SECTION 3

EMISSIONS INVENTORY

3.0 EMISSIONS INVENTORY

The Emissions Inventory Section covers the PM-10 emission estimates for residential wood combustion (RWC), resuspended road dirt and cinders, mobile source tail pipe emissions and point sources. The methodology and data used to determine emissions is discussed for each source type. Because Mammoth Lakes exceeds the 24-hour PM-10 Standard, the emissions inventory is estimated for a peak 24-hour period. The estimates will consider the large influx of visitors to Mammoth Lakes during the winter ski season.

3.1 Woodstoves and Fireplaces

Emission rates for wood stoves and fireplaces are based on the type of wood burner, the type of wood burned and the usage rate. The usage rate was based on the different burning habits of 1) condominium residents, 2) permanent residents in single family homes and 3) permanent residents in apartments and mobile homes. An estimate for the annual and 24-hour PM-10 emissions is calculated for wood burning. The annual emissions estimates, which are based on survey data, provide good information to improve the estimate for the peak 24-hour period.

3.1.1 Number of Woodstoves and Fireplaces

The numbers of wood stoves and fireplaces is based on the numbers of condominiums, single family homes, apartments and mobile homes, and the estimated number of wood stoves and fireplaces in each type of housing. Table 3.1 shows the estimated number of wood burning units from surveys for each housing type in the planning area.

3.1.2 Wood Stove and Fireplace Usage

The amount of wood burned is based on two surveys conducted during the winter of 1987-88. One survey was sent to all the condominium managers while the other went to 250 of the 2500 post office boxes in Mammoth Lakes. From the surveys that were sent out 35% of the condominium surveys and 40% of the post office box surveys were returned. Table 3.2 summarizes the average amount of wood burned during the winter heating season in homes that have a wood burning device.

TABLE 3.1

WOOD STOVE AND FIREPLACE COUNT

	Condos	Single Fam. Residents	Mobile Homes & Apartments	Total
Fireplaces	2,941	324	0	3,265
Wood Stoves	1,470	971	240	2,681

TABLE 3.2

AMOUNT OF WOOD BURNED IN HOMES WITH WOODSTOVES OR FIREPLACES (Survey taken Winter 1987-88)

Wood Burning Device	Condos Cords	Condos (%)	Sgl. Fam. Residents Cords	Sgl. Fam. Residents (%)	Mbl. Home & Apts. Cords	Mbl. Home & Apts. (%)
Fireplace	1.25	64%	0.8	18%		
Wood Stoves						
Conventional	1.25	12%	4.3	79%	2.5	100%
Certified			2.5	5%		
FP Insert	1.26	24%	5.3	5%		

Percentage of survey respondents for single family residents is greater than 100%. This accounts for both fireplaces and wood stoves in some homes.

3.1.3 Annual PM-10 Emission Estimates for RWC Devices

The emission estimates for RWC devices are based on the Environmental Protection Agency's emission factors (U.S. EPA, Compilation of Air Pollution Emission Factors, AP-42, 1985). These

emission factors are based on in-situ tests of the wood burning devices. The emission factors are given as grams of PM-10 per kilogram of dry wood burned. The emission factors are shown in Table 3.3. This table also summarizes the total emissions for each RWC device and housing type. Emissions for each RWC device are calculated using the following equation:

$$\text{PM-10 emissions/device} = \text{Mass}_{wood} \times \text{e.f.}$$

$$\text{Mass}_{wood} = (\#\ \text{cords} \times 800\ \text{kg/cord}),\ \text{Jeffrey \& Pinion Pine}$$

e.f. = 8.1 g/kg, certified wood stoves
= 14.0 g/kg, fireplaces
= 15.0 g/kg, conventional wood stoves & fireplace inserts

The cord density (800 kg/cord) is assumed for Ponderosa Pine which has a weight density of 10 kg/ft^3 and a cord is approximately 80 ft^3 of wood per cord (Davis & Read, Guidance Document for Residential Wood Combustion Emission Control Measures, 1989). Based on available data, this is the best approximation for the Jeffrey and Pinon Pine that is primarily burned in Mammoth Lakes. The total number of fireplaces is taken from Table 3.1. The total number of wood stoves is also taken from Table 3.1, but this category is further broken down into conventional, certified and fireplace inserts according to the proportions from the survey shown in Table 3.2.

Table 3.3 shows a summary of the calculations for the Annual PM-10 emissions from RWC devices.

TABLE 3.3

ANNUAL PM-10 EMISSION ESTIMATES FOR RESIDENTIAL WOOD COMBUSTION

Wood Burning Device	Emission Factor (g/kg)	Condos Cords	Condos Units	Condos PM-10 (Mg)	Single Family Res. Cords	Single Family Res. Units	Single Family Res. PM-10 (Mg)	Motel, Hotel & Lodge Cords	Motel, Hotel & Lodge Units	Motel, Hotel & Lodge PM-10 (Mg)	Total Emissions (Mg)
Fireplace	14.0	1.25	2,941	41.2	0.8	324	3.0	---	---	---	44.2
Wood Stoves											
Conventional	15.0	1.25	490	7.4	4.3	861	44.4	2.5	240	7.2	59.0
Certified	8.1	---	---	---	2.5	55	0.9	---	---	---	0.9
FP Insert	15.0	1.25	980	14.7	5.3	55	3.5	---	---	---	18.2
				63.3			51.8			7.2	122.3

The annual emission estimate for PM-10 of 125,800 kg (139 tons) is based on well researched data and provides a good basis for comparison with a peak 24-hour emission estimate. The 24-hour emission estimate is critical since wood burning is a significant contributor to the 24-hour PM-10 standard exceedances.

3.1.4 <u>24-hour PM-10 Emissions Estimate for RWC Devices</u>

To estimate the peak 24-hour emission inventory for wood burning, it is assumed that all RWC devices are operating and burn an average of 2.4 cubic feet (or 24 kg) of wood. The amount of wood burned is based on information provided through the woodburning surveys. Table 3.4 shows a summary of the estimates for the PM-10 emissions from each type of wood burning device and from different housing types. With these assumptions, it is estimated that RWC devices contribute about 1,839 kg (2.03 tons) of PM-10 during a peak wood burning day.

TABLE 3.4

PEAK 24-HOUR PM-10 EMISSION ESTIMATE FOR RESIDENTIAL WOOD COMBUSTION

RWC Device	Emission Factor g/kg	Condos Wood kg/d	Condos Units	Condos PM-10 kg	Sgl. Family Res. Wood kg/d	Sgl. Family Res. Units	Sgl. Family Res. PM-10 kg	Mobile Homes & Apts Wood kg/d	Mobile Homes & Apts Units	Mobile Homes & Apts PM-10 kg	Total Emissions kg
Fireplace	14.0	19	2,941	782	22	324	100	—	—	—	882
Wood Stoves											
Conventional	15.0	[illegible]	[illegible]	141	33	861	426	19	240	68	635
Certified	9.0	—	—	—	18	55	9	—	—	—	9
FP Insert	15.0	19	980	279	41	55	34	—	—	—	313
				1,202			569			68	1,839

Assume the peak wood usage is [illegible] higher than the average wood usage rate, except for residential fireplaces which were assumed to be used on holidays and half of the weekends.

3.2 Road Cinders

The PM-10 emission estimate for resuspended road cinders is based on the AP-42 methodology for estimating reentrained road dust emissions from paved roads (U.S. EPA, Compilation of Air Pollution Emission Factors, AP-42, 1985).

$e = 2.28\ (sL/0.5)^{0.8}$ (grams/VKT)

s = silt content (fraction of mass < 75 microns)
L = street loading (grams/m^2)
VKT = vehicle-kilometer traveled

Based upon the Town of Mammoth Lake General Plan and a Caltrans study of road cinders used in Mammoth Lakes the following information is used for the PM-10 emission estimate (Town of Mammoth Lakes General Plan, 1987; Kemp, Comparative Study of Sand Vs. Cinders, 1986):

- Peak Holiday traffic = 66,300 Vehicle-miles-traveled (VMT)
- Unit Weight of Cinders , loose = 68 lbs/cubic foot
- Silt Content (< 200 mesh or 75 microns) = 0.02 before use, 0.08 after use on roads

Assumption: Cinders of average height of 1/16" (1.6 mm) are spread evenly on the road and they cover 1/4th of the surface area.

Silt Loading

Volume of cinders spread on road = (0.0016 m)(m^2)/4 m^2
= 0.0004 m^3/m^2

Street Loading Mass = 0.0004 m^3/m^2 x 68 lb/ft^3 x 454 g/lb x (3.28 ft/m)^3 = 436 g/m^2

Silt Loading Before Use (sL) = 436 g/m^2 x 0.02 = 8.7 g/m^2

The silt content of the cinders will increase as the traffic breaks-up the cinders, but the total mass loading will decrease as the cinders are resuspended and dispersed away from the road. Because of these offsetting effects on the silt loading (sL) value, the initial value of 8.7 g/m^2 is intuitively a good approximation to use for emission estimates.

Emission Calculation

emission = 2.28 ((silt content fraction * street loading)/0.5)$^{0.8}$
e = 2.28 (8.7/0.5)$^{0.8}$ = 22.4 g/VKT

VKT = 66,300 VMT x 1.61 km/mile = 106,700 VKT/day

PM-10 = 22.4 g/VKT x 106,700 VKT/day = 2,390 kg/day

Peak 24-hour PM-10 emission estimate for road cinders = 2,390 kg

3.3 Vehicle Tail Pipe & Tire-wear Emissions

PM-10 emissions from motor vehicle exhaust and tire-wear were determined by the California Air Resources Board (CARB) for Mono County (CARB, Predicted California Vehicle Emissions, 1988). CARB's estimates were adjusted using traffic counts in Mammoth Lakes to determine the peak 24-hour emissions from gas and diesel powered vehicles.

CARB's estimated average daily PM-10 emissions for gas and diesel powered vehicles for the entire Mono County is:

Light Duty Passenger	0.13 T/D	522,000 VMT/D	5.0×10^{-4} lbs/VMT
Light Duty Trucks	0.07 T/D	287,000 VMT/D	4.9×10^{-4} lbs/VMT
Medium Duty Trucks	0.02 T/D	69,000 VMT/D	5.8×10^{-4} lbs/VMT
Heavy Duty Diesel	0.14 T/D	58,000 VMT/D	4.8×10^{-3} lbs/VMT
	0.36 T/D	936,000 VMT/D	

Assume the same vehicle mix in Mammoth Lakes with buses taking the place of diesel trucks and buses. This is very close since the average diesel truck and bus numbers for Mono County was 116 in 1987, that is about the same as the number of charter buses that come into Mammoth Lakes during a winter holiday. (Town of Mammoth Lakes General Plan, 1987)

VMT in Mammoth Lakes = 66,300 VMT/day (See Appendix E)

Light Duty Passenger	37,000 VMT/D	5.0×10^{-4} lbs/VMT	18.50 lbs/D
Light Duty Trucks	20,300 VMT/D	4.9×10^{-4} lbs/VMT	9.90 lbs/D
Medium Duty Trucks	4,900 VMT/D	5.8×10^{-4} lbs/VMT	2.84 lbs/D
Heavy Duty Diesel	4,100 VMT/D	4.8×10^{-3} lbs/VMT	19.80 lbs/D
	66,300 VMT/D		51.04 lbs/D

The assumptions used in this calculation yield a rough estimate for vehicle exhaust and tire-wear of 23 kg/day (51 lbs/day). It should be pointed out that diesel trucks and buses emit a large proportion of the vehicle emissions. Although a concentrated gathering of idling diesel vehicles may have a significant effect on air quality in the immediate area, the quantity of PM-10 is much less than the amount emitted by either road cinders or wood burning.

3.4 Industrial Point Sources

There are two industrial sources located in the Mammoth Lakes Planning area that emit PM-10; Hunewill Ready Mix (6.3 kg/day) and

Mammoth Hospital (1.1 kg/day). Peak 24-hour PM-10 emissions for industrial point sources in Mammoth Lakes is 7.4 kg/day (16.3 lbs/day).

3.5 Summary of PM-10 Emissions

Wood burning and resuspended road cinders comprise almost all of the PM-10 emissions during the winter. Motor vehicle exhaust, tire-wear and industrial sources contribute less than 1% to the area-wide inventory.

SOURCE	Peak 24-Hour PM-10 Emissions (kg/day)	
Fireplaces	882	(20.7%)
Wood Stoves	957	(22.5%)
Resuspended Road Dirt/Cinders	2,390	(56.1%)
Motor Vehicles	23	(0.5%)
Industrial Sources	7	(0.2%)
TOTAL	4,259 kg/day	