.03	0.07	✓
Ruby Star Airpark	14AZ	Green Valley	0.01	0.01	0.03	0.07	✓
Ryan Field	RYN	Tucson	87.66	48.69	480.32	266.82	✓
Saguaro	5AZ5	Tucson	0.01	0.01	0.03	0.07	✓
Sells	E78	Sells	0.11	0.11	0.58	0.58	
St. Mary's Helistop	65AZ	Tucson	0.01	0.01	0.03	0.07	✓

Table 7-1. Pima County Aircraft Emissions in 2014 NEI

Airport	ID	City	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)	In Domain?
The Ultralight Strip	4AZ8	Marana	0.01	0.02	0.04	0.10	✓
Tucson International	TUS	Tucson	323.75	123.13	1,773.99	674.69	✓
Tucson Medical Center	AZ37	Tucson	0.01	0.01	0.03	0.07	✓
University Medical Center Hospital	5AZ4	Tucson	0.01	0.01	0.03	0.07	✓
Total – Pima County			444.6	195.4	2,436.3	1,070.6	
Total – Inventory Domain			444.5	195.3	2,435.7	1,069.9	

It should be noted that the aircraft emissions at Davis-Monthan AFB are likely to be significantly underestimated. In general, emissions from military aircraft operations are not reported by FAA. Although Davis-Monthan AFB is listed in Table 7-1, it is not clear what the associated emission values are based upon and it seems likely that military aircraft operations are not included. This issue is a potential source of inventory uncertainty and will be discussed in Section 11.0.

Aircraft emission estimates for the inventory domain were estimated by subtracting airport-specific emissions totals for the two airports Ajo Municipal and Sells airports from the Pima County total emissions.

Example calculations for estimating annual NO_x emissions from aircraft are shown below.

$$E_{NOx-Domain} = E_{NOx-Pima} - E_{NOx-Ajo} - E_{NOx-Sells}$$

Where $E_{NOx-Domain}$ = Annual NO_x emissions for inventory domain (tpy);

$E_{NOx-Pima}$ = Annual NO_x emissions for Pima County (tpy);

$E_{NOx-Ajo}$ = Annual NO_x emissions for Ajo Municipal Airport (tpy); and

$E_{NOx-Sells}$ = Annual NO_x emissions for Sells Airport (tpy).

$$E_{NOx-Domain} = 444.63 \text{ tpy NO}_x - 0.01 \text{ tpy NO}_x - 0.11 \text{ tpy NO}_x = 444.5 \text{ tpy NO}_x$$

7.2 Locomotives

The Pima County Emissions Inventory includes estimates for three types of locomotive emissions: Class I line haul operations, Class II/III line haul operations, and railyard operations. Because locomotive fuel consumption quantities are typically considered to be confidential business information by railroad companies, ERG determined that using locomotive emissions data from the 2014 NEI (U.S. EPA, 2016) was the most appropriate method available.

Line haul locomotive emission estimates for the inventory domain were estimated by applying the ratio of railway length within the inventory domain (178.769 miles) to railway length within Pima County (206.109 miles) to the Pima County locomotive emissions. Railway lengths were obtained from 2014 NEI documentation (U.S. EPA, 2016).

Example calculations for estimating annual NO_x emissions from locomotives are shown below.

$$E_{NOx-I-Domain} = E_{NOx-I-Pima} \times \left(\frac{RL_{Domain}}{RL_{Pima}} \right)$$

Where $E_{NOx-I-Domain}$ = Annual NO_x emissions for Class I line haul in inventory domain (tpy);

$E_{NOx-I-Pima}$ = Annual NO_x emissions for Class I line haul in Pima County (tpy);

RL_{Domain} = Railway length in domain (miles); and

RL_{Pima} = Railway length in Pima County (miles).

$$E_{NOx-I-Domain} = 1,363.1 \text{ tpy NO}_x \times (178.769 \text{ miles}/206.109 \text{ miles}) = 1,182.3 \text{ tpy NO}_x$$

Railyard locomotive emission estimates for the two railyards located in the inventory domain (i.e., Tucson Railyard and PFE Railyard) were obtained from the 2014 NEI (U.S. EPA, 2016).

As shown in Table 7-2, emissions from Class I line haul operations are the largest component of locomotive emissions in the inventory domain.

Table 7-2. Locomotive Emissions Summary

Source	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
Class I Line Haul	1,363.1	70.0	7,469.1	383.5
Class II/III Line Haul	7.9	0.3	43.2	1.7
Total Line Haul – Pima County	1,371.0	70.3	7,512.3	385.1
Total Line Haul – Inventory Domain	1,189.1	61.0	6,515.8	334.1
Tucson Railyard	106.9	7.4	586.0	40.6
PFE Railyard	293.1	20.3	1,605.8	111.3
Total Railyard	400.0	27.7	2,191.8	151.9
Total Locomotives – Inventory Domain	1,589.1	88.7	8,707.6	486.0

8.0 Biogenic Sources

Biogenic emissions are emissions that come from natural sources and must be accounted for in photochemical grid models because they are significant contributors to background air chemistry.

For this first-time inventory, ERG used the biogenic emissions that were computed for the 2014 NEI. These estimated emissions were 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.

As shown in Table 8-1, the 2014 NEI includes VOC emissions from vegetation and NO_x emissions from soils.

Table 8-1. Biogenic Emissions Summary

Source	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
Vegetation	NA	194,918.0	NA	1,068,043.8
Soils	795.4	NA	4,358.1	NA
Total – Pima County	795.4	194,918.0	4,358.1	1,068,043.8
Total – Inventory Domain	335.7	82,263.8	1,839.3	450,760.7

ERG estimated biogenic emissions for the inventory domain by applying the ratio of land area within the inventory domain (3,877.88 square miles) to land area within Pima County (9,188.36 square miles).

Example calculations for estimating annual NO_x emissions from biogenic sources are shown below.

$$E_{NOx-Domain} = E_{NOx-Pima} \times \left(\frac{LA_{Domain}}{LA_{Pima}} \right)$$

Where $E_{NOx-Domain}$ = Annual NO_x emissions for biogenic sources in inventory domain (tpy);

$E_{NOx-Pima}$ = Annual NO_x emissions for biogenic sources in Pima County (tpy);

LA_{Domain} = Land area in domain (square miles); and

LA_{Pima} = Land area in Pima County (square miles).

$$E_{NOx-Domain} = 795.35 \text{ tpy NO}_x \times (3,877.88 \text{ square miles} / 9,188.36 \text{ square miles}) = 335.67 \text{ tpy NO}_x$$

9.0 Summary of Emissions Inventory Results

The overall summary of the Pima County Emissions Inventory is presented in Table 9-1 by source type.

Table 9-1. Overall Pima County Emissions Inventory Summary

Source Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
Point	3,891.0	264.1	21,320.8	1,446.8
Area	1,512.6	11,699.6	5,815.5	61,259.9
On-road motor vehicles	9,127.9	4,231.4	48,921.9	24,521.9
Nonroad mobile	2,720.4	2,941.0	15,783.5	18,989.6
Aircraft and locomotives	2,033.6	284.0	11,143.3	1,555.9
Biogenics	335.7	82,263.8	1,839.3	450,760.7
Total	19,621.2	101,683.9	104,824.3	558,534.8

As shown in Table 9-1, on-road motor vehicles are the largest source of NO_x emissions (46.5 percent of total emissions) and biogenic sources are the largest source of VOC emissions (80.9 percent of total emissions).

Although Table 9-1 presents summarized results of the Pima County Emissions Inventory, it should be noted that there is also uncertainty associated with this inventory. Any emissions inventory that is not based on directly measured will have associated uncertainty. Emissions inventory development is an iterative process; multiple iterations will reduce the associated uncertainty and improve the overall inventory quality.

Specific uncertainties identified during the development of the Pima County Emissions Inventory are presented in Section 11.0, along with recommendations for improvement.

10.0 Development of Model Ready Files

In conjunction with the submittal of the final report, ERG submitted formatted annual and OSD emission data files in FF10 format to facilitate eventual air quality modeling of the Pima County emissions inventory.

ERG formatted the annual and OSD emissions data in Flat File 2010 (FF10) format. The FF10 format is the current standard compatible with the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System and photochemical grid models that likely would be used in nonattainment area planning (e.g., CAMx). ERG also provided the data dictionary for the FF10 format.

ERG also provided GIS shapefiles obtained from U.S. Census Bureau and Pima County GIS department. These spatial allocation data may also be used in the future by WRAP and other entities for regional air quality modeling.

11.0 Uncertainty and Recommendations for Improvement

As identified in this inventory report, there were a number of potential sources of uncertainty associated with the Pima County Emissions Inventory. These sources of uncertainty are presented in Table 11-1, along with some associated recommendations for improvement. Implementation of these recommendations will reduce uncertainty and improve the overall quality of the emissions inventory.

Table 11-1. Areas of Inventory Uncertainty and Recommendations for Improvement

Area of Uncertainty	Recommendation for Improvement
Point sources: lack of operational data needed to determine accurate OSD emissions.	Require operational data to be reported along with annual emissions.
Point and area sources: potential double counting with point sources and industrial fuel combustion, industrial surface coating, and degreasing area source categories.	Require point sources to provide activity data along with annual emissions to facilitate reconciliation process.
Area sources: all underground tank filling operations were balanced submerged fill.	Confirm with underground tank operators what type of filling process is used.
Area sources: household waste burning and agricultural waste burning source categories were assumed not to occur within the inventory domain.	Examine permits to confirm that these types of burning do not actually occur.
Area sources: landfills (other than three in point source inventory) were assumed not to occur within the inventory domain.	Confirm with county waste department that there are no other activity landfills in the inventory domain.
Aircraft: Davis-Monthan AFB military aircraft emissions appear to be uninventoried.	Because military aircraft emissions are a potentially significant category that is covered by national security considerations, County staff should initiate discussions with Davis-Monthan AFB staff about this issue. It may be appropriate to involve ADEQ in these discussions.

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Appendix A. Area Source Emission Factors

Table A-1. Area Source Emission Factors

SCC	Description	EF NO _x	Units	EF VOC	Units	EF Source
2102002000	Industrial /Bituminous/Subbituminous Coal /Total: All Boiler Types	11	lb/ton	0.05	lb/ton	Industrial, Commercial, and Institutional Fuel Combustion: Documentation for EPA's Nonpoint Emissions Estimation Tool, ICI Tool Version 1.4, December 2015.
2102004000	Industrial/Distillate Oil /Total: Boilers & IC Engines	20	lb/1000 gallons	0.2	lb/1000 gallons	
2102006000	Industrial /Natural Gas /Total: Boilers and IC Engines	100	lb/MMcf	5.5	lb/MMcf	
2102007000	Industrial /Liquified Petroleum Gas /Total: All Boiler Types	14.23	lb/1000 gallons	0.52	lb/1000 gallons	
2102008000	Industrial /Wood /Total: All Boiler Types	0.22	lb/MMBtu	0.017	lb/MMBtu	
2102011000	Industrial /Kerosene /Total: All Boiler Types	19.29	lb/1000 gallons	0.19	lb/1000 gallons	
2103004000	Commercial/Institutional /Distillate Oil /Total: Boilers & IC Engines	20	lb/1000 gallons	0.34	lb/1000 gallons	
2103006000	Commercial/Institutional /Natural Gas /Total: Boilers and IC Engines	100	lb/MMcf	5.5	lb/MMcf	
2103007000	Commercial/Institutional /Liquified Petroleum Gas /Total: All Combustor Types	14.23	lb/1000 gallons	0.52	lb /1000 gallons	
2103008000	Commercial/Institutional /Wood /Total: All Boiler Types	0.22	lb/MMBtu	0.017	lb/MMBtu	
2103011000	Commercial/Institutional /Kerosene /Total: All Combustor Types	19.3	lb/1000 gallons	0.33	lb/1000 gallons	
2104004000	Residential /Distillate Oil /Total: All Combustor Types	18	lb/1000 gallons	0.713	lb/1000 gallons	Chapter 1.3, AP-42 (May 2010)
2104006000	Residential /Natural Gas /Total: All Combustor Types	94	lb/MMscf	5.5	lb/MMscf	Chapter 1.4, AP-42 (July 1998)
2104007000	Residential /Liquified Petroleum Gas /Total: All Combustor Types	562.8	lb/1000 bbl	21.911	lb/1000 bbl	2014 U.S. NEI
2104011000	Residential /Kerosene /Total: All Heater Types	18	lb/1000 gallons	0.713	lb/1000 gallons	Chapter 1.3, AP-42 (May 2010)
2401001000	Surface Coating /Architectural Coatings /Total: All Solvent Types	Not Applicable		2.34	lb per-capita population	Solvent Utilization: Documentation for EPA's Nonpoint Emissions Estimation Tool, Version 1.5, December 2015.
2401005000	Surface Coating /Auto Refinishing /Total: All Solvent Types	Not Applicable		87	lb per-capita employee	
2401008000	Surface Coating /Traffic Markings /Total: All Solvent Types	2014 NEI*		2014 NEI*		
2401015000	Surface Coating /Factory Finished Wood /Total: All Solvent Types	Not Applicable		48	lb per-capita employee	

Table A-1. Area Source Emission Factors

SCC	Description	EF NO _x	Units	EF VOC	Units	EF Source
2401020000	Surface Coating /Wood Furniture /Total: All Solvent Types	Not Applicable		437	lb per-capita employee	Solvent Utilization: Documentation for EPA's Nonpoint Emissions Estimation Tool, Version 1.5, December 2015.
2401025000	Surface Coating /Metal Furniture /Total: All Solvent Types	Not Applicable		537	lb per-capita employee	
2401040000	Surface Coating /Metal Cans /Total: All Solvent Types	Not Applicable		2493	lb per-capita employee	
2401055000	Surface Coating /Machinery & Equipment /Total: All Solvent Types	Not Applicable		44	lb per-capita employee	
2401065000	Surface Coating /Electronic & Other Electrical /Total: All Solvent Types	Not Applicable		30	lb per-capita employee	
2401070000	Surface Coating /Motor Vehicles /Total: All Solvent Types	Not Applicable		168	lb per-capita employee	
2401075000	Surface Coating /Aircraft /Total: All Solvent Types	Not Applicable		14	lb per-capita employee	
2401090000	Surface Coating /Miscellaneous Manufacturing /Total: All Solvent Types	Not Applicable		78	lb per-capita employee	
2401100000	Surface Coating /Industrial Maintenance Coatings /Total: All Solvent Types	Not Applicable		0.6031	lb per-capita population	
2401200000	Surface Coating /Other Special Purpose Coatings /Total: All Solvent Types	Not Applicable		0.006	lb per-capita population	
2415000000	Degreasing /All Processes/All Industries /Total: All Solvent Types	Not Applicable		37	lb per-capita employee	
2420000000	Dry Cleaning /All Processes /Total: All Solvent Types	Not Applicable		10	lb per-capita employee	
2425000000	Graphic Arts /All Processes /Total: All Solvent Types	Not Applicable		3.7	lb per-capita population	
2460100000	Miscellaneous Non-industrial: Consumer & Commercial /All Personal Care Products /Total: All Solvent Types	Not Applicable		2	lb per-capita population	
2460200000	Miscellaneous Non-industrial: Consumer & Commercial /All Household Products /Total: All Solvent Types	Not Applicable		2.2	lb per-capita population	
2460400000	Miscellaneous Non-industrial: Consumer & Commercial /All Auto Aftermarket Products /Total: All Solvent Types	Not Applicable		1.36	lb per-capita population	
2460500000	Miscellaneous Non-industrial: Consumer & Commercial /All Coatings & Related Products /Total: All Solvent Types	Not Applicable		0.95	lb per-capita population	

Table A-1. Area Source Emission Factors

SCC	Description	EF NO _x	Units	EF VOC	Units	EF Source
2460600000	Miscellaneous Non-industrial: Consumer & Commercial /All Adhesives & Sealants /Total: All Solvent Types	Not Applicable		0.57	lb per-capita population	Solvent Utilization: Documentation for EPA's Nonpoint Emissions Estimation Tool, Version 1.5, December 2015.
2460800000	Miscellaneous Non-industrial: Consumer & Commercial /All FIFRA Related Products /Total: All Solvent Types	Not Applicable		1.78	lb per-capita population	
2460900000	Miscellaneous Non-industrial: Consumer & Commercial /Miscellaneous Products (Not Otherwise Covered) /Total: All Solvent Types	Not Applicable		0.07	lb per-capita population	
2461021000	Miscellaneous Non-industrial: Commercial /Cutback Asphalt /Total: All Solvent Types	Not Applicable		2014 NEI*		
2461022000	Miscellaneous Non-industrial: Commercial /Emulsified Asphalt /Total: All Solvent Types	Not Applicable		2014 NEI*		
2501011011	Residential Portable Gas Cans /Permeation	Not Applicable		2014 NEI*		
2501011012	Residential Portable Gas Cans /Evaporation (includes Diurnal losses)	Not Applicable		2014 NEI*		
2501011013	Residential Portable Gas Cans /Spillage During Transport	Not Applicable		2014 NEI*		
2501011014	Residential Portable Gas Cans /Refilling at the Pump - Vapor Displacement	Not Applicable		2014 NEI*		
2501011015	Residential Portable Gas Cans /Refilling at the Pump - Spillage	Not Applicable		2014 NEI*		
2501012011	Commercial Portable Gas Cans /Permeation	Not Applicable		2014 NEI*		
2501012012	Commercial Portable Gas Cans /Evaporation (includes Diurnal losses)	Not Applicable		2014 NEI*		
2501012013	Commercial Portable Gas Cans /Spillage During Transport	Not Applicable		2014 NEI*		
2501012014	Commercial Portable Gas Cans /Refilling at the Pump - Vapor Displacement	Not Applicable		2014 NEI*		
2501012015	Commercial Portable Gas Cans /Refilling at the Pump - Spillage	Not Applicable		2014 NEI*		
2501050120	Petrol & Petrol Product Storage /Bulk Terminals: All Evaporative Losses /Gasoline	Not Applicable		2014 NEI*		
2501055120	Petrol & Petrol Product Storage /Bulk Plants: All Evaporative Losses /Gasoline	Not Applicable		2014 NEI*		

Table A-1. Area Source Emission Factors

SCC	Description	EF NO _x	Units	EF VOC	Units	EF Source
2505030120	Petrol & Petrol Product Transport /Truck /Gasoline	Not Applicable		2014 NEI*		
2505040120	Petrol & Petrol Product Transport /Pipeline /Gasoline	Not Applicable		2014 NEI*		
2501080050	Petrol & Petrol Product Storage /Airports: Aviation Gasoline /Stage 1: Total	Not Applicable		0.02462	lb/gallon aviation gas	2014 U.S. NEI
2501080100	Petrol & Petrol Product Storage /Airports: Aviation Gasoline /Stage 2: Total	Not Applicable		0.0136	lb/gallon aviation gas	2014 U.S. NEI
2501060053	Gasoline Service Stations /Stage 1: Balanced Submerged Filling	Not Applicable		0.3	lb/1000 gallons	EIIP Vol III, Chapter 11
2501060201	Gasoline Service Stations /Underground Tank: Breathing and Emptying	Not Applicable		1	lb/1000 gallons	EIIP Vol III, Chapter 11
2630020000	Publicly Owned Treatment Works (POTW)	Not Applicable		2014 NEI*		
2461850000	Agricultural Pesticide Application	Not Applicable		2014 NEI*		
2104008100	Fireplace: general	2014 NEI*		2014 NEI*		
2104008210	Woodstove: fireplace inserts; non-EPA certified	2014 NEI*		2014 NEI*		
2104008220	Woodstove: fireplace inserts; EPA certified; non-catalytic	2014 NEI*		2014 NEI*		
2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	2014 NEI*		2014 NEI*		
2104008310	Woodstove: freestanding, non-EPA certified	2014 NEI*		2014 NEI*		
2104008320	Woodstove: freestanding, EPA certified, non-catalytic	2014 NEI*		2014 NEI*		
2104008330	Woodstove: freestanding, EPA certified, catalytic	2014 NEI*		2014 NEI*		
2104008400	Woodstove: pellet-fired, general	2014 NEI*		2014 NEI*		
2104008510	Furnace: Indoor, cordwood-fired, non-EPA certified	2014 NEI*		2014 NEI*		
2104008610	Hydronic heater: outdoor	2014 NEI*		2014 NEI*		
2104008700	Outdoor wood burning device, NEC	2014 NEI*		2014 NEI*		
2104009000	Residential Firelog Total: All Combustor Types	2014 NEI*		2014 NEI*		
2810050000	Motor Vehicle Fires	4	lbs/ton burned	32	lbs/ton burned	EIIP, Volume 3b – Area Source Method Abstracts - Vehicle Fires, May 2000.

Table A-1. Area Source Emission Factors

SCC	Description	EF NO _x	Units	EF VOC	Units	EF Source
2810030000	Structure Fires	1.4	lbs/ton burned	11	lbs/ton burned	EIIP Vol III, Chapter 18
2302003200	Commercial Cooking - Clamshell Griddle Frying	2014 NEI*		2014 NEI*		
2302003100	Commercial Cooking - Flat Griddle Frying	2014 NEI*		2014 NEI*		
2302003000	Commercial Cooking - Deep Fat Frying	2014 NEI*		2014 NEI*		
2302002200	Commercial Cooking - Under-fired Charbroiling	2014 NEI*		2014 NEI*		
2302002100	Commercial Cooking - Conveyorized Charbroiling	2014 NEI*		2014 NEI*		
2302050000	Bakeries	Not Applicable		5	lbs/1000 lbs bread	EIIP, Volume 3b – Area Source Method Abstracts - Bakeries, June 1999.
2810060100	Human Cremations	23.81	lbs/ton cremated	0.0833	lbs/ton cremated	2011 U.S. NEI

* Estimates for these source categories were obtained directly from the U.S. EPA’s 2014 *National Emissions Inventory* (NEI) and so emission factors are not presented in the Table above.

Appendix B. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2260001010	2-Stroke Gasoline - Recreational – Off-road Motorcycles	1.8	217.5	12.0	1,437.8
2260001020	2-Stroke Gasoline - Recreational - Snowmobiles	0.0	0.0	-	0.0
2260001030	2-Stroke Gasoline - Recreational - All Terrain Vehicles	2.6	224.3	17.4	1,483.1
2260001060	2-Stroke Gasoline - Recreational - Specialty Vehicles/Carts	0.6	3.9	4.2	25.6
2260002006	2-Stroke Gasoline - Construction & Mining - Tampers/Rammers	0.3	13.9	1.9	79.4
2260002009	2-Stroke Gasoline - Construction & Mining - Plate Compactors	0.0	0.5	0.1	2.9
2260002021	2-Stroke Gasoline - Construction & Mining - Paving	0.0	0.6	0.2	3.4
2260002027	2-Stroke Gasoline - Construction & Mining - Signal Boards/Light Plants	0.0	0.0	0.0	0.0
2260002039	2-Stroke Gasoline - Construction & Mining - Concrete/Industrial Saws	0.9	34.8	5.0	198.8
2260002054	2-Stroke Gasoline - Construction & Mining - Crushing/Processing	0.0	0.1	0.0	0.7
2260003030	2-Stroke Gasoline - Industrial - Sweepers/Scrubbers	0.0	0.1	0.0	0.4
2260003040	2-Stroke Gasoline - Industrial - Other General Industrial	0.0	0.0	0.0	0.0
2260004015	2-Stroke Gasoline - Lawn & Garden - Rotary Tillers < 6 HP (Residential)	0.1	2.6	0.6	17.5
2260004016	2-Stroke Gasoline - Lawn & Garden - Rotary Tillers < 6 HP (Commercial)	0.5	11.5	3.7	79.9
2260004020	2-Stroke Gasoline - Lawn & Garden - Chain Saws < 6 HP (Residential)	1.2	39.5	6.3	223.1
2260004021	2-Stroke Gasoline - Lawn & Garden - Chain Saws < 6 HP (Commercial)	6.0	269.0	32.7	1,471.8
2260004025	2-Stroke Gasoline - Lawn & Garden - Trimmers/Edgers/Brush Cutters (Residential)	1.6	50.9	11.3	348.9
2260004026	2-Stroke Gasoline - Lawn & Garden - Trimmers/Edgers/Brush Cutters (Commercial)	5.3	135.6	36.4	940.8
2260004030	2-Stroke Gasoline - Lawn & Garden - Leafblowers/Vacuums (Residential)	1.0	39.2	7.2	266.2
2260004031	2-Stroke Gasoline - Lawn & Garden - Leafblowers/Vacuums (Commercial)	4.9	135.9	33.8	942.6
2260004035	2-Stroke Gasoline - Lawn & Garden - Snowblowers (Residential)	0.0	0.0	-	0.0
2260004036	2-Stroke Gasoline - Lawn & Garden - Snowblowers (Commercial)	0.0	0.0	-	0.0
2260004071	2-Stroke Gasoline - Lawn & Garden - Turf (Commercial)	0.0	0.0	0.0	0.3

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2260005035	2-Stroke Gasoline - Agricultural/Sprayers	0.0	0.0	0.0	0.2
2260006005	2-Stroke Gasoline - Commercial - Generator Sets	0.1	2.9	0.6	16.0
2260006010	2-Stroke Gasoline - Commercial - Pumps	0.7	19.9	3.9	109.7
2260006015	2-Stroke Gasoline - Commercial - Air Compressors	0.0	0.0	0.0	0.0
2260006035	2-Stroke Gasoline - Commercial - Hydro-power Units	0.0	0.1	0.0	0.7
2260007005	2-Stroke Gasoline - Logging - Chain Saws: 6 HP	0.0	0.0	0.0	0.0
2265001010	4-Stroke Gasoline - Recreational - Motorcycles: Off-road	1.2	11.7	7.8	78.0
2265001030	4-Stroke Gasoline - Recreational - All Terrain Vehicles	10.7	137.0	67.0	911.3
2265001050	4-Stroke Gasoline - Recreational - Golf Carts	3.1	10.5	19.7	69.4
2265001060	4-Stroke Gasoline - Recreational - Specialty Vehicles/Carts	0.8	3.6	5.0	24.5
2265002003	4-Stroke Gasoline - Construction & Mining - Pavers	0.3	0.8	1.7	4.5
2265002006	4-Stroke Gasoline - Construction & Mining - Tampers/Rammers	0.0	0.0	0.0	0.0
2265002009	4-Stroke Gasoline - Construction & Mining - Plate Compactors	0.5	2.1	2.8	12.0
2265002015	4-Stroke Gasoline - Construction & Mining - Rollers	0.5	1.3	2.6	7.6
2265002021	4-Stroke Gasoline - Construction & Mining - Paving	1.1	4.4	6.0	26.8
2265002024	4-Stroke Gasoline - Construction & Mining - Surfacing	0.4	1.4	2.1	8.1
2265002027	4-Stroke Gasoline - Construction & Mining - Signal Boards/Light Plants	0.0	0.1	0.1	0.4
2265002030	4-Stroke Gasoline - Construction & Mining - Trenchers	1.0	2.5	5.3	14.8
2265002033	4-Stroke Gasoline - Construction & Mining - Bore/Drill Rigs	0.5	1.5	2.7	9.2
2265002039	4-Stroke Gasoline - Construction & Mining - Concrete/Industrial Saws	1.7	5.1	9.2	29.7
2265002042	4-Stroke Gasoline - Construction & Mining - Cement & Mortar Mixers	1.2	7.1	6.2	44.3
2265002045	4-Stroke Gasoline - Construction & Mining - Cranes	0.2	0.2	1.1	1.2
2265002054	4-Stroke Gasoline - Construction & Mining - Crushing/Processing	0.1	0.4	0.7	2.3
2265002057	4-Stroke Gasoline - Construction & Mining - Rough Terrain Forklifts	0.2	0.2	1.3	1.1

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2265002060	4-Stroke Gasoline - Construction & Mining - Rubber Tire Loaders	0.3	0.2	1.8	1.4
2265002066	4-Stroke Gasoline - Construction & Mining - Tractors/Loaders/Backhoes	0.6	1.7	3.0	9.7
2265002072	4-Stroke Gasoline - Construction & Mining - Skid Steer Loaders	0.9	1.3	4.7	7.5
2265002078	4-Stroke Gasoline - Construction & Mining - Dumpers/Tenders	0.2	1.1	1.1	6.8
2265002081	4-Stroke Gasoline - Construction & Mining - Other Construction	0.4	0.3	1.9	1.7
2265003010	4-Stroke Gasoline - Industrial - Aerial Lifts	1.3	1.3	6.5	7.6
2265003020	4-Stroke Gasoline - Industrial - Forklifts	1.7	1.1	8.8	6.0
2265003030	4-Stroke Gasoline - Industrial - Sweepers/Scrubbers	0.3	0.4	1.3	2.4
2265003040	4-Stroke Gasoline - Industrial - Other General Industrial	0.4	1.4	2.2	8.0
2265003050	4-Stroke Gasoline - Industrial - Other Material Hauling	0.1	0.1	0.4	0.5
2265003060	4-Stroke Gasoline - Industrial - AC\Refrigeration	0.0	0.0	0.1	0.2
2265003070	4-Stroke Gasoline - Industrial - Terminal Tractors	0.1	0.0	0.4	0.3
2265004010	4-Stroke Gasoline - Lawn & Garden - Lawn Mowers (Residential)	15.4	188.6	100.8	1,286.5
2265004011	4-Stroke Gasoline - Lawn & Garden - Lawn Mowers (Commercial)	12.4	77.7	82.2	538.1
2265004015	4-Stroke Gasoline - Lawn & Garden - Rotary Tillers < 6 HP (Residential)	1.3	15.2	8.5	104.1
2265004016	4-Stroke Gasoline - Lawn & Garden - Rotary Tillers < 6 HP (Commercial)	7.6	56.1	50.5	388.6
2265004025	4-Stroke Gasoline - Lawn & Garden - Trimmers/Edgers/Brush Cutters (Residential)	0.1	0.9	0.5	6.4
2265004026	4-Stroke Gasoline - Lawn & Garden - Trimmers/Edgers/Brush Cutters (Commercial)	0.3	2.0	2.0	14.1
2265004030	4-Stroke Gasoline - Lawn & Garden - Leafblowers/Vacuums (Residential)	0.2	2.0	1.0	13.6
2265004031	4-Stroke Gasoline - Lawn & Garden - Leafblowers/Vacuums (Commercial)	15.4	48.5	102.0	336.2
2265004035	4-Stroke Gasoline - Lawn & Garden - Snowblowers (Residential)	0.0	0.0	-	0.0
2265004036	4-Stroke Gasoline - Lawn & Garden - Snowblowers (Commercial)	0.0	0.0	-	0.0
2265004040	4-Stroke Gasoline - Lawn & Garden - Rear Engine Riding Mowers (Residential)	3.3	29.2	21.7	196.9

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2265004041	4-Stroke Gasoline - Lawn & Garden - Rear Engine Riding Mowers (Commercial)	1.5	5.0	9.9	34.7
2265004046	4-Stroke Gasoline - Lawn & Garden - Front Mowers (Commercial)	2.5	9.6	16.7	66.4
2265004051	4-Stroke Gasoline - Lawn & Garden - Shredders < 6 HP (Commercial)	0.9	7.1	6.0	49.1
2265004055	4-Stroke Gasoline - Lawn & Garden - Lawn & Garden Tractors (Residential)	44.3	264.7	290.6	1,795.2
2265004056	4-Stroke Gasoline - Lawn & Garden - Lawn & Garden Tractors (Commercial)	20.3	62.7	134.7	434.2
2265004066	4-Stroke Gasoline - Lawn & Garden - Chippers/Stump Grinders (Commercial)	3.5	7.2	23.5	50.0
2265004071	4-Stroke Gasoline - Lawn & Garden - Turf (Commercial)	62.2	193.5	413.3	1,337.4
2265004075	4-Stroke Gasoline - Lawn & Garden - Other Lawn & Garden (Residential)	1.7	15.4	11.0	103.9
2265004076	4-Stroke Gasoline - Lawn & Garden - Other Lawn & Garden (Commercial)	2.8	24.9	18.3	168.5
2265005010	4-Stroke Gasoline - Agricultural - 2-Wheel Tractors	0.0	0.0	0.0	0.1
2265005015	4-Stroke Gasoline - Agricultural - Agricultural Tractors	0.0	0.0	0.1	0.1
2265005020	4-Stroke Gasoline - Agricultural - Combines	0.0	0.0	0.0	0.0
2265005025	4-Stroke Gasoline - Agricultural - Balers	0.0	0.1	0.2	0.4
2265005030	4-Stroke Gasoline - Agricultural - Agricultural Mowers	0.0	0.0	0.0	0.1
2265005035	4-Stroke Gasoline - Agricultural - Sprayers	0.1	0.2	0.4	1.3
2265005040	4-Stroke Gasoline - Agricultural - Tillers: 6 HP	0.1	0.4	0.6	3.0
2265005045	4-Stroke Gasoline - Agricultural - Swathers	0.1	0.1	0.4	0.5
2265005055	4-Stroke Gasoline - Agricultural - Other Agricultural	0.1	0.1	0.4	0.6
2265005060	4-Stroke Gasoline - Agricultural - Irrigation Sets	0.0	0.0	0.1	0.1
2265006005	4-Stroke Gasoline - Commercial - Generator Sets	25.3	117.7	127.9	706.7
2265006010	4-Stroke Gasoline - Commercial - Pumps	5.8	19.2	29.1	109.6
2265006015	4-Stroke Gasoline - Commercial - Air Compressors	3.1	7.7	15.6	43.4
2265006025	4-Stroke Gasoline - Commercial - Welders	6.1	17.0	31.0	95.0
2265006030	4-Stroke Gasoline - Commercial - Pressure Washers	9.4	41.4	47.5	239.7
2265006035	4-Stroke Gasoline - Commercial - Hydro-power Units	0.4	1.3	2.1	7.4

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2265007010	4-Stroke Gasoline - Logging - Shredders: 6 HP	0.0	0.0	0.0	0.0
2265007015	4-Stroke Gasoline - Logging - Feller/Bunch/Skidder	0.0	0.0	0.0	0.0
2265008005	Airport Ground Support Equipment, 4-Stroke Gasoline	0.1	0.2	0.7	1.1
2265010010	4-Stroke Gasoline - Industrial - Other Oil Field	0.0	0.1	0.2	0.5
2267001060	LPG - Recreational - Specialty Vehicles/Carts	0.2	0.0	1.1	0.2
2267002003	LPG - Construction & Mining - Pavers	0.1	0.0	0.7	0.1
2267002015	LPG - Construction & Mining - Rollers	0.1	0.0	0.6	0.1
2267002021	LPG - Construction & Mining - Paving	0.1	0.0	0.3	0.1
2267002024	LPG - Construction & Mining - Surfacing	0.0	0.0	0.1	0.0
2267002030	LPG - Construction & Mining - Trenchers	0.4	0.1	2.2	0.4
2267002033	LPG - Construction & Mining - Bore/Drill Rigs	0.3	0.1	1.9	0.4
2267002039	LPG - Construction & Mining - Concrete/Industrial Saws	0.1	0.0	0.8	0.1
2267002045	LPG - Construction & Mining - Cranes	0.2	0.1	1.4	0.3
2267002054	LPG - Construction & Mining - Crushing/Processing	0.0	0.0	0.2	0.0
2267002057	LPG - Construction & Mining - Rough Terrain Forklifts	0.3	0.1	1.6	0.3
2267002060	LPG - Construction & Mining - Rubber Tire Loaders	0.4	0.1	2.3	0.4
2267002066	LPG - Construction & Mining - Tractors/Loaders/Backhoes	0.0	0.0	0.2	0.0
2267002072	LPG - Construction & Mining - Skid Steer Loaders	0.8	0.2	4.6	1.0
2267002081	LPG - Construction & Mining - Other Construction	0.4	0.1	2.3	0.5
2267003010	LPG - Industrial - Aerial Lifts	3.0	0.7	16.6	3.6
2267003020	LPG - Industrial - Forklifts	102.0	19.2	557.7	104.9
2267003030	LPG - Industrial - Sweepers/Scrubbers	0.6	0.1	3.2	0.5
2267003040	LPG - Industrial - Other General Industrial	0.2	0.0	1.1	0.2
2267003050	LPG - Industrial - Other Material Hauling	0.2	0.0	0.8	0.2
2267003070	LPG - Industrial - Terminal Tractors	0.3	0.0	1.4	0.2
2267004066	LPG - Lawn & Garden - Chippers/Stump Grinders (Commercial)	1.6	0.3	10.9	1.9
2267005055	LPG - Agricultural - Other Agricultural	0.0	0.0	0.0	0.0

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2267006005	LPG - Commercial - Generator Sets	12.3	2.0	67.3	11.1
2267006010	LPG - Commercial - Pumps	1.8	0.3	10.0	1.6
2267006015	LPG - Commercial - Air Compressors	1.4	0.2	7.8	1.2
2267006025	LPG - Commercial - Welders	1.8	0.4	10.1	2.1
2267006030	LPG - Commercial - Pressure Washers	0.0	0.0	0.2	0.1
2267006035	LPG - Commercial - Hydro-power Units	0.0	0.0	0.1	0.0
2267008005	Airport Ground Support Equipment, LPG	0.2	0.0	0.8	0.1
2268002081	CNG - Construction & Mining - Other Construction	0.0	0.0	0.1	0.1
2268003020	CNG - Industrial - Forklifts	7.3	4.9	39.9	26.8
2268003030	CNG - Industrial - Sweepers/Scrubbers	0.0	0.0	0.0	0.0
2268003040	CNG - Industrial - Other General Industrial	0.0	0.0	0.0	0.0
2268003060	CNG - Industrial - AC\Refrigeration	0.0	0.0	0.1	0.1
2268003070	CNG - Industrial - Terminal Tractors	0.0	0.0	0.1	0.0
2268005055	CNG - Agricultural - Other Agricultural	0.0	0.0	0.0	0.0
2268005060	CNG - Agricultural - Irrigation Sets	0.0	0.0	0.0	0.0
2268006005	CNG - Commercial - Generator Sets	3.8	2.2	20.5	12.1
2268006010	CNG - Commercial - Pumps	0.1	0.1	0.8	0.5
2268006015	CNG - Commercial - Air Compressors	0.1	0.1	0.6	0.3
2268006020	CNG - Commercial - Gas Compressors	1.5	0.7	8.4	4.0
2268010010	CNG - Industrial - Other Oil Field	0.0	0.0	0.1	0.1
2270001060	Diesel - Recreational - Specialty Vehicles/Carts	2.4	0.6	16.1	3.9
2270002003	Diesel - Construction & Mining - Pavers	21.4	1.9	122.1	10.8
2270002006	Diesel - Construction & Mining - Tampers/Rammers	0.1	0.0	0.3	0.1
2270002009	Diesel - Construction & Mining - Plate Compactors	1.0	0.1	5.4	0.8
2270002015	Diesel - Construction & Mining - Rollers	58.5	5.2	333.3	29.6
2270002018	Diesel - Construction & Mining - Scrapers	59.5	4.3	338.8	24.7
2270002021	Diesel - Construction & Mining - Paving	3.8	0.4	21.9	2.0
2270002024	Diesel - Construction & Mining - Surfacing	3.0	0.2	17.0	1.4
2270002027	Diesel - Construction & Mining - Signal Boards/Light Plants	9.3	1.0	53.0	5.9
2270002030	Diesel - Construction & Mining - Trenchers	33.4	2.9	190.0	16.6

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2270002033	Diesel - Construction & Mining - Bore/Drill Rigs	39.3	3.3	223.6	18.6
2270002036	Diesel - Construction & Mining - Excavators	184.2	16.7	1,049.4	94.9
2270002039	Diesel - Construction & Mining - Concrete/Industrial Saws	2.4	0.2	13.6	1.2
2270002042	Diesel - Construction & Mining - Cement & Mortar Mixers	1.6	0.2	9.0	1.0
2270002045	Diesel - Construction & Mining - Cranes	57.2	4.4	326.0	25.1
2270002048	Diesel - Construction & Mining - Graders	45.8	4.2	261.0	24.1
2270002051	Diesel - Construction & Mining - Off-highway Trucks	190.9	16.5	1,087.4	94.1
2270002054	Diesel - Construction & Mining - Crushing/Processing	11.2	0.8	64.0	4.8
2270002057	Diesel - Construction & Mining - Rough Terrain Forklifts	80.7	7.6	459.4	43.4
2270002060	Diesel - Construction & Mining - Rubber Tire Loaders	275.2	21.7	1,567.5	123.9
2270002066	Diesel - Construction & Mining - Tractors/Loaders/Backhoes	211.3	41.6	1,203.5	237.1
2270002069	Diesel - Construction & Mining - Crawler Tractor/Dozers	222.1	18.0	1,265.0	102.3
2270002072	Diesel - Construction & Mining - Skid Steer Loaders	155.5	36.6	885.9	208.6
2270002075	Diesel - Construction & Mining - Off-highway Tractors	31.4	2.3	179.1	12.9
2270002078	Diesel - Construction & Mining - Dumpers/Tenders	0.5	0.1	2.9	0.7
2270002081	Diesel - Construction & Mining - Other Construction	31.0	2.3	176.3	13.0
2270003010	Diesel - Industrial - Aerial Lifts	5.1	1.3	27.7	7.0
2270003020	Diesel - Industrial - Forklifts	33.4	2.8	182.5	15.5
2270003030	Diesel - Industrial - Sweepers/Scrubbers	18.8	1.7	102.6	9.0
2270003040	Diesel - Industrial - Other General Industrial	22.8	2.0	124.9	10.9
2270003050	Diesel - Industrial - Other Material Hauling	1.3	0.2	7.1	1.3
2270003060	Diesel - Industrial - AC\Refrigeration	101.0	7.6	550.7	41.2
2270003070	Diesel - Industrial - Terminal Tractors	20.0	2.0	109.5	10.8
2270004031	Diesel - Lawn & Garden - Leafblowers/Vacuums (Commercial)	0.0	0.0	0.1	0.0
2270004036	Diesel - Lawn & Garden - Snowblowers (Commercial)	0.0	0.0	-	-
2270004046	Diesel - Lawn & Garden - Front Mowers (Commercial)	49.2	5.3	341.1	36.6

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2270004056	Diesel - Lawn & Garden - Lawn & Garden Tractors (Commercial)	10.0	1.2	69.6	8.3
2270004066	Diesel - Lawn & Garden - Chippers/Stump Grinders (Commercial)	68.1	6.4	472.3	44.1
2270004071	Diesel - Lawn & Garden - Turf (Commercial)	6.1	0.5	42.0	3.5
2270004076	Diesel - Lawn & Garden - Other Lawn & Garden (Commercial)	0.2	0.0	1.3	0.2
2270005010	Diesel - Agricultural - 2-Wheel Tractors	0.0	0.0	0.0	0.0
2270005015	Diesel - Agricultural - Agricultural Tractors	33.2	3.0	230.7	21.0
2270005020	Diesel - Agricultural - Combines	3.6	0.3	24.8	2.2
2270005025	Diesel - Agricultural - Balers	0.0	0.0	0.1	0.0
2270005030	Diesel - Agricultural - Agricultural Mowers	0.0	0.0	0.0	0.0
2270005035	Diesel - Agricultural - Sprayers	0.3	0.0	2.0	0.2
2270005040	Diesel - Agricultural - Tillers: 6 HP	0.0	0.0	0.0	0.0
2270005045	Diesel - Agricultural - Swathers	0.3	0.0	1.9	0.2
2270005055	Diesel - Agricultural - Other Agricultural	0.7	0.1	4.9	0.5
2270005060	Diesel - Agricultural - Irrigation Sets	0.4	0.0	3.0	0.3
2270006005	Diesel - Commercial - Generator Sets	63.0	7.1	344.4	38.6
2270006010	Diesel - Commercial - Pumps	14.8	1.6	80.7	8.8
2270006015	Diesel - Commercial - Air Compressors	31.5	2.8	172.1	15.4
2270006025	Diesel - Commercial - Welders	19.3	4.8	105.7	26.1
2270006030	Diesel - Commercial - Pressure Washers	2.1	0.2	11.5	1.3
2270006035	Diesel - Commercial - Hydro-power Units	1.4	0.1	7.7	0.7
2270007015	Diesel - Logging - Feller/Bunch/Skidder	0.0	0.0	0.0	0.0
2270008005	Airport Ground Support Equipment, Diesel	21.3	1.7	116.1	9.4
2270010010	Diesel - Industrial - Other Oil Field	0.3	0.0	1.8	0.1
2282005010	2-Stroke Gasoline - Pleasure Craft - Outboard	2.9	32.8	21.2	232.1
2282005015	2-Stroke Gasoline - Pleasure Craft - Personal Water Craft	1.2	5.8	9.0	41.8
2282010005	4-Stroke Gasoline - Pleasure Craft - Inboard/Stern-drive	3.2	5.8	22.4	39.8
2282020005	Diesel - Pleasure Craft - Inboard/Stern-drive	3.4	0.2	24.6	1.2
2282020010	Diesel - Pleasure Craft - Outboard	0.0	0.0	0.1	0.0
2285002015	Diesel - Railroad - Railway Maintenance	3.0	0.5	16.3	2.8
2285004015	4-Stroke Gasoline - Railroad - Railway Maintenance	0.0	0.1	0.2	0.8

Table B-1. Nonroad Motor Vehicle Emissions Summary by Equipment Type

Source Type	Fuel Type – Equipment Type	NO _x (tpy)	VOC (tpy)	NO _x (lbs/OSD)	VOC (lbs/OSD)
2285006015	LPG - Railroad - Railway Maintenance	0.0	0.0	0.0	0.0
	Total Nonroad	2,720.4	2,941.0	15,783.5	18,989.6