2010 Carbon Monoxide Emission Inventory

In support of Missoula County's Limited Maintenance Plan for the Missoula Carbon Monoxide Maintenance Area

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ABBREVIATIONS

AP-42	Compilation of Air Pollutant Emission Factors (AP-42)
ATV	All-Terrain Vehicle(s)
BNSF	Burlington Northern and Santa Fe Railway Company
BTU	British Thermal Unit(s)
C	Centigrade
CDM	County Data Manager
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CV	Coefficient of Variation
CY	Calendar Year
Dsl	Diesel
E.I.	Emission Inventory
E_f	Emission Factor(s)
EIIP	Emission Inventory Improvement Program
EPA	United States Environmental Protection Agency
EtOH	Ethanol
F	Fahrenheit
FR	Federal Register
ft	Foot (Feet)
ft^2	Feet Squared
ft^3	Cubic Foot (Feet)
g	Gram(s)
GAF	Growth Adjustment Factor
GF	Growth Factor
GIS	Geographic Information System
GVW	Gross Vehicle Weight
HDD	Heating Degree Day(s)
HPMS	Highway Performance Monitoring System
hr	Hour(s)
I/M	Inspection and Maintenance
in	Inch(es)
kg	Kilogram
lb	Pound(s)
LMP	Limited Maintenance Plan
LPG	Liquid Petroleum Gas
m	Meter(s)
MA	Maintenance Area
MASZ	Missoula Air Stagnation Zone
MCCHD	Missoula City-County Health Department
MDEQ	Montana Department of Environmental Quality
MDOR	Montana Department of Revenue
MRL	Montana Rail Link

MT	Montana
MY	Model Year
NAAQS	National Ambient Air Quality Standard
NOAA	National Oceanic and Atmospheric Administration
NOx	Oxides of Nitrogen
NSPS	New Source Performance Standards
PM	Particulate Matter
PTE	Potential to Emit
RVP	Reid Vapor Pressure
RWBS	Residential Wood Burning Survey
scf	Standard Cubic Foot (Feet)
SIP(s)	State Implementation Plan(s)
temp.	Temperature
ton(s)	English Ton(s)
TPY	Tons Per Year
USEPA	United States Environmental Protection Agency
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled
Vol	Volume
yr	Year

UNITS AND CONVERSION FACTORS

Metric and English units will be used in this document. Listed below are common conversion factors used in this document to convert English units to metric units or metric units to English units.

To convert kilogram to metric ton, divide by 1,000.

To convert pound to kilogram, multiply by 0.453592.

To convert short tons to kilograms, multiply by 907.2.

To convert kilogram to pound, multiply by 2.2046.

1. INTRODUCTION

1.1 Overview

This document outlines the Missoula City-County Health Department's (MCCHD) update to the carbon monoxide (CO) emission inventory (E.I.) for the CO Missoula Maintenance Area (MA). The inventory was conducted in support of the second 10-year limited maintenance plan (LMP) for the Missoula MA.

According to LMP guidance (1), MCCHD's maintenance plan should include an emissions inventory. The inventory should represent emissions during the time period associated with the monitoring data showing attainment. The inventory should also be based on actual "typical winter day" emissions of CO. Because CO monitoring in Missoula was terminated in 2011, this emission inventory used 2010 as its base year.

In 2004, the Montana Department of Environmental Quality (MDEQ) developed a 2000 Missoula CO emission inventory (E.I.) that included the MA in its geographic scope (2). The 2000 emission inventory was prepared in support of the Missoula County Carbon Monoxide Redesignation Request and Maintenance Plan. The Governor of Montana submitted the redesignation request to the U.S. Environmental Protection Agency (EPA) on May 27, 2005, and EPA approved it in an Federal Register (FR) notice on August 17, 2007 (72 FR 46158). The 2000 CO E.I. estimated area and industrial point emissions within the Missoula urban and outlying areas, including the Missoula CO MA. For the 2010 CO E.I., MCCHD determined CO emissions from MA sources identified in the Missoula 2000 CO emission inventory.

1.2 Agencies Responsible for the Emission Inventory

The MCCHD Air Quality Division has primary responsibility for preparing and submitting the 2010 CO Emission Inventory for the Missoula CO Maintenance Area. Point source and area source emission estimates were prepared by MCCHD. The MDEQ Air Quality Bureau prepared nonroad mobile source emission estimates, which the MCCHD allocated to the MA. The MDEQ also provided emission estimates for onroad mobile sources.

Table 1.2 lists those responsible for inventory preparation and quality assurance/ quality control activities.

Table 1.2 Authors and QA/QC contacts for the 2010 Missoula CO emission inventory

Source	Author(s)	QA/QC contacts
Point	Sarah Coefield MCCHD (406) 258-4755	Cyra Cain MDEQ (406) 444-3490
Area	Sarah Coefield MCCHD (406) 258-4755	Cyra Cain MDEQ (406) 444-3490
Nonroad Mobile Sources	Sarah Coefield MCCHD (406) 258-4755 Cyra Cain MDEQ (406) 444-3490	Kristen Martin MDEQ (406) 444-3490
Onroad Mobile Sources	Cyra Cain MDEQ (406) 444-3490	Cyra Cain MDEQ (406) 444-3490

1.3 Temporal Scope

An emission inventory in support of a LMP for CO should represent emissions during the time period associated with the monitoring data showing attainment. The inventory should also be based on actual "typical winter day" emissions of CO. Because CO monitoring in Missoula was terminated in 2011, this emission inventory used 2010 as its base year.

This emission inventory was based on a winter day in 2010. Winter was defined for this E.I. as December, January and February.

Table 1.3 Seasonal apportionment for the 2010 Missoula CO emission inventory

Season	Months	Number of days
Winter	December, January, February	90

1.4 Geographic Scope

Due to data availability, this inventory was confined to the MA. The MA roughly follows the Missoula City limits (Appendix B), with a few variations. The Missoula CO maintenance area includes the following (Range and Township) sections: R19W T14N – sections: 29 and 32; R19W T13N – sections: 2, 5, 7, 8, 11, 14 through 24, and 26 through 34; R19W T12N – sections: 4 through 7; R20W T13N – sections: 23 through 26, 35 and 36 (3).

In the 2000 CO E.I., MDEQ used a gridded system to apportion emissions throughout the inventory area, which was considerably larger than the 2010 E.I. area and encompassed the City of Missoula and several surrounding communities. The grids allowed MDEQ to track emissions in specific locations, including the MA. For this inventory, MCCHD looked at emissions as a whole for the MA, and consequently, the emission inventory will not use grids.

1.5 Overview of local demographics

In 2010, Missoula was the second largest city in Montana, with a population of 66,788 according to the 2010 U.S. Census (4). Because the Missoula CO MA resembles and overlays the Missoula City limits boundary (Appendices A and B), demographic data for the city of Missoula was used in this emission inventory to derive estimates of activity or emissions within the CO MA from county-level calculations.

Table 1.5 Demographic and land profile

Demographic/geographic variable	Missoula County	Missoula City
Total Population	109,299	66,788
Land area (square miles)	2,593	27.51
Management, business, science, and arts employment	20,647	13,745
Service employment	11,671	7,749
Sales and office employment	16,277	10,306
Natural resources, construction, and maintenance employment	4,944	2,350
Production, transportation, and material moving employment	3,396	1,856
Total civilian employment	**56,935**	**36,006**

1.6 Emission Inventory Design

Several types of information were reviewed prior to designing the format of this 2010 Missoula CO emission inventory. This information included previous Missoula CO emission inventories, local air monitoring data and meteorological data. The City of Missoula lies within a deep mountain valley just above the confluence of the Clark Fork and Bitterroot Rivers. The city's elevation is approximately 985 meters (m) (3,232 feet (ft)) above sea level. The peaks of the mountains surrounding Missoula range from 1,219 to 2,134 m (4,000 to 7,000 ft) above sea level. Due to its location, frequent temperature inversions occur during the fall and winter months that persist for days or weeks at a time. The mountains also tend to block the prevailing westerly winds. The resulting light surface winds, when coupled with the fall and winter temperature inversions, lead to stagnant air conditions, which cause air pollution accumulation in the Missoula valley. Under these circumstances, citywide ambient CO levels, primarily from onroad vehicular traffic and wood stove emissions are raised to the point where violations of the 8-hour average CO federal and state standards have occurred. Based on this background information, MCCHD anticipated that the most important CO emission sources in the Missoula urban area would be area sources such as onroad mobile emissions and residential wood combustion.

1.7 Emission Overview by Source Category

1.7.1 Point Sources

The point source category includes those stationary sources that emit a significant amount of pollution into the air, such as power plants, industrial processes and large manufacturing facilities, as well as minor point sources such as refinery flares and small incinerators.

Table 1.7.1 summarizes typical winter daily emissions from point sources in the Missoula CO MA. A detailed breakdown of emissions calculations for all point sources is contained in Chapter 2.

Table 1.7.1 Typical winter day emissions from point sources in the Missoula CO MA

Source category	Typical winter day (kg CO)
Major point	1,591.45
Minor point	137.45

1.7.2 Area Sources

Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively they can release significant amounts of pollution.

A detailed breakdown of emissions calculations for each area source category is contained in Chapter 3.

Emissions from stationary sources that were not identified as point sources in this report have been included in the area source inventory. Examples of stationary sources included as area source categories include residential wood burning and natural gas combustion.

Table 1.7.2-1 Summary of typical winter day emissions from stationary area sources in the Missoula CO MA

Category	Typical winter day (kg CO)
Residential wood burning	4,646.71
Natural gas combustion	684.27
Total	**5,330.98**

Nonroad mobile sources include off-highway vehicles and engines that move or are moved within a 12-month period. Table 1.7.2-2 summarizes winter-day emissions from nonroad mobile sources for the Missoula CO maintenance area.

Table 1.7.2-2 Typical winter day emissions from nonroad mobile sources in the Missoula CO MA

Category	Typical winter day (kg CO)
Commercial	2,876.67
Construction	401.17
Industrial	370.83
Residential lawn and garden	297.96
Commercial lawn and garden	229.55
Railway maintenance	29.28
Railway locomotives	33.74
Total	**4,239.20**

Emissions from onroad mobile sources were calculated for the Missoula CO Maintenance Area. Table 1.7.2-3 summarizes typical winter day emissions from onroad mobile sources in the Missoula CO MA.

Table 1.7.2-3 Typical winter day emissions from onroad mobile sources in the Missoula CO MA

Category	Typical winter day (kg CO)
Mobile emissions	**27,406.13**

1.7.5 Summary of All Source Categories

Table 1.7.5 provides summary totals of typical winter day emissions from all emission sources in the Missoula CO Maintenance Area. Figures 1.7.5-1 and 1.7.5-2 illustrate the contributions the emission sources make to daily winter CO emissions in the CO MA. The onroad mobile sources (motor vehicle exhaust) account for 71 percent of winter CO emissions in the Missoula CO MA.

Table 1.7.5 Typical winter day emissions from all sources in the Missoula CO MA

Section	Typical winter day (kg CO)
Point Sources	1,728.90
Area Sources:	
Residential wood burning	4,646.71
Natural gas combustion	684.27
Nonroad Mobile Sources:	
Commercial equipment	2,876.67
Construction equipment	401.17
Industrial equipment	370.83
Residential lawn and garden equipment	297.96
Commercial lawn and garden equipment	229.55
Railway maintenance equipment	29.28
Railway locomotives	33.74
Onroad Mobile Sources:	
Motor vehicle exhaust	27,406.13
TOTAL All Sources	**38,705.21**

Figure 1.7.5-1 Winter 2010 Missoula CO source categories and their emissions

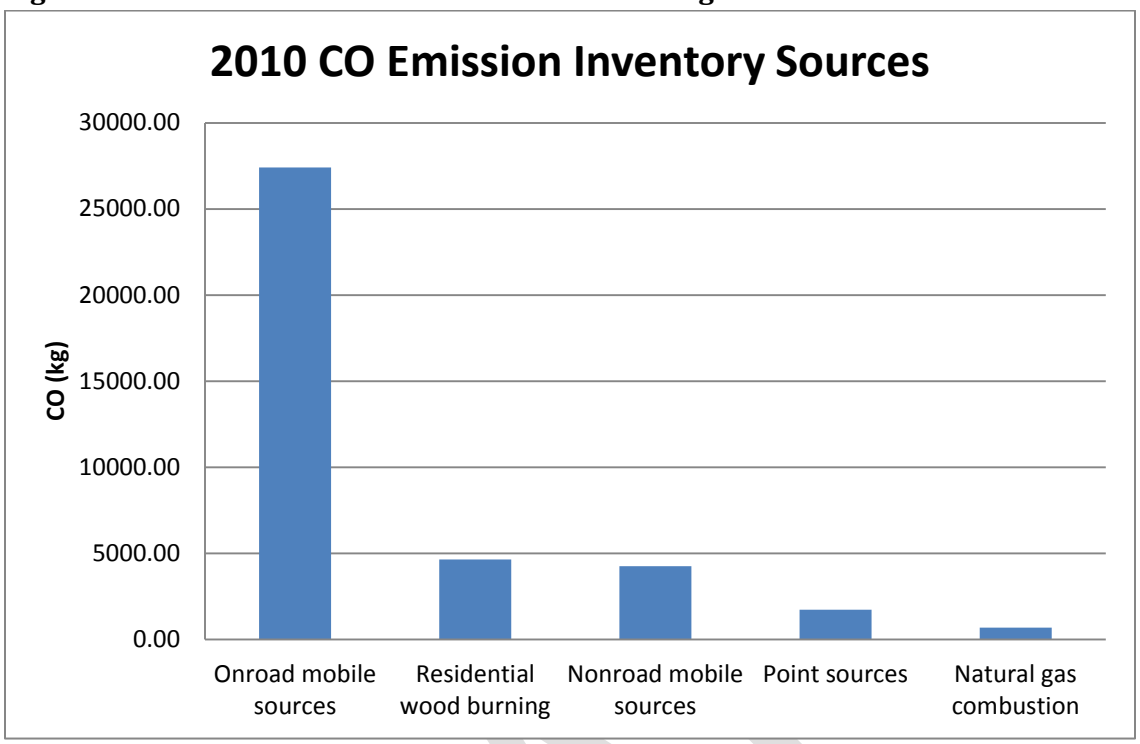
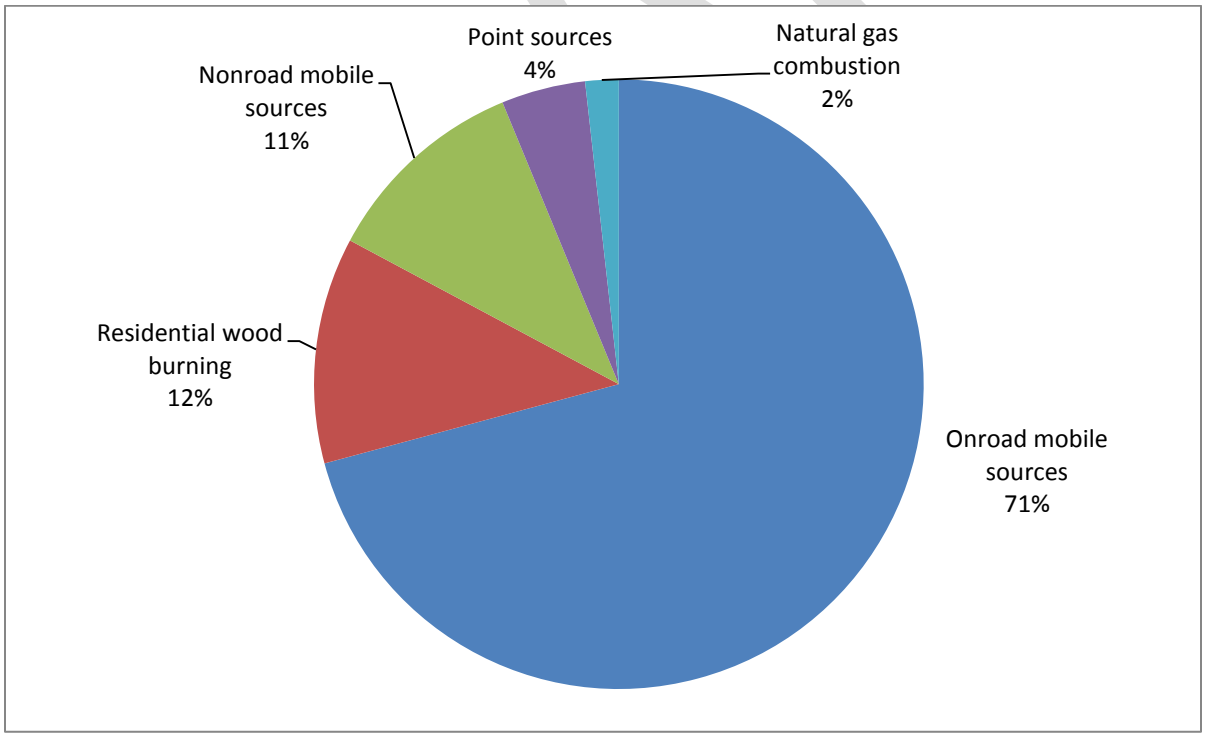


Figure 1.7.5-2 Winter CO emission sources in the Missoula CO MA



2. POINT SOURCES

2.1 Introduction and Scope

There are relatively few industrial point sources in the Missoula MA. The point sources in Missoula are either permitted by the MCCHD, the MTDEQ, or by a combination of both agencies. MTDEQ permits sources in Missoula County with the potential to emit greater than 25 English tons of air pollutants per year. MCCHD examined the MDEQ Air Quality Bureau 2010 database to identify those point sources that are located within the MA. MCCHD used each facility's 2010 Montana Air Quality Permit emission inventory potential to emit (PTE) CO estimates for the emission inventory. The potential to emit was based upon maximum design capacity and continuous 24-hour of operation per day.

There are two major point sources within the Missoula CO MA that have CO emissions listed in their MDEQ ARMB permits: Roseburg Forest Products and Momentive Specialty Chemicals, Inc. Roseburg Forest Products, located in Section 8, Township 13 North, Range 19 West, processes raw wood fiber into particleboard by refining the fiber, adding resin, and pressing the material into boards. The plant also contains a remanufacturing section, which processes the particle board into finished wood that is used in furniture production. Momentive Specialty Chemicals, Inc., located in Section 8, Township 13 North, Range 19 West, operates a formaldehyde and thermoset resin production facility

MCCHD reviewed the MCCHD Air Division Industrial Permit files to identify minor point sources permitted by Missoula County for carbon monoxide. Minor sources permitted by the County included flares at refineries and incinerators. In 2010, these sources included two refineries (CHS Inc. and ConocoPhillips) and two incinerators (Garden City Funeral Home and Crematory, and The Humane Society of Western Montana).

Point sources that were outside the MA or did not operate during the 2010 winter months were not included in this CO emission inventory.

2.2 Temporal Apportionment

Daily estimates were calculated for point sources that operated during the winter in the MA based on the number of days the source operates.

Example:
Roseberg Forest Products
2010 PTE: 606.1 tons per year (TPY)
Days of operation in 2010: 365
Daily emissions: 606.1 TPY/365 days = 1.66 tons CO per day

2.3 Summary of Point Source Emissions

Table 2.3 provides an overview of point source emissions for the Missoula CO MA.

Table 2.3 Typical 2010 daily point source emissions in the Missoula CO MA

	Source name	CO emissions (kg/day)
Major Point Sources	Roseburg Forest Products	1,506.42
	Momentive Specialty Chemicals, Inc.	85.03
Minor Point Sources	CHS Inc.	54.68
	ConocoPhillips	77.37
	Garden City Funeral Home and Crematory	4.03
	Humane Society of Western Montana	1.37
Total		**1,728.90**

3. AREA SOURCES

This section discusses the specific procedures that were used to calculate CO emissions from each area source category in the E.I. area.

All area sources in the 2000 CO E.I. were included in the 2010 CO emission inventory.

3.1 RESIDENTIAL WOOD BURNING

The MCCHD initiated the regulation of residential wood burning in the Missoula urban area through the amendment and revision of the Missoula City-County Air Pollution Control Program on November 16, 1983. Through the years, the regulations have become progressively more stringent. In 1986, the MCCHD limited the types of wood stoves that could be installed in the Missoula Air Stagnation Zone (MASZ) by amending the program regulations. In 1989, further restrictions were adopted for stoves that could be installed in the MASZ. To ensure that Missoula would continue to meet the federal ambient air quality standards, the MCCHD adopted regulations in 1994 that specified that only pellet stoves with emission rates of less than 1 gram of particulates an hour (g/hr) could be installed in MASZ. These regulations reflected the EPA New Source Performance Standards (NSPS) for new residential heaters established in 1988 (5). At the same time, the MCCHD added new regulations that required many existing, high particulate emitting wood stoves to be removed upon sale of a residential property. The changes to the Missoula City-County Air Pollution Control Program regulations were documented in the 1997 SIP version amended on November 1, 1997. The 2014 Missoula City-County Air Pollution Control Program contains the following regulations, but note that the emission rates mentioned in the following paragraphs reference the particulate matter (PM) emission rates (6).

Rule 9.202 – Permits Required for Solid Fuel Burning Devices

(1) After July 1, 1986, a person may not install or use any new solid fuel burning device in any structure within the Air Stagnation Zone without an Installation permit.

Rule 9.203 – Installation Permits Inside the Air Stagnation Zone

(1) Inside the Air Stagnation Zone, the department may only issue installation permits for pellet stoves with emissions that do not exceed 1.0 gram per hour weighted average when tested in conformance with the EPA method.

Rule 9.501 - Removal of Solid Fuel Burning Devices Upon Sale of the Property

(1) After October 1, 1994, in the Air Stagnation Zone, all solid fuel burning devices contained on property to be sold must be removed from the property or rendered permanently inoperable unless they meet the emissions requirements listed in Section (2) of this rule.

(2) The following solid fuel burning devices may remain on a property in the Air Stagnation Zone to be sold:

  (a) Woodstoves or Pellet Stoves installed with a valid permit if the emissions do not exceed:

    (i) 6.0 grams per hour weighted average when tested in conformance with the Oregon Method; or

    (ii) 5.5 grams per hour weighted average when tested in conformance with the EPA Method.

  (b) Commercially manufactured pellet stoves:

    (i) that have not been tested, but were installed prior to October 1, 1994; or

    (ii) with emissions that do not exceed 1.0 grams per hour when tested in conformance with the USEPA Method.

  (c) Fireplaces meeting the definition of Rule 9.102(6).

  (d) Wood-fired, forced-air combustion furnaces that primarily heat living space, through indirect heat transfer using forced air duct work or pressurized water systems.

Due to these restrictions, the number of solid fuel burning devices in the Air Stagnation Zone has declined since 1994, despite population growth and accompanying increase in housing. The Montana School of Technology conducted the most recent residential wood burning survey (RWBS) for the Missoula area during February through April 1996 (7). The results from this survey were adjusted to account for the effects of the MCCHD air regulations, residential growth, and other variables.

The 2000 CO E.I. used the RWBS and household data to calculate CO emissions from wood burning devices. This inventory used the household data from the 2000 E.I. (e.g. number of households in the MA in 2000) and data on houses sold in the MA 2000 - 2010 in order to determine how many wood burning devices have likely been removed from the MA since the last emission inventory.

3.1.1 Emission Factors and CO Emission Rates

The 1996 residential wood burning survey divided the wood burning devices into ten categories: Fireplace, Catalytic Pre-phase I, Catalytic Phase I, Catalytic Phase II, Conventional, Non-catalytic Pre-phase I, Non-catalytic Phase I, Non-catalytic Phase II, Masonry Heater, and Pellet. The Non-catalytic Phase I wood stoves became available for purchase after July 1, 1990. The Phase II Non-catalytic wood stoves were available for purchase after July 1, 1992.

The particulate emission rates listed in supporting Compilation of Air Pollutant Emission Factors (AP-42) documentation were as high as 8.5 g/hr for Non-catalytic Phase I stoves and as high as 7.5 g/hr for Non-catalytic Phase II stoves (8). The MCCHD records showed that most stoves installed inside the MASZ from 1990 onward met MCCDH Class I designation. A Class I designation meant that the stove emitted 4.1 g/hr or less of particulates by the EPA Method 39. In the MSAZ, the Missoula City-County Air Pollution Control Program regulations allowed wood stoves that emit 5.5 g/hr or less to remain on a residential property when the property was sold; wood stoves that emitted more than 5.5 g/hr had to be removed from a property when the property was sold. For this inventory, all Non-catalytic Phase I and II wood stoves were assumed to have been low particulate emitting units when the RWBS was conducted. Without this assumption, more stoves were removed from the wood stove population with time, thereby decreasing the overall CO emissions from this source category in 2010. The CO emission rates for the various wood stoves are listed in Table 3.1.1.

Table 3.1.1 CO emission factors for residential wood burning devices

Wood Burning Device	CO Emission Factor (g CO/kg-dry wood)
Fireplaces[a]	126.0
Catalytic Pre-phase I (pre-1988)[b]	115.4
Catalytic Phase I[b]	52.2
Catalytic Phase II[b]	53.5
Conventional (pre-1986)[b]	115.4
Non-catalytic Pre-phase I (pre-1988)[b]	115.4
Non-catalytic Phase I[b]	115.4
Non-catalytic Phase II[b]	70.4
Masonry Heater[b]	74.5
Pellet[b,c]	19.7

[a] Emission Factor Documentation for AP-42 Section 1.9, Residential Fireplaces (9).
[b] Emission Factor Documentation for AP-42 Section 1.10, Residential Wood Stoves (8)
[c] Certified pellet stove

3.1.2 Type of Wood Burning Devices

The residential wood burning survey was conducted from February through April 1996. Information on the proportion and number of wood burning devices in the entire survey area

was estimated, which has changed from that time to the year 2010, the base year for this emission inventory. The influential factors included the MCCHD regulations, residential housing sales, and increase in number of housing units due to population growth. Cyra Cain at MDEQ developed a method to account for these factors and resulting changes in the population of wood burning devices for the Missoula 2000 Carbon Monoxide Emission Inventory (2).

Since permits were required from the MCCHD for the installation of pellet stoves from 1996 through 2010, the exact number of new pellet stoves was known. The first step, then, was to determine the total number of occupied housing units within the E.I. area, since only occupied housing units with wood stoves burned wood during the 2010 inventory year.

For the 2000 CO emission inventory, MDEQ and MCCHD collaborated to determine occupied housing units in the MASZ on a grid basis. Readers are referred to that document for more detailed information.

According to data in the 2000 CO E.I., there were 24,178 old occupied housing units in the MA in 2000. Some of residential housing units were sold after the 2000 CO E.I. was compiled. To determine the number of old units sold, the City of Missoula Geographic Information System (GIS) Services office gathered data from the Montana Department of Revenue (MDOR) to identify the number of one- or two-family housing units with at least one deed on record between 2000 and 2010, which included both new and old housing units. Data on new residential construction (one- or two-family homes) in the MA between 2000 and 2010 were also collected from the MDOR. A Missoula City/County parcel GIS layer was used to determine parcels in the MDOR database that were within the CO Maintenance Area. Geocode, Year Built and Residence Type were compiled from the MDOR database and address information was gathered from the City of Missoula Accela Automation database. An approximation of the number of old housing units sold between 2000 and 2010 was the difference between the MDOR deed data (new + old housing) and the number of building projects completed (new housing). The following assumptions were compiled to support this process of determining the number of old and new housing units in the Missoula MA.

- Wood burning devices were installed in single and two-family housing units only.
- Multiple family housing units defined in the RWBS were two-family structures. (The survey estimated the percentages of dwellings that burned wood were 85.1 and 14.9 for single and multiple family dwellings, respectively.)
- A deed in the MDOR files for an address in the MA represented a change in ownership
- The distribution of the stove types in old residential housing units was determined by the 2000 CO E.I.
- In old housing units, the Non-catalytic Phase I and II devices were low particulate emitters.
- No new residence was constructed for personal habitation.

By applying these assumptions to the MDOR deeds and building information, the number of old housing units that potentially had wood burning devices was estimated. The 2000 housing sales data were included since housing sales occur throughout the year, but traditionally the lowest

transactions occur during the wintertime.

According to the 2000 CO E.I., the percentage of residences that burned wood in 2000 was 17.62. Assuming the same fraction burned wood in this old housing population, 1,808 sold residences (10,263 old houses sold 2000 – 2010 x 0.1762) had wood burning devices on the property (7). Due to MCCHD regulations, some devices had to be removed when the property was sold due to their high particulate emission rates. This factor changed the overall proportion of the wood burning devices from when the 2000 CO E.I. was conducted. The distribution of devices was calculated for this new population of devices using the distribution identified from the 2000 CO E.I., which is displayed in Table 3.1.2. For the 2010 CO E.I., this number of old units (1,808) was multiplied by the same percentages of the devices noted in the 2000 CO E.I., and the number of devices that had to be removed from the property due to the regulations was calculated (Table 3.1.2).

Table 3.1.2. 2000 and 2010 distribution and number of stove types in the 2010 Missoula MA

Type of Device	Device removed if property sold?	2000 Distribution of devices (%)[a]	2000 Total number devices in MA	2000-2010 Devices in sold MA housing units[a]	2010 Remaining devices in MA	2010 Distribution of devices (%)[a]
Fireplaces	No	49.41	2105	893	**2105**	54.42
Catalytic Pre-phase I	Yes	0	0	0	**0**	0.00
Catalytic Phase I	No	0	0	0	**0**	0.00
Catalytic Phase II	No	3.82	163	69	**163**	4.21
Conventional	Yes	22.22	947	402	**545**	14.09
Non-catalytic Pre-phase I	Yes	1.69	72	31	**41**	1.06
Non-catalytic Phase I	No	3.8	162	69	**162**	4.19
Non-catalytic Phase II	No	7.6	324	137	**324**	8.38
Masonry Heater	No	1.89	81	34	**81**	2.09
Pellet	No	9.57	408	173	**447**	11.56
Total		**100**	**4,262**	**1,808**	**3,868**	**100.00**

[a] Variance may occur due to rounding conventions.
[b] Thirty-nine (39) permitted pellet stove were added.

3.1.3 Type Of Wood Burned And Weight Of Wood

The information pertaining to the type of wood burned was obtained from the RWBS. It was assumed that the type of wood burned did not change over time. Since woodburners generally measure the wood they cut or buy by the cord, the survey asked each respondent the number of cords of wood the household burned per season. In order to convert cords of wood to kilograms (emission factor unit), the density and volume of solid wood in a cord were required. The RWBS provided the wood species that was burned. The oven-dry specific gravity for each wood species was obtained from the Wood handbook: Wood as an engineering material (10). The volume of solid wood in a cord excludes the air spaces between each log of wood and the density of the wood is dependent upon the specie of wood and moisture content. Table 3.1.3-1 displays the parameters necessary to calculate the weighted average specific gravity.

Table 3.1.3-1. Wood species, specific gravities, percentages of species burned, and calculated weighted specific gravity for the 2010 Missoula CO emission inventory

Wood specie	Specific gravity [a],[b]	Percentage of specie burned (%)	Specific gravity [a],[b],[c]
Douglas-fir	0.5000	17.22	0.0861
Ponderosa Pine	0.4000	0.00	0.0000
Lodgepole Pine	0.4100	10.74	0.0440
Spruce	0.4400	1.85	0.0081
Western Larch or Tamarack [d]	0.5300	20.19	0.1070
Miscellaneous [e]	0.4560	50.00	0.2280
Weighted Specific Gravity		**100.00**	**0.4733**

[a] Specific gravity was based on 12 percent oven dry weight and volume from Table 5-3b, Wood handbook: Wood as an engineering material (10)
[b] Specific gravity does not have unit of measurement.
[c] Variance may occur due to rounding conventions.
[d] Tamarack specific gravity was used.
[e] Weighted average of other wood species.

According to the wood burning survey, 100 percent of the woodburners said they burned wood that was well seasoned. The Woodburners Encyclopedia reports that the moisture content of seasoned (covered) cordwood during a northwest winter cannot be less than 18 percent (oven-dry basis) (11). Considering both sapwood and heartwood for all of these species, an average moisture content of 20 percent (oven-dry basis) seemed appropriate. In the survey, over 25 percent of the wood was uncovered; therefore, it was assumed that this wood had higher

moisture content than the covered wood. Therefore, uncovered wood had overall moisture content of approximately 25 percent, an increase of 7 percent from the covered wood. Equation 4-11 in the Wood handbook: Wood as an engineering material was used to determine the specific gravity, although this equation should be used with the specific gravity based on green volume. The specific gravity at 25 percent moisture content was calculated by the following procedure.

$$\frac{G_b}{(1 - 0.2650(a)\,G_b)} = G_m$$

G_m = Specific gravity based on moisture content m
a = 1 – m/30 where m < 30
G_b = Basic specific gravity on green volume

$$\frac{0.4733}{(1 - (0.2650(25/30)0.4733))} = 0.4834$$

Applying Table 4-6b at 25 percent moisture content and 0.48 specific gravity, the density of the wood was approximately 37.4 pounds per cubic feet (lb/ft^3) via linear interpolation.

The weight of a cord of wood was also needed since most firewood was cut or purchased in this manner. A standard cord (128 ft^3) is approximately 60 to 100 cubic feet of solid wood according to The Woodburners Encyclopedia. Sawing the cord into shorter lengths and splitting reduces the volume of a cord of wood by as much as 25 percent (or increases the amount of solid wood in a cord by as much as 33 percent). Therefore, a cord of wood sawed into two foot lengths, split, and stacked contains about 106 cubic feet of solid wood (80 ft^3 x 1.33 = 106 ft^3). Since many woodburners purchased their wood in 8-foot lengths, 100 cubic feet of solid wood per cord was considered a good approximation. Table 3.1.3-2 demonstrates the method of computing the weight of a cord that was used for this 2010 inventory.

Table 3.1.3-2. Weight per cord computation used in the 2010 Missoula CO emission inventory

Wood Specie [a]	Douglas -fir	Ponderosa Pine	Lodgepole Pine	Spruce	Tamarack	Miscellaneous [a]
Specific Gravity [b]	0.5000	0.4000	0.4100	0.4400	0.5300	0.4560
Specie Composition[c] (%)	17.22	0.00	10.74	1.85	20.19	50.00
Specific Gravity x Specie Composition	0.0861	0.000	0.0440	0.0081	0.1070	0.2280
Weighted Specific Gravity [d]	0.4733					
Moisture Content [e] (%)	25.00					
General Density [f] (lb/ft^3)	37.4					
Volume Per Cord (ft^3)	100.00					
Weight Per Cord [g] (kg/cord)	1,696.46					

[a] Mix of wood type burned according to the Missoula RWBS, calculated weighted averages.
[b] Wood handbook: Wood as an engineering material; specific gravity is unitless (10)
[c] Residential Wood Burning Survey For Missoula, Montana (7)
[d] Sum of specific gravity multiplied by species composition (unit less).
[e] Assumption.
[f] Wood handbook: Wood as an engineering material, Table 4-6b, via linear interpolation (10)
[g]Based on the following calculation: (37.4000 lb/ft. ^{3})(100.0000 ft. ^{3}/cord)(0.4536 kg/lb)= 1,696.46 kg/cord. The wood burning survey estimated 8,895 total cords of wood were burned in Missoula greater urban area during 1996. Using the conversion factor of 1,696.46kg/cord, approximately 15,090,011.7 kilograms of wood was burned in greater Missoula urban area during the 1995 - 1996 winter season. Variance may occur due to rounding conventions.

The overall weight of the wood burned in the E.I. area was 1,696.46 kilograms per cord of wood burned. However, the wood burning survey used a composite unit weight of 1,743.36 kg per cord weight. The reason for the difference was the selected specific gravity of the "Miscellaneous" class of the wood specie, which was 0.50 for the RWBS analysis. Since the weight of the wood burned by each device was based the number of cords burned, the amount of wood per device had to be modified by dividing by the old composite cord weight (1,743.36) and multiplying by the new one (1,696.46), which was about 3 percent lower.

3.1.4 Total Amount Of Wood Burned In The E.I. Area

The new distribution of the devices for year 2010 was multiplied by the average amount of wood burned per device to calculate the amount of wood burned in the Missoula MA during 2010. The number of devices and quantities with percentages of wood burned by stove type during the 1996 and 2010 in Missoula non-attainment area is listed in Table 3.1.4.

Table 3.1.4. 1996 and 2010 Number of devices and quantities of wood burned by stove type in the 2010 Missoula CO emission inventory area

Device Category	1996 Amount of wood burned per device (kg-dry wood)	2010 Remaining devices in MA	2010 Total amount of wood burned (kg-dry wood)	2010 Percentage wood burned (%)[a]
Fireplaces	1,826.40	2105	3,844,576.70	42.59
Catalytic Pre-phase I	0.00	0	0.00	0.00
Catalytic Phase I	0.00	0	0.00	0.00
Catalytic Phase II	3,381.41	163	551,169.29	6.11
Conventional	3,844.52	545	2,095,261.78	23.21
Non-catalytic Pre-phase I	852.97	41	34,971.71	0.39
Non-catalytic Phase I	845.35	162	136,947.15	1.52
Non-catalytic Phase II	4,670.28	324	1,513,171.73	16.76
Masonry Heater	1,705.94	81	138,180.90	1.53
Pellet	1,595.49	447	713,182.92	7.90
Total	**18,722.35**	**3,868**	**9,027,462.18**	**100**

[a] Variance may occur due to rounding conventions.

In 2010, there were about 9,023,490 total kilograms of wood burned in the Missoula E.I. area.

3.1.5 Residential Wood Burning Emissions

The amount of wood burned per device type in the Missoula CO MA was multiplied by the appropriate emission factor to calculate CO emissions.

Example for Non-catalytic Phase I Stoves in the emission inventory area:

Amount of wood burned by Non-catalytic Phase I Stoves = 136,947.15 kg dry-wood (Table 3.1.4-1)

CO emission factor from AP-42 = 115.4 g/kg-dry wood (Table 3.1.1-1).

(136,947.15 kg-dry wood)(CO Emission Factor 115.4g/kg-dry wood) = 15,803.70 kg CO

3.1.6 Seasonal and Temporal Apportionment

The amount of wood burned by the resident population depends on the ambient temperature. Low temperatures increase the likelihood of burning wood for home heating and the number of heating degree-days (HDD) accounts for this factor. For this inventory, the heating degree-days were computed for each month. The data was obtained from local climatological data collected at the Missoula International Airport weather station, because it is the nearest weather station to the CO MA. Climate data were obtained from the Midwestern Regional Climate Center cli-MATE Database http://mrcc.isws.illinois.edu/CLIMATE/.

For January, February and December, there were 3,384 heating degree-days. By dividing the HDD for this winter season by the annual 2010 HDD, a percentage of the HDD for this season can be computed.

$$\left(\frac{3,385}{7,346}\right)(100) = 46.08\%$$

This percentage of wood stove emission in winter was then multiplied by the total annual wood burning emissions per device. This reflects the actual weather conditions that occurred during the winter season.

(29,487.56 kg CO from Catalytic Phase II Stoves)(0.4608) = 13,587.87 kg CO/winter

The seasonal emissions were then divided by the number of days in the winter 2010 months (n=90) to determine the wood burning emissions on a winter day.

13,587.87 kg CO/90 days = 150.98 kg CO/day from catalytic phase II stoves in the MA

3.1.7 Summary of Residential Wood Burning Emissions

Table 3.1.7 provides an overview of residential wood burning emissions for the CO MA

Table 3.1.7 Winter day CO emissions from residential wood burning in the Missoula CO MA

Device	Emission factor (g/kg dry wood)	Wood burned in MA (kg)	Total 2010 CO in MA (kg)	Winter CO in MA (kg)[a]	Winter day CO in MA (kg)
Fireplaces	126.30	3,844,576.70	485,570.04	223,750.67	2,486.12
Catalytic Pre-phase I	115.40	0.00	0.00	0.00	0.00
Catalytic Phase I	52.20	0.00	0.00	0.00	0.00
Catalytic Phase II	53.50	551,169.29	29,487.56	13,587.87	150.98
Conventional	115.40	2,095,261.78	241,793.21	111,418.31	1,237.98
Non-catalytic Pre-phase I	115.40	34,971.71	4,035.74	1,859.67	20.66
Non-catalytic Phase I	115.40	136,947.15	15,803.70	7,282.34	80.91
Non-catalytic Phase II	70.40	1,513,171.73	106,527.29	49,087.78	545.42
Masonry Heater	74.50	138,180.90	10,294.48	4,743.70	52.71
Pellet	19.70	713,182.92	14,049.70	6,474.10	71.93
Total		**9,027,462.18**	**907,561.72**	**418,204.44**	**4,646.71**

[a] Winter emissions were calculated by multiplying mton CO in MA by the % winter HDD (0.4608).

3.2 ONROAD MOBILE EXHAUST

On August 17, 2007, the EPA approved the Montana SIP revisions to redesignate the Missoula, Montana carbon monoxide "moderate" nonattainment status to attainment for the 8-hour CO National Ambient Air Quality Standard (NAAQS); the associated 2000 attainment emission inventory was also approved. At the same time, the EPA approved the first of two Missoula 10-year full maintenance plans to maintain the NAAQS which included the transportation conformity motor vehicle emission budgets (MVEB) for 2000, 2010, and 2020. Lastly, the EPA also approved the periodic CO E.I.s for 1993 and 1996 (72 FR 159 46158 – 461661). All of these early emission inventories used an EPA on-road mobile emissions model called MOBILE: MOBILE5a for the 1993 and 1996 E.I.s (58 FR 7780 - 7781; February 9, 1993), and MOBILE6.2 for the 2000 E.I. (69 FR 97 28830 – 28832; May 19, 2004).

The current EPA on-road mobile emissions model is called MOVES, Motor Vehicle Emission Simulator. The latest MOVES version is MOVES2014 which was officially released on October 7, 2014 (79 FR 194 60343 - 60347). Earlier MOVES versions included MOVES2010, MOVES2010a

and MOVES2010b; these version were released in March 2, 2010 (75 FR 40 9411 – 9414), August 2010 (EPA-420-F-10-050), and April 2012 (EPA-420-B-12-001b), respectively. In February 2015, the Missoula City-County Health Department requested the Department of Environmental Quality, Air Quality Bureau (Department), to develop the on-road mobile emissions for the second 10-year CO maintenance area emission inventory. To determine these emissions, the latest EPA mobile emissions model, MOVES2014 (October 2014 release) was used for the 2010 base year. The MOVES2014 on-road mobile emissions model and relevant information are located on the EPA website: http://www.epa.gov/otaq/models/moves/index.htm. The following EPA documents were used as guidance:

- *MOVES2014 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity* (http://www.epa.gov/otaq/models/moves/index.htm#sip).
- *Motor Vehicle Emission Simulator (MOVES): User Guide for MOVES2014* (http://www.epa.gov/otaq/models/moves/).

The primary source of the associated 2010 Microsoft Office Excel spreadsheets for MOVES2014 input was provided by the Planning Section of the Missoula Development Services Transportation Division (Missoula Planners). The Missoula Planners developed the inputs explicitly for the Missoula CO Maintenance Area for the year 2010 for the *2012 Missoula Long Range Transportation Plan Update* (Missoula LRTP) for Missoula (12). In some cases, the MOVES2014 defaults were used as recommended by the MOVES2014 technical document.

The exhaust emission factors for CO in the MA were calculated using MOVES2014 by the Montana Department of Environmental Quality. The contact person for the MOVES2014 emission estimates is Cyra Cain (406-444-3490).

3.2.1 MOVES2014 Inputs

Through an interagency consultation process, the required MOVES inputs reflecting local existing conditions were established. These inputs are summarized below. A sample of the run specification file for the 2010 CO analysis is contained in Appendix D.

The individual MOVES2014 model inputs for the Missoula CO Maintenance Area are addressed in the following main sections: the navigation panel and the County Data Manager (CDM); the CDM allows a user to import county-specific data.

MOVES NAVIGATION PANEL:
Model: Onroad.

Scale: County.

Calculation Type: Inventory.

Time Span: Time Aggregation Level = Hour; Year = 2010; Months = January; Days = Weekdays; Hours = All hours.

In Montana, the highest CO concentrations occur weekday along roadways from on-road vehicle exhaust emissions during the wintertime under stagnant atmospheric and cold temperature conditions.
Geographic Bounds: Montana, Missoula (County).

Vehicle Equipment, On Road Vehicles: Fuels = Diesel, Gasoline, and Ethanol; Source Use Types = All vehicles types and fuel types combinations with exceptions. The following vehicle and fuel types are not in the MOVES2014 database and therefore, these vehicles were unselected: Motorcycle, Diesel; Combination Long-Haul Truck, Gasoline; Intercity Bus, Gasoline; Combination Long-Haul Truck, Ethanol; Combination Short-Haul Truck, Ethanol; Intercity Bus, Ethanol; Motorhome, Ethanol; Motorcycle, Ethanol; Refuse Truck, Ethanol; School Bus, Ethanol; Single Long-Haul Truck, Ethanol; Single Short-Haul Truck, Ethanol; and Transit Bus, Ethanol. The public transit buses in the Missoula area do not use compressed natural gas (CNG) as fuel due to the extra expense of the bus modifications and fuel storage tanks which was considered economically unviable. The MOVES model always assumes there are CNG buses in the vehicle fleet so the Alternative Fuels & Technology (AVFT) table was modified as discussed in the fuels input file section.

Road Type: Road types: All: (1) Off-Network to account for start and idling emissions, (2) Rural Restricted Access, (3) Rural Unrestricted Access, (4) Urban Restricted Access or interstate, and (5) Urban Unrestricted Access. Restricted roads have limited access and unrestricted can represent arterials, collectors, and/or local roads.

Pollutants and Processes: CO

- Start Exhaust (MOVES process ID 2 for MOVES Road Type 1)
- Crankcase Start Exhaust (MOVES process ID 16 for MOVES Road Type 1)
- Crankcase Extended Idling (MOVES process ID 17 for MOVES Road Type 1)
- Extended Idling (MOVES process ID 90 for MOVES Road Type 1)
- Auxiliary Power Exhaust (MOVES process ID 91 for MOVES Road Type 1)
- Running Exhaust (MOVES process ID 1 for MOVES Road Types 2 - 5)
- Crankcase Running Exhaust (MOVES process ID 15 for MOVES Road Types 2 - 5)

Manage Input Data Sets: NONE; the County Data Manager was used.

Strategies: NONE; currently, the state does not have a retrofit emissions control equipment program and rate of progress only applies to SIP analysis for certain ozone nonattainment areas.

Output: General Output: Mass Unit = Grams; Distance = Miles. Activity = Distance Travelled, Population. Output Emission Detail: Hour, County; for All Equipment/Fuel Categories = Emission Process; On Road = Road Type.

Advanced Performance Features: NONE; not required for SIP or regional transportation conformity and is used for long model runs times.

MOVES COUNTY DATA MANAGER (CDM):
Age Distribution and Source Type Population: The Missoula Planners developed these MOVES inputs using the 2011 Missoula County vehicle registration data; MDEQ assumed that the county registration year 2011 was identical to the 2010 registration year. Two common vehicle types existed between the county data and MOVES source types: motorcycle and passenger car. In the county registration database, four different weights were recorded: Gross Vehicle Weight (GVW), Gross Curb Weight, Vehicle Weight, and Declared Gross Vehicle Weight. Only certain groups of weight data were available for different vehicles. The Missoula Planners developed each registration dataset into the MOBILE6 16 vehicle classes based on maximum of available weights then further divided the data into 28 vehicle categories based on maximum available weight and fuel type. Finally, the dataset was further delineated into the 25 model year (MY) MOBILE6 age categories. The vehicles 1986 MY and older vehicles were classified as group 24, then sequentially to group 0 (newest) which contained the 2010 and 2011 MY vehicles. Using an EPA worksheet tool, the 25 MOBILE6 age distribution dataset was converted into the MOVES 31 MY age categories and 13 vehicle types. The worksheet tool, RegistrationDistributionConverter_Veh16, was obtained from the following EPA MOVES tools website: http://www.epa.gov/otaq/models/moves/tools.htm#mobile6inputs.

Although there were more age classes in the MOVES age distribution profile, the oldest 3 to 4 age classes (28 through 30) were generally represented by zeros (0) from the normalization of the data in the previous MY classes. In addition, the previous MOVES model registration vehicle classes divided the light-duty vehicles into two classes: passenger cars (ID = 20) and 2-axle, 4-tire trucks (ID = 30). MOVES2014 combines these categories into a single light-duty category (ID = 25). MDEQ modified the Missoula Planners MOVES2010a input file to reflect this change. The data was also modified in another manner. The MOVES defaults age distributions were applied for the single unit and combination long-haul trucks (MOVES source IDs 53 and 61) as recommended by EPA (Chris Dresser, personal communications, June 15, 2015); these age distributions were found on the MOVES tools page and incorporated into this MOVES2014 input file.

Average Speed Distribution (speed distribution by road type, hour, and vehicle type): The Missoula Planners used a county travel model, TransCad™ version 4.5, to develop the total vehicle hours travel (VHT) data. The TransCad™ transportation planning software was developed by Caliper, Inc. The distribution of VHT by speed, time of day, and roadway classification were determined by the model whereas the distribution of the vehicle type was assumed to be uniform for all vehicle types. For these variables, the Missoula Planners MOVES2010a input file was used.

Fuel Supply, Formulation, Usage Fraction, and AVFT: Urban Missoula has a wintertime oxygenated fuel program required for the Missoula CO Maintenance Area (6); oxygenated fuel

is sold in Missoula from November 1 through February 28, so ethanol was the dominate fuel type for the vehicles using gasoline since modeling was conducted to represent a January weekday. With USEPA assistance, the model inputs for the fuel supply and usage fractions are noted in Tables 3.2.1-1 and 3.2.1-2; the fuel formulations are listed in Appendix C.

Table 3.2.1-1 Missoula maintenance area fuel supply

Fuel region ID	Fuel year ID	Month group ID	Fuel formulation ID	Fuel type	Market share[a]	Market share CV[b]
500000000[c]	2010	1[d]	2617	Gasoline (E-0)	0	0.5
500000000	2010	1	2619	Gasoline (E-10)	1	0.5
500000000	2010	1	25001	Diesel	1	0.5
500000000	2010	1	27001	E-85	1	0.5
500000000	2010	1	28001	Compressed Natural Gas	1	0.5

[a] Market Share is the fraction of each fuel formulation volume consumed in the area.
[b] CV = coefficient of variation of the market share. This would be used if uncertainty calculations were enabled; a value is not required for MOVES and may be left blank.
[c] Rocky Mountain region.
[d] 1 = January

Table 3.2.1-2 Missoula CO maintenance area fuel usage

County ID	Fuel year ID	Source bin fuel type ID	Fuel supply fuel type ID	Fuel type	Usage fraction
30063[a]	2010	1	1	Gasoline	1
30063	2010	2	2	Diesel	1
30063	2010	3	3	Compressed Natural Gas	1
30063	2010	4	4	Liquid Propane Gas	1
30063	2010	5	1	E-85	0.987697
30063	2010	5	5	E-85	0.012303
30063	2010	9	9	Electricity	1

[a] State (30) and Missoula County codes (063).

As discussed previously, the public transit buses in the Missoula area do not use CNG as fuel. The applicability of CNG was evaluated but due to the extra expense of the bus modifications and fuel storage tanks, it was considered economically unviable. As noted previously, the MOVES model assumes there are CNG buses in the fleet unless the AVFT table in the fuels input file is manually changed. The Department modified this file by setting this fuel usage to zero (0) in the transit bus source type and redistributing its original fuel fraction usage to the other fuel types (gasoline and diesel) proportionally so the total fuel faction equaled to one (1).

Meteorological Inputs: Ambient air temperature and relative humidity data were required for MOVES input. The daily minimum (25.1 degrees Fahrenheit, ° F) and maximum ambient (44.3°

F) temperature data from the Missoula International Airport National Weather Station for the month of January 2010 was obtained from the following website: http://cdo.ncdc.noaa.gov/qclcd/QCLCD. The EPA tool Meteorological Data Converter Mobile6 spreadsheet was obtained from the tool website which developed the MOVES2014 meteorological data for a 24-hour period. The relative humidity profile was set arbitrarily to 50% since the indirect effects through air conditioning adjustment on the CO emissions estimated by MOVES are unaffected at temperatures less than or equal to 75° F (http://www.epa.gov/ttnchie1/conference/ei19/session6/choi.pdf).

Ramp Fraction: The MOVES model ramp default is 8% on the urban restricted (interstate) road vehicle hours traveled. However, transportation modeling conducted for the Missoula LRTP document had various vehicle hours traveled data for ramps for the year 2010. The most conservative (highest) was for the Missoula Metropolitan Organization study area which was 2.55%. Assuming this percentage was representative for the Missoula CO Maintenance Area for the same year, a 3% ramp fraction was applied in the MOVES modeling.

Road Type Distribution: This variable pertains to the fraction of source (vehicle) type vehicle miles traveled (VMT) on different road types. The Missoula Planners developed this information which was used as input into MOVES.

Source (Vehicle) Type Distribution: The Missoula Planners MOVES2010a input file was used.

Starts: No local data were available; the MOVES2014 default file was used.

Vehicle Type VMT (HPMSVTypeYear, monthVMTFraction, dayVMTFraction, and hourVMTFraction): These parameters describe how much a vehicle type travels on public roads. The MOVES AADVMT (annual average daily vehicle miles traveled) converter tool on the EPA tool website was used with the daily HPMS VMT by vehicle type; the Missoula Planners developed the 2010 base year data (annual VMT by vehicle type). Without additional information, MDEQ divided these values by 365 to derive the daily data. Additional input for this converter tool were: average day, no specific month, use MOVES monthly and weekend-day default adjustment factors, and rural county. This tool then calculated the annual, month, day, and hour VMT by the 5 HPMS vehicle types required for input. Using this converter also eliminated any post-processing steps (Chris Dresser, EPA, personal communications, June 15, 2015).

Hotelling: The MOVES2014 defaults were used.

I/M Programs (IMCoverage): NONE; a state vehicle Inspection and Maintenance (I/M) program has never existed in the state.

Retrofit Data: The state does not have a retrofit program and since the MOVES2014 model database does not contain any national default data for this variable, none was applied.

3.2.2 Onroad Mobile Exhaust Results

The MOVES2014 modeling results for the Missoula CO Maintenance Area are listed in Table 3.2.2 and the corresponding MOVES2014 run specification file is listed in Appendix D.

Table 3.2.2 2010 Missoula CO maintenance area MOVES2014 modeling results

Road type	MOVES road type	MOVES process	Description	CO (kg per wintertime weekday)
Off-Network	1	2	Start exhaust	17,891.72
		16	Crankcase Start	12.20
		17	Crankcase Extended Idle Exhaust	0.13
		90	Extended Idle Exhaust	14.61
		91	Auxiliary Power exhaust	0.08
Rural Interstate	2	1	Running Exhaust	525.62
		15	Running Crankcase Start	0.70
Rural Arterial, Collector, and Local	3	1	Running Exhaust	1,044.09
		15	Running Crankcase Start	1.41
Urban Interstate	4	1	Running Exhaust	796.34
		15	Running Crankcase Start	1.08
Urban Arterial, Collector, and Local	5	1	Running Exhaust	7,108.06
		15	Running Crankcase Start	10.09
Total				**27,406.13**

3.3 NATURAL GAS COMBUSTION

Natural gas was used to heat residential and commercial buildings in Missoula during 2010. The NorthWestern Energy Corporation (NorthWestern) is the only natural gas distributor in the CO MA. NorthWestern personnel identified the amount of natural gas usage within the Missoula City limits for January, February and December 2010. This data was used to calculate daily winter consumption of natural gas usages in the E.I. area.

3.3.1 Emission Factors

The CO emission factors for natural gas were obtained from AP-42, which listed 40 lb/(10^6 scf) (lb = pounds; scf = standard cubic feet) for residential consumption and 84 lb/(10^6 scf) for commercial/industrial boilers (13). The commercial/industrial emission factor was used for the "transportation" class of natural gas users provided by Northwestern Energy, because the users include large facilities such as the University of Montana and St. Patrick's Hospital. The data from NorthWestern was given in decatherms, which was equivalent to one million British Thermal Units (BTU). Therefore, the natural gas consumption data were converted to the

emission factor units (scf) by dividing by 1,000. Finally, another conversion factor (0.4536 lb/kg) was used with the emission factors to obtain the desired reporting units (kg CO).

3.3.2 Source Activity Levels

NorthWestern provided the amount of natural gas used by residential and commercial customers inside Missoula City limits for each winter month of 2010. Data for the city of Missoula were used to calculate emissions because natural gas consumption data specifically for the MA were unavailable. In addition, the MA overlaps extensively with the city of Missoula.

3.3.3 Temporal Apportionment

CO emissions for a winter day were calculated by dividing the total winter emissions by 90 days.

Table 3.3.3. Winter natural gas combustion CO emissions

Utility	Winter natural gas usage (10^6 scf)	Winter natural gas CO emissions (kg CO)	Winter day CO emissions from natural gas combustion (kg CO/day)
Residential	1,053.53	19,114.82	212.39
Commercial	593.52	22,613.97	251.27
Industrial	5.82	221.91	2.47
Transportation	515.27	19,632.72	218.14
Total	**2,168.14**	**61,583.42**	**684.27**

3.4 NONROAD GASOLINE AND DIESEL EXHAUST

Nonroad mobile sources include off-highway vehicles and engines that move or are moved within a 12-month period (14). Nonroad mobile sources are vehicles and engines that fall under the following categories:

- Agricultural equipment, such as tractors, combines and balers;
- Airport ground support equipment, such as baggage tugs and terminal tractors;
- Commercial equipment, such as generators and pumps;
- Industrial equipment, such as forklifts and sweepers;
- Construction and mining equipment, such as graders, back hoes and trenchers;
- Lawn and garden equipment, such as leaf blowers and lawn mowers;
- Logging equipment;
- Recreational marine, such as power boats and personal watercraft;
- Railway maintenance equipment, such as rail straighteners;
- Recreational equipment, such as all-terrain vehicles and off-road motorcycles;
- Underground mining and oil field equipment; and
- Aircraft, such as jet and piston engines

The MDEQ Air Quality Bureau applied the EPA NONROAD version 2008a model to determine the 2010 wintertime weekday 24-hour CO emissions in Missoula County from five nonroad mobile source categories: Commercial, Construction, Industrial, Lawn and Garden (residential and commercial), and Railroad Maintenance. The months composing the 2010 winter season were January, February, and December.

Seven equipment classes were not included in this inventory:

Commercial Marine:	There were no water bodies within the emission inventory area in 2010.
Recreational Marine:	There were no water bodies within the emission inventory area in 2010.
Agriculture:	There were no agricultural areas within the emission inventory area in 2010.
Airport Service:	There were no airports within the emission inventory area in 2010.
Logging:	There were no logging areas within the emission inventory area in 2010.
Recreational:	There were no snowmobile or all-terrain vehicle (ATV) trails within the emission inventory area in 2010 and golf carts would see limited use in the winter months.
Mining:	There were no underground mines or oil fields within the emission inventory area in 2010.

The emissions model required the following fuel inputs: Reid Vapor Pressure (RVP), oxygen weight percentage, gas and diesel sulfur content percentages, ethanol blend market share, and ethanol volume percentage. The fuel RVP, oxygen weight percentage, and ethanol market share and volume percentage model inputs were obtained from the mobile emissions model inputs for the *2012 Missoula Long Range Transportation Plan* (12). The MDEQ gathered the sulfur percentages in the gas and diesel internally (Howard Haines, Montana Department of Environmental Quality, personal communications, February 19, 2014). Another fuel composition variable, the CNG/LPG sulfur percentage, was required and the default NONROAD percentage was used.

Ambient temperatures were also required: the minimum, maximum, and average. From the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center, website, 2010 January, February, and December ambient temperature data collected at the Missoula International Airport were downloaded (http://cdo.ncdc.noaa.gov/qclcd/QCLCD?prior=N). The weekend data were eliminated to calculate the wintertime weekday minimum, maximum, and average ambient temperatures. The resulting model inputs for all of these variables were as follows:

Fuel RVP for gas: 12.5
Oxygen Weight %: 3.4
Gas sulfur %: 0.003
Diesel sulfur %: 0.0015

Marine Diesel (Dsl) sulfur %: 0.0435 (Not used; default)
CNG/LPG sulfur % : 0.003 (default)
Minimum temp. (F): 20.19
Maximum temp. (F): 34.23
Average temp. (F): 27.49
Ethanol (EtOH) Blend % Mkt: 99.94
EtOH Vol %: 10.0

The model calculated the 2010 Missoula County CO emissions for each emitting equipment within each source category in tons per wintertime weekday then the emissions were converted into kilograms of CO per day in various Excel workbooks.

Spatial allocation factors were developed (based on EPA guidance documents) to apportion nonroad emissions to the CO maintenance area. The approaches used are described in each section of this chapter. In many cases, zip code data were obtained from the 2010 Zip Codes Business Patterns (15). Zip codes 59801, 59802, 59804 and 59808 were chosen for analysis as representative of the CO MA. These zip codes exceed the MA in area, and as a result, CO emissions from these data provided a conservative estimate of MA CO emissions.

3.4.1 Commercial Equipment

Winter weekday emissions from commercial equipment in Missoula County were calculated using EPA's NONROAD model, as described in Section 3.4. Winter weekday emissions for the CO maintenance area for this category were derived by applying the ratio of wholesale trade establishments (16) in nonattainment area zip codes (59801, 59802, 59804 and 59808) (15) to Missoula County-level totals from the 2010 U.S. Census Business Patterns for Missoula County (17).

CO MA emissions from commercial equipment	=	Total Missoula County CO emissions from commercial equipment	x	Wholesale establishments allocation factor
	=	3,333.72 kg CO/day	x	86.29%
	=	2,876.67 kg CO/day		

Table 3.4.1 Typical winter day CO emissions (kg/day) from commercial equipment usage

Area	CO (kg/day)
Missoula County	3,333.72
Missoula CO MA	2,876.67

3.4.2 Construction Equipment

Winter weekday emissions from construction equipment in Missoula County were calculated using EPA's NONROAD model as described in Section 3.4. Winter weekday emissions for the CO

maintenance area for this category were derived by applying the ratio of construction employment in the maintenance area zip codes to Missoula County-level totals (17) as a conservative estimate, as the Emission Inventory Improvement Program (EIIP)-recommended allocation factor of total dollar value of construction was unavailable (16). The Zip Code Business Patterns database provided the number of industry establishments by employment-size class in 2010. To estimate the number of construction employees in a zip code, the number of establishments in an employment-size class was multiplied by the median of the size class. The results for each size class were then added together to estimate the total number of employees.

For example, in zip code 59801 there 106 construction establishments in 2010.

Table 3.4.2-1. Number of construction establishments in zip code 59801 by employment-size class

Industry	Number of Establishments by Employment-size class								
	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	1000 or more
Construction	71	25	8	1	1	0	0	0	0

Estimated Zip 59801 Construction employees = (71x2.5)+(25x7)+(8x14.5)+(1x34.5)+(1x74.5)
= 577.5

Table 3.4.2-2 Typical winter day CO emissions (kg/day) from construction equipment usage

Area	CO (kg/day)
Missoula County	428.88
Missoula CO MA	401.17

3.4.3 Industrial Equipment

Winter weekday emissions from industrial equipment in Missoula County were calculated using EPA's NONROAD model, as described in Section 3.4. Winter weekday emissions for the CO maintenance area for this category were derived by applying the ratio of manufacturing employment in the maintenance area to Missoula County-level totals as recommended by EIIP guidance (16). Manufacturing data for Missoula County were obtained from the County Business Patterns database (17). The Zip Codes Business Patterns database (15) was used to determine MA-level manufacturing employment data, using methods described in section 3.4.2.

Table 3.4.3 Typical winter day CO emissions (kg/day) from industrial equipment usage

Area	CO (kg/day)
Missoula County	415.59
Missoula CO MA	370.83

3.4.4 Lawn and Garden Equipment

Winter weekday emissions from lawn and garden equipment in Missoula County were calculated using EPA's NONROAD model, as described in Section 3.4. Because this emission inventory is for a winter day in a largely urban area, only emissions from snow blowers and chain saws (for cutting firewood) were evaluated. Lawn and Garden emissions were calculated on both the commercial and residential scales.

EIIP guidance recommends using landscaping employee data to allocate commercial lawn and garden emissions (16). However, the employment data for landscape employees derived by the zip-code method (previously described) exceeded the number of landscape employees in Missoula County. Therefore, maintenance area commercial lawn and garden equipment emissions were derived by applying the ratio of the population in the maintenance area to Missoula County-level totals. Missoula City population data were used as a surrogate for the MA population because MA population data were unavailable and the MA closely resembles the Missoula City limits. Population data for the City and County were obtained from the 2010 U.S. Census (4).

Table 3.4.4-1 Typical winter day CO emissions (kg/day) from commercial lawn and garden equipment usage

Area	CO (kg/day)
Missoula County	375.64
Missoula CO MA	229.55

Housing unit data were used to determine residential winter weekday lawn and garden CO emissions as recommended by EIIP guidance (16).

Table 3.4.4-2 Typical winter day CO emissions (kg/day) from residential lawn and garden equipment usage

Area	CO (kg/day)
Missoula County	364.83
Missoula CO MA	297.96

3.4.5 Railway Maintenance Equipment

Winter weekday emissions from railway maintenance equipment in Missoula County were calculated using EPA's NONROAD model, as described in Section 3.4. Winter weekday emissions for the CO maintenance area for this category were derived by applying the ratio of population in the maintenance area to Missoula County-level totals, as locomotive NOx emissions data recommended by EIIP guidance (16) were unavailable. Missoula City population data were used as a surrogate for the MA population because MA population data were unavailable and the MA closely resembles the Missoula City limits.

Table 3.4.5 Typical winter day CO emissions (kg/day) from railway maintenance equipment usage

Area	CO (kg/day)
Missoula County	47.91
Missoula CO MA	29.28

3.5 RAILROAD LOCOMOTIVE EXHAUST

The Missoula CO MA includes a railyard, a stretch of East-West railroad that sees significant traffic, and an infrequently used North-South railroad. In 2010, the Burlington Northern and Santa Fe Railway Company (BNSF) generated the primary rail activity in the Missoula CO MA. However, the Montana Rail Link (MRL) managed all of the trains, including those operating under the BNSF through contract agreements. Two locomotive activities occurred in the Missoula CO MA: line haul and yard (or switch). These locomotive activities fall under the nonroad mobile area source category, but the emissions were not calculated using the modeling discussed in Section 3.4.

3.5.1 CO Emissions

In the 2000 Missoula CO E.I., railroad locomotive exhaust for line haul and yard locomotives contributed 26.34 kg CO/day to the CO MA (2). The 2000 CO E.I. included railroad transportation growth factors through 2010 (Table 3.5.1-1).

Table 3.5.1-1 Montana railroad transportation growth factors: 1999-2010

Year	Montana railroad transportation growth factors
1999	1.199
2000	1.249
2002	1.322
2005	1.433
2007	1.500
2008	1.533
2010	1.600

These growth factors were applied to the 2000 railroad locomotive exhaust CO emissions to determine 2010 CO emissions from locomotive exhaust. To determine the growth of the CO emissions from the 2000 base year, the following equation was applied.

$$GAF_{2010}=(GF_{2010})/(GF_{2000})$$

GAF_{2010}	=	Growth Adjustment Factor for Year 2010
GF_{2010}	=	Growth Factor for Year 2010
GF_{2000}	=	Growth Factor for Base Year 2000

The resulting GAF_{2010} was multiplied by the 2000 CO season day emissions for railroad locomotive activity within the Missoula CO MA to derive the projected emissions for 2010.

Table 3.5.1-2 Typical winter day CO emissions (kg/day) from railroad locomotive exhaust

Category	Typical winter day (kg CO)
Locomotive emissions	**33.74**

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Appendix A: Map of Missoula CO Maintenance Area

Appendix B: Map of Missoula City Limits

Appendix C: MOVES2014 Fuel Formulation for the Missoula CO Maintenance Area

Appendix D: MOVES2014 CO Maintenance Area Run Specification File

Appendix E: Quality Assurance Plan for the 2010 Carbon Monoxide Emission Inventory in support of Missoula County's 2nd 10-year Limited Maintenance Plan for the Carbon Monoxide Maintenance Area.

Appendix F: Data and Supporting Documents