Chapter 5

Emissions from Agricultural Burning and Alternatives to Burning and Health Considerations

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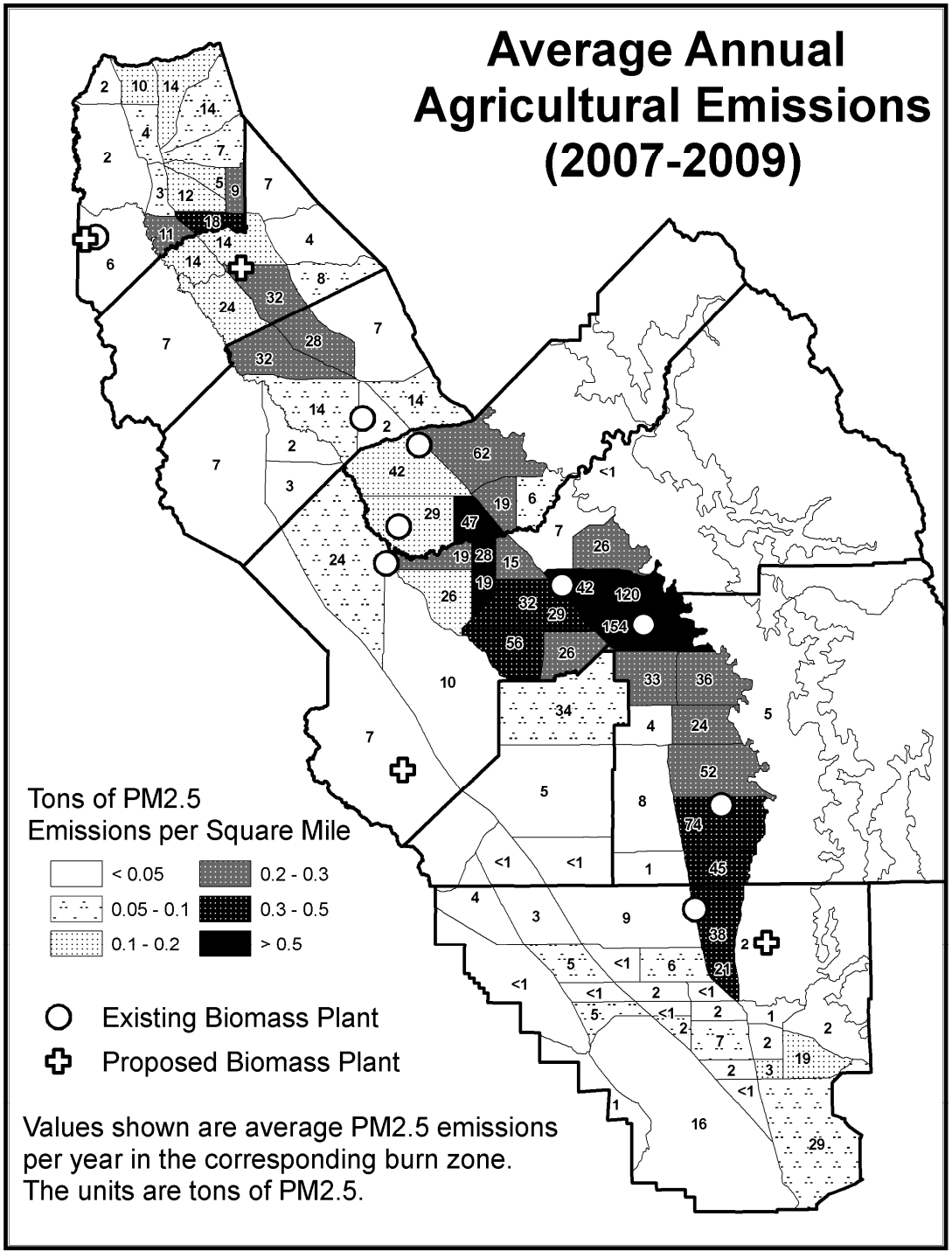
Chapter 5: EMISSIONS FROM AGRICULTURAL BURNING AND ALTERNATIVES TO BURNING, AND HEALTH CONSIDERATIONS

Figure 5.1 Map illustrating PM2.5 Emissions in the Valley from Open Burning



5.1 DISTRIBUTION OF AGRICULTURAL OPEN BURNING EMISSIONS

The map on the previous page illustrates the tons of PM2.5 emissions per square mile and existing and proposed biomass plants in the San Joaquin Valley air basin (Valley). The Sectional divisions of the map are the 103 burn allocation zones as developed by the District for use in the smoke management system (SMS). Each zone in the map is marked to illustrate the three-year average annual tons of PM 2.5 emissions per square mile generated from agricultural burning of all types for that zone between the years of 2007 and 2009. Most of the burn allocation zones with the highest emissions from agricultural burning have biomass facilities in or near them.

5.2 CURRENT EMISSIONS INVENTORY FROM AGRICULTURAL BURNING

For purposes of this report, the criteria pollutants analyzed include volatile organic compounds (VOC), oxides of nitrogen (NOx), and particulate matter (PM2.5). The 2007 Ozone Plan control measure for Open Burning (S-AGR-1) (Managed Burning and Disposal) pertains to the burning of any material including agricultural materials. The Plan identified the summer 2005 emissions inventory for open burning as 4.8 tons of NOx per day and 5.7 tons of VOC per day. In the winter, the 2008 PM2.5 Plan control measure for Open Burning (S-AGR-1) (Managed Burning and Disposal) identifies the 2005 emissions inventory for open burning as 8.16 tons of NOx per day, 10.70 tons of PM2.5 per day and 0.19 tons of SO_2 per day. As shown in Figure 5-2, agricultural burning is concentrated in winter months when PM2.5 is elevated and ozone values are relatively low.

Figure 5-2
Average Monthly Agricultural Burning (2007-2009)

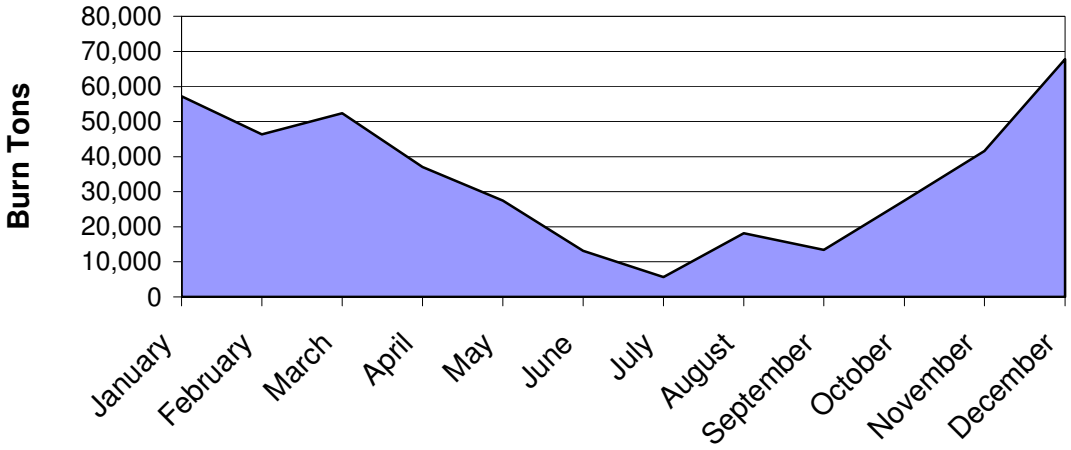


Table 5-1 below presents the burn tons, burn acres, and tons of associated criteria pollutant emissions associated with agricultural burning averaged over a three year period for specific crop types and activities. The specific crop types and activities are the crops to be analyzed for the 2010 burn prohibitions resulting from state law. Because several crops are not a part of this analysis and do not pertain to this report, the data from those crops has been omitted from the table below. The data for this table is the best available information, and came from the District SMS emission database.

Table 5-1
Average Annual Tons, Acres, and Emissions
from Open Burning of the Remaining CH&SC Crop Types (2007-2009)

Crop Name	Burn Tons	Burn Acres	Emissions (Tons)			
			NOx	PM 2.5	VOC	PM 10
Almond Pruning	51718	51718	152.57	173.26	134.47	181.01
Apple Pruning	900	391	2.34	1.66	1.03	1.75
Fig Pruning	1227	558	3.19	3.99	3.68	4.23
Pear Pruning	286	110	0.74	1.19	0.73	1.26
Pecan Pruning	501	295	1.30	1.83	1.58	1.96
Quince	47	28	0.12	0.17	0.15	0.18
Walnut Pruning	17083	14236	38.44	34.17	41.00	35.88
<20 Acre Orchard Removal (all crops)	70010	2334	182.03	255.54	220.53	273.04
Apple Orchard Removal	691	23	1.80	1.28	0.79	1.35
Citrus Orchard Removal	54035	1801	140.49	151.30	183.72	159.40
Fig Orchard Removal	2392	80	6.22	7.78	7.18	8.25
Pear Orchard Removal	490	16	1.27	2.03	1.25	2.16
Quince Orchard Removal	10	0	0.03	0.04	0.03	0.04
Brooder Paper	<1	n/a	0.00	0.00	0.00	0.00
Diseased Beehives	90	41	0.20	0.68	0.48	0.71
Goat	<1	n/a	0.00	0.00	0.00	0.003
Ponding/Levee Banks	302	139	0.68	2.29	1.62	2.40
Rice *	9049	3073	23.45	27.79	21.98	29.65
Raisin Trays	890	29683	1.90	0.33	1.94	0.35
Vineyard Removal	197140	13143	512.56	719.56	620.99	768.85
Totals:	**406,861**	**117,668**	**1,069.3**	**1,384.9**	**1,243.2**	**1,472.5**

* Note: no citrus pruning after 2005
1. Rice category includes residual rice straw, rice straw, rice stubble, and rice field levees.

Table 5-1 includes the Phase IV materials that were issued open burning permits. District staff calculated the burn acres and associated emissions from a list of the amounts of selected Phase IV materials that were issued open burning

permits, averaged from 2007-2009. The list includes almond pruning, walnut pruning, pecan pruning, vineyard removal, raisin trays, and rice stubble. The total acres burned from the three-year average of the crops previously mentioned are 109,128 acres. The emissions from such activities are presented below:

Table 5-2
Average Annual Emissions From
Open Burning of Selected Phase IV Crops (2007-2009)

Emissions	NOx	PM 2.5	VOC	PM 10
Tons per Year	706.98	929.38	800.17	988.30

5.3 EXPECTED EMISSIONS FROM ALTERNATIVES (Criteria Pollutant – PM 2.5)

Pruning Materials

The analysis in this report indicates that prunings from several crops will most likely be shredded on site, or already are shredded on site, as an alternative to open burning. The table below is a comprehensive comparison of the average annual PM 2.5 emissions from open burn versus shredding for the aforementioned crops. For purposes of this analysis, District staff assumed the average burn acres would remain constant and that all burn acres would be shredded on site.

The information for this analysis was derived by inputting the burn acre data from the "Average Annual Tons, Acres, and Emissions from Open Burning of Crops (2007-2009) table presented in Section 5-1 of this report into the District Emissions Calculator. The District Emissions Calculator incorporates the emissions from various pieces of equipment, including tractors and excavators associated with the activity, emissions from transfer and delivery vehicles, and other processes such as chipping, as well as the emission factor for each crop type and activity. The data presented in the table below is a comprehensive emission inventory encompassing all aspects of the affected crops.

Table 5-3
Comparison of the Average Annual PM 2.5 Emissions
From Open Burning and Shredding (2007-2009)

Crop Name	Burn Acres	PM 2.5 Emissions (Tons)	
		Open Burn	Shred
Almond Pruning	51718	203.0	4.8
Apple Pruning	391	3.5	0.1
Fig Pruning	558	4.8	0.1
Pear Pruning	110	1.1	0.01
Pecan Pruning	295	2.0	0.0
Quince	28	0.2	0.003
Walnut Pruning	14236	67.0	1.4
Total:	67336	281.6	6.4

Orchard Removal Materials

The analysis in this report also indicated that several crops are sent to the biomass facilities and will most likely continue to be sent to biomass facilities as biomass fuel as an alternative to open burning. The table below is a comprehensive comparison of the average annual PM 2.5 emissions from open burn versus biomass processing for the aforementioned crops. For purposes of this analysis, District staff assumed the average burn acres would remain constant and that all burn acres would be sent to the biomass plant as fuel.

The information for this analysis was derived by inputting the burn acre data from the "Average Annual Tons, Acres, and Emissions from open burning of Crops (2007-2009) table presented in Section 5-1 of this report into the District Emission Calculator. The District Emission Calculator incorporates the emissions created from various pieces of equipment, including tractors and excavators associated with the activity, emissions from transfer and delivery vehicles, and other processes such as chipping, as well as the emission factor for each crop type and activity. The data presented in the next table is a comprehensive emission inventory encompassing all aspects of the affected crops.

Table 5-4
Comparison of the Average Annual PM 2.5 Emissions
From Open Burning and Biomass Operations (2007-2009)

Crop Name	Burn Acres	PM 2.5 Emissions (Tons)	
		Open Burn	Biomass
<20 Acre Orchard Removal (all crops)	2334	264.2	32.8
Citrus Orchard Removal	1801	203.9	25.3
Fig Orchard Removal	80	9.1	1.1
Total:	4215	477.2	59.2

5.4 EMISSION REDUCTION ANALYSIS

5.4.1 Introduction

The recommendations as described elsewhere in this report will result in greater curtailment of agricultural open burning currently allowed under District Rule 4103. The recommendations will result in the following additional prohibitions:

Orchard Removals

- The prohibition of burning of all orchard removals from fig crops over 15 acres (District Rule 4103 currently allows burning at all acreage sizes).

- The prohibition of burning of all orchard removals for all crops (with the exception of citrus, apples, pears, and quince) with acreages over 15 acres up to and including 20 acres (District Rule 4103 currently allows burning of acreages in this range).

Prunings

- The prohibition of burning of all orchard pruning material from fig crops for all acreages (District Rule 4103 currently allows burning at all acreage sizes).

- The prohibition of burning of prunings for each agricultural operation whose total nut acreage (i.e., almonds, walnuts, and pecans) at all agricultural operation sites is 3,500 acres or more. For each agricultural operation whose total nut acreage at all agricultural operation sites is less than 3,500 acres, burning of up to 20 acres of prunings per year is allowed plus additional acreage when a determination of economic hardship is made by the District (District Rule 4103 currently allows burning at all acreage sizes).

The estimated emission reductions to be achieved by the new prohibitions listed above are presented in Table 5-5. Details of the emission reduction analysis are discussed in the next section (Methodology and Calculations).

Table 5-5
Total Annual Emission Reductions from All New Open Burning Prohibitions

Category	Crop	Nox (ton/year)	PM2.5 (ton/year)	VOC (ton/year)
Orchard Removals	Figs	2.8	6.7	6.1
	All Orchards Less Than 20 Acres*	25.8	61.7	56.4
Orchard Prunings	Figs	0.4	2.1	1.7
	Almond	9.5	48.8	38.0
	Pecan	0.0	0.1	0.1
	Walnut	0.7	3.7	2.9
Total		39.2	123.1	105.2

* except citrus, apples, pears and quince

5.4.2 Methodology and Calculations

Step 1: Determine the reduction in acreage which will be burned as a result of the new prohibitions

District staff analyzed information collected during 2007-2009 from the District's Smoke Management System (SMS) in order to estimate the reduction in acreage of burning resulting from the new prohibitions. The SMS manages agricultural open burning in the San Joaquin Valley Air Basin (SJVAB) and collects and maintains information pertinent to the amount and type of material burned in the SJVAB. For each permitted open burning operation during the time period, the SMS identifies the specific item burned and the associated acreage.

In order to estimate the reductions in acreage of orchard burning resulting from each of the new orchard prohibitions listed, it was assumed that average annual acreage of permitted burns in the SMS for the period 2007-2009 is representative of the expected burning reduction for each category.

Extraction and analysis of data from the SMS for orchard removals yielded the following annual reductions in acres burned:

Table 5-6 Data from the SMS for Orchard Removal and Pruning

New Prohibition	Annual Reduction in Acreage Burned
Orchard removals from fig crops over 15 acres	61
Orchard pruning material from fig crops for all acreages	557
Orchard removals for all crops (with the exception of citrus, apples, pears, and quince)	560
Almond pruning material	12,670
Pecan pruning material	22
Walnut pruning material	969

Step 2: Establish Applicable Emission Factors on a Per Acre Basis

Differential emission reduction factors for orchard removals and for orchard prunings, along with the basis for their development, are presented in Tables 5-7 and 5-8 respectively of the cost and emissions section of this staff report (Chapter 5).

Differential emission reduction factors for orchard removals (assuming 30 tons dry biomass per acre) are based on chipping and conversion of the removed trees to biomass fuel rather than burning:

Differential Emission Factor (tons/acre) = Burning Emission Factor (tons/acre) - Chipping/Biomass Emission Factor (tons/acre)

From Table 5-4 of the cost and emissions section the differential emission factors for orchard removals between 15 and 20 acres are:

NO_x 0.0460 tons per acre
$PM_{2.5}$ 0.1101 tons per acre
VOC 0.1007 tons per acre

Differential factors for prunings (assuming 1 ton of dry prunings per acre) are based on chipping and land incorporation of prunings in lieu of burning:

Differential Emission Factor (lb/acre)	=	Burning Emission Factor (lb/acre)	-	Land Incorporation Emission Factor (lb/acre)

From Table 5-8 of the cost and emissions section the differential emission factors for orchard prunings are:

NO_x 1.5 lb per acre
$PM_{2.5}$ 7.7 lb per acre
VOC 6.0 lb per acre

Step 3: Apply Applicable Emission Factor to Acreage Data Extracted from the SMS

Tables 5-11 and 5-12 present the results for orchard removals and prunings respectively.

Table 5-7
Emission Reductions from New Orchard Removal Prohibitions

Prohibition			Acres Reduced per SMS	NOx		PM2.5		VOC	
Crop	Current Permitted Open Burning	New Prohibition		Differential Emission Factor (ton/acre)	Annual Emission Reduction (tons)	Differential Emission Factor (ton/acre)	Annual Emission Reduction tons)	Differential Emission Factor (ton/acre)	Annual Emission Reduction tons)
Figs	Permitted at all acreages	Prohibited for acreage greater than 15 acres	61	0.046	2.8	0.1101	6.7	0.1007	6.1
All other crops (with the exception of citrus, apples, pears, and quince)	Permitted for 20 acres or Less	Prohibited for acreage greater than 15 acres	560	0.046	25.8	0.1101	61.7	0.1007	56.4

Table 5-8
Emission Reductions from New Orchard Pruning Prohibitions

Prohibition			Acres Reduced per SMS	NOx		$PM_{2.5}$		VOC	
Crop	Current Permitted Open Burning	New Prohibition		Differential Emission Factor (lb/acre)	Annual Emission Reduction (ton)	Differential Emission Factor (lb/acre)	Annual Emission Reduction (ton)	Differential Emission Factor (lb/acre)	Annual Emission Reduction (ton)
Figs	Permitted at all acreages	Prohibited for all acreages	557	1.5	0.4	7.7	2.1	6.0	1.7
Almond (surface harvested crop)	Permitted at all acreages	Prohibited for acreage greater than 20 acres	12,670	1.5	9.5	7.7	48.8	6.0	38.0
Pecan (surface harvested crop)	Permitted at all acreages	Prohibited for acreage greater than 20 acres	22	1.5	0.0	7.7	0.1	6.0	0.1
Walnut (surface harvested crop)	Permitted at all acreages	Prohibited for acreage greater than 20 acres	969	1.5	0.7	7.7	3.7	6.0	2.9

5.5 HEALTH BENEFITS OF REDUCED OPEN BURNING

Given the minimal impact of open burning on ozone levels in the Valley mentioned above, this discussion emphasizes the health benefits of reduced open burning and associated PM 2.5 emissions. Prior scientific studies as well as District experience have shown the importance of steadily reducing population exposure to PM 2.5 through controls on residential wood burning and open burning. The San Joaquin Valley experiences some of the highest annual average concentrations of PM 2.5 in the nation. Well-defined epidemiological relationships have been established between exposure to elevated PM 2.5 and a range of health endpoints, including ischemic heart disease, asthma, chronic bronchitis, premature mortality, and others. The region can experience multi-day periods of atmospheric stagnation during which very little air mass is transferred in and out of the Valley. The net result can be a daily buildup of PM 2.5 levels, sometimes beyond the 24 hour federal standard of 35 $\mu g/m^3$.

Unlike areas such as Southern California where PM 2.5 levels are more distributed throughout the year, fine particulates are seasonally concentrated in the Valley. Because of this seasonal concentration effect, District controls currently imposed on open burning and residential wood burning have had a disproportionate effect in reducing wintertime PM 2.5 concentrations. In the case of residential wood burning, an external scientific evaluation was conducted by California State University (CSU) Fresno of Rule 4901's periodic curtailments (see www.cvhpi.org). This assessment found that as of the winter 2007-08 season (prior to the October 2008 amending of Rule 4901), daily curtailments coupled with reduced household wood burning overall had resulted in a 12.9% and 13.6% reduction in annual PM 2.5 concentrations for Bakersfield and Fresno, respectively. Using the US EPA's BenMAP model for calculating health benefits of reduced PM2.5 exposure, these reductions translated into significant public health benefits, including significantly reduced cardiovascular disease, pulmonary disease, and pre-mature deaths.

A key element in this success has been the imposition of restrictions in residential wood burning on days when meteorological conditions create the risk of health standard violations. Initially, as of November 1, 2003, that threshold was established at the 1997 24 hr. PM 2.5 standard of 65 $\mu g/m^3$. As amended in October 2008 for the 2008-09 winter season, that daily curtailment threshold was substantially reduced to 30 $\mu g/m^3$. That reduced curtailment threshold has benefited public health in three ways: First, it has resulted in an absolute reduction in the total seasonal tonnage of residential wood burned. Second, it has insured that on days when wood burning is allowed, each ton of emissions is more thoroughly diluted and dispersed, with attendant reductions in harmful peak exposures. And third, by restricting burning to days with reasonably good

atmospheric dispersion, the formation of secondary aerosols such as ammonium nitrate during multi-day stagnation events is minimized.

By restricting the analysis to the Bakersfield and Fresno/Clovis metro areas, the health evaluation of Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) was made possible by a well-defined pre-and post-Rule 4901 population exposure estimate for PM2.5. However, in the case of health benefits from reduced burning under Rule 4103, it is not possible to replicate this analysis for several reasons. First, ambient monitors are generally not found in rural areas. In addition, the population density is considerably lower. As a result, estimating accurate population exposure reductions resulting from current or estimated reductions on agricultural burning is very difficult and not attempted here.

However, it is possible to draw on the experience of the District evaluation of Rule 4901 to draw some reasonable conclusions that provide a public health justification for past and prospective reductions in open burning under Rule 4103. First, the basin-wide emissions inventory for open burning and residential wood combustion are comparable. According to the 2008 CARB emissions inventory, estimated tons per day (tpd) of PM2.5 from wood burned by households was 9.5 and 14.8 for agricultural material. Second, it is important to note at that as of December 2009, daily county-level curtailments of open burning are based on the same predicted 24 hr. 30 $\mu g/m^3$ concentration threshold used in Rule 4901. This means that a predominant source of rural and urban open burn emissions has been eliminated on low dispersion days, with corresponding reductions in overall exposure to individuals in areas where open burning is occurring, as well as minimizing exposure to secondary PM2.5.

Reduced emissions from Rule 4103 are presented below in Table 5-9. In a historical sense, reductions achieved to date represent a very rapid rate of emission decline in a given economic sector, with attendant health benefits to a more dispersed, rural population.

Table 5-9
Reductions in Criteria Pollutants Under Rule 4103 Since 2004

	NOx	PM10	PM2.5	VOC	CO
Total Tonnage Reduction Since 2004	1,217	1,981	1,860	1,516	15,273
% Reduction Since 2004	48.9%	52.7%	52.6%	50.4%	48.5%
TPD Reduction Since 2004	3.3	5.4	5.1	4.2	41.8

Additional reductions anticipated under the amended Rule 4103 are shown above. The more modest reductions arising from the recommendations reflect the current balance of commodity profitability and costs for processing at biomass plants, as defined by the CH&SC. Past experience has shown that the

per unit costs of alternative disposal options with less environmental impacts tend to decline over time due to, in this case, new biomass plant capacity and the emergence of alternative disposal technologies. The District supports legislation that will encourage, promote and facilitate alternative uses for agricultural material as well as policies and initiatives that encourage renewable energy and energy efficiency including supporting legislation that provides additional biomass capacity utilizing agricultural materials. It is likely that the current constraints on open burning emission reductions imposed by the CH&SC will be reduced over time, with proportional health benefits.

5.6 HEALTH RISK ASSESSMENT OF OPEN BURNING AND ALTERNATIVES

Often under the requirements of CEQA-mandated risk assessments, the District routinely employs several health risk assessment (HRA) models in order to estimate health risks posed by exposure to air pollutants from existing or hypothetical sources. These HRA models are based on the following elements: (1) knowledge from prior scientific studies about the relative toxicity of pollutants, (2) similar knowledge about the relative effects of increased concentrations of a given pollutant, (3) the hourly rate of emissions by mass or parts per volume, i.e. emission factor, from a given source and the duration of those emissions, (4) specification of meteorological conditions, (5) how the pollutants are dispersed and/or transformed in the atmosphere, (6) a gradient or exposure surface that specifies various concentration levels at a given distance from a source and time, (7) (in some cases) the spatial distribution and characteristics of the exposed population, and (8) (in some cases) whether and how different sub-populations may be differentially affected such as children to a given level and duration of exposure.

To evaluate the acute (short-term) and chronic (long-term) health impact of open burning of agricultural material and alternative disposal methods, the following scenarios were analyzed (modeled):

Scenario 1: Open burning of prunings from 20 acres of nut trees. Emission sources included diesel exhaust from equipment used to form the burn piles, and emissions from combustion of the organic material.

Scenario 2: Land incorporation of prunings from 20 acres of nut trees. Emission source included diesel exhaust from equipment used to shred and incorporate prunings into the soil.

Scenario 3: Transfer of prunings from 20 acres of nut trees to a biomass facility. Emission sources included diesel exhaust from equipment used to collect and chip/shred prunings, diesel exhaust from trucks used to transport the chipped material to the biomass plant, diesel exhaust

from equipment used to unload and process the chipped material at the biomass plant, and emissions from the biomass combustor.

Scenario 4: Open burning of 20 acres of nut trees (orchard removal). Emission sources included diesel exhaust from equipment used to form the burn piles and emissions from the combustion the organic material.

Scenario 5: Transfer of 20 acres of nut trees (orchard removal) to a biomass facility. Emission sources included diesel exhaust from equipment used to collect and chip/shred the orchard material, diesel exhaust from a truck used to transport the chipped material to the biomass plant, diesel exhaust from equipment used to unload and process the chipped material at the biomass plant, and emissions from the biomass combustor.

5.6.1 Methodology and Calculations

Emissions for each scenario evaluated were calculated using District-developed spreadsheets and the parameters listed below:

Table 5-10
Variables used to estimate scenario emissions

Variables	Prunings	Orchard Removal
Crop type	Orchard	Orchard
Ag material (acres)	20	20
Material removed (tons/acre)	1	30
Roots removed (tons/acre)	0	1
Field equipment activity (hours/acre)	1	1
Power plant equipment activity (hours/acre)	2	2
Ag material delivered to power plant (tons/truck)	24	24
Round trip distance to power plant (miles)	100	100

Off-road diesel equipment was used to process crop material in the field and at the biomass facility. Off road equipment activity was modeled as an area source over the entire surface of the orchard or that portion of the biomass facility used to receive and process wood chips. All particulate matter from off-road diesel equipment exhaust was modeled as diesel particulate matter (DPM). Relative risks generated by air contaminants from the open burning of agricultural material were calculated using the California Air Resources Board (CARB) particulate matter speciation profile 450 for particulates, and emission factors from Lemieux, Lutes and Santoianni (2002) for volatile organic compounds. Emissions from open burn piles were modeled as point sources to allow for thermal loft from the heat of combustion. The open burning of orchard prunings was assumed to

occur in four separate piles located at the southern border of the orchard. The open burning of the orchard removal material was assumed to occur in twenty piles evenly distributed within the orchard over a 24 hr. period. All particulate matter from on-road diesel truck exhaust was modeled as DPM. On-road truck travel was modeled as a line source consisting of a one mile series of volume sources.

To calculate pollutant dispersion and the resulting exposure gradient, the AERMOD model was used. Meteorological data for 2004-2008 from Bakersfield was employed to determine the dispersion factors (i.e., the predicted concentration or X divided by the normalized source strength or Q) for a receptor (human population) grid. These dispersion factors were input into the Hot Spots Analysis and Reporting Program (HARP) risk assessment module to calculate the chronic and acute hazard indices as well as the carcinogenic risk for five scenarios outlined above. No actual locations and nearby populations were used in the model analysis.

5.6.2 Health Risk Assessment Results

Worst case health risks for the open burning of agricultural material and their alternatives are presented in Table 5-11 (pruning scenario) and Table 5-12 (orchard removal scenario). The model results for open burning of prunings show that the cancer risk and chronic hazard indices are very low and not of concern for all disposal options. The acute hazard index in this case pertains to risk of an acute respiratory response over the short-term (24 hour) exposure generated by the burning of the prunings for a person standing within 25 meters of the burn piles. In this air pollutant modeling scenario, any acute hazard index score of over 1.0 indicates the potential for a negative impact on respiratory health. As shown, this threshold is not exceeded for a maximum 24 hour. exposure scenario.

In the case of a worst-case health risk assessment for orchard removal options are shown in Table 5-11. As in the case of prunings, cancer and chronic hazard indices for all options are very low values that do not indicate excessive risk. As shown in Figure 5-3, the open burning exposure scenario is based on the assumption that removed trees are put into 20 piles, one per acre, and burned simultaneously. In this case, the acute hazard index score for 24 hr. exposure in the zone nearest the burn piles is excessive (10.70). As one moves further from the burn zone this relative hazard to short-term respiratory health drops relatively quickly, falling by approximately 50% after 500 meters and to an acceptable level of less than 1.0 after 1,000 meters.

Table 5-11
Comparative Pruning Risk (20 Acres): Open Burning vs. Chipping/Shredding and Incorporation vs. Biomass Facility

Source	Health Risk		
	Maximum Individual Cancer Risk[2] (x 10^{-6})	Acute Hazard Index	Chronic Hazard Index
Orchard Burning	3.32	0.83	0.07
Land Incorporation	7.59	nc[1]	nc
Biomass Facility – Off Site			
Orchard	9.69	nc	nc
Transit	0.00	nc	nc
Off Site Total	9.69	nc	nc
Biomass Facility – On Site			
Facility	0.10	0.00	0.00
Transit	0.00	nc	nc
On Site Total	0.10	0.00	0.00

[1] Acute and Chronic Hazard Indices were not calculated since there is no risk factor or the risk factor is so low that it has been determined to be insignificant for this type of unit.
[2] 70 year exposure used.

Table 5-12
Comparative Orchard Burning Risk (20 Acres): Open Burning vs. Chipping/Shredding, On-Site Biomass Facility vs. Off-Site Biomass Facility

Source	Health Risk		
	Maximum Individual Cancer Risk[2] (x 10^{-6})	Acute Hazard Index	Chronic Hazard Index
Orchard Burning	2.69	10.70	0.58
Biomass Facility – Off Site			
Orchard	1.84	nc[1]	nc
Transit	0.09	nc	nc
Off Site Total	1.93	nc	nc
Biomass Facility – On Site			
Facility	0.55	0.00	0.00
Transit	0.09	nc	nc
On Site Total	0.65	0.00	0.00

[1] Acute and Chronic Hazard Indices were not calculated since there is no risk factor or the risk factor is so low that it has been determined to be insignificant for this type of unit.
[2] 9 year exposure used.

Figure 5-3
Acute Respiratory Risk Isopleths for Open Burning of Prunings (24 hr exposure)

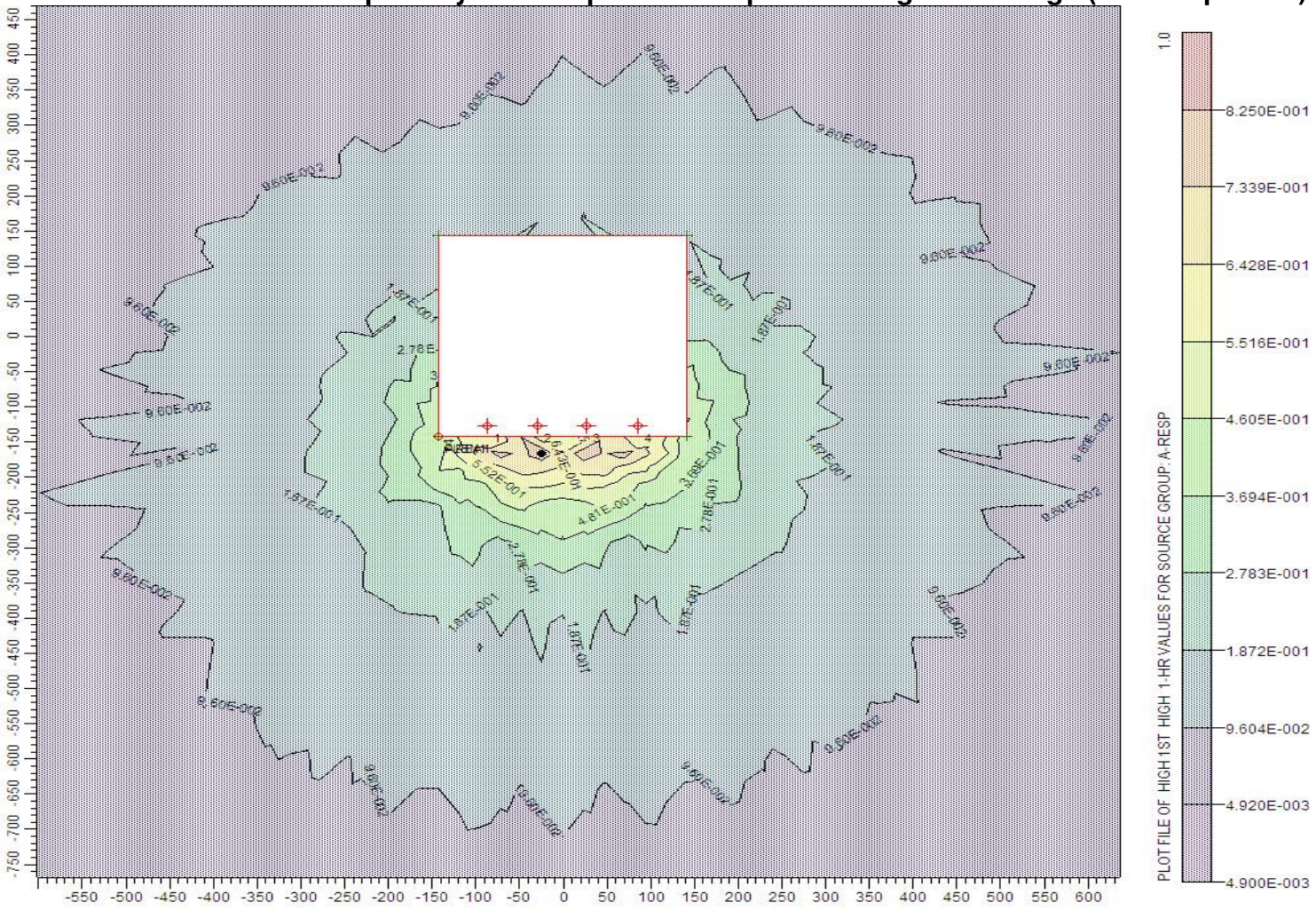
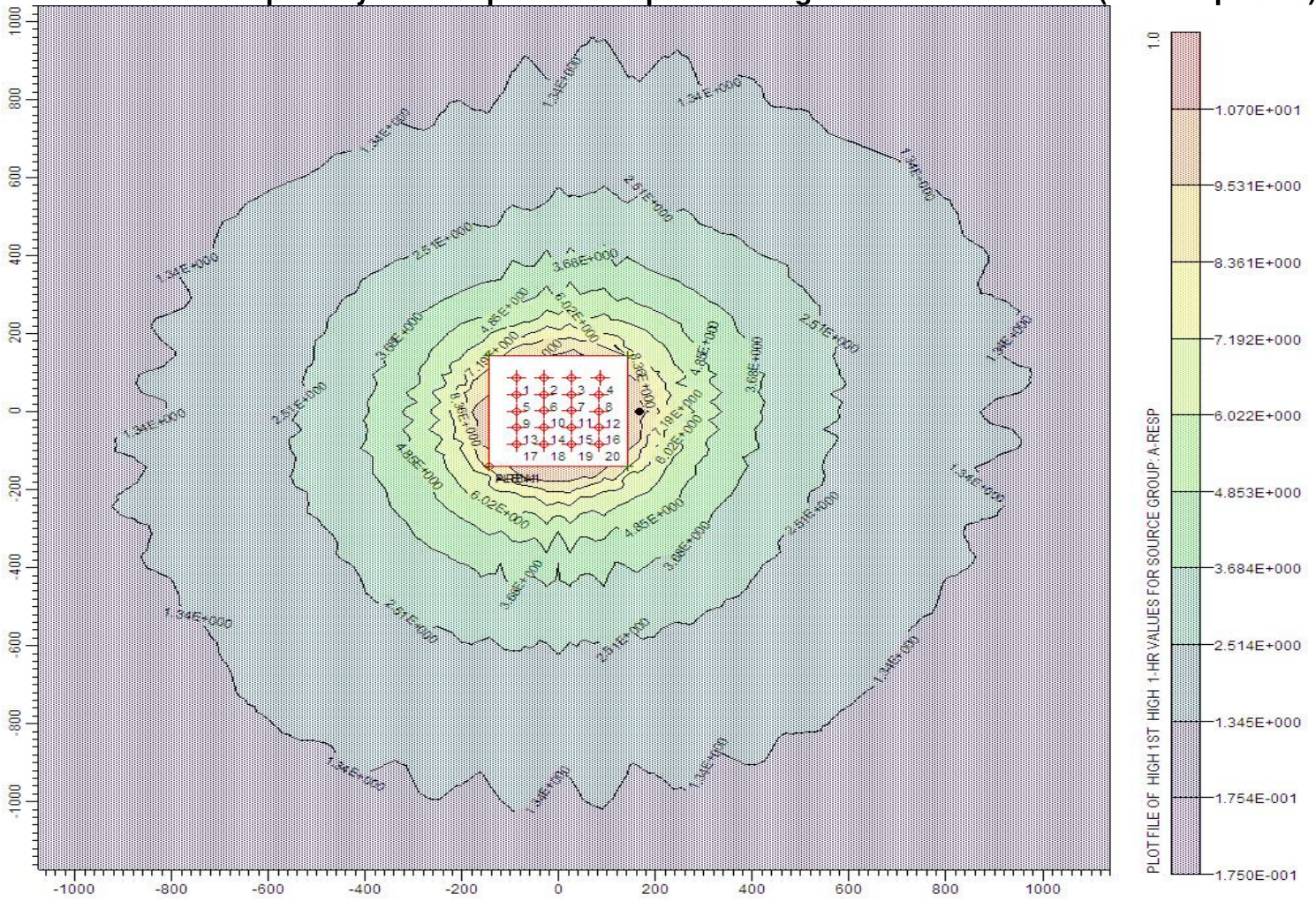


Figure 5-4
Acute Respiratory Risk Isopleths for Open Burning of Orchard Removal (24 hr exposure)



There are a number of practices currently employed by District Compliance staff under the policy for Rule 4103 that are designed to minimize the potential health hazard of orchard removal burnings of this scale. The Appendix A (p. 7) from the Rule 4103 District Policy identifies the conditions that must be satisfied when District Compliance staff conduct their mandatory field site inspections prior to granting approval to proceed with burning:

> **Burn permits issued in rural residential areas**, or in other areas where smoke may affect smoke sensitive areas, must include site-specific instructions and permit conditions. The instructions and/or conditions must limit the possible smoke impact on nearby neighbors and/or smoke sensitive areas.
>
> 1. The permit applicant must be advised that only those materials produced along with the crop and listed on the burn permit may be permitted to burn.
>
> 2. Additional permit conditions may stipulate any or all of the following:
>
> a. The wind direction required at the time of ignition
> b. The burn site location on the property
> c. The day(s) of the week the burning may occur
> d. The time of day a burn may be ignited
> e. The time of day to cease burning or cease adding material to the fire
> f. The size of the burn pile permitted to be burned at one time
> g. The permit will be issued for the duration of need only.

Compliance Appendix A (p. 35) from the Rule 4103 District Policy also makes explicit limits on burning in smoke sensitive areas with greater population densities or facilities with sensitive individuals:

> **SMOKE SENSITIVE AREAS**: Smoke sensitive areas are populated areas or other areas where smoke and air pollutants can adversely affect public health or welfare. These areas can include cities, towns, communities, campgrounds, trails, recreational areas, hospitals, nursing homes, medical clinics, schools, day-care centers, roads and highways, airports, public events, and shopping centers.
>
> A District on-site inspection is required near dense populations or smoke sensitive areas. If the District determines there is a reason to believe smoke produced from a proposed burn may cause

complaints or create a nuisance, the burning may only be permitted under the following conditions:

A. The District must determine there is no other reasonable method of disposal.

B. The quantities of materials to be burned shall be limited as needed.

C. The days burning may be authorized may be limited. For example, a burn site upwind from a school may have to limit burning to when school is not in session, such as on weekends or during school vacation provided that no other special events or school functions are occurring during these off times.

D. Permittee must establish and provide an at-ready means to extinguish the fire if directed to do so by the District or any public officer.

E. Additional permit conditions may stipulate:

1. The wind direction required at the time of ignition.
2. The burn site location on the property.
3. The day(s) of the week the burning may occur.
4. The time of day a burn may be ignited.
5. The time of day to cease burning or cease adding material to the fire.
6. The size of the burn pile and/or the number of burn piles authorized to burn at one time.
7. The permit will be issued for the duration of need only.

F. If any of the conditions provided above cannot be met, such burning shall not be permitted.

Because of these limitations, excess acute health risks from orchard removals are minimized. As noted above, the overall trajectory of health risks from agricultural open burning has been following a steep downward path since 2004. The results of this health risk assessment underscore the logic of (1) the current balance stuck under the current CH&SC between the economic costs of alternatives to burning on the one hand and the potential health impacts of open burning on the other, as well as (2) the ongoing importance of finding new incentives and technologies for the long-term elimination of open burning of agricultural materials.

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