

**Technical Memorandum  
No. 2: MANE-VU  
Residential Wood  
Combustion EI Project:  
Format for Activity Data  
in the Wood Consumption**

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## Technical Memorandum #2: Format for Activity Data in the Wood Consumption Model

The purpose of this technical memorandum is to describe the format for reporting activity data derived from the residential wood combustion (RWC) survey of the MANE-VU region. Pechan uses the term *wood consumption model* when referring to the aggregate activity data for the RWC source categories. Table 1 below is an example wood consumption model for fireplaces and masonry heaters similar to the one provided in the Work Plan for this project (Pechan, 2001). Table 2 is the sample frame selected for this project. The selected sample frame has two additional strata (for suburban areas), but is otherwise the same as the sample frame originally used to illustrate the wood consumption model in Table 1.

The following activity variables will be developed for each source category:

- *User Fraction (UF)*: this is the fraction of the population of households that conduct RWC with some specified equipment (e.g. fireplace, wood stove); and
- *Annual Activity Estimate*: this is the annual consumption of wood per equipment type (cords/household-year) for the user population. The activity estimates may be normalized using annual heating degree day (HDD) data from the National Climatic Data Center (e.g. producing units of cords/household-yr-HDD). The format of the activity data will be determined during an analysis of the survey data. For example, if Pechan finds a good correlation between annual consumption and number of HDD, then the HDD-normalized activity data will be used.

As shown in Tables 1 and 2, for each equipment type, UF and annual activity can vary among geographic areas, including high versus low heating degree day (HDD) zones and rural, suburban, and urban areas. These values may also vary by housing unit type (single-family versus other housing unit type). A statistical analysis of the survey data will be performed to establish each of these values within each cell of the sample frame (i.e. forming the wood consumption model). In some instances, statistically significant differences may not be found between the activity data in some sample frame cells (e.g. through analysis of variance). As shown in the hypothetical Table 1 example, significant differences do not exist between high and low HDD geographic zones for fireplaces/masonry heaters for “other housing units” (except in rural forested areas). In these cases, the survey results are merged. A conceptual idea of the entire wood consumption model really consists of a separate table (such as Table 1) for each equipment type (equipment type = source classification code) and the number of associated households.

Tables 3a and 3b provide Pechan’s structure for storing information for the wood consumption model. Table 3a includes the necessary information for categorizing census tracts and the number of single-family housing units and other housing units (e.g. multi-family units). Table 3b contains the activity data by SCC for each census tract as developed from the survey data. Together the data elements in these tables will be used to construct census tract-level estimates of annual wood consumption. Note that the SCC’s provided in Table 3b are somewhat different than those prescribed in the EIIP guidance (EIIP, 2001). Changes were necessary to add an SCC for masonry heaters, wood-fired furnaces, and outdoor wood combustion equipment. Different SCCs were also used for wood stoves to match up with the activity data to be collected during the survey (i.e. designation of stoves as either Phase II or non-Phase II stoves). Where consistency could not be maintained with the EIIP, SCCs were selected to be consistent with the NEI. For the purposes of this project, stoves purchased after July 1990 will be considered EPA Phase II (i.e. Phase I and Phase II certified stoves will be combined).

The information in Tables 3a and 3b relate to one another via the Cell ID field. Using the FIPS code provided in Table 3a, the annual activity can be aggregated from the census tract to county- or state-

level. To develop the activity data in units of tons/yr, Pechan will convert the survey responses from a volume to a mass basis with information on wood density from the EIIP document and other sources. For each cell in the sample frame the activity data will be weighted based on the reported type of wood (e.g. oak, pine, compressed logs).

Temporal allocation profiles (monthly, weekly, and daily) will be developed from the survey data for each SCC. Pechan expects that these profiles, especially the monthly profiles, will vary in different parts of the RPO. For example, the heating season in Maine is longer than the season in Maryland. Therefore, the profiles will be specific to both SCC and census tract. The structure of the temporal allocation profiles is shown in Tables 3c through 3f.

A sample calculation for annual activity is provided below for a specified census tract and SCC:

$$\text{Activity (tons/yr)} = (\text{HU}_s \times \text{UF}_s \times \text{A}_s) + (\text{HU}_o \times \text{UF}_o \times \text{A}_o) \quad (\text{equation 1})$$

Where:

- $\text{HU}_s$  = single-family housing units;
- $\text{UF}_s$  = single-family housing units user fraction for equipment type (SCC);
- $\text{A}_s$  = single-family housing units annual activity (tons/yr);
- $\text{HU}_o$  = other housing units;
- $\text{UF}_o$  = other housing units user fraction for equipment type (SCC); and
- $\text{A}_o$  = other housing units annual activity (tons/yr).

For each SCC, the annual activity can be aggregated from the census tract to the county or state levels using the FIPS code in Table 3a. If, during the analysis of survey data, Pechan finds a good correlation between wood consumption and annual HDD, the activity variable will take the form of tons/HDD-yr (where HDD are annual heating-degree days). The calculation of annual activity for a specified census tract and SCC would take the form shown in equation 2 below:

$$\text{Activity (tons/yr)} = [\text{HU}_s \times \text{UF}_s \times (\text{A}_s \times \text{HDD})] + [\text{HU}_o \times \text{UF}_o \times (\text{A}_o \times \text{HDD})] \quad (\text{equation 2})$$

Where:

- $\text{HU}_s$  = single-family housing units;
- $\text{UF}_s$  = single-family housing units user fraction for equipment type (SCC);
- $\text{A}_s$  = single-family housing units annual activity (tons/HDD-yr);
- $\text{HDD}$  = annual heating-degree days for the census tract;
- $\text{HU}_o$  = other housing units;
- $\text{UF}_o$  = other housing units user fraction for equipment type (SCC); and
- $\text{A}_o$  = other housing units annual activity (tons/HDD-yr).

Note that for annual HDD, Pechan may have to use the long term averages that were used to construct the sample frame instead of year 2002 specific data for each census tract. Initial discussions with National Climatic Data Center staff indicated that the form of data available for each weather station does not allow for the data to be easily obtained and manipulated. For example, a separate text file for each weather station tied to a survey response would need to be downloaded and the HDD information extracted. For a survey with approximately a thousand responses, this would be an enormous task. Pechan will re-evaluate the availability of this information in February or March as the survey is being conducted.

## **References**

EIIP, 2001. *Residential Wood Combustion, Volume III, Chapter 2*, Emission Inventory Improvement Program, Area Sources Committee, January 2001.

Pechan, 2001. *Work Plan for a Survey to Determine Residential Wood Combustion and Open Burning Activity*, prepared by E.H. Pechan & Associates, Inc., under contract to the Mid-Atlantic Regional Air Management Association for the Ozone Transport Commission, July 13, 2001.

**Table 1. Example Wood Consumption Model for MANE-VU (Fireplaces and Masonry Heaters)**

Region <sup>1</sup>	General Land Use/Cover							
	Urban <sup>2</sup>		Suburban <sup>2</sup>		Rural – Forested <sup>2</sup>		Rural - Non-Forested <sup>2</sup>	
	Single-Family	Other (Apt./ Multi-family/ mobile home)	Single-Family	Other (Apt./ Multi-family/ mobile home)	Single-Family	Other (Apt./ Multi-family/ mobile home)	Single-Family	Other (Apt./ Multi-family/ mobile home)
North	UF = 0.3 Activity = 0.3	UF = 0.1 Activity = 0.2	UF = 0.3 Activity = 0.3	UF = 0.1 Activity = 0.2	UF = 0.9 Activity = 0.8	UF = 0.5 Activity = 1.2	UF = 0.7 Activity = 0.8	UF = 0.4 Activity = 0.5
South-OTC	UF = 0.2 Activity = 0.2		UF = 0.2 Activity = 0.2		UF = 0.8 Activity = 0.3	UF = 0.4 Activity = 0.9	UF = 0.5 Activity = 0.1	

<sup>1</sup> Regions will be defined as high or low HDD zones, based on HDD data from the National Climatic Data Center.

<sup>2</sup> Units are: User Fraction = fraction of wood users; all equipment activity is in cords/household-year (or cords/household-yr-HDD).

**Table 2. Sample Frame for This Project**

Geographic Zone	Urban		Suburban		Rural-Forested		Rural-Non-Forested	
	Single-Family	Other	Single-Family	Other	Single-Family	Other	Single-Family	Other
<i>High HDD</i>	61	61	61	61	61	61	61	61
<i>Low HDD</i>	61	61	61	61	61	61	61	61

**Table 3a. Wood Consumption Model Census Tract Information**

Census Tract	FIPS <sup>1</sup>	Annual HDD	Sample Frame Cell ID <sup>2</sup>	Single-Family Units	Other Units <sup>3</sup>
XXXX.XX	XXXXX	XXXXX	1	XXXXXX	XXXXXX
XXXX.XX	XXXXX	XXXXX	7	XXXXXX	XXXXXX
XXXX.XX	XXXXX	XXXXX	10	XXXXXX	XXXXXX
XXXX.XX	XXXXX	XXXXX	10	XXXXXX	XXXXXX

<sup>1</sup> State and county code.

<sup>2</sup> The cell ID's correspond to one of the 16 sample frame cells.

<sup>3</sup> Includes multi-family units and mobile homes.

**Table 3b. Wood Consumption Model Activity Data**

Sample Frame Cell ID	SCC	SCC Description <sup>1</sup>	User Fraction		Annual Activity (tons/household-yr) <sup>2</sup>	
			Single-Family Unit	Other Unit	Single-Family Unit	Other Unit
1	21-04-008-001	Residential Wood Combustion – Fireplaces	0.0000	0.0000	0.0000	0.0000
1	21-04-008-010	Residential Wood Combustion – Woodstoves: Non-EPA Phase II	0.0000	0.0000	0.0000	0.0000
1	21-04-008-030	Residential Wood Combustion – Woodstoves: EPA Phase II Catalytic	0.0000	0.0000	0.0000	0.0000
1	21-04-008-050	Residential Wood Combustion – Woodstoves: EPA Phase II Non-Catalytic	0.0000	0.0000	0.0000	0.0000
1	21-04-008-060	Residential Wood Combustion – Non-Catalytic Woodstoves: Pellet Fired	0.0000	0.0000	0.0000	0.0000
1	21-04-008-090	Residential Wood Combustion – Wood-Fired Furnaces	0.0000	0.0000	0.0000	0.0000
1	21-04-008-100	Residential Wood Combustion – Outdoor Wood-Fired Equipment	0.0000	0.0000	0.0000	0.0000
2	21-04-008-001	Residential Wood Combustion – Fireplaces	0.0000	0.0000	0.0000	0.0000
2	21-04-008-010	Residential Wood Combustion – Woodstoves: Non-EPA Phase II	0.0000	0.0000	0.0000	0.0000
2	Repeat from above for all sample frame cells					
2	Repeat from above for all sample frame cells					

<sup>1</sup> Masonry heaters are included in the SCC for fireplaces. Fireplace inserts are included under the corresponding woodstove SCC. Each SCC can have up to 16 different UF and activity combinations corresponding to the sample frame cell ID.

<sup>2</sup> Pechan will also evaluate the use of activity data that vary depending on the annual HDD associated with each census tract.

**Table 3c. Temporal Allocation Profile Formats (monthly)**

Sample Frame Cell ID	SCC	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21-04-008-001	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-010	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-030	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-050	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-060	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-090	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
1	21-04-008-100	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
2	21-04-008-001	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
2	21-04-008-010	0.250	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.250
Repeat from above for all sample frame cells													
Repeat from above for all sample frame cells													

**Table 3d. Temporal Allocation Profile Formats (weekly)**

Sample Frame Cell ID	SCC	Day of Week						
		Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	21-04-008-001	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-010	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-030	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-050	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-060	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-090	0.125	0.125	0.125	0.000	0.125	0.250	0.250
1	21-04-008-100	0.000	0.000	0.000	0.000	0.000	0.500	0.500
2	21-04-008-001	0.125	0.125	0.125	0.000	0.125	0.250	0.250
2	21-04-008-010	0.125	0.125	0.125	0.000	0.125	0.250	0.250
Repeat from above for all sample frame cells								
Repeat from above for all sample frame cells								

**Table 3e. Temporal Allocation Profile Formats (daily; weekday)**

Sample Frame Cell ID	SCC	Weekday Hour										Repeat for each hour of the day	Repeat for each hour of the day
		1200	0100	0200	0300	0400	0500	0600	0700	0800	0900		
1	21-04-008-001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
2	21-04-008-001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
2	21-04-008-010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
Repeat from above for all sample frame cells													
Repeat from above for all sample frame cells													

**Table 3f. Temporal Allocation Profile Formats (daily; weekend day)**

Sample Frame Cell ID	SCC	Weekend Day Hour										Repeat for each hour of the day	Repeat for each hour of the day
		1200	0100	0200	0300	0400	0500	0600	0700	0800	0900		
1	21-04-008-001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
1	21-04-008-100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
2	21-04-008-001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
2	21-04-008-010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042		
Repeat from above for all sample frame cells													
Repeat from above for all sample frame cells													