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Methodology for Estimating Emissions from Waste Burning

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Background

This document describes the methods used to estimate emissions from waste burning. Emissions in this source category come from the open burning of agricultural residues (such as crop stubble and orchard pruning), weed abatement (such as ditch and canal bank burning), range improvement (such as chaparral and grass land burning), and other materials. See Table 1 below for the emission inventory categories updated.

Waste burning is a district reported emissions inventory category. While several districts have updated this category in the recent past, others have not. This update provides default emission estimates for those districts that will be required to do federal ozone and particulate matter State Implementation Plans (SIP) and are not currently updating this category (Attachment A - Map of updated areas). The following districts have updated, or are in the process of updating, these categories and are therefore excluded: the San Joaquin Valley Air Basin; San Francisco Bay Air Basin; Ventura County; South Sutter County portion of the Feather River District; Butte County; and the Sacramento Region 8-hour ozone nonattainment area.

Table 1. Updated Waste Burning and Disposal Emissions Inventory Categories

EIC category	EIC Code
Agricultural Burning – Prunings	670-660-0262-0000
Agricultural Burning – Field Crops	670-662-0262-0000
Range Improvement	670-660-0200-0000
Weed Abatement	670-668-0200-0000
Other	670-995-0240-0000

Source Data

Waste burn information was gathered from the districts based on their permit data. How individual districts permit, manage, and submit waste burn information varied significantly from district to district. As a result, a significant amount of work was done to organize, categorize, and format the waste burn information for emission inventory purposes.

There were two primary data gathering efforts. The first was done via contract. UC Berkeley’s Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER), in cooperation with Les Fife of Fife Environmental, gathered 2000 waste burn data for several counties in California (Scarborough et al. 2002). This update uses the CAMFER 2000 waste burn data for San Diego and Imperial Counties. Please note that the emission estimates reported in the referenced CAMFER report may not match the emission estimates reported here. That is because data provided by the CAMFER study

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was further refined to apply the expanded suite of crop specific emission factors (Attachment B - Emission Factors Table). For the remaining areas, ARB staff compiled 2002 waste burn information either by directly contacting the individual districts or from the annual reports submitted to ARB. These districts include Amador, Calaveras, Mariposa, Tuolumne, Nevada, Eastern Kern, Antelope Valley, Mojave Desert, and South Coast.

Emissions Estimation

The districts provided the amount of material burned in either acres or tons burned, though acres were the most common. Emissions were calculated by first multiplying the acres reported by the crop specific fuel loading factors and then by multiplying the calculated tons of material by the crop specific emission factors. If tons of material were provided, emissions were calculated by multiplying the reported tons by the crop specific emission factors. Emissions were then converted from pounds (lbs) to tons, and then summed by county, air basin, and district area. Table 2 below lists the emissions estimated by county, air basin, and district. Table 2 also shows if the source data were compiled by CAMFER or by ARB and the year of the activity data.

Emission Factors

Emissions are calculated for PM₁₀, PM_{2.5}, NO_x, SO₂, VOC, and CO. Background information for emission factors and fuel loading is explained in the Agricultural Burning Emission Factors memo dated August 17, 2000 (Attachment C - Memo). The San Joaquin Valley Air Pollution Control District further expanded the suite of crop specific emission factors using the same approach outlined in the memo. Emission factors come from the measurements conducted at the University of California at Davis in 1992 and 1993 (Jenkins, B., 1996). Where the more recent Jenkins data are not available for specific materials burned, default emission factors are used from the U.S. EPA's "Compilation of Air Pollutant Emission Factors," which is often referred to as AP-42. These emission factors are based on ARB sponsored tests performed in 1974 and 1977.

Changes

As described above, the specific crops that have emission factors and fuel loading values were expanded to include the varied suite of crops burned. There are no changes to the underlying methodology used to estimate emissions for these categories (see sample equations). All districts use the same set of emission factors, fuel loading assumptions and methodology described here to estimate emissions for waste burning.

Projections

The agricultural burning projection factor is based on California Department of Conversation's Farmland Mapping and Monitoring Program irrigated and non-irrigated acreage.

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Uncertainty

The permitted acres burned do not necessarily reflect the actual acres burned, therefore waste burning emissions may be overestimated. A burner sometimes overestimates acreage for the permit to ensure they remain within their permit even if they vary their burn. They may also retain a permit for more acres than they can burn so that they don't have to go through the permit process again if they want to burn additional acres. There is not an effective feedback loop in place that requires the burner to report back to the district the actual acres they burned. One solution would be to require that burners report to the district the actual acres they burned.

Sample Equations

$Crop\ acres * FL\ (tons\ fuel/crop\ acres) * EF\ (lbs\ pollutant/ton) * tons/2000\ lbs$
EF - emission factor
FL - fuel loading

Example Equation for PM10 Emissions

ABC County burned 250 acres of Almond orchard:

Fuel Loading - 1.00 ton/acre
PM10 Emission Factor - 7.00 lbs PM10/ton

$$\left(250\ ac\ Almond\right) * \left(\frac{1.00\ ton\ Almond\ pruning}{1\ ac\ Almond\ orchard}\right) * \left(\frac{7.00\ lbs\ PM10}{tons\ Almond\ pruning}\right) * \left(\frac{tons}{2000\ lbs}\right) = 0.875\ tons\ PM10$$

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Table 2. Table of Emission Estimates

Waste Burning Emission Estimates (tons/year)										
EIC Categories: Agricultural-Field, Agricultural-Pruning, Range Improvement, Weed Abatement, and Other										
COUNTY	AB	DIS	PM10	PM25	NOx	SO2	VOC	CO	Source	Year
AMADOR	MC	AMA	66.17	60.20	16.63	1.42	45.59	490.29	ARB	2002
CALAVEROUS	MC	CAL	no data							
RIVERSIDE	SS	SC	19.75	18.33	8.81	0.48	14.38	162.71	ARB	2002
KERN	MD	KER	0.18	0.17	0.15	0.00	0.13	1.61	ARB	2002
IMPERIAL	SS	IMP	864.35	828.07	246.87	39.45	711.56	6662.02	CAMFER	2000
SAN DIEGO	SD	SD	114.21	106.67	31.76	3.23	81.14	839.43	CAMFER	2000
LOS ANGELES	SC	AV	200.08	190.86	54.26	6.73	139.79	1316.44	ARB	2002
LOS ANGELES	MD	SC	36.77	32.57	7.48	0.50	25.93	276.63	ARB	2002
ORANGE	SC	SC	0.04	0.04	0.03	0.00	0.03	0.34	ARB	2002
RIVERSIDE	SC	SC	39.62	35.90	10.52	0.71	28.83	301.97	ARB	2002
SAN BERNARDINO	SC	SC	63.45	57.20	14.40	1.20	44.31	473.41	ARB	2002
MARIPOSA	MC	MPA	0.00	0.00	0.00	0.00	0.00	0.00	ARB	2002
TUOLUMNE	MC	TUO	42.95	39.02	10.19	0.91	29.95	319.22	ARB	2002
NEVADA	MC	NSI	28.40	25.66	6.45	0.55	19.83	211.44	ARB	2002
SAN BERNARDINO	MD	MD	192.25	183.53	52.51	7.10	131.15	1331.72	ARB	2002

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References

Scarborough, J.; Gong, P. "Creating a Statewide Spatially and Temporally Allocated Agricultural Burning Emissions Inventory Using Consistent Emission Factors", May 2002. Report. Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER); College of Natural Resources, UC Berkeley. ARB Contract Number: 99-714.

Jenkins, B., "Atmospheric Pollutant Emission Factors from Open Burning of Agricultural and Forest Biomass by Wind Tunnel Simulation", April 1996. UC Davis. ARB Contract Number A932-126.

Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Fifth Edition, AP-42, January 1995, U.S. EPA. Table 2.5-5. Fuel loadings and EFs. AP-42 values are used where Jenkins data are not available. Section 13.1 used for forest burning.