

## DATA ANALYSIS AND METHODOLOGY

The objectives of the survey were to determine the quantity of wood consumed and the activity levels of the RWC devices owned by the residents of Washoe County during the 1999-2000 winter season. There were 1,131 Washoe County residents questioned during the survey. Of those 1,131 people, 411 reported burning some type of solid fuel. For each category of RWC device the corresponding percentage of the whole sample population was calculated. This percentage was then multiplied by the estimated total number of dwellings in Washoe County, which for 1999 was 141,500 dwellings. The number derived from this calculation was then considered the 1999 estimate of total number of a specific type of device in the area.

Estimates of the wood-burning devices and wood used in the PM10/CO nonattainment area (NAA) were also calculated. Based on zip code, approximately 893 of the total 1,131 respondents were determined to be within the NAA. Based on that it was determined that approximately 78.9% of the households would be within the NAA. Therefore, 80% of 141,500 is 113,200 households in the NAA.

### Percentage of Fireplaces:

Countywide respondents reported having 316 fireplaces either as their first, second, or third device. Of the respondents who reported having a fireplace as their first, second, or third device, 50.6% reported actually using them. Within the NAA, respondents reported 278 fireplaces with 48.2% of those actually used.

#### County Wide:

$316 \text{ fireplaces} \div 1,131 \text{ respondents} \times 100\% = 27.9\% \text{ fireplaces}$   
 $27.9\% \times 141,500 \text{ households} = 39,479 \text{ fireplaces}$   
 $50.6\% \text{ used} \times 39,479 \text{ fireplaces} = 19,976 \text{ fireplaces used}$

#### NAA:

$278 \text{ fireplaces} \div 893 \text{ respondents} \times 100\% = 31.1\% \text{ fireplaces}$   
 $31.1\% \times 113,200 \text{ households} = 35,205 \text{ fireplaces}$   
 $48.2\% \text{ used} \times 35,205 \text{ fireplaces} = 16,968 \text{ fireplaces used}$

### Average Wood Consumption for Fireplaces:

Based on the raw data for fireplaces the number of cords burned per device 1, 2 and 3 was on average for fireplaces 0.57 cords/device (NAA – 0.58 cords/device).

### **Percentage of Woodstoves/Inserts:**

Respondents reported having 95 woodstoves or inserts as either their first, second, or third device. Of the respondents who reported having a woodstove/insert as their first, second, or third device, 70.5% were reported as actually being used. Within the NAA, respondents reported 71 woodstoves or inserts with 69% of those actually used.

#### County Wide:

$95 \text{ woodstove/inserts} \div 1,131 \times \text{respondents} \times 100\% = 8.4\% \text{ woodstove/inserts}$

$8.4\% \times 141,500 \text{ households} = 11,886 \text{ woodstove/inserts}$

$70.5\% \text{ used} \times 11,886 \text{ woodstove/inserts} = 8,380 \text{ used}$

#### NAA:

$71 \text{ woodstove/inserts} \div 893 \text{ respondents} \times 100\% = 8\% \text{ woodstove/inserts}$

$8\% \times 113,200 \text{ households} = 9,056 \text{ woodstove/inserts}$

$69\% \text{ used} \times 9,056 \text{ woodstove/inserts} = 6,249 \text{ used}$

### **Average Wood Consumption for Woodstove/Inserts:**

Based on the raw data for woodstove/inserts the number of cords burned per device 1, 2 and 3 on average is 1.33 cords/device (NAA – 1.24 cords/device).

### **Percentage of Pellet Stoves:**

Respondents reported having 16 pellet stoves as either their first, second, or third device. Of the respondents who reported having a pellet stove as their first, second, or third device, 81.3% reported actually using them. Within the NAA, respondents reported 13 pellet stoves with 68.8% of those actually used.

#### County Wide:

$16 \text{ pellet stoves} \div 1,131 \text{ respondents} \times 100\% = 1.4\% \text{ pellet stoves}$

$1.4\% \times 141,500 \text{ households} = 1,981 \text{ pellet stoves}$

$81.3\% \text{ used} \times 1,981 \text{ pellet stoves} = 1,611 \text{ used}$

#### NAA:

$13 \text{ pellet stoves} \div 893 \text{ respondents} \times 100\% = 1.5\% \text{ pellet stoves}$

$1.5\% \times 113,200 \text{ households} = 1,698 \text{ pellet stoves}$

$68.8\% \text{ used} \times 1,698 \text{ pellet stoves} = 1,168 \text{ used}$

The number of pellet stoves sold since 1988 as estimated from WCDHD-AQMD Dealer Affidavits of Sale (DAS) is 1763. The 1999-2000 survey calculated number of 2,052 pellet stoves is greater than the DAS count.

### Average Pellet Consumption for Pellet Devices:

Based on the raw data for pellet devices the tons of pellets burned per device 1, 2 and 3. On average is 0.85 tons/device (NAA – 0.89 tons/device).

### Estimated Emissions Based on the 1999-2000 Survey

Tables XI and XII list the activity data based on the 1999-2000 Survey for the NAA and the entire County, respectively.

**TABLE XI  
1999-2000 NAA Activity Data**

Type of Device	Average cords or tons used per Device	Total # of Units	# of Units Actually Used	Total # of Cords/Tons Used	Average Weight of Wood (lbs./cord)	Total Lbs. of Wood/Yr.
Fireplace	0.58	35,205	16,968	9,841	2,673	26,304,993
Woodstove/Inserts						
Certified	1.24	4,528	3,124	3,874	2,673	10,355,202
Uncertified	1.24	4,528	3,124	3,874	2,673	10,355,202
			<b>Wood Totals</b>	17,589		47,015,397
Pellet Stoves	0.89	1,698	1,168	1,040		

**TABLE XII  
County Wide Activity Data**

Type of Device	Average cords or tons used per Device	Total # of Units	# of Units Actually Used	Total # of Cords/Tons Used	Average Weight of Wood (lbs./cord)	Total Lbs. of Wood/Yr.
Fireplace	0.57	39,479	19,976	11,386	2,673	30,434,778
Woodstove/Inserts						
Certified	1.33	5,943	4,190	5,573	2,673	14,896,629
Uncertified	1.33	5,943	4,190	5,573	2,673	14,896,629
			<b>Wood Totals</b>	22,530		60,228,036
Pellet Stoves	0.85	1,981	1,611	1,369		

The estimated emissions based on the 1999-2000 Survey data are calculated using AP-42, Fifth Edition, emission factors. Table XIII gives the estimate for the NAA and Table XIV gives the estimate on the County Wide basis.

**TABLE XIII**  
**1999-2000 NAA ESTIMATED EMISSIONS**

Type of Device	Total tons of wood or pellets/yr.	Emission Factors (lbs./ton)				Emissions (tons/yr.)			
		PM10	CO	NOX	VOC	PM10	CO	NOX	VOC
<b>Fireplaces</b>	13,152.5	34.6	252.6	2.6	229	224.9	1,661.2	17.1	1,506
<b>Woodstove/Inserts</b>									
<b>Certified</b>	5,177.6	19.6	104.4	2.0	15	50.7	270.3	5.2	38.8
<b>Uncertified</b>	5,177.6	30.6	230.8	2.8	53	79.2	597.5	7.2	137.2
	Total Woodstoves/Inserts =					129.9	867.8	12.4	176
<b>Pellet Stoves</b>	1,040	4.2	39.4	13.8	0**	2.2	20.5	7.2	0
	*Total Fireplaces + Woodstoves + Pellets (tons/yr.) =					357	2,550	37	1,682

\*rounded to fewer significant digits

\*\*no data

**TABLE XIV**  
**1999-2000 COUNTY WIDE ESIMATED EMISSIONS**

Type of Device	Total tons of wood or pellets/yr.	Emission Factors (lbs./ton)				Emissions (tons/yr.)			
		PM10	CO	NOX	VOC	PM10	CO	NOX	VOC
<b>Fireplaces</b>	15,217.4	34.6	252.6	2.6	229	263.3	1,922	19.8	1,742.4
<b>Woodstove/Inserts</b>									
<b>Certified</b>	7,447	19.6	104.4	2	15	73	388.7	7.4	55.9
<b>Uncertified</b>	7,447	30.6	230.8	2.8	53	113.9	859.4	10.4	197.3
	Total Woodstoves/Inserts =					186.9	1,248.1	17.8	253.2
<b>Pellet Stoves</b>	1,369	4.2	39.4	13.8	0**	2.9	27	9.4	0
	*Total Fireplaces + Woodstoves + Pellets (tons/yr.) =					453	3,197	47	1,996

\*rounded to fewer significant digits

\*\*no data

## SURVEY COMPARISONS

Tables XV and XVI compares the three recent surveys conducted by the WCDHD-AQMD and MarkeTec.

**TABLE XV**  
**Washoe County RWC Activity**

Device Type	Estimate of Total # of Devices		# of Devices Actually Used		Total # of Cords/Pellets used	
	Estimates	Average*	Estimates	Average*	Estimates	Average*
<b>Fireplaces:</b>		34,900		18,600		0.72
92-93 Survey	34,431		17,695		0.84	
94-95 Survey	34,047		18,777		0.73	
95-96 Survey	31,701		18,008		0.73	
99-00 Survey	39,479		19,976		0.57	
<b>Woodstove/Inserts</b>		12,600		9,200		1.63
92-93 Survey	13,845		9,573		1.90	
94-95 Survey	10,972		8,031		1.72	
95-96 Survey	13,803		10,640		1.57	
99-00 Survey	11,886		8,380		1.33	
<b>Pellet Stoves</b>		2,300		2,100		1.12
92-93 Survey	1,264		1,264		1.08	
94-95 Survey	3,053		2,939		1.29	
95-96 Survey	2,808		2,574		1.25	
99-00 Survey	1,981		1,611		0.85	

\*rounded to fewer significant digits

**TABLE XVI**  
**NAA Average RWC Activity**

Device Type	Estimate of Total # of Devices		# of Devices Actually Used		Total # of Cords/Pellets used	
	Estimates	Average*	Estimates	Average*	Estimates	Average*
<b>Fireplaces:</b>		32,944		17,199		0.58
92-93 Survey	33,054		17,684		Unknown	
94-95 Survey	33,336		18,142		0.61	
95-96 Survey	30,179		16,003		0.56	
99-00 Survey	35,205		16,968		0.58	
<b>Woodstove/Inserts</b>		9,082		6,361		1.44
92-93 Survey	9,692		6,784		Unknown	
94-95 Survey	7,564		5,128		1.64	
95-96 Survey	10,015		7,283		1.43	
99-00 Survey	9,056		6,249		1.24	
<b>Pellet Stoves</b>		1,636		1,382		0.92
92-93 Survey	822		712		Unknown	
94-95 Survey	2,179		1,773		0.67	
95-96 Survey	1,560		1,431		1.2	
99-00 Survey	1,981		1,611		0.89	

\*rounded to fewer significant digits

Some results of the three surveys compare well and some do not. Since there are minor variations because of the methodology, staff elected to use the average activity data from three years' surveys to estimate emissions for emission inventory purposes.

Table XVII summarizes the estimates of average firewood consumption from the last five-woodstove surveys/reports.

**TABLE XVII  
AVERAGE FIREWOOD CONSUMPTION\***

	<b>1984</b>	<b>1991</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1999</b>
Fireplaces	0.91 cords	0.39 cords	0.84 cords	0.73	0.73	0.57
Stoves/Inserts	2.25 cords	1.24 cords	1.90 cords	1.72	1.57	1.33
Total cords	38,593	20,305	34,673	27,521	29,851	22,530

\*Based on devices reported used

## ESTIMATED EMISSIONS

Tables XVIII and XIX list the activity data for the NAA and the entire County based on the average of the data collected from the last three surveys.

**TABLE XVIII  
Average NAA Activity Data**

Type of Device	Average Cords or tons used per Device	Total # of Units	# of Units Actually Used	Total # of Cords/Tons Used	Average Weight of Wood (lbs./cord)	Total Lbs. of Wood/Yr.
Fireplace	0.58	32,994	17,199	9,975	2,673	26,663,175
Woodstove/Inserts						
Certified	1.44	4,541	3,181	4,581	2,673	12,245,013
Uncertified	1.44	4,541	3,181	4,581	2,673	12,245,013
			<b>Wood Totals</b>	19,137		51,153,201
Pellet Stoves	0.92	1,636	1,382	1,271		

**TABLE XIX  
Average County Wide Activity Data**

Type of Device	Average cords or tons used per Device	Total # of Units	# of Units Actually Used	Total # of Cords/Tons Used	Average Weight of Wood (lbs./cord)	Total Lbs. of Wood/Yr.
Fireplace	0.72	34,900	18,600	13,392	2,673	35,796,816
Woodstove/Inserts						
Certified	1.63	6,300	4,600	7,498	2,673	20,042,154
Uncertified	1.63	6,300	4,600	7,498	2,673	20,042,154
			<b>Wood Totals</b>	28,388		75,881,124
Pellet Stoves	1.12	2,300	2,100	2,352		

The estimated emissions based on the average survey data are calculated using AP-42, Fifth Edition, emission factors. Table XX gives the estimate for the NAA and Table XXI gives the estimate on the County Wide basis.

**TABLE XX**  
**NAA ESTIMATED EMISSIONS BASED ON AVERAGED ACTIVITY DATA**

Type of Device	Total tons of wood or pellets/yr.	Emission Factors (lbs./ton)				Emissions (tons/yr.)			
		PM10	CO	NOX	VOC	PM10	CO	NOX	VOC
<b>Fireplaces</b>	13,331.6	34.6	252.6	2.6	229	230.6	1,683.8	17.3	1526.5
<b>Woodstove/Inserts</b>									
<b>Certified</b>	6,122.5	19.6	104.4	2	15	60	319.6	6.1	45.9
<b>Uncertified</b>	6,122.5	30.6	230.8	2.8	53	93.7	706.5	8.6	162.2
	Total Woodstoves/Inserts =					153.7	1026.1	14.7	208.1
<b>Pellet Stoves</b>	1,271	4.2	39.4	13.8	0**	2.7	25	8.7	0
	*Total Fireplaces + Woodstoves + Pellets (tons/yr.) =					387	2734.9	40.7	1734.6

\*rounded to fewer significant digits

\*\*no data

**TABLE XXI**  
**COUNTY WIDE ESTIMATED EMISSIONS BASED ON AVERAGED ACTIVITY DATA**

Type of Device	Total tons of wood or pellets/yr.	Emission Factors (lbs./ton)				Emissions (tons/yr.)			
		PM10	CO	NOX	VOC	PM10	CO	NOX	VOC
<b>Fireplaces</b>	17,898.4	34.6	252.6	2.6	229	309.6	2,260.6	23.3	2,049.4
<b>Woodstove/Inserts</b>									
<b>Certified</b>	10,021.1	19.6	104.4	2	15	98.2	523.1	10	75.2
<b>Uncertified</b>	10,021.1	30.6	230.8	2.8	53	153.3	1156.4	14	265.6
	Total Woodstoves/Inserts =					251.5	1,679.5	24	340.8
<b>Pellet Stoves</b>	2,352	4.2	39.4	13.8	0**	4.9	46.3	16.2	0
	*Total Fireplaces + Woodstoves + Pellets (tons/yr.) =					566	3,986	64	2,390

\*rounded to fewer significant digits

\*\*no data

## SUMMARY

Residential wood combustion (RWC) is a significant source of air pollution in Washoe County. RWC emissions have been directly linked to monitored violations of the national ambient air quality standards. It is therefore important that we quantify and characterize this emission source to the best of our abilities in order to develop appropriate preventative and mitigative measures.

This RWC report represents the third in a series of annual professionally administered surveys. The establishment of a consistent survey instrument and the comparison of socioeconomic data with other agency surveys have allowed the District staff to achieve a high degree of confidence in the results. Some highlights of the three surveys:

- In Washoe County, there are approximately 35,000 fireplaces, 12,600 woodstoves/inserts, and 2,300 pellet stoves.
- The surveys indicate that only about one-half (53%) of the fireplaces, and three-quarters (73%) of the woodstoves/inserts, are actually used. Virtually all of the pellet devices are used on a regular basis.
- Approximately 46% of the woodstoves/inserts were described as nine (9) or more years old and therefore are uncertified and assumed to have high emission rates.
- The number of wood burning devices has remained relatively flat over the eight-year survey period, despite an over 15% increase in population. The exception has been pellet stoves; their number has doubled over the same period. Natural gas-fired appliances are not accounted for in this survey because they do not contribute significantly to carbon monoxide or particulate air pollution.
- Fuel consumption data indicate there is a downward trend in the amount of wood burned. Approximately 0.7 fewer cords per device were reported consumed in the 99-00 survey verses the 92-93 survey.
- The Red-Yellow-Green curtailment program maintains a high level of public awareness (89%) and compliance (81%); however these numbers are down slightly from previous surveys probably because we have not done a media campaign addressing this program.

All together the surveys indicate a declining trend in residential wood stove emissions in Washoe County. This reduction has been reflected in the improved ambient air quality monitored in Washoe County over the last few years. With the high cost of fuel staff will be performing another survey after the next winter season 2001-2002 to see if there is an increase.