

APPENDIX I

**EFFECTIVENESS CALCULATIONS
FOR THE TOWN OF MAMMOTH LAKES
PARTICULATE EMISSIONS REGULATIONS**

- ADOPTED ORDINANCE -

**EFFECTIVENESS CALCULATIONS FOR THE
TOWN OF MAMMOTH LAKES
PARTICULATE EMISSIONS REGULATIONS**

Adopted November 7, 1990

The effect of the Particulate Emissions Regulations on the future ambient PM-10 concentrations for each section of the regulation was determined by following 3 steps;

Step 1 - Estimate the uncontrolled emissions from the affected sources for each year.

Step 2 - Estimate the controlled emissions from the affected sources for each year, and

Step 3 - Estimate the ambient PM-10 contribution resulting from the controlled emissions using the proportional roll-back method in Section 5.4. For all ambient contribution estimates in this appendix, the road dust and cinders dominated day is used for the C_{di} values.

$$C_T = \Sigma C_i + C_b = \Sigma [C_{di} (E_i/E_{di})] + C_b$$

C_T = Total PM-10 Concentration
 C_b = Background PM-10 Concentration, $5 \mu\text{g}/\text{m}^3$
 C_i = PM-10 Concentration Due to the Source i
 C_{di} = Design Day Source Contribution for Source i
 E_i = PM-10 Emissions from Source i
 E_{di} = Peak PM-10 Emissions from Source i

To determine the ambient source contributions for either design day scenario, use the following emissions for E_{di} :

E_{di} = 882 kg/day for fireplaces
= 957 kg/day for wood stoves
= 2,390 kg/day for road dust & cinders
= 23 kg/day for vehicle tailpipes

For the Wood Burning Dominate Design Day use the source contributions estimated using the Chemical Mass Balance model in Section 4:

$$\begin{aligned}
C_{di} &= 94 \mu\text{g}/\text{m}^3 && \text{for fireplaces} \\
&= 101 \mu\text{g}/\text{m}^3 && \text{for wood stoves} \\
&= 5 \mu\text{g}/\text{m}^3 && \text{for road dust and cinders} \\
&= 5 \mu\text{g}/\text{m}^3 && \text{for vehicle tailpipes}
\end{aligned}$$

For the Road Dust and Cinders Dominated Design Day:

$$\begin{aligned}
C_{di} &= 54 \mu\text{g}/\text{m}^3 && \text{for fireplaces} \\
&= 58 \mu\text{g}/\text{m}^3 && \text{for wood stoves} \\
&= 93 \mu\text{g}/\text{m}^3 && \text{for road dust and cinders} \\
&= \text{negligible} && \text{for vehicle tailpipes}
\end{aligned}$$

Section 8.30.110, Road Dust Reduction Measures

Step 1 - Emissions Growth

Two emissions growth calculations will be determined; 1) for no controls, and 2) for VMT growth limited through the adoption of Control Measure number 2.

No Controls - Uncontrolled Growth

This growth estimate was calculated for Section 5.1 and displayed in Table 5.2. A summary of the VMT and emission estimates is shown below for an emission rate of 36.064 grams/VMT (22.4 grams/VKT) for road dust and cinders. The VMT projections can be found in Appendix E.

Example Calculation

$$\begin{aligned}
\text{Emissions} &= \text{VMT/day} \times 36.064 \text{ grams/VMT} \times \text{kg}/1000 \text{ grams} \\
&= 82,403 \times 36.064 = 2,972 \text{ kg/day}
\end{aligned}$$

Road Dust & Cinders Emission Growth

No Controls - Uncontrolled Growth

<u>Year</u>	<u>VMT</u>	<u>Emissions (kg/day)</u>
1990	66,275	2,390
1993	82,403	2,972
1995	93,155	3,360
2000	120,035	4,329
2005	146,915	5,298

Future VMT is limited to 106,600 VMT. It is assumed that the peak VMT will be reached in 15 years. From section 3.2, the emissions factor for road dust and cinders is 36 grams/VMT and the 1990 peak VMT is 66,300. A straight line interpolation of the VMT from 1990 to 2005 will yield the following VMT's and emission estimates:

Road Dust & Cinders Emission Growth
VMT Growth Limited by Control
Measure 2 - Vehicle Traffic Reduction

<u>Year</u>	<u>VMT</u>	<u>Emissions (kg/day)</u>
1990	66,275	2,390
1993	74,339	2,681
1995	79,715	2,875
2000	93,155	3,360
2005	106,600	3,844

Step 2 - Controlled Emissions

Vacuum sweeping is credited with a 34% reduction in emissions from roadways. Using the emissions from Step 1 for the uncontrolled growth emissions and for the case with vehicle traffic reductions resulting from the adoption of control measure 2, the effect of street sweeping is shown below.

Example Calculation

$$\begin{aligned} \text{Controlled Emissions} &= \text{emissions (kg/day)} \times (1 - 0.34) \\ &= 2,972 \times (1 - 0.34) = 1,961.5 \text{ kg/day} \end{aligned}$$

<u>Year</u>	<u>Street Sweeping Only</u>		<u>Street Sweeping & Vehicle Traffic Reductions</u>	
	<u>Emissions (kg/day)</u>	<u>Controlled (kg/day)</u>	<u>Emissions (kg/day)</u>	<u>Controlled (kg/day)</u>
1990	2,390	1,577	2,390	1,577
1993	2,972	1,962	2,681	1,769
1995	3,360	2,218	2,875	1,898
2000	4,329	2,857	3,360	2,218
2005	5,298	3,497	3,844	2,537

Step 3 - Ambient PM-10 Contribution

The ambient contribution from road dust can be estimated from the roll-back equation for road dust dominated days,

$$\text{Ambient Contribution} = (93 \mu\text{g}/\text{m}^3) \times (\text{Ctrl Emissions}/2,390 \text{ kg/day})$$

For convenience the summary table for the ambient contributions is shown as a function of the VMT's. To perform the calculations the

controlled emissions from the previous table must be used. A summary of the VMT's and the ambient PM-10 contributions from roadway emissions are shown below for the uncontrolled contributions and the contributions with street sweeping alone and with vehicle traffic reductions.

Example Calculation

For street sweeping in 1993

$$\text{Ambient Concentration} = 93 \times (1,962/2,390) = 76.3 \mu\text{g}/\text{m}^3$$

Year	Uncontrolled		Controlled by Street Sweeping		Controlled by SS & VMT Reduction	
	VMT	($\mu\text{g}/\text{m}^3$)	VMT	($\mu\text{g}/\text{m}^3$)	VMT	($\mu\text{g}/\text{m}^3$)
1990	66,275	93	66,275	61.4	66,275	61.4
1993	82,403	115.6	82,403	76.3	74,339	68.8
1995	93,155	130.7	93,155	86.3	79,715	73.9
2000	120,035	168.5	120,035	111.2	93,155	86.3
2005	146,915	206.2	146,915	136.1	106,600	98.7

Section 8.30.100, POLLUTION REDUCTION EDUCATION PROGRAMS

There are no emission reductions associated with this measure. Although it is an essential part of the wood burning program there is no practical method to calculate the affect of the program on emission reductions.

Section 8.30.030, STANDARDS FOR REGULATION OF SOLID FUEL APPLIANCES

Section 8.30.050, REPLACEMENT OF NON-CERTIFIED APPLIANCES UPON SALE OF PROPERTY

IMPACT ON WOOD STOVES

Note: Fireplaces are also regulated under these sections, but will be treated separately to simplify calculations.

Step 1 - Emissions Growth

The uncontrolled emissions growth for emissions from wood stoves is based upon the present number of wood stoves, including fireplace inserts, and the growth rate of the number of residents

and visitors. This emission estimate must also consider that all new stoves that are installed in Mammoth Lakes must meet EPA's Phase I certification, and will meet Phase II certification after January 1, 1991.

The 1990 emission estimates for wood stoves which were discussed in Section 3 and summarized in Table 3.4 are shown below.

Example Calculation

$$\text{Emissions} = \text{emission factor (g/kg)} \times \text{wood usage (kg/day)} \times \text{\# units} \times \text{kg/1000 g}$$

$$= 15.0 \times 19 \times 490/1000 = 139.65 \text{ kg}$$

Wood Stove	Emission Factor g/kg	Condos			Sql. Family Res.			Mobile Homes & Apts			Total Emissions kg
		Wood kg/d	Units	PM-10 kg	Wood kg/d	Units	PM-10 kg	Wood kg/d	Units	PM-10 kg	
Conventional	15.0	19	490	140	33	861	426	19	240	68	635
Certified	9.0	--	--	--	19	55	9	--	--	--	9
FP Insert	15.0	19	980	279	41	55	34	--	--	--	313

The population projections in Table 5.1 for permanent residents and visitors are used to estimate the effect of growth on the number of wood stoves.

<u>Year</u>	<u>Permanent Residents</u>	<u>Skiers & Visitors</u>
1990	5,000	24,000
1993	5,680	27,280
1995	6,130	29,470
2000	7,270	34,930
2005	8,400	40,400

To project the number of wood stoves from 1990 to 2005, the wood stoves for 1990 must be re-categorized to fit the permanent resident and visitor population groups. To do this, it is assumed that the single family residence and the mobile home and apartments categories can be projected using the permanent resident growth rate and the condominium emissions can be projected using the visitor growth rate. It is also assumed that fireplace inserts and wood stoves can be re-grouped into the wood stove category. Since they have the same emission factor, the emission calculations will not be affected. Because the Town requires that all new stoves be EPA certified, the number of conventional stoves is held constant in the projections and the additional number of stoves due to growth are added to the number of certified stoves. The certified wood stoves can also be broken down into Phase I and Phase II certified stoves by assuming that all new stoves before 1991 are

Phase I certified. The result of the re-categorization and the projection results in the following:

Example Calculation

Projected Total # of Stoves

$$= (\text{Stoves \# in 1990}) \times (\text{Pop. in given year}) / (\text{1990 Pop.})$$

Projected # of Certified stoves

$$= (\text{Total \#}) - (\text{1990 \# of conventional}) + (\text{1990 \# of certified})$$

For Visitors, total number of stoves in 2005

$$= 1,470 \times 40,400 / 24,000 = 2,474.5 \text{ stoves}$$

Number of conventional stoves is held constant at 1,470.

$$\text{Projected number of certified stoves} = 2,474.5 - 1,470 = 1004.5$$

Projected Number of Wood Stoves

<u>Wood Stoves</u>	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	1,470	1,470	1,470	1,470	1,470	1,470
Certified Ph I	0	67	67	67	67	67
Certified Ph II	0	0	134	268	602	938
<u>Residents</u>						
Conventional	1,156	1,156	1,156	1,156	1,156	1,156
Certified Ph I	55	110	110	110	110	110
Certified Ph II	0	0	110	218	495	768
	<u>2,681</u>	<u>2,803</u>	<u>3,047</u>	<u>3,289</u>	<u>3,900</u>	<u>4,509</u>

The emissions from these stoves can be estimated by using the following PM-10 emission factors:

15 grams/kg wood for conventional wood stoves & fireplace inserts
 9.0 grams/kg wood for Phase I stoves (1990), and
 7.5 grams/kg wood for Phase II stoves installed after 1990.

Based on the wood use survey, a weighted average of 30.5 kg wood/day for conventional wood stoves is used for the residents and 19 kg/day is used for visitors. From the survey, the wood usage rate for certified wood stoves is 19 kg wood/day for residents and visitors. The number of wood stoves in the previous table is used to project the emissions.

Example Calculation

$$\text{Emissions} = \text{wood use} \times \text{emission factor} \times \# \text{ stoves} \times \text{kg}/1000 \text{ g}$$

For Residents with Phase I stoves in 1990

$$\text{Emissions} = 19 \times 9.0 \times 55 / 1000$$

$$= 9.4 \text{ kg/day}$$

Projected Wood Stove Emissions Considering Phase II Stoves are Required after January 1, 1991.

<u>Wood Stoves</u>	<u>PM-10 Emissions (kg)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	419	419	419	419	419	419
Certified Ph I	0	11	11	11	11	11
Certified Ph II	0	0	19	38	86	134
<u>Residents</u>						
Conventional	529	529	529	529	529	529
Certified Ph I	9	19	19	19	19	19
Certified Ph II	0	0	16	31	78	109
	<u>957</u>	<u>978</u>	<u>1,013</u>	<u>1,047</u>	<u>1,135</u>	<u>1,221</u>

Step 2- Controlled Emissions

Replace Non-certified Wood Stoves Upon Resale of Dwelling, it is assumed that 90% of the dwellings in Mammoth Lakes will be sold over the next 15 years. This will result in 90% of the wood stoves to be switched from conventional stoves to Phase II certified wood stoves after 1990. This change-over, which is proportioned over the next 15 years, will result in the following breakdown for the stoves.

Projected Number of Wood Stoves Considering Replacement of Non-Certified Wood Stoves Upon Resale of Dwelling and Require Phase II Stoves after January 1, 1991.

<u>Wood Stoves</u>	<u>Projected Number of Wood Stoves</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	1,470	1,470	1,205	1,029	588	147
Change - Ph II	0	0	265	441	882	1,323
New Cert. Ph I	0	67	67	67	67	67
New Cert. Ph II	0	0	134	268	602	938
<u>Residents</u>						
Conventional	1,156	1,156	948	809	462	116
Change - Ph II	0	0	208	347	694	1,040
New Cert. Ph I	55	110	110	110	110	110
New Cert. Ph II	0	0	110	218	495	768
	<u>2,681</u>	<u>2,803</u>	<u>3,047</u>	<u>3,298</u>	<u>3,900</u>	<u>4,509</u>

Using the same method that was used in step 1 to calculate the PM-10 emissions, the following table summarizes the effect of replacing conventional wood stoves with certified wood stoves.

Projected Wood Stove Emissions Considering Replacement of Non-Certified Wood Stove Upon Resale of Dwelling and Require Phase II Certified Stoves After January 1, 1991

<u>Wood Stoves</u>	<u>Controlled PM-10 Emissions (kg)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	419	419	343	293	168	42
Change - Ph II	0	0	38	63	126	189
Certified Ph I	0	11	11	11	11	11
Certified Ph II	0	0	19	38	86	134
<u>Residents</u>						
Conventional	529	529	434	370	211	53
Change - Ph II	0	0	30	49	99	148
Certified Ph I	9	19	19	19	19	19
Certified Ph II	0	0	16	31	71	109
	<u>957</u>	<u>978</u>	<u>910</u>	<u>874</u>	<u>791</u>	<u>705</u>

Step 3 - Ambient PM-10 Contribution

The ambient PM-10 contribution from wood stoves can be estimated from the roll-back equation for road dust dominated days,

$$\text{Ambient conc.} = (58 \mu\text{g}/\text{m}^3) \times (\text{controlled emissions}/957 \text{ kg/day})$$

The ambient contribution for each of the stove types from residents and visitors is shown below.

Projected Ambient Contributions for Wood Stove Emissions Considering Replacement of Non-certified Wood Stoves Upon Resale of Dwelling and Requirement for EPA Phase II Certified Wood Stoves After January 1, 1991.

<u>Wood Stoves</u>	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	25.3	25.3	20.8	17.7	10.2	2.5
Change - Ph II	0	0	2.3	3.8	7.6	11.9
New Cert. Ph I	0	0	0.6	0.6	0.6	0.6
New Cert. Ph II	0	0	1.2	2.3	5.2	8.1
<u>Residents</u>						
Conventional	32.1	32.1	26.3	22.4	12.8	3.2
Change - Ph II	0	0	1.8	3.0	6.0	9.0
New Cert. Ph I	0.5	1.2	1.2	1.2	1.2	1.2
New Cert. Ph II	0	0	0.9	1.9	4.3	6.6
	<u>57.9</u>	<u>58.6</u>	<u>55.1</u>	<u>52.9</u>	<u>47.9</u>	<u>43.1</u>

IMPACT ON FIREPLACES

Step 1 - Emissions Growth

The uncontrolled emissions growth from fireplaces is based upon the present number of fireplaces, not including fireplace inserts, and the growth rate of the number of residents and visitors. The 1990 emission estimates for fireplaces which were discussed in Section 3 are summarized in Table 3.4 and shown below.

Example Calculation

$$\text{Emissions} = \text{emissions factor (g/kg wood)} \times \text{wood usage (kg wood/day)} \times \# \text{ of fireplaces} \times \text{kg}/1000 \text{ g}$$

For Fireplaces the emissions factor is 14 g/kg wood
 For residents,
 Emissions = 14 x 22 x 324/1000 = 99.8 kg

1990 Fireplace Emissions

	<u>Wood Use</u>	<u>Number</u>	<u>Emissions</u>
Condos	19 kg/d	2,941	782 kg/d
Residents	22 kg/d	324	100 kg/d

Using the same population projection figures and method that was used for the wood stove measures, the effect of growth on the number of fireplaces and the emissions is shown below.

Projected Number of Fireplaces and Emissions

<u>Year</u>	<u>Condominiums</u>		<u>Residents</u>		<u>Total Emissions</u>
	<u>Number</u>	<u>Emissions (kg/day)</u>	<u>Number</u>	<u>Emissions (kg/day)</u>	
1990	2,941	782	324	100	882
1991	3,075	818	353	109	927
1993	3,343	889	412	127	1,016
1995	3,611	961	434	134	1,095
2000	4,280	1,138	471	145	1,283
2005	4,951	1,317	544	168	1,485

Step 2 - Controlled Emissions

Regulations that affect fireplaces will institute a ban on new fireplaces except in common areas of lodges and condominiums. In addition, fireplaces must be replaced with Phase II certified wood stoves or cleaner burning appliances before sale of a dwelling.

Note: New fireplaces in common areas of lodges and condominiums is assumed to be negligible as compared to the total wood burning emissions. These fireplaces are not included in the calculations. It is also assumed that fireplaces that would have been installed in new dwellings will be gas logs.

The strategy assumes that 90% of the dwellings will be sold over the next 15 years. This will result in 90% of the open wood burning fireplaces to be rendered inoperable or to be replaced with a cleaner burning device. The control efficiency for the affected dwellings is conservatively assumed to be 46%, based on the replacement of the fireplace with a Phase II certified wood stove. Although it is likely that many fireplaces will be rendered inoperable, or be replaced with gas logs or pellet stoves, there is no data to support consideration of these variables.

The projected number of fireplaces that are replaced for the next 15 years is shown below.

<u>Projected Number of Fireplaces and Those That Are Replaced</u>						
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Visitors						
Fireplaces	2,941	3,075	2,706	2,337	1,415	492
FP to Phase II	0	0	369	738	1,661	2,583
Residents						
Fireplaces	324	353	311	268	162	56
FP to Phase II	0	0	42	85	191	297

From the number of fireplaces and Phase II wood stoves an estimate of the controlled emissions can be made using the emissions equation in Step 1 for the fireplaces emissions and step 1 from the Phase II wood stove emissions. The fireplace wood usage rate for visitors is 19 kg/day and for residents it is 22 kg/day. The wood usage rate in Phase II stoves is 19 kg/day for both visitors and residents. The emissions factor for fireplaces is 14 g/kg of wood and the emission factor for phase II wood stoves is 7.5 g/kg of wood.

<u>Projected Emissions (kg/day)</u>						
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Visitors						
Fireplaces	782	818	720	622	376	131
FP to Phase II	0	0	53	105	237	368
Residents						
Fireplaces	100	109	96	83	50	17
FP to Phase II	0	0	6	12	27	42
Total	<u>882</u>	<u>927</u>	<u>875</u>	<u>822</u>	<u>690</u>	<u>558</u>

Step 3 - Ambient PM-10 Contribution

The ambient PM-10 contribution can be estimated from the roll-back equation for road dust dominated days,

$$\text{Ambient Contribution} = 54 \mu\text{g}/\text{m}^3 \times (\text{Ctrl Emissions}/882 \text{ kg/day})$$

A summary of the ambient contributions is shown in the table below.

**Projected Ambient Contributions With Sections 8.30.030 and 8.30.050
Ban New Fireplaces and Remove Fireplaces Upon Sale of Dwelling**

	Ambient Contributions ($\mu\text{g}/\text{m}^3$)					
	1990	1991	1993	1995	2000	2005
Visitors						
Fireplaces	47.9	50.1	44.1	38.1	23.0	8.0
FP to Phase II	0	0	3.2	6.4	14.5	22.5
Residents						
Fireplaces	6.1	6.7	5.9	5.1	3.1	1.0
FP to Phase II	0	0	0.4	0.7	1.7	2.6
Total	54.0	56.8	53.6	50.30	42.3	34.1

Section 8.30.040, DENSITY LIMITATIONS

This section of the ordinance limits the number of wood burning appliances to one certified wood stove in new units, or two appliances if one is a pellet stove. The previous calculations assume one appliance per dwelling unit. It is anticipated that the emissions from the additional pellet stoves will be insignificant. This section also requires an inspection of new installations by a certified inspector. This is credited with a 5% reduction from new units.

Step 1 - Emissions Growth

The emissions growth calculation for new wood stoves can be taken from the new wood stove estimates that have been completed in previous sections.

Projected Wood Stove Emissions with Replacement of Non-certified appliance Upon Resale, Change-over of Fireplaces, Require Phase II Wood Stoves

New Wood Stoves	PM-10 Emissions (kg)					
	1990	1991	1993	1995	2000	2005
Visitors						
Conv WS to Ph II	0	0	38	63	126	189
New Ph II	0	0	19	38	86	134
FP to Phase II	0	0	53	105	237	368
Residents						
Conv WS to Ph II	0	0	30	49	99	148
New Ph II	0	0	16	31	71	109
FP to Phase II	0	0	6	12	27	42
	0	0	162	298	646	990

Step 2 - Controlled Emissions

Wood Stove Installer Certification is credited with a 5% reduction in emissions from new stoves that are installed.

Example Calculation

For 1993,

$$\begin{aligned} \text{Controlled emissions} &= 162 \text{ kg/day} \times (1 - 0.05) \\ &= 154 \text{ kg/day} \end{aligned}$$

Controlled PM-10 Emissions (kg)

<u>New Wood Stoves</u>	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
	0	0	154	283	614	941

Step 3 - Ambient PM-10 Contribution

The ambient PM-10 contribution from the previous wood stove ordinances can be estimated from the roll-back equation for road dust dominated days,

$$\text{Ambient Concentration} = (58 \mu\text{g}/\text{m}^3) \times (\text{ctrl emissions}/957 \text{ kg/day})$$

Using the controlled emissions estimates from the previous table, the ambient contributions are shown below.

Ambient Contributions from the Wood Stove Certification and All Previous Wood Stove Ordinances for New Wood Stoves

<u>New Wood Stoves</u>	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1992</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
	0	0	9.3	17.2	37.2	57.0

Section 8.30.080, PROHIBITED FUELS

There are no emission reductions associated with this measure. It is intended to give the regulating agencies a tool to prevent the general public from burning materials that may cause odors or excessive smoke.

Section 8.30.070, OPACITY LIMITS

There are no emission reductions associated with this measure. It is included as a possible enforcement tool for individuals that may cause repeated complaints of smoke or odor.

Section 8.30.090, MANDATORY CURTAILMENT

Initially the mandatory wood burning curtailment will exempt certified wood burning appliances. If more reductions are needed this exemption may be dropped and the curtailment will affect all wood burning. The following calculations will consider the affect of the curtailment with and without exemptions for certified wood stoves.

Step 1 - Emissions Growth

The total emissions growth estimate for mandatory wood burning bans can be estimated from the previous estimates for emissions from new and existing wood stoves and fireplaces. These emission estimates assume that the previous controls were implemented.

	<u>Projected Emissions (kg/day)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Fireplaces</u>						
Visitors	782	818	720	622	376	131
Residents	100	109	96	83	50	17
Sub-total	<u>882</u>	<u>927</u>	<u>816</u>	<u>705</u>	<u>426</u>	<u>148</u>
<u>Non-Certified Wood Stoves</u>						
Vis Conv WS	419	419	343	293	168	42
Res Conv WS	529	529	434	370	211	53
Sub-total	<u>948</u>	<u>948</u>	<u>777</u>	<u>663</u>	<u>379</u>	<u>95</u>
Non-Certified Total	1,830	1,875	1,593	1,368	805	243
<u>Certified Wood Stoves</u>						
Visitor Ph I	0	11	11	11	11	11
Resident Ph I	9	19	19	19	19	19
Vis/Res Phase II	0	0	154	283	614	941
Certified Total	<u>9</u>	<u>30</u>	<u>184</u>	<u>313</u>	<u>644</u>	<u>971</u>
All Wood Burning Total	<u>1,839</u>	<u>1,905</u>	<u>1,777</u>	<u>1,681</u>	<u>1,449</u>	<u>1,214</u>

Step 2 - Controlled Emissions

A mandatory wood burning ban is credited with a 50% reduction from the uncontrolled emissions. The summary of the controlled emissions is shown below.

Example Calculation

Controlled Emissions = Emissions (kg/day) x (1 - 0.5)

For all wood burning in 1993,

Controlled emissions = 1,777 x (0.5) = 889 kg/day

	<u>Controlled Emissions (kg/day)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Non-certified	915	938	797	684	403	122
Certified (exempt)	9	30	184	313	644	971
All Wood Burning	920	953	889	841	725	607

Step 3 - Ambient PM-10 Contribution

The ambient PM-10 contribution from wood burning can be estimated from the roll-back equation for road dust dominated days. Although the ambient contribution estimates for wood stoves and fireplaces can be calculated separately, it can also be calculated for wood burning in general by using the following equation:

For all wood burning,

Ambient Conc. = $(58 + 54 \mu\text{g}/\text{m}^3) \times$
 $(\text{wood burning emissions}) / (957 + 882 \text{ kg/day})$

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Non-certified	55.7	57.1	48.5	41.7	24.5	7.4
Certified (exempt)	0.5	1.8	11.2	19.1	39.2	59.1
Total w/exemption	56.2	58.9	59.7	60.8	63.7	66.5
All Wood Burning (no exemptions)	56.0	58.0	54.1	51.2	44.2	37.0

Section 8.30.060, SOLID FUEL BURNING APPLIANCE REPLACEMENT SCHEDULE

If the National Ambient Air Quality Standard for PM-10 is not attained by January 1, 1993, all non-certified solid fuel

appliances must be replaced by November 1, 1994. The following section will include an analysis of the impact of this schedule.

Step 1 - Emissions Growth

The emissions growth for wood burning can be calculated from the number of wood stoves and fireplaces. This has been determined in previous calculations. It is important to assume the wood burning regulations that affect the number of devices is in effect.

Projected Number of Wood Stoves & Fireplaces Considering Replacement of Non-Certified Wood Stoves and Fireplaces Upon Resale of Dwelling and Require Phase II Stoves after January 1, 1991.

<u>Wood Stoves</u>	<u>Projected Number of Wood Stoves</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	1,470	1,470	1,205	1,029	588	147
Change - Ph II	0	0	265	441	882	1,323
New Cert. Ph I	0	67	67	67	67	67
New Cert. Ph II	0	0	134	268	602	938
<u>Residents</u>						
Conventional	1,156	1,156	948	809	462	116
Change - Ph II	0	0	208	347	694	1,040
New Cert. Ph I	55	110	110	110	110	110
New Cert. Ph II	0	0	110	218	495	768
	<u>2,681</u>	<u>2,803</u>	<u>3,047</u>	<u>3,298</u>	<u>3,900</u>	<u>4,509</u>

Projected Number of Fireplaces and Those That Are Replaced

	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Fireplaces	2,941	3,075	2,706	2,337	1,415	492
FP to Phase II	0	0	369	738	1,661	2,583
<u>Residents</u>						
Fireplaces	324	353	311	268	162	56
FP to Phase II	0	0	42	85	191	297

Step 2 - Controlled Emissions

If all wood burning appliances are required to be changed to certified wood stoves by November 1994, then after 1995 there should be zero non-certified appliances. An accelerated change over of appliance should begin in 1993. It is assumed that it will be a straight line linear reduction from the expected number of non-certified devices, to zero devices in 1995. The reduction of non-certified devices is assumed to match the increase of certified devices over that 2 year period.

Projected Number of Wood Stoves & Fireplaces Considering Replacement of Non-Certified Wood Stoves and Fireplaces Upon Resale of Dwelling and Require Phase II Stoves after January 1, 1991 and Accelerated Change-over from 1993 to 1995.

<u>Wood Stoves</u>	<u>Projected Number of Wood Stoves</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	1,470	1,470	1,205	0	0	0
Change - Ph II	0	0	265	1,470	1,470	1,470
New Cert. Ph I	0	67	67	67	67	67
New Cert. Ph II	0	0	134	268	602	938
<u>Residents</u>						
Conventional	1,156	1,156	948	0	0	0
Change - Ph II	0	0	208	1,156	1,156	1,156
New Cert. Ph I	55	110	110	110	110	110
New Cert. Ph II	0	0	110	218	495	768
	<u>2,681</u>	<u>2,803</u>	<u>3,047</u>	<u>3,298</u>	<u>3,900</u>	<u>4,509</u>

	<u>Projected Number of Fireplaces and Those That Are Replaced</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Fireplaces	2,941	3,075	2,706	0	0	0
FP to Phase II	0	0	369	3,075	3,075	3,075
<u>Residents</u>						
Fireplaces	324	353	311	0	0	0
FP to Phase II	0	0	42	353	353	353

Projected Wood Stove and Fireplace Emissions Considering Replacement of Non-Certified Wood Stove Upon Resale of Dwelling, Require Phase II Certified Stoves After January 1, 1991, 5% Reduction for Certified Installer of Phase II Stoves and Accelerated Change-over from 1993 to 1995.

<u>Wood Stoves</u>	<u>Controlled PM-10 Emissions (kg)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Conventional	419	419	343	0	0	0
Certified Stoves						
Change - Ph II	0	0	36	199	199	199
Certified Ph I	0	11	11	11	11	11
Certified Ph II	0	0	18	36	82	127
<u>Residents</u>						
Conventional	529	529	434	0	0	0
Certified Stoves						
Change - Ph II	0	0	29	157	157	157
Certified Ph I	9	19	19	19	19	19
Certified Ph II	0	0	15	29	67	104
Sub-total	<u>957</u>	<u>978</u>	<u>905</u>	<u>451</u>	<u>535</u>	<u>617</u>

	<u>Projected Emissions (kg/day)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
<u>Visitors</u>						
Fireplaces	782	818	720	0	0	0
Certified Stoves						
FP to Phase II	0	0	50	416	416	416
<u>Residents</u>						
Fireplaces	100	109	96	0	0	0
Certified Stoves						
FP to Phase II	0	0	6	48	48	48
Sub-total	<u>882</u>	<u>927</u>	<u>872</u>	<u>464</u>	<u>464</u>	<u>464</u>

	<u>Projected Emissions (kg/day)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Certified Stoves						
Visitors						
Change - Ph II	0	0	36	199	199	199
Certified Ph I	0	11	11	11	11	11
Certified Ph II	0	0	18	36	82	127
FP to Phase II	0	0	50	416	416	416
Residents						
Change - Ph II	0	0	29	157	157	157
Certified Ph I	9	19	19	19	19	19
Certified Ph II	0	0	15	29	67	104
FP to Phase II	0	0	6	48	48	48
Certified						
Sub-total	9	30	184	915	999	1,081
Non-Certified						
Visitors						
Conventional	419	419	343	0	0	0
Fireplaces	782	818	720	0	0	0
Residents						
Conventional	529	529	434	0	0	0
Fireplaces	100	109	96	0	0	0
Non-Certified	1,830	1,875	1,593	0	0	0
Sub-total						
All Wood Burning						
Total	1,839	1,905	1,777	915	999	1,081

Step 3 - Ambient PM-10 Contribution

The ambient PM-10 contribution from wood burning can be estimated from the roll-back equation for road dust dominated days. Although the ambient contribution estimates for wood stoves and fireplaces can be calculated separately, it can also be calculated for wood burning in general by using the following equation:

For all wood burning,
 Ambient Conc. = $(58 + 54 \mu\text{g}/\text{m}^3) \times$
 $(\text{wood burning emissions}) / (957 + 882 \text{ kg/day})$

Without the Mandatory Curtailment

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
All Wood Burning	112.0	116.0	108.2	55.7	60.8	65.8

For the mandatory curtailment program a 50% reduction in the ambient contribution from wood burning is expected. The mandatory wood burning curtailment will initially exempt certified wood stoves. If more reductions are needed the mandatory curtailment may instituted without the exemptions. The impact of both cases is estimated.

With the Mandatory Curtailment

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Certified (exempt)	0.5	1.8	11.2	55.7	60.8	65.8
Non-Certified (not exempt)	55.8	57.1	48.5	0	0	0
Total w/exemption	<u>56.3</u>	<u>58.9</u>	<u>59.7</u>	<u>55.7</u>	<u>60.8</u>	<u>65.8</u>
All Wood Burning	56.0	58.0	54.1	27.9	30.4	32.9

SUMMARY OF AMBIENT PM-10 CONTRIBUTIONS
 Assume NAAQS Attained by January 1, 1993

Mandatory Burning Curtailment Program
 (With an Exemption for Certified Wood Stoves)

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Wood Burning	56.2	58.9	59.7	60.8	63.7	66.5
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>122.6</u>	<u>127.8</u>	<u>133.5</u>	<u>139.7</u>	<u>155.0</u>	<u>170.2</u>

Mandatory Burning Curtailment Program
 (No Exemption for Certified Wood Stoves)

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
Wood Burning	56.0	58.0	54.1	51.2	44.2	37.0
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>122.4</u>	<u>126.9</u>	<u>127.9</u>	<u>130.1</u>	<u>135.5</u>	<u>140.7</u>

Without the Mandatory Burning Curtailment Program

	<u>Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)</u>					
	<u>1990</u>	<u>1991</u>	<u>1993</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
All Wood Burning	112.0	116.0	108.2	102.4	88.4	74.0
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>178.4</u>	<u>184.9</u>	<u>182.0</u>	<u>181.3</u>	<u>179.7</u>	<u>177.7</u>

SUMMARY OF AMBIENT PM-10 CONTRIBUTIONS
 Assume NAAQS Not Attained by January 1, 1993

Mandatory Burning Curtailment Program
 (With an Exemption for Certified Wood Stoves)

	Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)					
	1990	1991	1993	1995	2000	2005
Wood Burning	56.3	58.9	59.7	55.7	60.8	65.8
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>122.7</u>	<u>127.8</u>	<u>133.5</u>	<u>134.6</u>	<u>152.1</u>	<u>169.5</u>

Mandatory Burning Curtailment Program
 (No Exemption for Certified Wood stoves)

	Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)					
	1990	1991	1993	1995	2000	2005
All Wood Burning	56.0	58.0	54.1	27.9	30.4	32.9
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>122.4</u>	<u>126.9</u>	<u>127.9</u>	<u>106.8</u>	<u>121.7</u>	<u>136.6</u>

Without the Mandatory Burning Curtailment Program

	Ambient PM-10 Contribution ($\mu\text{g}/\text{m}^3$)					
	1990	1991	1993	1995	2000	2005
All Wood Burning	112.0	116.0	108.2	55.7	60.8	65.8
Traffic	61.4	63.9	68.8	73.9	86.3	98.7
Background	5.0	5.0	5.0	5.0	5.0	5.0
	<u>178.4</u>	<u>184.9</u>	<u>182.0</u>	<u>134.6</u>	<u>152.1</u>	<u>169.5</u>