USE INFORMATION AND AIR MONITORING RECOMMENDATION FOR 1,3-DICHLOROPROPENE, METHYL BROMIDE, CHLOROPICRIN, AND METHYL IODIDE

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Daniel R. Oros
Environmental Scientist

Rosemary Neal
Staff Environmental Scientist

California Department of Pesticide Regulation
Environmental Monitoring and Pest Management Branch

ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

STATE OF CALIFORNIA
Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring Branch
1001 I Street
Sacramento, California, 95814

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1. BACKGROUND

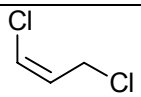
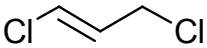
This recommendation contains general information regarding the physical and chemical properties of 1,3-dichloropropene (1,3-D), methyl bromide (MeBr), and methyl iodide (MeI) and the reported historical uses as pesticides in California. The Department of Pesticide Regulation (DPR) provides this information to assist the Air Resources Board (ARB) in their selection of appropriate locations for conducting pesticide air monitoring operations.

1.1. Physical and Chemical Properties

1,3-Dichloropropene

Table 1 lists some of the physical and chemical properties of 1,3-D.

Table 1. Physical and chemical properties of 1,3-dichloropropene

Chemical name	1,3-Dichloropropene	
Common name	1,3-Dichloropropene, 1,3-D	
Chemical structure	 (Z)-1,3-Dichloropropene	 (E)-1,3-Dichloropropene
Registered Trade names	Telone II, Tri-Form	
CAS number	542-75-6	
Empirical formula	$C_3H_4Cl_2$	
Molecular weight	111.0	
Appearance	Colorless-to-amber liquid with sweet penetrating odor (Tomlin, 2000)	
Vapor pressure	3.43×10^{1} mmHg at 25°C (Kollman and Segawa, 1995)	
Solubility	2 g/L at 20°C (Tomlin, 2000)	
Henry's Law constant	2.29×10^{-3} atm-m3/ mole at 25°C (Kollman and Segawa, 1995)	
Soil adsorption coefficient (Kd)	3.91×10^{-1} g/cm3 (Kollman and Segawa, 1995)	
Hydrolysis half-life (20°C)	11.3 days (CDPR, 2010)	
Soil degradation half-life	Aerobic: 11.5 to 53.9 days (Kollman and Segawa, 1995) Anaerobic: 2.5 days at 25°C (Tomlin, 2000)	

† Disclaimer: The mention of commercial products, their source, or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

1,3-D is a preplant soil fumigant used primarily for controlling all major species of nematodes, including root knot, lesion, stubby root, dagger, ring, and cyst nematodes. 1,3-D is injected into the soil as a liquid where it immediately converts to a gas, creating a zone of protection around developing roots. Table 1 depicts the chemical structures of the two isomers of 1, 3-D. The technical product is a mixture of approximately equal quantities of (E) or trans isomer and the (Z) or cis isomer, of which the (Z) isomer is more nematicidally active (Tomlin, 1997).

Methyl Bromide

Table 2 lists some of the physical and chemical properties of MeBr.

Table 2. Physical and chemical properties of methyl bromide[1]	
Chemical name	Methyl bromide
Common name	Methyl bromide, Bromomethane
Chemical structure	H_3C-Br
Registered Trade names	Metabrom, Terro-O-Gas
CAS number	74-83-9
Empirical formula	CH_3Br
Molecular weight	94.9 grams/mole
Appearance	Non-flammable, colorless, odorless gas at room temperature (Tomlin, 2000)
Vapor pressure	215,449 Pa at 25°C
Solubility	Water: 13,400 mg/L at 25°C
Henry's Law constant	1.59×10^{-2} (calculated value)
Soil adsorption coefficient (Kd)	3.45 - 9.4
Soil degradation half-life	Aerobic: 0.15 to 17 days Anaerobic: 1.63 – 6.0 days

[1] Data from: Kollman, W., Segawa, R. 1995. Interim report of the pesticide chemistry database. Report No. EH 95-04. California Environmental Protection Agency, Department of Pesticide Regulation. Sacramento, California.

[†] Disclaimer: The mention of commercial products, their source, or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

MeBr is used as a fumigant against insects, termites, rodents, weeds, nematodes, and soil-borne diseases (EXTOXNET, 2010). About 70% of MeBr produced in the U.S. goes into pesticide formulations. MeBr is odorless, except at high concentrations, and is generally used with a warning agent such as chloropicrin. The MeBr product labels offer several methods for application including: chamber and vault fumigation, vacuum chamber fumigation, tarpaulin fumigation, warehouse, grain elevator, food processing plant, restaurant and other structures containing commodities, and shipboard fumigations. MeBr is available as a gas fumigant, is a restricted use pesticide due to its acute toxicity, and includes the Signal Word "Danger" on the label. Table 2 depicts the chemical structure of MeBr.

Methyl Iodide

Table 3 lists some of the physical and chemical properties of MeI.

Table 3. Physical and chemical properties of methyl iodide	
Chemical name	Methyl Iodide
Common name	Methyl iodide, Iodomethane
Chemical structure	H_3C-I
Registered Trade names	Midas, TM-425 Technical
CAS number	74-88-4
Empirical formula	CH_3I
Molecular weight	141.95
Appearance	Colorless transparent liquid (turns brown on exposure to light)
Vapor pressure	410 mmHg (54,662 Pa) at 25°C (CDPR, 2010)
Solubility	14,200 mg/L at 25°C (CDPR, 2010)
Octanol/Water Partition (Kow)	Log Kow = 1.51 (Hansch et al. 1995)
Henry's Law constant	5.4×10^{-3} atm-m^3/ mole at 25°C (CDPR, 2010)
Soil adsorption coefficient (Kd)	0.7 g/cm^3 (CDPR, 2010)
Hydrolysis half-life	113 days (25°C, pH 7) (CDPR, 2010)
Soil degradation half-life	Aerobic: 0.083 days at 20°C in Sandy Loam (CDPR, 2010)
† Disclaimer: The mention of commercial products, their source, or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.	

MeI is a preplant biocide used primarily for controlling insects, plant parasitic nematodes, soil borne pathogens, and weed seeds. The USEPA approved its use as a preplant soil treatment for field grown strawberries, peppers, tomatoes, stone fruits, tree nuts, grape vines, ornamentals and turf and nursery grown strawberries, stone fruits, tree nuts, and conifer trees (USEPA, 2007). There are currently no registered MeI products in California. Monitoring for MeI is needed only if DPR registers this pesticide. Proposed methods of application for MeI include raised bed-shank injection (75-175 lbs active ingredient (a.i)./treated acre), broadcast/flat fume-shank injection (100-175 lbs a.i./acre), auger probe-deep injection (0.5-2 lbs a.i./injection site), and raised bed-drip application (100-175 lb a.i./treated acre). Table 3 depicts the chemical structure of MeI.

1.2. Environmental Fate Brief

1,3-Dichloropropene

Air: 1,3-D is quickly broken down in air, usually within several days, depending on the concentrations of (Z) and (E) isomers and reactive hydroxyl radicals. Air half life $t_{1/2}$ is 2.9 to 27.8 h based on estimated rate constants for reaction with hydroxyl radicals and ozone in air (Howard et al., 1991). 1,3-D is rarely detected in urban air samples with measured levels usually

less than 0.5 parts per billion (ppb). Higher levels (5 ppb and lower) were measured in areas where there is high 1,3-D use (ATSDR, 2008).

Soil and Water: A significant proportion of the 1,3-D released into soil or surface waters is expected to volatilize into the atmosphere. 1,3-D is non-persistent in soils undergoing hydrolysis to the corresponding 3-chloroallyl alcohols. Its soil half life $t_{1/2}$ is 133 to 271 h based on measured rate of hydrolysis at pH 7 and 25°C (Howard, 1991). Low levels of 1,3-D have been measured in water samples and the average concentration was 0.5 ppb (ATSDR, 2008). 1,3-D may also undergo biodegradation or hydrolysis in natural waters.

Methyl Bromide

Air: The high vapor pressure suggests that volatilization is the most important route of dissipation. MeBr is a short-lived chemical in the atmosphere with a half life $t_{1/2}$ = 2.4 to 24 h, based on the reaction with hydroxyl radicals (USEPA, 1974). Howard et al. (1991) reported an air half life $t_{1/2}$ = 1633 to 16327 h, based on a measured rate constant for the vapor phase reaction with hydroxyl radical in air.

Soil and Water: MeBr readily evaporates at temperatures normally encountered during fumigation, but some of the chemical may become entrapped in soil following application (EXTOXNET, 2010; Wauchope et al., 1992). Transformation of MeBr to bromide increases as the amount of organic matter in the soil increases. MeBr is very poorly sorbed by soils. It has a soil half life $t_{1/2}$ = 168 to 672 h, based on unacclimated aerobic aqueous screening test data for bromoform from experiments utilizing settled domestic wastewater inoculum (Tabak et al., 1981). MeBr is soluble in water and can hydrolyze forming methane and hydrobromic acid with an estimated hydrolysis half-life $t_{1/2}$ = 20 days in water at 25°C and pH 7 (Montgomery, 1997). Runoff from fields into surface waters is rare since MeBr quickly evaporates at temperatures encountered during fumigation.

Methyl Iodide

Air: The high vapor pressure and low affinity for sorption on soil suggest that volatilization is the most important environmental route of dissipation (USEPA, 2007). Once volatilized to the air MeI rapidly degrades due to direct photolysis. MeI is a short-lived chemical in the atmosphere with an air half life $t_{1/2}$ = 2.4 to 24 h, based on the reaction with hydroxyl radicals (USEPA, 1974). Howard et al. (1991) reported an air half life $t_{1/2}$ = 535 to 5348 h, based on a measured rate constant for the vapor phase reaction with hydroxyl radical in air. Estimated air concentrations are highest on the pesticide application day with estimated concentrations ranging from 0.987 ppm at 30 cm above the tarp and up to 0.453 ppm at 80 cm above the tarp. These values are estimated flux values based on cumulative charcoal tube residues collected following an application of 242 lb. a.i./acre (USEPA, 2007).

Soil and Water: A significant proportion of MeI released into soil is expected to volatilize into the atmosphere. Its soil half life $t_{1/2}$ = 168 to 672 h, based on estimated aqueous aerobic biodegradation half-life (Howard et al., 1991). MeI can undergo hydrolysis in surface waters (Hydrolysis half life $t_{1/2}$ = 113 days at 25°C and pH 7; DPR, 2010). MeI's low Henry's Law

Constant (K_H = 5.4 X 10^{-3} atm-m^3/ mole) suggests that it is rapidly volatilized to the atmosphere. However, because, MeI is soluble in water, there is the possibility of leaching to ground water if a field application is immediately followed by a rain event (USEPA, 2007).

1.3. Toxicity Brief

1,3-Dichloropropene

Humans: Possible routes of human exposure to 1,3-D include inhalation of contaminated air, ingestion of contaminated drinking water, and dermal contact with pesticides containing 1,3-D. Consistent with its reactive properties, some of the major effects of exposure occur at the point of contact: nasal epithelium following inhalation exposure, stomach following oral exposure, and skin following dermal exposure (ATSDR, 2008). Also, case reports of high level exposures confirm portal-of-entry effects in the respiratory system after inhalation exposure, gastrointestinal effects following accidental ingestion, and contact dermatitis leading to sensitization reactions following dermal exposure (ATSDR, 2008). Additional effects noted following high-level exposure included cardiovascular effects prior to multiorgan failure and death (ATSDR, 2008).

According to DPR (1994) metabolism and pharmacokinetic data on 1,3-D indicate facile conjugation as a mercapturate, and renal elimination after inhalation. The primary mode of exposure is inhalation, with dermal adsorption of the vapor considered unimportant. Inadvertent exposure of humans during application equipment failure or repair has resulted in skin and/or eye irritation. Furthermore, biological monitoring of workers demonstrated an estimated Absorbed Daily Dosage of 1.9 µg/kg/day (1.13 and 0.73 µg/kg/day for application and loading, respectively), when adjusted for respiratory protection worn during the entire fumigation cycle. Non-occupational inhalation exposure for residents of a Telone reinstatement area was estimated by stochastic simulation. Estimated 95th percentile Lifetime Average Daily Dosages ranged from 0.167 ug/kg/day for residents living 500 m from treated fields for 30 years, to 0.373 ug/kg/day for residents living 100 m from fields for 70 years. Estimated 95th percentile 62-day Average Daily Dosages ranged from 0.674 µg/kg/day for infants living 500 m from treated fields, to 6.272 µg/kg/day for young children living 100 m from fields.

Other Species: 1,3-D LD_{50} for bobwhite quail is 152 mg/kg, while the dietary LC_{50} (5 day) for bobwhite quail and mallard ducks is >10000 mg/kg diet (Tomlin, 2000). 1,3-D 96-hour LC_{50} for rainbow trout is 3.9 mg/L, while for bluegill sunfish the 96-hour LC_{50} is 7.1 mg/L (Tomlin, 2000). The 48-hour LC_{50} for the freshwater crustacean *Daphnia magna* is greater than 6.2 mg/L (Tomlin, 2000).

Methyl Bromide

Humans: According to DPR (2002a) the primary route of human exposure to MeBr is inhalation. Exposure may occur from accidental spills, drift, leakage, or residual levels of MeBr released after treatment. Signs and symptoms of inhalation exposure depend on the concentration and exposure duration. Early symptoms of acute exposure to lethal concentrations include: malaise, headache, visual disturbances, nausea, and vomiting, while later symptoms

include delirium, convulsions, and respiratory failure or cardiovascular collapse leading to death. Nonlethal exposures result in neurological effects similar to the early symptoms for fatal exposure. These symptoms may persist after exposure, depending on the severity of the effects.

Inhalation of 6 mg/L for 10 to 20 hours, or 30 mg/L for 1.5 hours is lethal to humans (EXTOXNET, 2010 and references therein). The lowest inhalation level found to cause toxicity in humans is 0.14 mg/L in air (ACGIH, 1991).

*Rodent*s: In rodents, the primary acute inhalation toxicity of MeBr was neurotoxicity, with the severity of the effects dependent on the dose and duration of exposure (DPR, 2002b). The acute clinical signs included decreased activity and tremors, while tissue lesions were observed in the brain and other organs. For chronic toxicity, the nasal cavity, brain, and heart were major target organs in rodents after chronic inhalation exposure. Olfactory epithelial damage and myocardial degeneration were observed in rats and mice. Cerebellar and cerebral degeneration was detected in mice, while reduced brain weight was observed in rats.

Other Species: The acute oral LD_{50} for bobwhite quail is 73 mg/kg (Tomlin, 2000). The 96-hour LC_{50} for fish is 3.9 mg/L. The 48-hour EC_{50} for the freshwater crustacean *Daphnia magna* is 2.6 mg/L (Tomlin, 2000). MeBr is not toxic to bees. MeBr 1-hr inhalation LC_{50} for rats is 4.5 mg/L, while the 11-hr LC_{50} in rabbits is 8 mg/L (EXTOXNET, 2010 and references therein).

Methyl Iodide

Humans: The principal route of human exposure to MeI is inhalation of contaminated air near treated sites. OSHA human permissible exposure level to MeI is 5 ppm as based from the product label (TOXNET, 2010). MeI is not listed in the current U.S. National Toxicology Program Report on Carcinogens as a potential carcinogen, and is not identified by OSHA as a potential carcinogen.

Rats: Nemec (2002a) conducted a whole-body inhalation exposure and reproductive toxicity study on Sprague-Dawley rats and showed that MeI may have developmental effects upon offspring: the Parental NOEL was 20 ppm (0.11 mg/l) based upon lower mean bodyweights and degeneration of olfactory epithelium at 50 ppm, the Reproductive NOEL was 20 ppm (0.11 mg/l) based upon reduced live litter size for both generations of a 50 ppm exposed group, and the Developmental NOEL was 5 ppm (0.03 mg/l) based upon lower mean body weights for 20 ppm exposed pups and delayed development of 20 ppm exposed female pups. In a similar inhalation exposure study conducted on New Zealand white female rabbits, Nemec (2002b) found adverse developmental effects at 10 and 20 ppm exposure including increased late resorptions, reduced numbers of viable fetuses, and lower fetal weights.

Aquatic Species: The USEPA does not consider MeI to pose an acute or chronic risk to fish and aquatic invertebrates because of low potential for MeI runoff from tarped post application sites to surface water bodies. The low Henry's Law Constant also suggests that chronic exposures to aquatic invertebrates and fish are not likely to occur (USEPA, 2007). The low Octanol/Water partition coefficient (log K_{ow} = 1.51-1.69) indicates that MeI is not likely to bioconcentrate in tissues of aquatic organisms (USEPA, 2007).

2. FUMIGANT USE DATA SUMMARY

With DPR's implementation of full pesticide use reporting in 1990, all users must report the agricultural use of any pesticide to their county agricultural commissioner, who subsequently forwards this information to DPR. DPR compiles and publishes the use information in the annual Pesticide Use Report. Because of California's broad definition for agricultural use, DPR includes data from pesticide applications to parks, golf courses, cemeteries, rangeland, pastures, and rights-of-way, postharvest applications of pesticides to agricultural commodities, and all pesticides used in poultry and fish production, and some livestock applications in the PUR. DPR does not collect use information for home and garden use, or for most industrial and institutional uses. The information included in this monitoring recommendation reflects widespread cropland applications of 1,3-D and MeBr (DPR, 2010).

Pesticide use data for 2009 is preliminary. The data may be incomplete and some quality control checks have not been conducted.

1,3-Dichloropropene

1,3-D is a multi-purpose liquid fumigant used to control nematodes, wireworms, and certain soil borne diseases in cropland. It is used for pre-planting control of most species of nematode in deciduous fruit and nuts, citrus fruit, berry fruit, vines, strawberries, hops, field crops, vegetables, tobacco, beet, pineapples, peanuts, ornamental and flower crops, tree nurseries, etc. It also has secondary insecticidal and fungicidal activity (Tomlin, 2000). As of April 2010, eighteen active products containing 1,3-D are registered for use in California. The 1,3-D product label offers methods for application, including: broadcast (using chisel, offset swing shank, Nobel plow or plow-sole application equipment) and row application. Immediately after application at a depth of approximately 12 inches below the soil/air interface, the soil must be "sealed" to prevent fumigant loss and to ensure that an effective concentration of fumigant is maintained within the soil for a period of several days. In California, growers primarily use 1,3-D on strawberries, carrots, almond, sweet potatoes, and wine grapes. 1,3-D recommended label use rates range from 9 to 55 gallons per acre depending on soil type or texture for a broadcast application and 26 to 162 fluid ounces per 1000 feet of row per outlet depending on soil type or texture.

Table 4 shows the amount of 1.3-dichloropropene used by county from 2006-2009. In 2009, the county that used the highest amount of 1,3-D was Fresno, which was followed by Kern and Merced counties. Table 5 shows the amount of 1,3-D used monthly from 2006-2009. The peak period of application is in the autumn season during the months of September, October, and November. ARB previously monitored for 1,3-D in Ventura County and results indicated that high use of 1,3-D and MeBr might also occur during June and July months (ARB, 2006). Table 6 shows the amounts of 1,3-D applied to the top 25 commodities during 2006-2009. Strawberries by far use the greatest amount of 1,3-D.

Table 4. 1,3-Dichloropropene use (lbs) by county 2006-2009

COUNTY	2006	2007	2008	2009	Grand Total
Fresno	1,305,054	1,276,972	1,597,346	847,786	5,027,158
Kern	1,016,640	1,516,834	1,324,651	557,161	4,415,286
Merced	1,102,097	893,237	1,095,046	698,435	3,788,816
Ventura	983,971	872,001	930,645	370,159	3,156,778
Monterey	711,974	648,803	710,494	517,754	2,589,025
Tulare	607,684	670,770	698,752	389,632	2,366,838
Stanislaus	408,076	709,484	585,987	577,888	2,281,436
Madera	467,731	434,779	421,525	178,397	1,502,432
Santa Barbara	271,957	419,583	348,945	279,998	1,320,483
Imperial	355,770	332,192	169,360	51,786	909,107
San Joaquin	254,091	356,805	262,560	13,380	886,836
San Luis Obispo	139,222	140,497	207,755	193,001	680,475
Sutter	126,393	112,331	165,710	113,148	517,582
Riverside	97,281	160,048	158,115	27,423	442,867
Del Norte	144,752	136,661	126,596		408,009
KINGS	115,987	105,336	125,255	25,091	371,669
Santa Cruz	89,633	120,540	86,161	47,487	343,821
Sonoma	71,064	132,033	116,360	19,043	338,499
Orange	49,830	59,353	67,917	47,596	224,696
Tehama	63,106	47,511	47,744	60,926	219,287
San Benito	105,728	52,879	49,182	1,587	209,376
Butte	47,972	37,563	31,614	21,450	138,599
Placer	32,037	35,556	26,695	24,405	118,693
Yuba	40,842	30,266	20,836	16,091	108,036
Colusa		188		89,251	89,439
Napa	19,006	40,000	19,514	8,152	86,672
Modoc		5,073	76,257	4,789	86,119
Los Angeles	14,799	48,343	18,234		81,376
Yolo	13,291	14,175	7,433	42,421	77,321
Santa Clara	24,921	25,386	14,091	0	64,399
San Diego	24,261	22,464		14,977	61,703
Solano		46,219	11,501	1,072	58,792
Sacramento	3,012	31,134	12,003		46,149
Humboldt	12,247	7,806	6,471		26,524
Glenn		19,442	6,304		25,746
San Mateo	2,279	12,100	4,248	2,481	21,108
Mendocino	3,811	12,494			16,305
Shasta	1,984	4,507			6,491
Siskiyou	4,489		1,240		5,729
Lake			2,757		2,757
Contra Costa	274	274	419		966
Alameda		8			8
Amador	1	5			7
Grand Total	8,733,270	9,591,652	9,555,724	5,242,767	33,123,414

Table 5. 1,3-Dichloropropene use (lbs) by month 2006-2009

COUNTY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Grand Total
Fresno	594,474	479,856	418,556	198,704	52,091	40,542	93,793	245,048	386,220	581,581	1,094,525	841,767	5,027,158
Kern	603,139	380,395	349,100	111,289	221,533	90,508	361,172	461,546	128,794	397,947	888,819	421,043	4,415,286
Merced	76,353	183,055	671,855	568,952	246,354	23,723		62,730	96,626	416,931	1,023,293	418,942	3,788,816
Ventura	13,952	31,399	139,062	134,264	90,798	460,027	183,935	651,152	1,387,396	48,791	9,428	6,573	3,156,778
Monterey	13,906	105,302	198,336	52,190	151,905	110,586	43,443	156,531	496,048	846,955	360,489	53,335	2,589,025
Tulare	328,150	155,544	35,355	151,184	21,945	64,574	30,041	90,514	117,115	343,256	462,151	567,009	2,366,838
Stanislaus	68,698	23,382	34,384	84,506	17,831	153,617	101,806	162,725	209,604	474,165	664,786	285,932	2,281,436
Madera	121,077	90,093	96,261	361,540	208,839	23,757	25,275	126,773	79,851	50,288	86,260	232,418	1,502,432
Santa Barbara	40,673		21,202	56,412	19,108	34,843		22,914	265,823	838,694	10,821	9,993	1,320,483
Imperial	101,339	50,035	21,069	21,288				29,374	346,460	304,627	31,769	3,145	909,107
San Joaquin	20,028	13,639	49,265	80,215	100,191	15,420	76,963	6,171	30,905	90,123	305,730	98,187	886,836
San Luis Obispo	48,645	458	72,450	21,113	14,133	11,462	645		154,812	325,501	13,712	17,544	680,475
Sutter	3,086	3,285					7,299	13,703	61,496	205,463	140,836	82,415	517,582
Riverside	108,873	21,194				4,791	24,871	436	120,353	5,617	3,717	153,014	442,867
Del Norte							300,486	107,523					408,009
KINGS	41,602	19,809	581	32,489			53,802	20,724	26,454	19,076	122,763	34,368	371,669
Santa Cruz		906	1,296	40,191	82,534	12,839	4,493	43,168	86,587	47,054	21,008	3,744	343,821
Sonoma				2,150	17,400	100,439	48,180	38,710	9,756	95,978	25,884		338,499
Orange						1,021		64,003	154,692	4,980			224,696
Tehama					8,903			21,500	8,561	76,543	103,782		219,287
San Benito	2,223	3,113	5,909	2,049	3,822		16,553		7,087	54,285	69,554	44,780	209,376
Butte		1,029				6,040	2	7,963	9,290	47,508	54,790	11,978	138,599
Placer					42,007	59,364	17,323						118,693
Yuba	2,263								39,150	38,454	22,860	5,309	108,036
Colusa							89,251			188			89,439
Napa				6,636	10,761	19,026	4,722	8,074	3,781	4,769	20,490	8,413	86,672
Modoc				24,187	11,814			13,204		36,915			86,119
Los Angeles	20,980	37,009	3,397	10,544				4,255	5,191				81,376
Yolo						55,939		1,872	11,845	7,646	19		77,321
Santa Clara						0		1	39	20,006	40,869	3,484	64,399
San Diego			11,335	295	2,847	3,674		1,089	42,462				61,703
Solano								1,489		55,786	1,516		58,792
Sacramento		3,137		7,651						3,012	10,783	21,566	46,149
Humboldt								26,524					26,524
Glenn			6,602							6,304	12,840		25,746
San Mateo		551	2,619	3,864	8,629	2,481				2,127	837		21,108
Mendocino										16,305			16,305
Shasta								4,008	2,483				6,491
Siskiyou				4,489					1,240				5,729
Lake										2,757			2,757
Contra Costa								274	693				966
Alameda										8			8
Amador	2	3	2										7
Grand Total	2,209,464	1,603,194	2,138,637	1,976,205	1,333,447	1,294,673	1,484,055	2,393,996	4,290,814	5,469,640	5,604,331	3,324,959	33,123,414

Table 6. 1,3-Dichloropropene use (lbs) by top 25 commodities 2006-2009

SITE	2006	2007	2008	2009	Grand Total
STRAWBERRY	1,660,985	1,903,980	1,789,564	1,118,170	6,472,700
SOIL FUMIGATION/PREPLANT	814,800	848,886	1,432,932	630,607	3,727,225
CARROT	889,808	1,088,833	952,273	370,423	3,301,337
ALMOND	802,009	1,151,035	700,677	510,512	3,164,234
SWEET POTATO	674,256	637,002	609,251	428,862	2,349,371
GRAPE	441,510	763,672	415,097	223,020	1,843,299
GRAPE, WINE	672,301	393,060	416,721	211,532	1,693,615
WALNUT	368,875	415,191	356,917	313,379	1,454,361
PEACH	558,700	398,705	261,057	143,725	1,362,187
TOMATO, PROCESSING	214,376	48,224	513,910	210,634	987,143
PEPPER, FRUITING	186,786	181,071	256,938	84,181	708,976
UNCULTIVATED AG	104,616	303,312	156,854	71,952	636,735
TANGERINE	10,310	104,281	322,224	73,690	510,505
POTATO	117,252	127,884	113,634	123,817	482,588
ORANGE	55,404	72,829	205,772	108,307	442,312
N-OUTDR TRANSPLANTS	138,596	135,395	128,386	23,185	425,562
NECTARINE	143,293	81,625	123,344	58,616	406,877
N-OUTDR PLANTS IN CONTAINERS	63,347	68,158	28,768	187,524	347,797
PRUNE	66,703	118,147	83,721	23,254	291,825
TOMATO	75,231	49,381	77,858	85,541	288,011
WATERMELON	67,465	89,648	72,290	51,786	281,190
ONION, DRY	90,696	95,113	64,284		250,092
BRUSSELS SPROUT	57,039	75,257	70,516	11,135	213,947
PLUM	72,630	39,327	29,445	14,249	155,651
MELON	50,888	36,302	37,481	26,217	150,888

Methyl Bromide

MeBr is a multi-purpose fumigant used to control fungi, grasses, diptera, beetles, weeds, insects, and nematodes in cropland. MeBr is used on asparagus, broccoli, cauliflower, eggplant, lettuce, melons, onions, peppers strawberry, tomato, and ornamental and flower crops. As of April 2010, thirty eight active products containing MeBr are registered for use in California. The MeBr product label offers methods for soil application, including: broadcast (using chisel, offset swing shank, Nobel plow or plow-sole application equipment) and row application. Immediately after application, the soil must be “sealed” to prevent fumigant loss and to ensure that an effective concentration of fumigant is maintained within the soil for a period of several days.

In California’s agricultural setting, growers primarily use MeBr on strawberries, preplant soil preparation, outdoor container/field grown plants, and outdoor grown transplants. For California, during 2006 through 2009 the median application rate was 200 pounds MeBr per acre of treated field. For Santa Barbara and Ventura counties during that same period the typical field application rates ranged between 100 to 400 lbs MeBr per treated acre. The label suggests waiting two weeks after the exposure period before introducing transplants or vegetative plant parts and waiting 96 hours before planting crop seeds.

Table 7 shows the amount of MeBr used by county 2006-2009. In 2009, the county using the highest amount of MeBr was Monterey, which was followed closely by Ventura County. Table 8 shows the amounts of MeBr used monthly from 2006-2009. The peak period of MeBr application is during the month of September. Table 9 shows the amounts of MeBr applied to the top 25 commodities during 2006-2009. Strawberries by far use the greatest amount of MeBr.

Table 7. Methyl bromide use (lbs) by county 2006-2009

COUNTY	2006	2007	2008	2009	Grand Total
Monterey	1,615,120	1,631,769	1,409,233	1,355,399	6,011,521
Ventura	1,037,732	834,961	539,979	526,791	2,939,462
Santa Cruz	663,359	653,501	600,545	565,161	2,482,566
Santa Barbara	484,812	497,023	584,768	503,874	2,070,477
Siskiyou	367,388	563,362	598,651	8,778	1,538,180
Merced	252,259	264,254	243,086	190,153	949,751
Kern	344,937	262,172	132,770	71,312	811,190
Tehama	195,917	152,111	161,768	161,563	671,358
Stanislaus	180,801	201,375	197,990	65,579	645,744
Los Angeles	145,376	122,961	183,592	171,384	623,312
San Joaquin	203,256	181,554	122,773	78,168	585,751
Fresno	125,760	103,129	165,583	167,835	562,307
Tulare	134,740	167,154	99,162	49,176	450,233
Sutter	91,704	144,662	94,148	101,009	431,525
San Luis Obis	41,693	71,151	169,022	146,721	428,586
San Diego	187,552	119,113	6,020	17,325	330,011
Orange	89,579	82,033	81,010	51,525	304,147
Shasta	86,037	75,768	32,653	56,125	250,583
Riverside	26,210	143,317	30,110	13,063	212,700
Glenn	56,439	37,016	11,742	39,700	144,896
Lassen	34,965	15	59,644		94,625
Madera	24,254	28,403	18,785	19,717	91,159
Yolo	23,766	18,728	19,024	13,612	75,129
Yuba	31,019	13,044	794	8,886	53,742
Butte	9,765	6,910	11,648	18,096	46,419
Napa	12,875	11,936	12,621	3,403	40,836
Santa Clara	10,061	11,057	11,838	6,133	39,090
San Benito	21,768	2,502	10,931	1,896	37,096
KINGS	17,141	6,462	10,056	201	33,860
Alameda	8,163	7,141	9,924	1,055	26,282
Placer		1,165		22,063	23,228
Colusa	1,644	3,242	2,917	2,970	10,773
Solano	2,927	1,565	3,816	1,230	9,537
Contra Costa	2,604	3,038	2,430	330	8,402
San Bernardin	2,750	2,012	1,591	490	6,843
Calaveras		4,658			4,658
Sonoma	499	1,250	496	352	2,597
Humboldt		2,178			2,178
Del Norte	647				647
Mendocino	151	181	36	103	472
Marin		50	235	173	458
Lake	101				101
Mono			3		3
Sacramento	1		1		2
Grand Total	6,535,773	6,433,920	5,641,393	4,441,350	23,052,436

Table 8. Methyl bromide use (lbs) by month 2006-2009

COUNTY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Grand Total
Monterey	28	33	64,533	93,195	52,802	96,097	168,759	985,950	2,608,809	1,764,508	174,294	2,513	6,011,521
Ventura	3,615	55,364	170,930	407,893	115,486	237,739	764,805	963,988	144,958	38,074	26,444	10,166	2,939,462
Santa Cruz	30		15,436	60,082	44,850	38,814	105,419	517,251	883,710	722,955	93,672	346	2,482,566
Santa Barbara	8,884	5,303	9,335	35,439	33,883	63,147	31,711	203,749	790,544	844,281	40,831	3,370	2,070,477
Siskiyou			14,346	78,361	2,993		45,473	723,357	592,211	81,439			1,538,180
Merced	55,237	17,137	102,310	191,935	45,613	5,249	5,773	63,792	121,519	133,261	118,504	89,421	949,751
Kern	83,797	32,887	27,658	50,090	1,584	28,048	153,828	178,689	152,789	78,930	20,539	2,351	811,190
Tehama	9,202	7,680	8,483	19,604	11,582	5,372	3,396	43,117	235,702	223,868	92,905	10,447	671,358
Stanislaus	23,529	12,279	3,669	9,994	20,357	4,381	170,020	253,996	31,703	57,670	41,399	16,746	645,744
Los Angeles	62,165	64,458	142,342	69,409	29,744	22,953	33,648	27,286	25,238	88,134	27,921	30,013	623,312
San Joaquin	21,589	5,596	86,243	85,567	57,687	46,873	5,639	4,945	44,434	103,564	90,961	32,651	585,751
Fresno	46,024	84,746	107,504	13,615	11,453	9,604	16,961	100,620	98,236	32,649	21,644	19,251	562,307
Tulare	4,505	6,507	28,779	24,157	8,457	14,122	65,018	41,581	24,874	131,930	58,135	42,168	450,233
Sutter	1,185	2,791	2,333	2,390	1,874	1,693	55,191	141,637	69,874	91,900	55,110	5,546	431,525
San Luis Obis	3,501	2,858	6,422	1,562	1,475	3,853	5,946	40,789	222,863	119,811	9,938	9,566	428,586
San Diego	5,344	1,125	15,232	13,460	43,577	65,864	35,783	77,466	46,212	9,276	11,642	5,029	330,011
Orange		548	202		1,573	2,810	141,990	146,920	8,883	1,181	40		304,147
Shasta		74	2,877	6,047	8,529		66,063	97,786	63,879	2,636	2,692		250,583
Riverside	24,579	8,878	8,466	4,177	35,210	47,905	36,933	5,227	7,089	8,470	16,315	9,453	212,700
Glenn			15,883	79,041	8,180	10,010			27,127	2,145	2,420	91	144,896
Lassen				5,452	21	5,205	4,664	73,825	5,457				94,625
Madera	99	5,560	1,767	3,054	5,503	408	453	43,717	27,968	1,409	787	435	91,159
Yolo	4,332	5,137	4,396	5,710	5,120	7,687	5,905	5,915	8,808	12,476	8,076	1,567	75,129
Yuba	2,352	10	11	14	10	37	479	821	78	48,562	1,017	352	53,742
Butte	678	6,981	695	550	683	1,717	1,056	778	1,205	23,040	5,644	3,392	46,419
Napa	25	17	22	26	6,847	3,384	9,560	8,668	8,379	1,221	2,670	17	40,836
Santa Clara	330	396	198	3,057	9,634	1,667	584	473	14,417	7,345	682	308	39,090
San Benito	22	907					837	1	5,156	27,777	1,259	1,137	37,096
KINGS		975	975	2,416	11,780		2,944	364	1,237	1,758	5,120	6,292	33,860
Alameda	3,165	1,640	2,143	1,071	2,266	2,118	2,614	1,974	3,027	2,387	1,618	2,260	26,282
Placer								1,165		385	21,678		23,228
Colusa	323	142	134	142	1,561	2,488	1,855	2,782	801	252	113	180	10,773
Solano	145	180	38	23	1,191	212	2,713	2,513	1,573	141		808	9,537
Contra Costa	1,140	279	339	651	480	660	510	600	600	1,260	848	1,035	8,402
San Bernardin	181	1,578	159	763	152	60	1,698	1,831	118	159	84	60	6,843
Calaveras										4,658			4,658
Sonoma	189	50	32	1,144	103	310	165	141	92	90	281		2,597
Humboldt							1,742	436					2,178
Del Norte							647						647
Mendocino	50	32		103	42		64		137	44			472
Marin	50	117	74		48	40					84	46	458
Lake				101									101
Mono						3							3
Sacramento						1		1			1		2

Table 9. Methyl bromide use (lbs) by top 25 commodities 2006-2009

Sum of AI APPLIED	YEAR				
SITE	2006	2007	2008	2009	Grand Total
STRAWBERRY	3,062,844	2,617,764	2,567,871	2,313,868	10,562,348
SOIL FUMIGATION/PREPLANT	991,912	1,347,722	1,056,250	509,337	3,905,220
N-OUTDR TRANSPLANTS	398,678	422,155	385,354	362,220	1,568,407
N-OUTDR PLANTS IN CONTAINERS	538,320	402,617	396,991	156,544	1,494,472
RASPBERRY	182,881	213,807	172,256	270,308	839,253
WALNUT	196,144	166,343	92,302	178,137	632,925
COMMODITY FUMIGATION	99,980	121,330	171,919	141,820	535,048
UNCULTIVATED AG	107,003	169,312	87,481	12,355	376,151
po STRAWBERRY	20,514	61,203	142,963	125,945	350,624
FUMIGATION, OTHER	104,340	76,105	106,157	54,112	340,714
N-OUTDR FLOWER	82,566	55,734	78,265	28,311	244,876
ALMOND	74,728	95,393	44,214	22,404	236,740
TOMATO	77,092	43,586	33,282	48,933	202,893
TURF/SOD	30,010	136,039	20,331	14,986	201,365
CHERRY	80,682	83,532	24,176	9,078	197,467
PEPPER, FRUITING	15,297	92,018	7,245		114,560
REGULATORY PEST CONTROL	21,716	19,613	21,971	21,663	84,962
LETTUCE, HEAD	54,044	13,039	706	16,664	84,452
STRUCTURAL PEST CONTROL	21,927	20,673	14,585	19,763	76,948
BLUEBERRY	9,246	47,695	16,584	1,995	75,520
GRAIN	34,431		32,032		66,463
PEACH	22,363	12,206	6,878	17,556	59,003
LETTUCE, LEAF	19,436	36,264			55,699
BLACKBERRY	14,719	10,897	14,587	14,716	54,919
LANDSCAPE MAINTENANCE	35,370	384	942	15,529	52,225
Grand Total	6,535,773	6,433,920	5,641,393	4,441,350	23,052,436

3. PREVIOUS AMBIENT AIR MONITORING

DPR has previously requested that ARB conduct ambient air monitoring for the fumigants MeBr and 1,3-D. Results of these monitoring events conducted in 2005 (Ventura County), 2001 (Monterey and Santa Cruz Counties), and 2000 (Monterey and Santa Cruz Counties) are discussed below. The sampling locations were chosen for their proximity to both agricultural fields and populations. Monitoring was designed to coincide with periods of peak use.

MeBr and 1,3-D (cis and trans isomers) were previously detected in ambient air samples collected in Ventura County during August and September 2005 (ARB, 2006). One hundred and eighty-one (181), 24-hour integrated air samples were collected from six locations throughout the county, Monday through Friday, using evacuated canisters equipped with sample flow controllers. MeBr results from 159 validated samples indicated ambient concentrations ranging from less than the Minimum Detection Level (MDL) of 7.7 ng/m^3 to a maximum of 15,800 ng/m^3 occurring on August 29-30 at the CA Department of Forestry site. 1,3-D (cis) results from 165 validated samples indicated ambient concentrations ranging from less than the MDL of 5.8 ng/m^3 to a maximum of 40,700 ng/m^3 occurring on September 12-13 at the CALTRANS site. 1,3-D (trans) results from 165 validated samples indicated ambient concentrations ranging from less than the MDL of 4.4 ng/m^3 to 36,100 ng/m^3 also occurring on September 12-13 at the CALTRANS site.

In comparison, during ambient air monitoring at 4 sites in Monterey County and 2 sites in Santa Cruz County in 2001, maximum reported concentrations of MeBr, cis 1,3-D, and trans-1,3-D at MacQuiddy Elementary School in Watsonville, California were 142,000, 3,860, and 3,420 ng/m^3 respectively (ARB, 2001). The sampling and analytical methods were essentially the same for both 2001 and 2005.

During the months of September to November 2000, ARB conducted ambient monitoring for MeBr and 1,3-D at four sites in Monterey County and one site at Santa Cruz County (ARB, 2001b). The reported concentrations of MeBr in canister samples were as high as 119,000 ng/m^3. This concentration was measured at the Pajaro Middle School near Watsonville. The highest average concentration for the eight-week canister monitoring period was 28,900 ng/m^3, which was also measured at the Pajaro Middle School site. All of the 179 ambient canister samples contained concentrations of MeBr above the estimated quantitation limit (reporting limit) of 36 ng/m^3. Concentrations of 1,3-D were measured as high as 4,300 ng/m^3. This concentration was measured at the Chualar School site in Chualar, California. The highest average concentration for the eight-week monitoring period was 400 ng/m^3, which was also measured at the Chualar School site. Of the 179 ambient canister samples, 41 contained concentrations of 1,3-D above the estimated quantitation limit of about 50 ng/m^3.

DPR and the ARB monitored for various pesticides for 12 months during 2006 in Parlier, California (DPR, 2009). ARB monitored for MeBr and 1,3-D at least once every six days. The quantitation limits for MeBr and 1,3-D were 116 and 454 ng/m^3, respectively. The reported highest 1-day concentrations for MeBr and 1,3-D were 2,524 ng/m^3 and 23,601 ng/m^3, respectively. In comparison, the reported highest 1-day concentrations for MeBr and 1,3-D in Fresno, California were 427 ng/m^3 and 5,991 ng/m^3, respectively (DPR, 2009).

4. AMBIENT AIR MONITORING RECOMMENDATIONS

DPR recommends that ARB conduct simultaneous ambient air monitoring for 1,3-D (both cis and trans isomers), MeBr, and MeI. Additionally, if possible, DPR further requests that ARB monitor for the fumigant chloropicrin because this fumigant is also contained in most 1,3-D and methyl bromide products. Environmental fate information for chloropicrin can be found in previous monitoring recommendations to ARB (DPR, 2001; DPR 2002a).

Based on a preliminary assessment of the toxicology data, DPR requests the following target quantitation limit:

- 1,3-Dichloropropene: 0.1 ppb for each isomer (current ARB quantitation limit)
- Methyl bromide: 0.03 ppb (current ARB quantitation limit)
- Methyl iodide: 0.1 ppb (current ARB quantitation limit)
- Chloropicrin: 0.01 ppb (or current ARB quantitation limit)

DPR recommends that ARB select ambient monitoring sites close to communities where there is high use of 1,3-D and MeBr and where the demographic factors are highest. DPR recommends that ARB monitor one community in Santa Barbara County, specifically Santa Maria. ARB's criteria air pollutant monitoring station in Santa Maria is an acceptable location. DPR recommends that ARB monitor one community in Ventura County, specifically the west side or south side of Camarillo. DPR considered ARB's criteria air pollutant monitoring station in El Rio, but this location is north of the high use areas. Appendices 1 through 8 show 1,3-D use in Santa Barbara and Ventura Counties from 2006 through 2009. Appendices 9 through 16 show MeBr use in Santa Barbara and Ventura Counties from 2006 through 2009. The cities are shown and the major roads are delineated on these maps to provide convenient references for monitoring site selection. DPR will establish an ambient air monitoring network beginning in 2011. DPR's monitoring network will include sampling for 1,3-D and MeBr in Kern and Monterey Counties for several years, so these high-use areas are not recommended for monitoring by ARB.

DPR recommends that ambient air monitoring begin on or about August 1, 2010 and continue for a 15 month sampling period. Air samples should be collected at least once every 7 days during the 15 month sampling period. Field spikes should be sampled at the same environmental conditions (e.g., temperature, humidity, and wind) and monitoring study conditions (e.g., air flow rates, exposure to sunlight) as those during ambient sampling. Field blanks, duplicate samples, and field spikes should be collected periodically throughout the monitoring study. DPR requests that the ambient monitoring report include:

1) Location of each sampler;
2) Distance of each sampler located above the ground;
3) Information relevant to the monitoring study (e.g., presence of trees, buildings, particular industrial or commercial facilities and activities) for the sampler surrounding areas; and
4) Latitude and longitude coordinates with a description of Datum used (e.g., NAD 27 or NAD 83).

5. SAFETY RECOMMENDATIONS – NONE

6. REFERENCES

ACGIH, American Conference of Governmental Industrial Hygienists. 1991. Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices, 6th Edition. Cincinnati, OH.

ARB. 2001a. Report on Ambient Air Monitoring for Methyl Bromide and 1,3-Dichloropropene in Monterey and Santa Cruz Counties Fall 2001. California Air Resources Board. March 29, 2002 (Available at web site: http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/mbr_13d.pdf).

ARB. 2001b. Report on Ambient Air Monitoring for Methyl Bromide and 1,3-Dichloropropene in Monterey/Santa Cruz Counties – Fall 2000. California Air Resources Board. January 31, 2001 (Available at web site: http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/mebr2000.pdf).

ARB. 2006. Report on Ambient Air Monitoring For Methyl Bromide and 1,3-Dichloropropene in Ventura County During August and September 2005. California Air Resources Board. November 3, 2006 (Available at web site: http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/mebrtelrept05.pdf).

ATSDR. 1992. A Toxicological Profile for Bromomethane. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 129 pp. (Available at web site: http://www.atsdr.cdc.gov/ToxProfiles/tp27.pdf).

ATSDR. 2008. A Toxicological Profile for 1,3-Dichloropropene. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 361 pp (Available at web site: http://www.atsdr.cdc.gov/ToxProfiles/tp40.pdf).

DPR. 1994. Human Exposure Assessment for 1,3-Dichloropropene. California Environmental Protection Agency, Department of Pesticide Regulation, Worker Health and Safety Branch. July, 1994. Available at web site: http://www.cdpr.ca.gov/docs/whs/pdf/hs1634.pdf.

DPR. 2001. Use Information and Air Monitoring Recommendations for Field Fumigations with the Pesticide Active Ingredients 1,3-Dichloropropene, Chloropicrin, Metam Sodium, and Methyl Bromide. California Environmental Protection Agency, Department of Pesticide Regulation. May, 2001. Available at web site: http://www.cdpr.ca.gov/docs/emon/pubs/tac/recomm/4chem_recom2001pdf.pdf.

DPR. 2002a. Use Information and Air Monitoring Recommendation for the Pesticide Active Ingredients Sulfuryl Fluoride and Chloropicrin. California Environmental Protection Agency, Department of Pesticide Regulation. January, 2002. Available at web site: http://www.cdpr.ca.gov/docs/emon/pubs/tac/recomm/sf_recom04.pdf.

DPR. 2002b. Methyl Bromide Risk Characterization Document, Volume III, Aggregate Exposure. California Environmental Protection Agency, Department of Pesticide Regulation,

Medical Toxicology Branch. October 24, 2002. Available at web site: http://www.cdpr.ca.gov/docs/risk/rcd/metb_agg.pdf.

DPR. 2009. Pesticide Air Monitoring In Parlier, CA. California Environmental Protection Agency, Department of Pesticide Regulation. December 2009.

DPR. 2010. DPR Pesticide Chemistry Database (Available at website: http://environmental-monitoring/pestchem/onecompoundselect.cfm).

DPR. 2010. Pesticide Use Reports Database. California Environmental Protection Agency, Department of Pesticide Regulation, Sacramento, California (Available at web site: http://calpip.cdpr.ca.gov/main.cfm).

EXTOXNET. 2010. Methyl Bromide Profile. Extension Toxicology Network, Pesticide Information Profiles [Online] (Available at web site: http://extoxnet.orst.edu/pips/methylbr.htm).

Hansch, C., Leo, A., Hoekman, D. 1995. Exploring QSAR – Hydrophobic, Electronic, and Steric Constants. Washington, DC: American Chemical Society, 1995, p.3

Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., Michalenko, E.M.. 1991. *Handbook of Environmental Degradation Rates*. Lewis Publishers, Chelsea, MI.

Kollman, W., Segawa, R. 1995. Interim Report of the Pesticide Chemistry Database. Report No. EH 95-04. California Department of Pesticide Regulation, Sacramento, California.

Montgomery, John H. 1997. Agrochemicals Desk Reference. 2nd Edition. Lewis Publishers, New York, New York.

Nemec, M.D. 2002a. An Inhalation Two-Generation Reproductive Toxicity Study of Iodomethane in Rats (Comprehensive Final Report). WIL Research Laboratories, Inc., Ashland, OH., Report# WIL-418004, June 28, 2002.

Nemec, M.D. 2002b. An Inhalation Prenatal Developmental Toxicity Study of Iodomethane in Rabbits. WIL Research Laboratories, Inc., Ashland, OH, Report# WIL-418002, January 28, 200.

Tabak, H.H., Quave, S.A., Mashni, C.I., Barth, E.F. 1981. Biodegradability studies with organic priority pollutant compounds. *Journal of the Water Pollution Control Federation*, 53:1503-1518.

Tomlin, C. (ed). 2000. *The Pesticide Manual*: 12th Edition. Crop Protection Publications, British Crop Protection Council and the Royal Society of Chemistry. Farnham, Surry, United Kingdom.

Tuazon, E.C., Atkinson, R., Winer, A.M., Pitts, J.N. 1984. A study of the atmospheric reactions of 1,3-dichloropropene and other selected organochlorine compounds. *Archives of Environmental Contamination and Toxicology*, 13(6):691-700.

TOXNET. 2010. Hazardous Substances Data Bank, National Library of Medicine. Available at web site: http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~rJyJ9j:1.

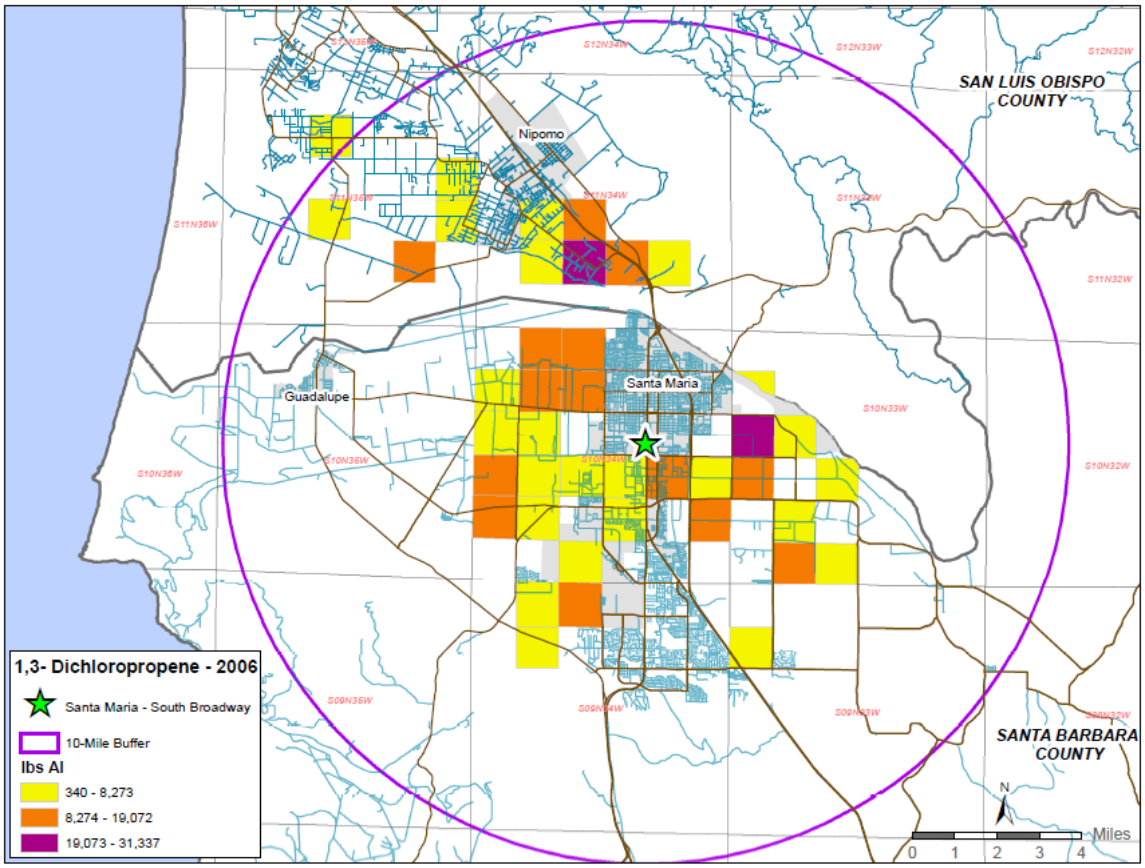
USEPA. 1974. Proceedings of the Solvent Reactivity Conference. U.S. Environmental Protection Agency. EPA-650/3-74/040. Research Triangle Park, North Carolina.

USEPA. 2007. Pesticide Fact Sheet for Iodomethane. 2007. Available at web site: http://www.epa.gov/opprd001/factsheets/iodomethane.pdf.

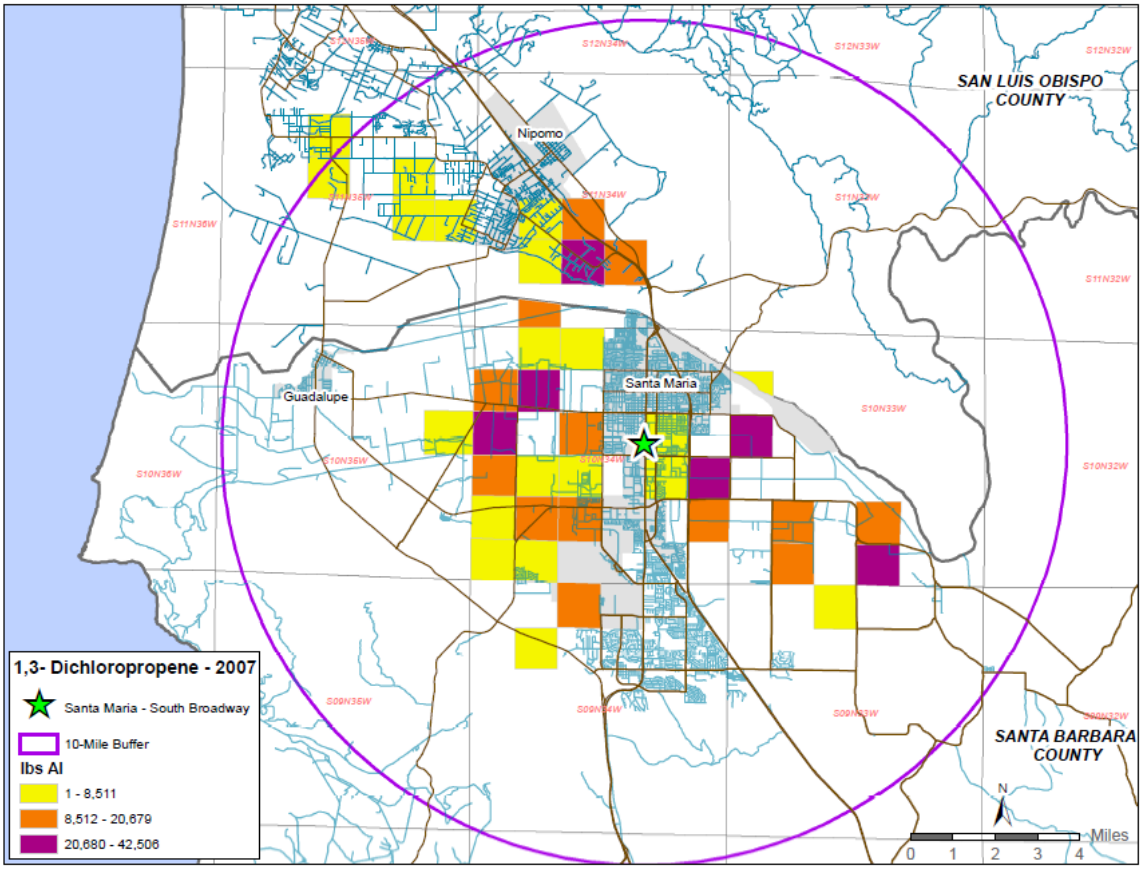
Wauchope, R.D., Butler, T.M., Hornsby A.G., Augustijn Beckers, P.W.M., Burt, J.P. 1992. SCS/ARS/CES Pesticide properties database for environmental decision making. *Reviews in Environmental Contamination and Toxicology*, 123:1-157.

7. APPENDICES

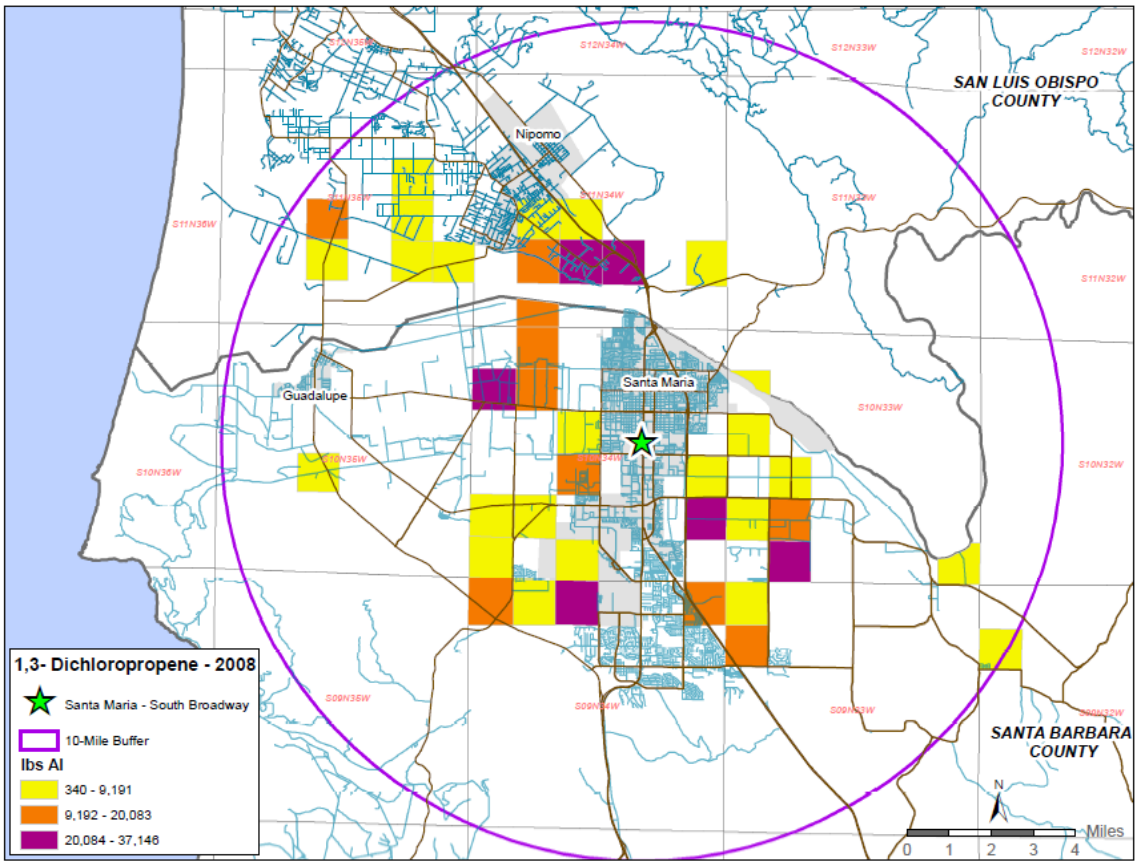
Appendix 1. 1,3-Dichloropropene use in Santa Barbara County 2006



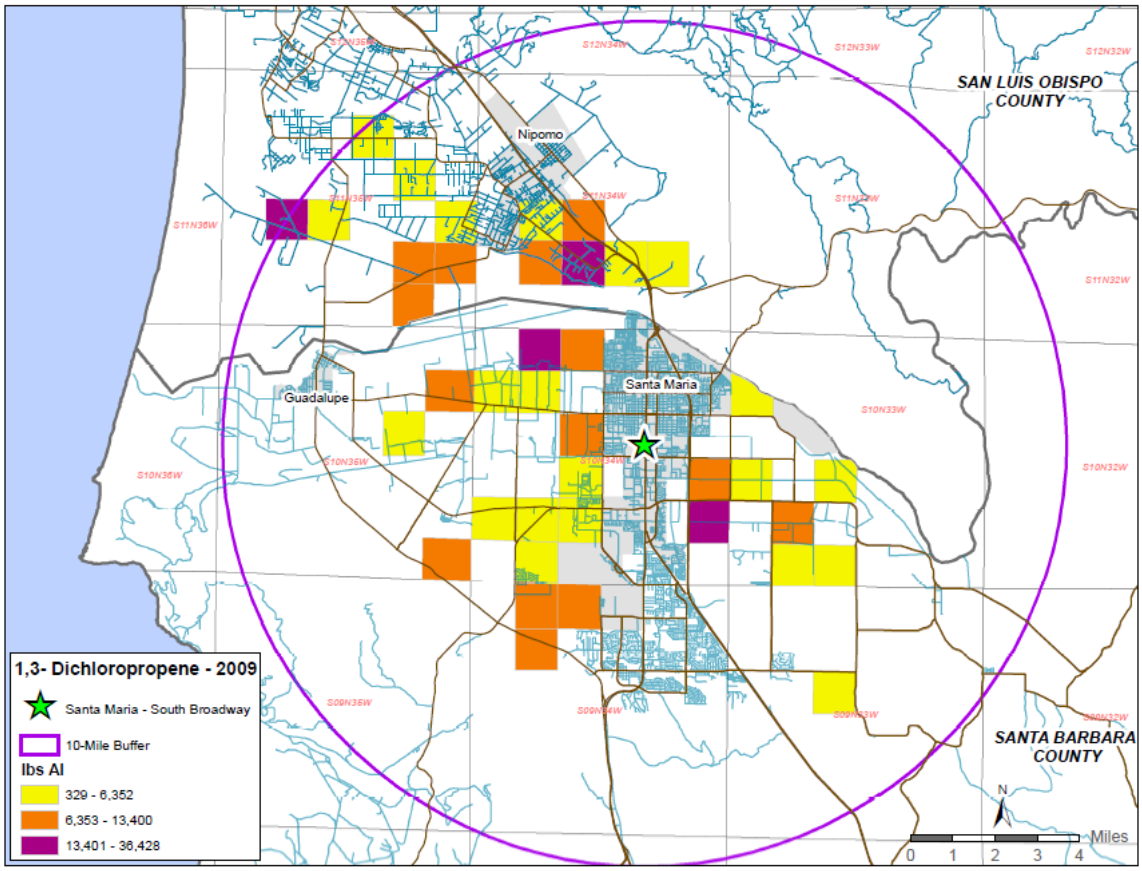
Appendix 2. 1,3-Dichloropropene use in Santa Barbara County 2007



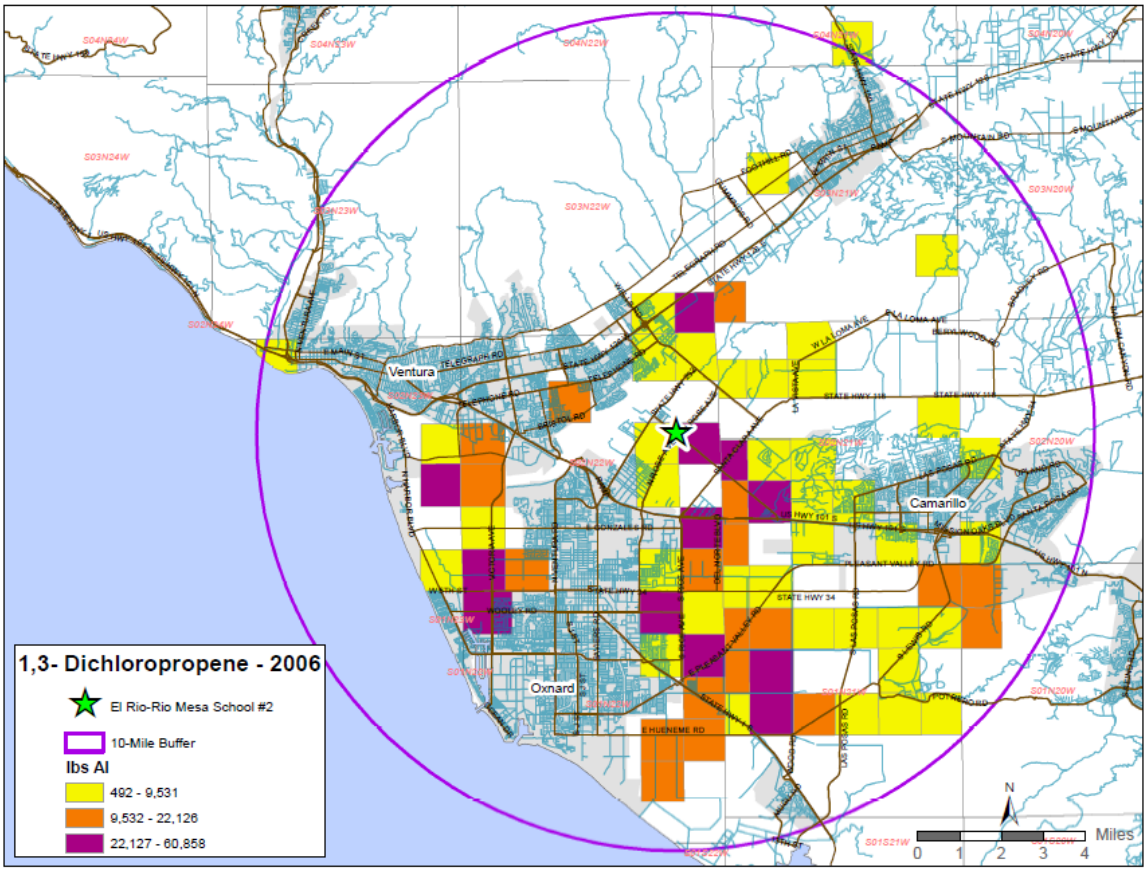
Appendix 3. 1,3-Dichloropropene use in Santa Barbara County 2008



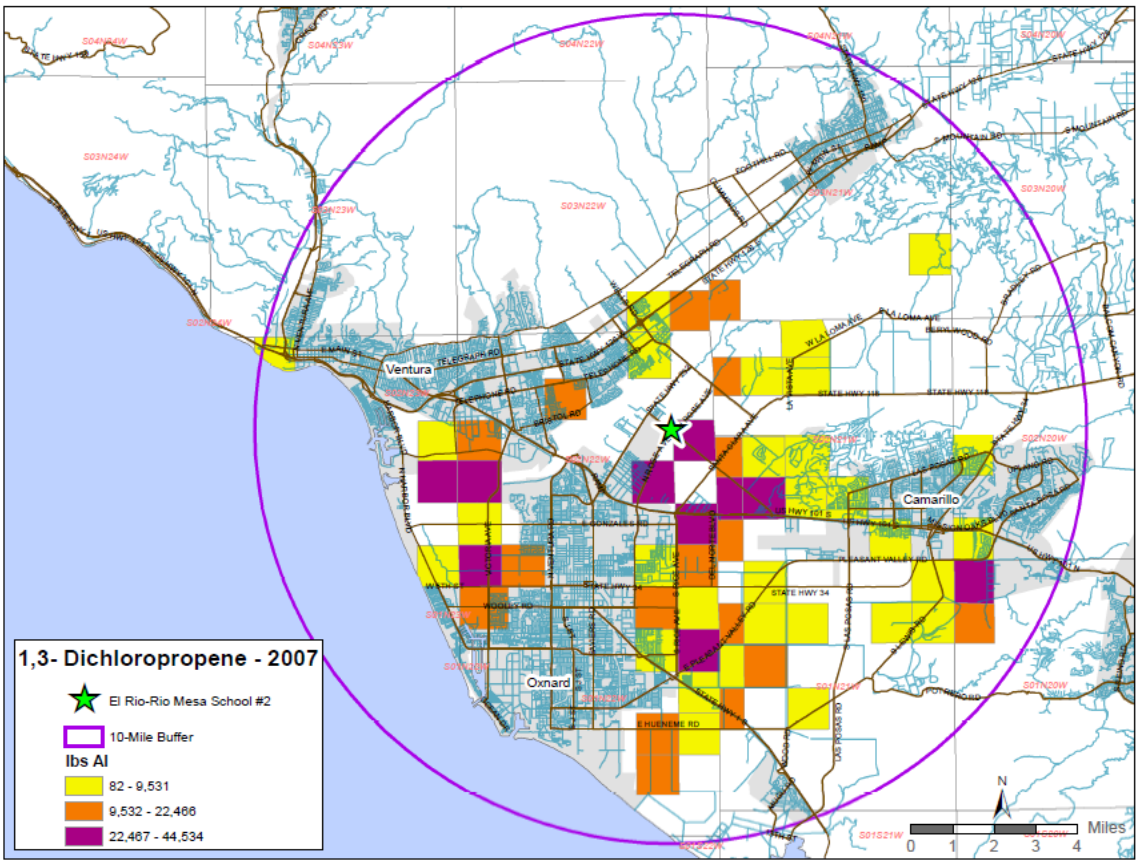
Appendix 4. 1,3-Dichloropropene use in Santa Barbara County 2009



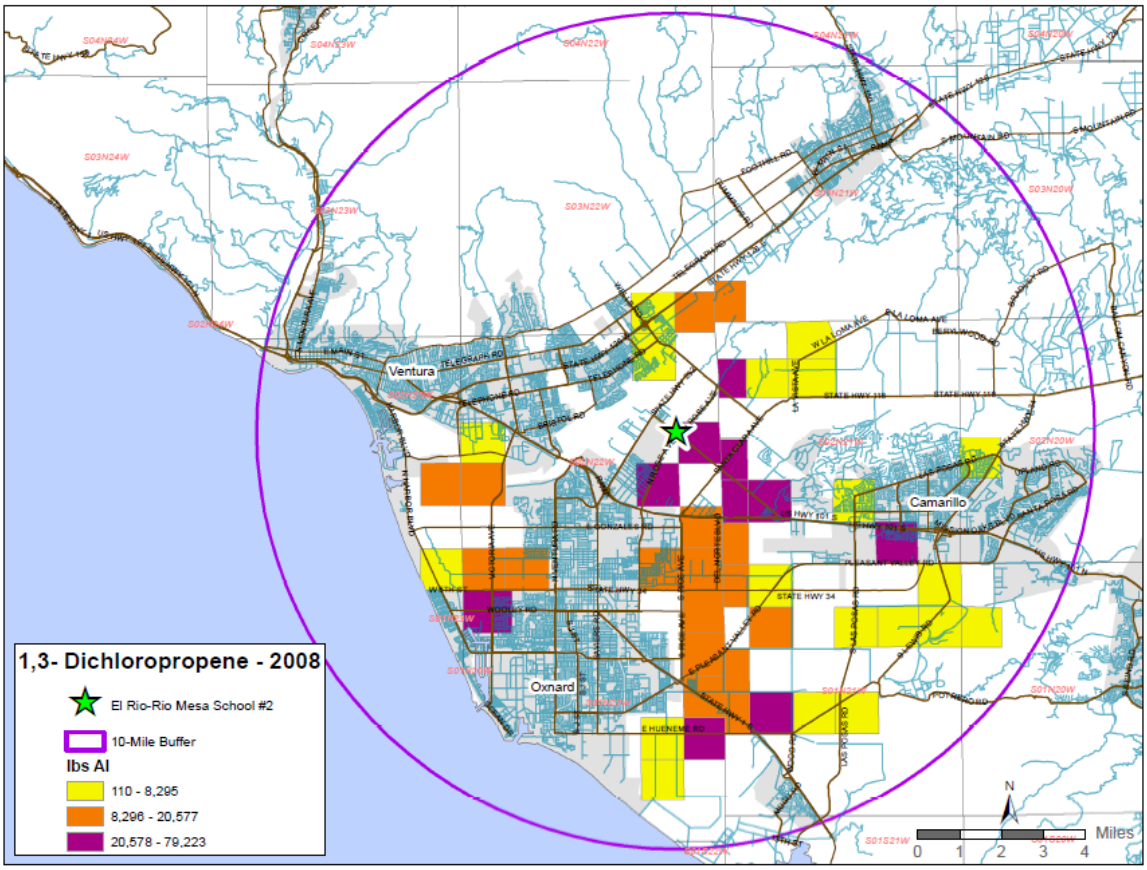
Appendix 5. 1,3-Dichloropropene use in Ventura County 2006.



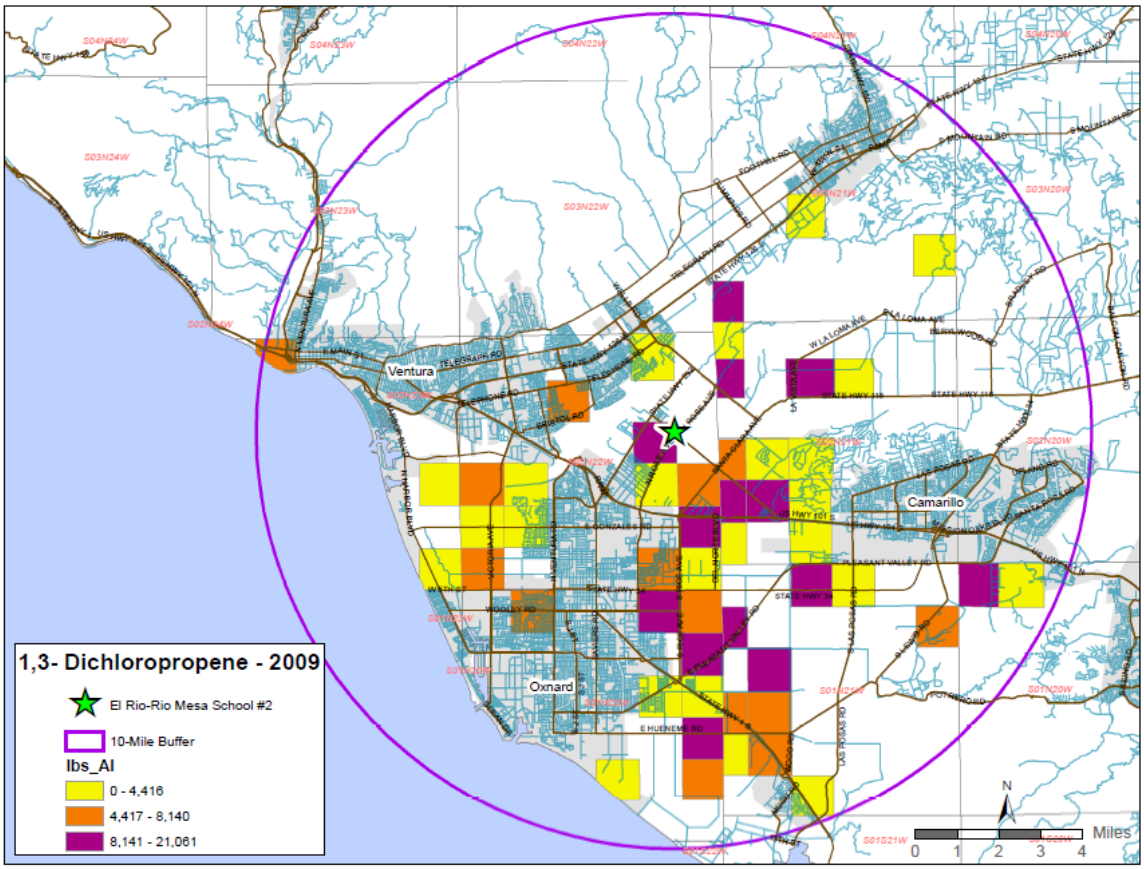
Appendix 6. 1,3-Dichloropropene use in Ventura County 2007.



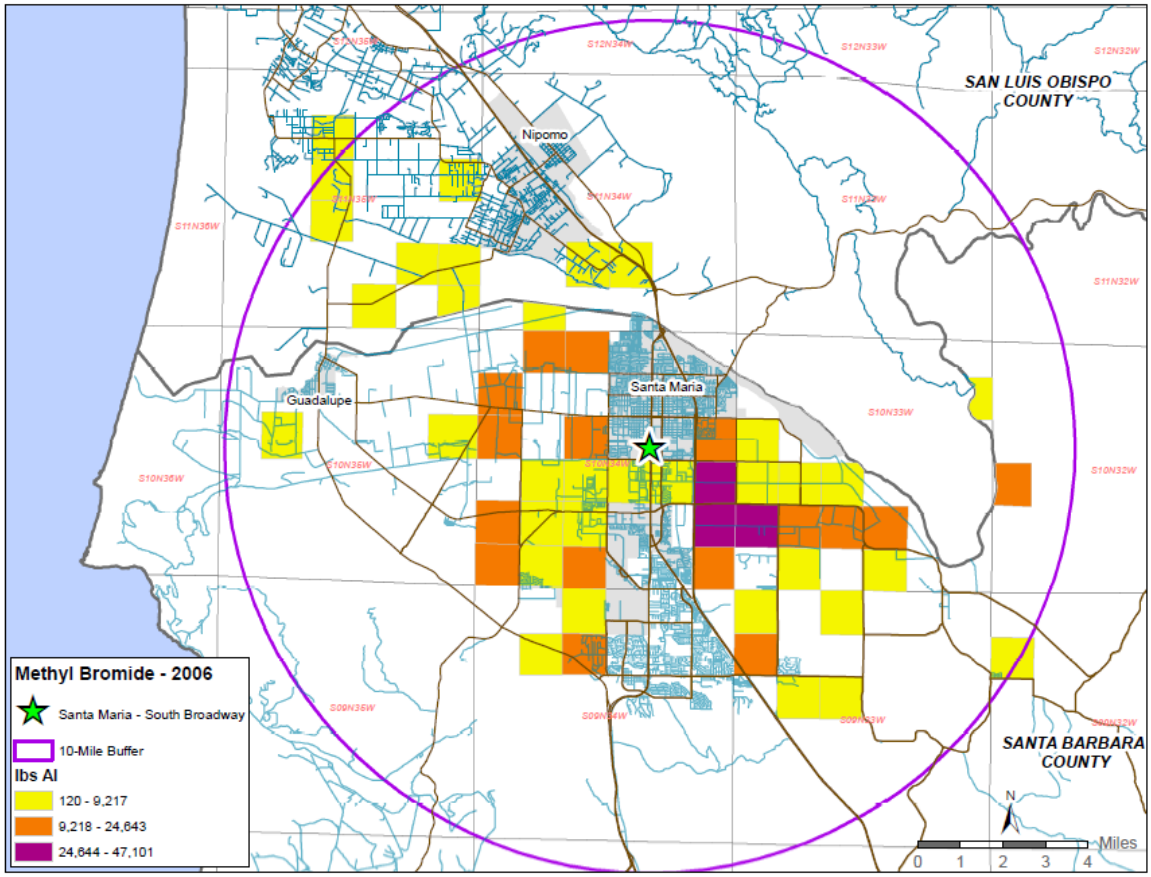
Appendix 7. 1,3-Dichloropropene use in Ventura County 2008.



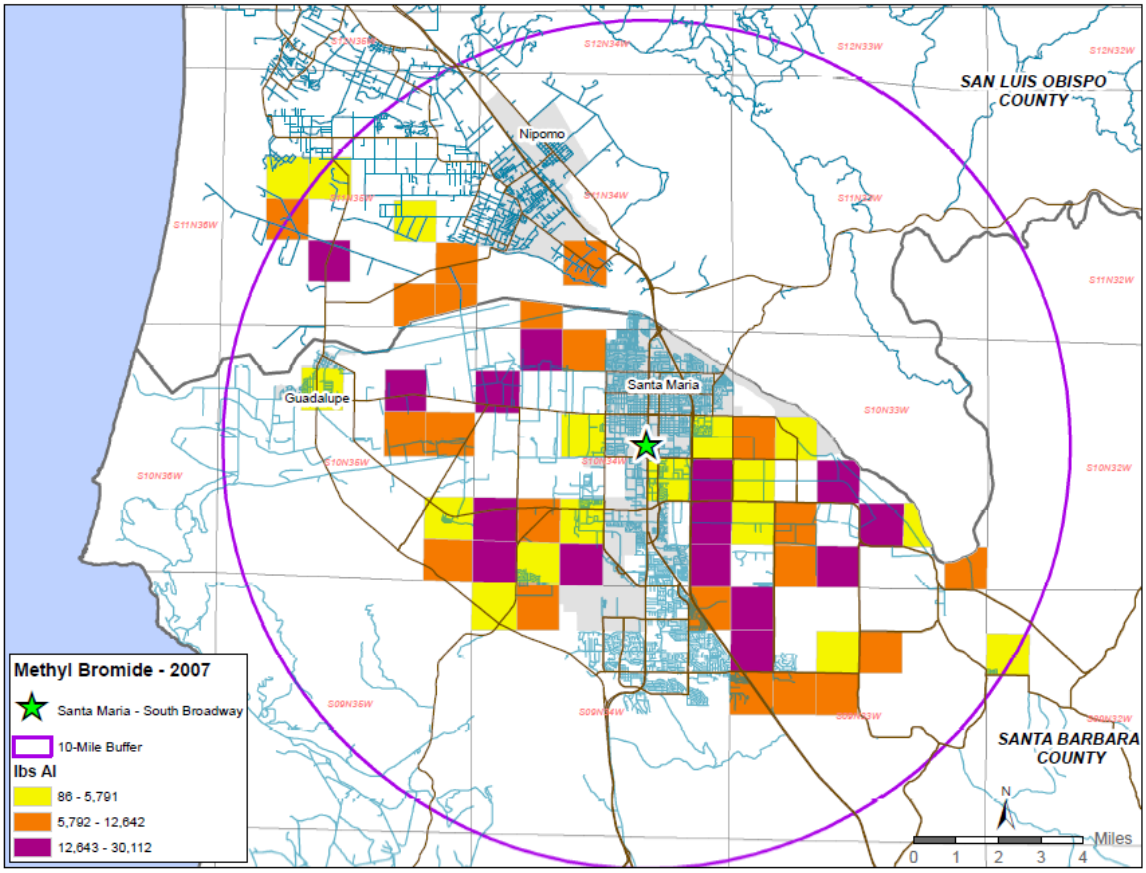
Appendix 8. 1,3-Dichloropropene use in Ventura County 2009.



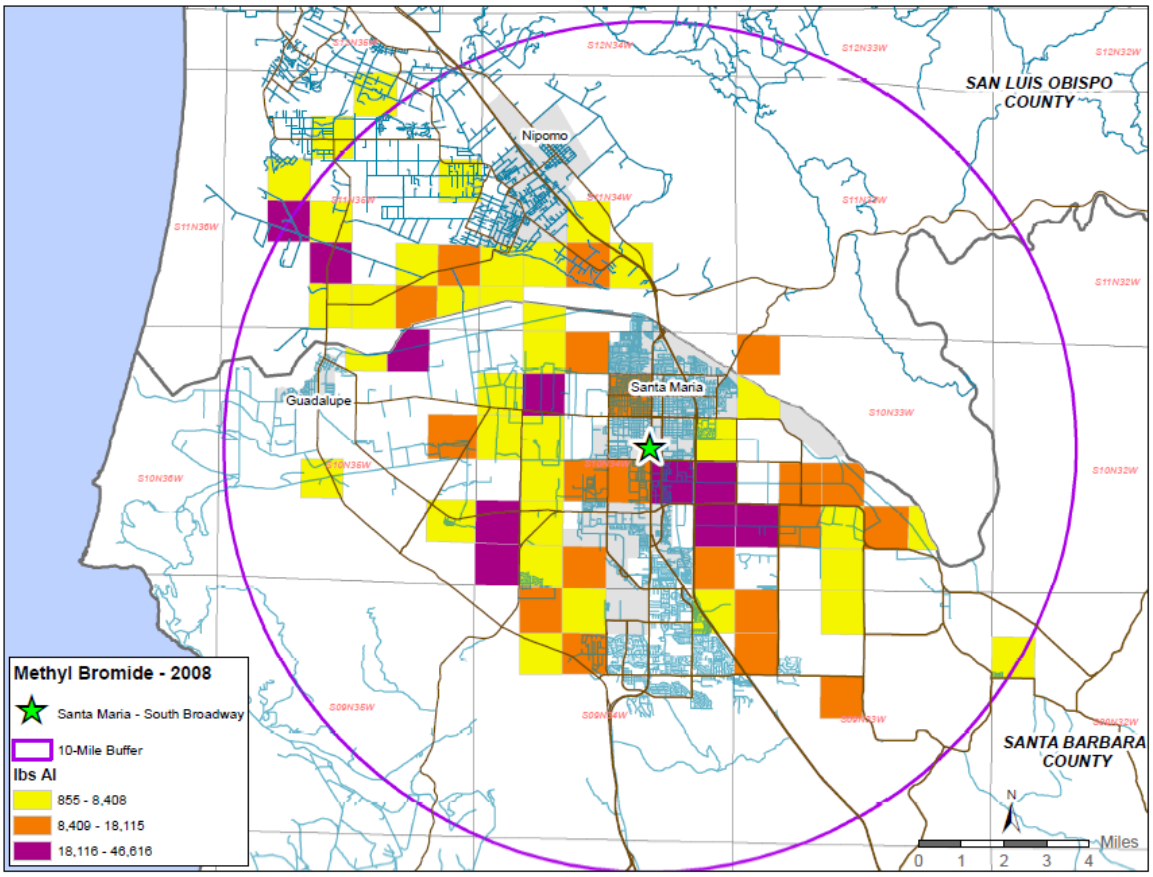
Appendix 9. Methyl bromide use in Santa Barbara County 2006.



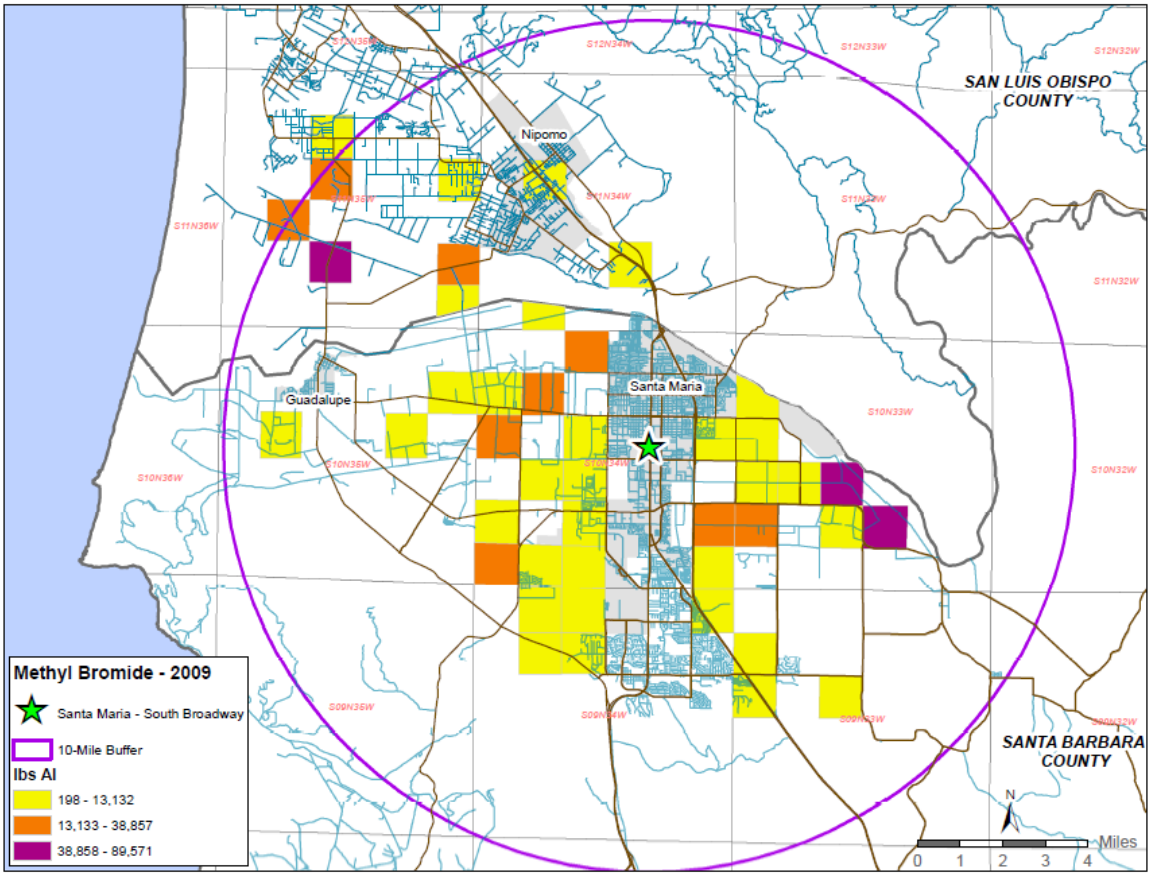
Appendix 10. Methyl bromide use in Santa Barbara County 2007.



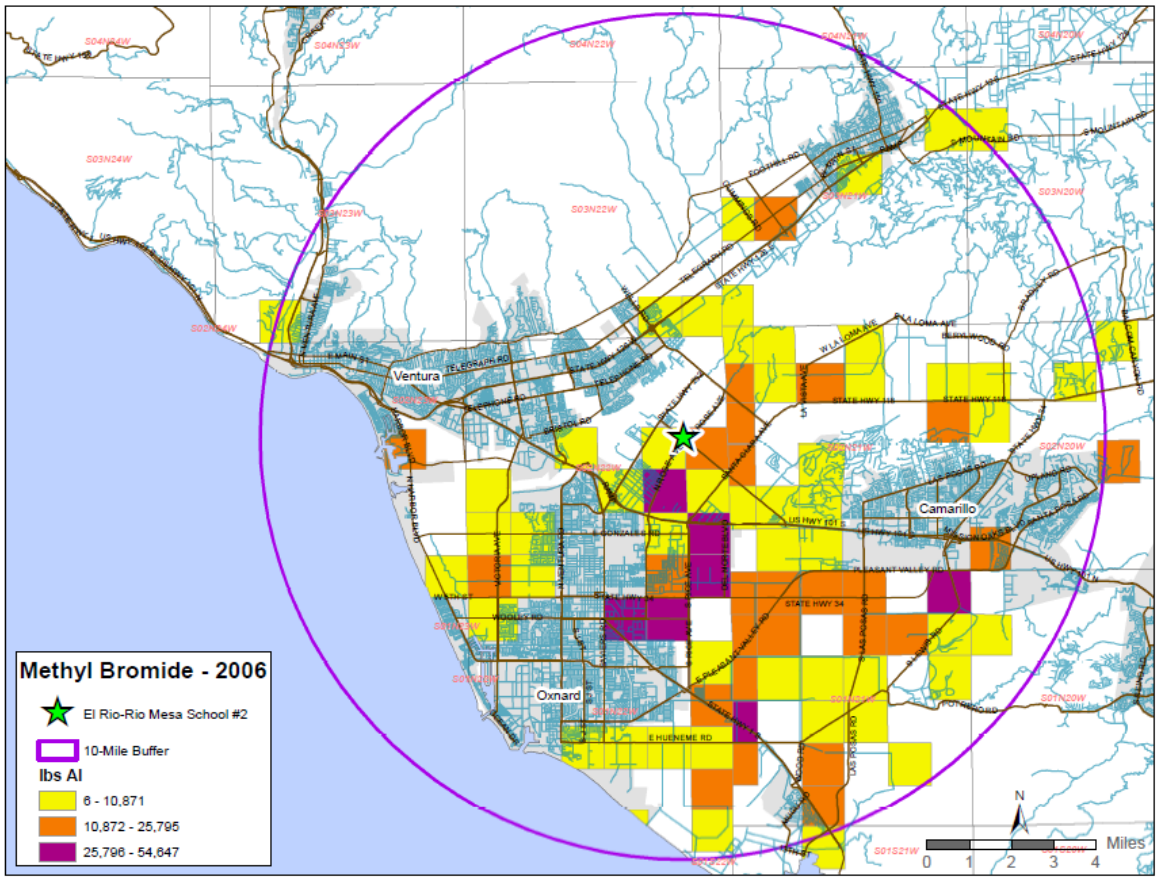
Appendix 11. Methyl bromide use in Santa Barbara County 2008.



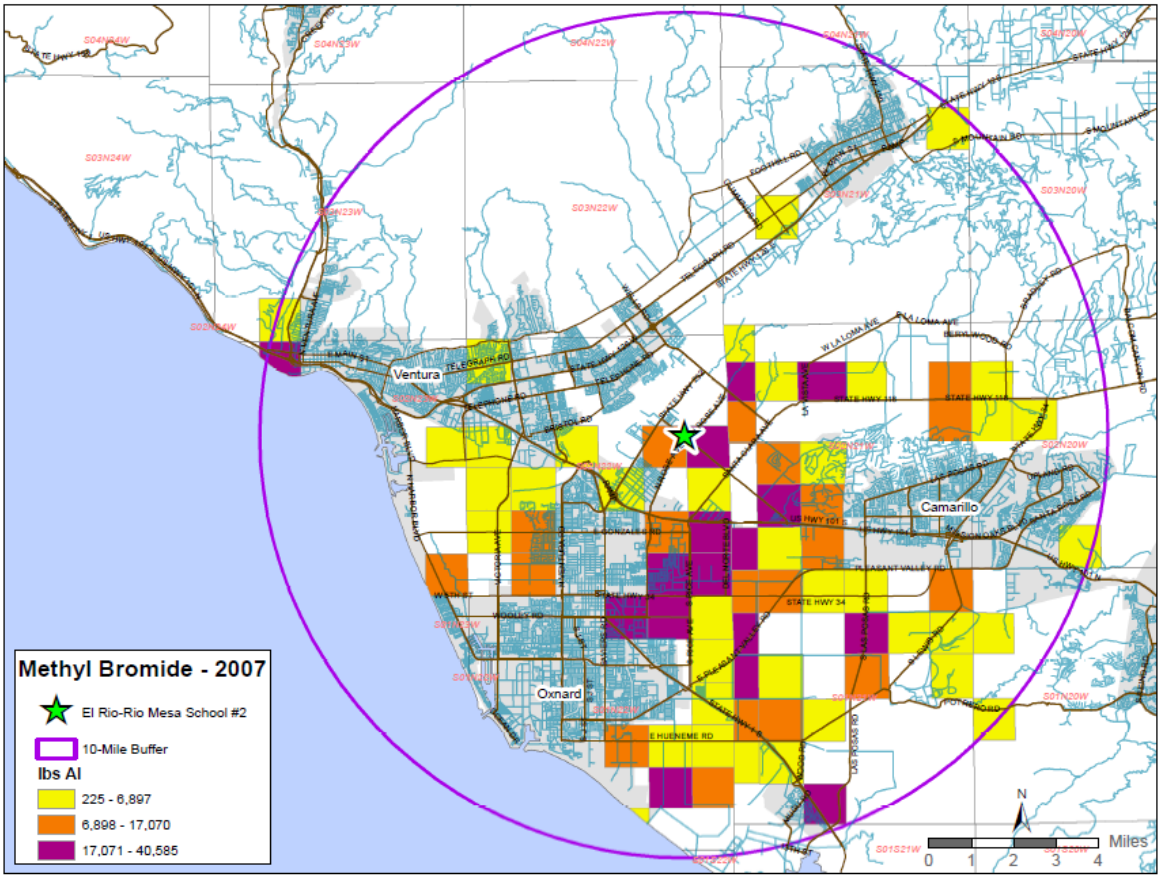
Appendix 12. Methyl bromide use in Santa Barbara County 2009.



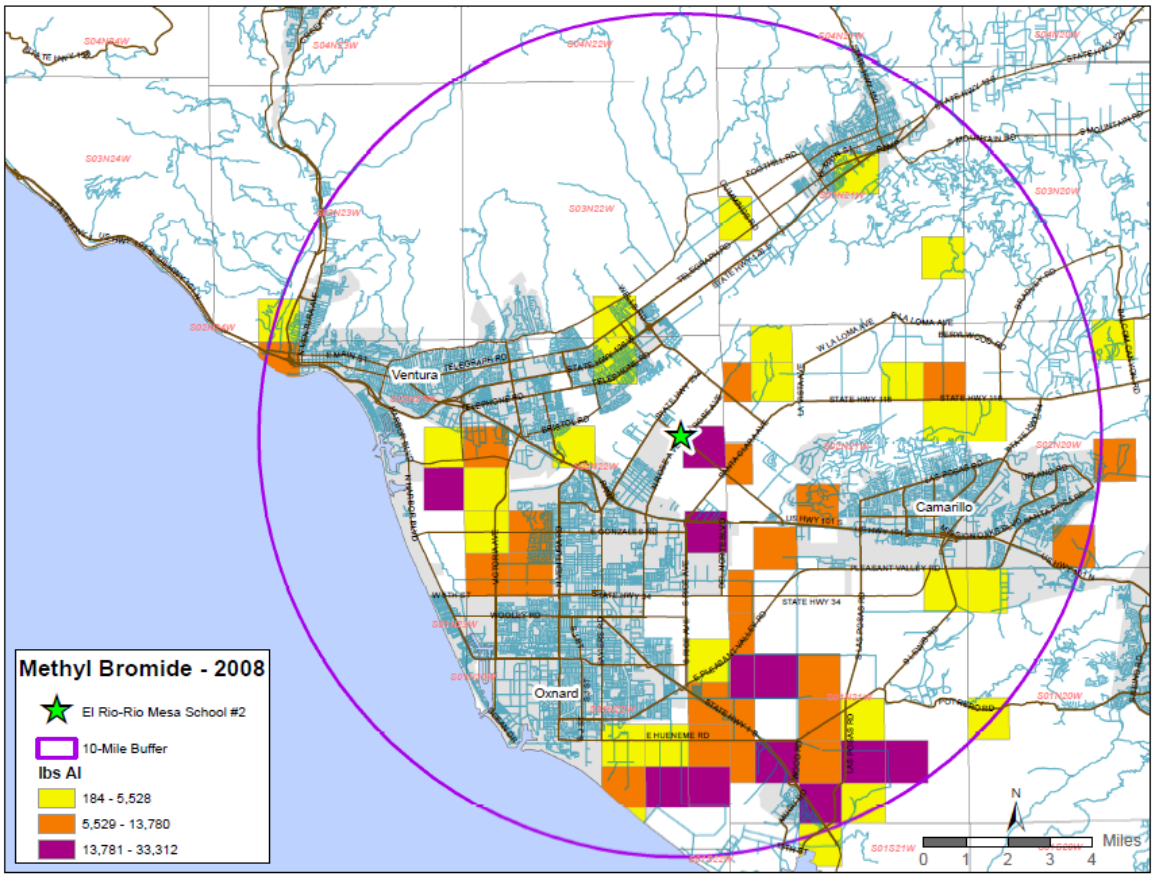
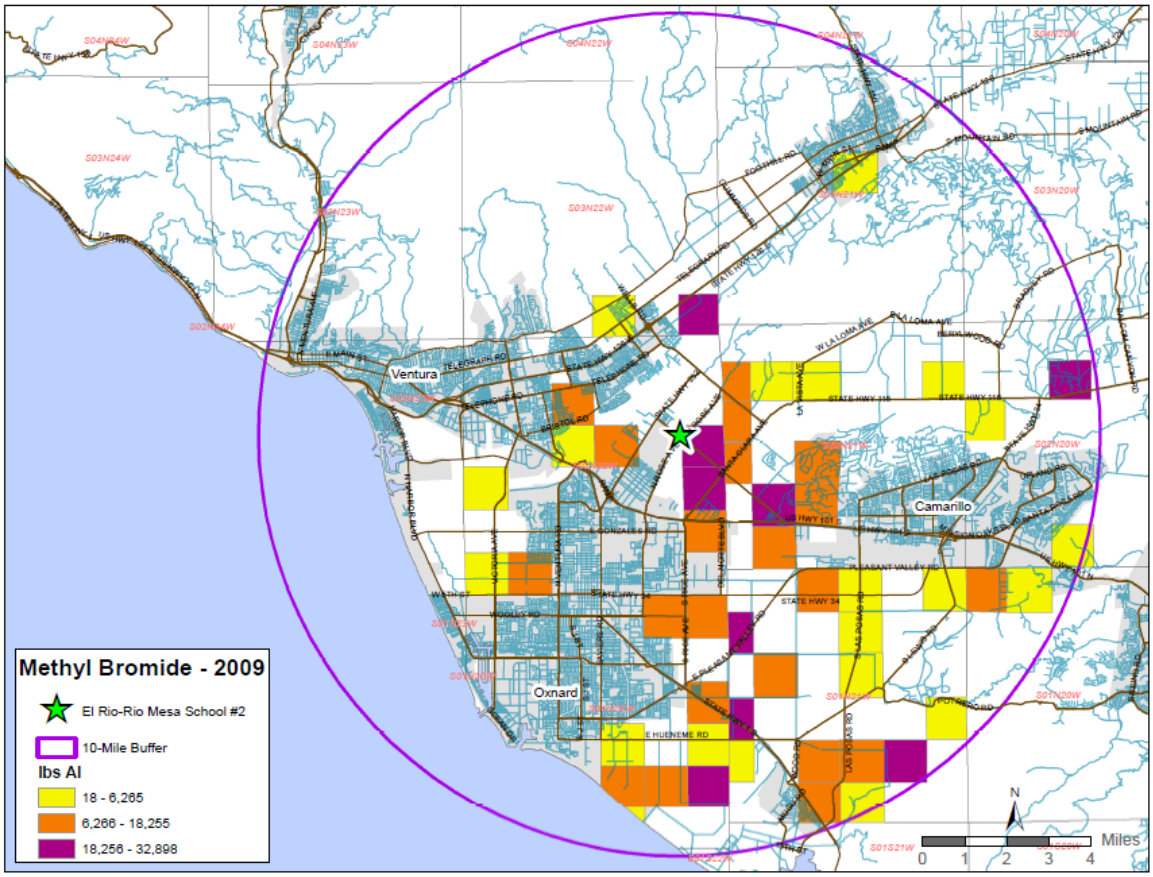
Appendix 13. Methyl bromide use in Ventura County 2006



Appendix 14. Methyl bromide use in Ventura County 2007.



Appendix 15. Methyl bromide use in Ventura County 2008.



Appendix 16. Methyl bromide use in Ventura County 2009.