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## MEMORANDUM

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Division of Registration and Health Evaluation

FROM: Bruce Johnson, Ph.D., Research Scientist III  
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DATE: March 27, 2007

SUBJECT: SIMULATION OF CONCENTRATIONS AND EXPOSURE ASSOCIATED WITH  
DOW AGROSCIENCES-PROPOSED TOWNSHIP CAPS FOR VENTURA  
COUNTY FOR 1,3-DICHLOROPROPENE

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### Summary

The Dow AgroSciences (DAS) proposed a configuration of township caps in a 5x5 township area of high 1,3-dichloropropene (1,3-d) use in Ventura. Four of the inner 9 townships were given 1.5X (135,375 pounds/year adjusted use) caps. The other 21 townships were lower than 1X (90,250 lbs/year adjusted use), with 19 townships at less than 0.1X (9025 lbs/year adjusted use). The DAS Soil Fumigant Exposure Assessment (SOFEA) modeling tool was utilized to estimate air concentrations associated with this proposal. The resulting air concentration distributions were then used as input to the High End Exposure Version 5 Crystal Ball (HEE5CB), a Worker Health and Safety exposure model, to estimate exposure. Input to the SOFEA model was based on Ventura-specific use from 2003-2005 and five years of meteorological data from Ventura. HEE5CB was used to simulate two mobility scenarios: Low Mobility (person spends entire life within the highest township), Intermediate Mobility (person's home in highest township, but travels around throughout the other 3x3 township area). For Low Mobility the lower and upper bound 95th tile risk exceeded the  $1.0 \times 10^{-5}$  reference level for males and females. The upper bounds were 28% and 26% higher than the reference level, respectively. For Intermediate Mobility the upper and lower bounds straddled the  $1.0 \times 10^{-5}$  95th percentile reference level for males and females. The upper bounds were 18%-19% higher than the reference level.

### Background

DAS proposed a set of township caps for the use of 1,3-d in Ventura (Wesenbeeck 2005). The exposure associated with the proposal was evaluated by DAS. First they used their modeling tool, SOFEA (SOFEA, Cryer 2004, 2005; Wesenbeeck and Cryer 2004), to produce concentration distributions associated with their proposal. Then they employed a risk model, based on the concepts in the exposure assessment portion (Sanborn and Powell 1994, Appendix B of the Department of Pesticide Regulation [DPR] 1997) of DPR risk assessment of 1,3-d (DPR 1997). In the intervening time, the modeling tool, SOFEA, has undergone modifications and review (Johnson 2005ab, Johnson 2006a).



Consequently, it is desirable to recalculate the exposures associated with the proposed township cap levels. A key theme to this calculation is that the computer simulation is based upon Ventura-specific use and meteorological data, in contrast to other simulation work (Johnson and Powell 2005, Johnson 2006b) which was based on statewide use information and combined meteorological data from Merced and Ventura.

### **Objectives**

1. Utilize Ventura use information to create probability distributions of field size, application rate, application date, and related variables for use in SOFEA.
2. Use SOFEA to estimate upper and lower bound concentration distributions reflecting low-mobility and intermediate-mobility assumptions using Ventura meteorology.
3. Utilize the appropriate concentration distributions with HEE5CB (HEE5CB, Powell 2006) to provide exposure estimates for male and female lifetime exposure for the four cases resulting from upper/lower bounds and low- and intermediate-mobility and to compare these estimates to the reference level of  $1.0E-5$  ( $=1.0 \times 10^{-5}$ ) at the 95th percentile.

### **Methods**

The Crop Data Management System (CDMS) data for Ventura for 2003, 2004, and 2005 was obtained from DAS and assembled into a database of use. The SOFEA model allows up to five 'crops.' Four of the crops in SOFEA (FC, SB, NC, and PP) are equivalent in terms of how the model uses them. One crop, TV, which represents tree and vine, has the special restriction that for multi-year simulations, the model keeps track of TV acreage locations, and does not allow for repeat applications to the same acreage. For the other four crops, repeat treatments are possible and, in fact, a retreatment probability can be specified. However, even though SOFEA has been designed for making multiple year runs, these multi-year runs with SOFEA became inadvisable due to model crashes which occur in multi-year runs, the model not changing the meteorological year, and biases in the actualized repeat frequencies. Johnson and Powell (2005) developed a procedure to address these issues. This consisted of running SOFEA for one-year periods and to use a procedure to estimate an upper and lower bound for multi-year runs. Using one-year run periods eliminates any differences in the way that SOFEA handles the crops. Consequently, the association between the crop and its acronym, such as TV, PP, etc. is arbitrary. I have tried to group the crops meaningfully so that TV generally represents tree and vine crops; SB represents strawberry crops and the remaining crops are grouped under FC.

To group the actual crops in Ventura into five or less categories, I used a crop-translation table from Johnson and Powell (2005). The table in Johnson and Powell (2005) was based on statewide 1,3-d use and not all statewide crops appear in the Ventura 1,3-d use records. After examining the groupings, I made some minor changes and classified the crops into three categories: TV, FC, and SB (Table 1). Table 1 shows a category, PP. There were no crops in the PP category in Ventura. The grouping into these three categories is utilized to establish governing crop acreages and creating probability distributions for sampling. Using Excel, the three crop categories were assigned to each record according to Table 1 and summaries based on the assigned crop were used to derive the acreage and distributional inputs needed to run SOFEA. For Ventura, SB consisted largely of strawberries, TV consisted mostly of lemons and tangerines and FC consisted primarily of peppers and tomatoes.

**Acreage.** Using the pivot table function in Excel yielded fractional acreages of .270, .689, and .041 for FC, SB, and TV, respectively. These fractional acreages were entered as percentages into the worksheet, PDF

Parameters!B9:F104, where the governing acreages for the central 9 townships reside and also into the worksheet, Crop%\_Ext!B9:F529, where the governing acreages for the crops outside of the central 3x3 reside.

**Acreage Modifications.** The original five runs at 0.27, 0.689, and 0.041 fractions for FC, SB, and TV, respectively, resulted in average acreages (computed from data in the Misc worksheets for runs J1312-J1316) of 0.22, 0.776, and 0.0028, respectively. This allocation exaggerated

ALDER,EUROPEAN	TV	CUCUMBERS	FC	PEARS	TV
ALFALFA	FC	EGGPLANT	FC	PEPPERS (BELL)	FC
ALMONDS	TV	FALLOW GROUND	FC	PEPPERS, CHILE	FC
APPLES	TV	FIGS	TV	PEPPERS-NO BEL	FC
APRICOTS	TV	FLORAL CROPS	FC	PLUMS	TV
ARTICHOKES	FC	FLOWERS	FC	POTATOES	PP
ASPARAGUS	FC	GRAPES (FRESH)	TV	PRUNES	TV
AVOCADOS	TV	GRAPES (RAISN)	TV	PUMPKINS	FC
BASIL	FC	GRAPES (WINE)	TV	RADISHES	FC
BEANS (DRY)	FC	HONEYDEW MELON	SB	RASPBERRIES	TV
BEANS (LIMA DR	FC	LEMONS	TV	RED BEETS	FC
BEDDING PLANTS	FC	LETTUCE (HEAD)	FC	ROSES	FC
BEETS (TABLE)	PP	LETTUCE (LEAF)	FC	RYEGRASS	FC
BEETS (TOP)	PP	LETTUCE,ROMAIN	FC	SANDSTRAWBERRY	SB
BITTER MELON	FC	LILY	FC	SPINACH	FC
BLACKBERRIES	TV	MAHALEB CHERRY	TV	SQUASH (SUMMR)	FC
BROCCOFLOWER	FC	MANDARIN/ORANG	TV	STRAWBERRIES	SB
BROCCOLI	FC	MELONS	FC	STRAWBERRY,BCH	SB
BRUSSELS SPRTS	SB	MUSTARD	FC	SUGAR BEETS	PP
CABBAGE	FC	NAPA CABBAGE	FC	SWEET POTATOES	PP
CANTALOUPE	FC	NECTARINES	TV	TANGERINES	TV
CARROTS	PP	NON CROP AREAS	PP	TOMATO SEEDED	FC
CAULIFLOWER	FC	NURSERIES	FC	TOMATO TRSPLT	FC
CELERY	FC	NURSERY STOCK	FC	TOMATOES FRESH	FC
CHERRIES, SAND	TV	ONIONS (DRY)	FC	TURFGRASS	FC
CHERRIES-SWEET	TV	ONIONS (SEED)	FC	Unknown	FC
CHERRY,BLACK	TV	ONIONS,SPANISH	FC	WALNUT (ORN)	TV
CITRUS HYBRIDS	TV	ORANGES (NAVEL	TV	WALNUTS (BLCK)	TV
CITRUS(NURSERY	TV	ORANGES(SWEET)	TV	WALNUTS (ENGL)	TV
CITRUS-ORN	TV	ORANGES(VALEN)	TV	WATERMELONS	FC
CONIFER NURSRY	TV	ORNAMENTALS	FC	YAMS	PP
CORN/SWEET	FC	PARSLEY	FC		
COTTON	FC	PEACHES	TV		

SB and underestimated both FC and TV. Because TV applications are generally at higher rates, it is important to adequately represent this category. Several exploratory runs were conducted with decreased governing percentages of SB and increased governing percentages of FC and TV in an attempt to tune the results to the measured acreages. Eventually, five additional runs (J1321-J1325) were conducted with fixed governing percentages of 0.25, 0.55, and 0.20, respectively. When the realized percentages from J1321-J1325 and J1312-J1316 were averaged, the result was 0.2313, 0.6717, and 0.964, respectively. While this result doubles the fraction of TV, the fraction of FC is somewhat understated. In future simulations, it may prove beneficial to combine these now distinct 'crop' distributions into a single distribution to avoid problems with specifying crop percentages. This is an area of SOFEA utilization, which I have not explored and in some cases, might be difficult to implement due to restrictions in Crystal Ball on the amount of data that can be utilized to define a probability distribution. In any event, I decided to use the results from all ten runs. Thus each meteorological year was run twice, at each of the two governing crop percentages and all ten years were combined for the distributional analysis.

**Probability Distributions.** For each crop type, there are three main probability distributions: application rate (kg/ha), field size distribution (ha), and Julian application date (day of the year). SOFEA uses Crystal Ball (Decisioneering, Inc 2001) to sample from these distributions in order to set up each run-year Industrial Source Complex Short Term Version 3 (ISCST3) control file. To enter these distributions into an Excel spreadsheet to be made available to the Crystal Ball sampling routines, it is most convenient to group the data in an Excel spreadsheet where the range can be specified.

To accomplish this with a minimum of complication, I computed the required variables, converting to the appropriate units in the spreadsheet (e.g. lbs/acre becomes kg/ha). Then I sorted the records by the TV, FC, or SB designator. Crystal Ball allows for the input of arbitrary distributions by specifying a range of values in a worksheet. After sorting by crop designator (TV, FC, and SB), the spreadsheet structure consisted of three sets of rows, each set encompassing one of the three crops (TV, FC, or SB) and three columns, each one corresponding to one of the three variables. Thus 9 distributions were defined by entering the appropriate Excel spreadsheet range into Crystal Ball into the appropriate cells (in the range PDF Parameters!B6:B32). Figures of the resulting distributions are shown in Appendix 3.

**Percent Drip Applications.** Like crop percent, this is another governing percentages and is based on the split within each crop between drip and nondrip applications. These values were determined using the Excel pivot table function on application method. For SB 100% were drip, while 6% and 7% were drip, respectively, for TV and FC. These percentages are entered into the same area as the probability distributions.

**Depth of Application.** Since SB was 100% drip, these applications were all set to a depth of 2.54 cm (1 inch). FC shank was approximately evenly split between deep and shallow shank (54.3% and 45.7% and TV shank was mostly deep at 90.3%. The shallow vs. deep shank was entered as a two-value probability distribution (with values of 45.72 cm (18 inches) and 30 cm (12 inches) for deep and shallow, respectively, at the given percentiles) into worksheet, PDF Parameters!C37:C39. Linear mass loss scaling was used. The ‘DPR’ method for depth scaling was used (at worksheet, PDF Parameters!B47:C47, option =2).

**Township Cap Weights.** Wesenbeeck (2005) proposed the set of township weights shown in Table 2. These townships correspond to 03N23W in the upper left to 02S19W in the lower right. Within the context of SOFEA, the numbering of the inner 9 townships (shaded region Table 2) starts with the lower left (Table 3). The central 3x3 townships contain four townships at 1.5x. The remaining 16 townships were set to low use amounts. While much focus has been on the highest use townships within the central 3x3 area, the distributions that result from this simulation depend on the low-, as well as the high-use townships. In that sense, regulatory strategies, which utilize these simulation results, must recognize that the ensuing restrictions on use depend on the levels of use in all of the townships in the simulation, not just the high use townships. These township weights were entered into worksheet, Twn\_Mass\_Wt!A1:B3, for the central 3x3 townships and into worksheet, Twn\_Mass\_Wt\_Ext!J12:N16, minus the central 9 townships (which are specified in Twn\_Mass\_Wt).

**Table 2. Township cap weights proposed by DAS for Ventura (Wesenbeeck 2005).**

0.00	0.01	0.03	0.03	0.03
0.00	<b>1.5</b>	<b>1.5</b>	<b>0.7</b>	0.00
0.00	<b>1.5</b>	<b>1.5</b>	<b>0.03</b>	0.00
0.00	<b>0.05</b>	<b>0.2</b>	<b>0</b>	0.00
0.00	0.00	0.00	0.00	0.00

**Section Weights.** Powell (2004) estimated section weights for Ventura for four townships. These weights reflect the heterogeneous use that occurs within every township between sections. Historically some sections receive greater use than others. I utilized these section weights directly for townships. In Ventura, there were weights available for townships 4, 5, 7, 8, and 9. The other 4 townships in the central 3x3 area did not have weights because low historical use precluded estimating weights. Therefore, weights from township 9 were used for townships 6 and 3, weights for 4 were used for 1, and weights for 5 were used for 2. Previous simulations have indicated that while it is important to have weights reflective of heterogeneous use, for annual or longer averages, the model results are insensitive to the

**Table 3. Township numbering within SOFEA for center 3x3 townships.**

<b>7</b>	<b>8</b>	<b>9</b>
<b>4</b>	<b>5</b>	<b>6</b>
<b>1</b>	<b>2</b>	<b>3</b>

actual placement of these weights (Johnson and Powell 2005). The townships around the central 3x3 utilize a uniform distribution of section weights since the purpose of those townships is to reduce the edge effect in the center 3x3. Early versions of the SOFEA model assumed uniform distribution of applications throughout the area. This assumption is not supported by use data that shows that clustering of applications is the normal situation. The fact that applications tend to cluster within limited number of sections increases the upper end of the concentration distributions because the same receptors experience higher concentrations year after year.

**Procedures to Analyze the Results.** The approach taken to analyze the results is fully described in Johnson and Powell (2005). Briefly, after a one year simulation was completed, the SOFEA worksheet, Chronic, contained a list of the one year average concentrations at each of 11,664 receptors (11,664 receptors=36 sq mile/township \* 9 townships \* 36 receptors/sq mile). These 11,664 receptors uniformly blanket the central 3x3 townships. After a model run, each receptor has an estimated concentration. This list of 11,664 concentrations was imported into a separate spreadsheet, where the ten simulation results were brought together into a single worksheet for further analysis.

**Upper and Lower Bounding Distributions.** Johnson and Powell (2005) describe a process to obtain an upper and lower bound distribution which bracket a long-term (multi-year) distribution for a given scenario. Appendix 2 in this current memorandum presents major elements of the Johnson and Powell (2005) discussion of upper and lower bounding. This process results in two distributions, one representing the lower bound and one representing the upper bound. These distributions are separately simulated in HEE5CB (Powell 2006) to obtain the corresponding lower and upper bound estimate on the 95th percentile Lifetime Average Daily Dosages (LADD).

**Mobility Assumptions.** Two mobility assumptions are simulated: low mobility and intermediate mobility. In order to set up these two scenarios, the concentration distributions from two spatial areas are utilized: (1) the single township with the highest exposure and (2) the entire 3x3 township area. These two concentration distributions are used as a basis for approximating 'mobility' of humans in the sense that when they are used in HEE5CB (Powell 2006), they represent concentrations from either localized (1 township, or 36 square miles) versus wider area (9 townships, or 324 square miles) distributions. Concentration distributions from a single township stand for low mobility, while concentration distributions from the 9 township area represent greater mobility. For this memorandum, low mobility is defined as exclusive use of the concentration distribution from the highest-exposure township. This is a more conservative scenario since it uses the highest exposure distribution and assumes that a lifetime is spent within that township. Intermediate mobility is defined as dominant use of the highest township, with secondary use of the distribution from the 3x3 township area. HEE5CB allows up to five different distributions to be sampled from. In this memorandum, the first distribution is the 'home' distribution, and all four others are considered 'away from home.' Mobility assumptions in HEE5CB change with individual's age. They range from about 80% of the time at 'home' in infancy (and the

complementary portion of 20% 'away from home') to about 60% 'home' for adults. The actual allocation of minutes per day to these divisions is itself a stochastic multinomial variable (Sanborn and Powell 1994 page 22).

**Determination of Highest Exposure Township.** The highest exposure township was determined by running HEE5CB (n=10000) with the upper bound distribution from each of the four 1.5x-treated townships and then choosing the township with the highest exposure at the 95th percentile. Township #5 exhibited the highest LADD at the 95th percentile (see Table 3 for numbering). While the overall distributions are of interest, Gosselin (2001) indicated that DPR regulatory effort regarding 1,3-d would be directed towards the 95th percentile risk level. To convert exposure to risk requires simple multiplication of the LADD by the upper-bound potency factor of 0.000055 kg-day/ug (Reed 2001). The 95th percentile upper bound risks associated with each of these four townships (in sequence as #4, #5, #7, and #8) were respectively (male): 1.09e-5, 1.26e-5, 1.15e-5, 1.18e-5, and (female): 1.07e-5, 1.24e-5, 1.12e-5, 1.16e-5.

Thus, two exposure scenarios were simulated, a low-mobility scenario and an intermediate mobility scenario. For these simulations, HEE5CB was run with n=50000. This means that HEE5CB sampled 50000 times from the concentration distributions and other distributions within HEE5CB, which represent population attributes.

In summary, a matrix of four scenarios was formed with low-mobility and intermediate-mobility crossed with upper and lower bound estimates. Within each of the four matrix cells, HEE5CB estimated exposure for males and females.

## **Results**

The resulting risk estimate bounds were mostly above the 1.0E-5 reference level (Table 4). Under the low mobility assumption, where lifetime exposures were based on the highest township, the male risk estimate was between 1.06E-5 and 1.28E-5 and the female was between 1.04E-5 and 1.26E-5. The intermediate mobility scenario resulted in risk estimates which, as expected, were somewhat lower than the low mobility scenario. Male risk estimates were between 0.95E-5 and 1.18E-5, while female risk estimates were between 0.96E-5 and 1.19E-5.

These results indicate that the use cap scenario proposed by Wesenbeeck (2005) is on the edge with respect to the reference level of 1.0E-5 (Gosselin 2001). Higher levels of use, beyond those proposed in Wesenbeeck (2005), probably cannot be sustained with regard to the

reference level. Higher levels of use refer to use levels, not only in the central 3x3 township area, but also in the surrounding townships as well. Higher use in the central 3x3 township would have the greatest impact on the concentration, and hence, exposure distributions. But higher use in the peripheral townships would also exert some affect, as well.

### Conclusion

DAS proposed a configuration of township caps in a 5x5 township area of high 1,3-d use in Ventura. Four of the inner 9 townships were given 1.5x (135,375 pounds/year adjusted use) caps. The other 21 townships were lower than 1x (90,250 lbs/year adjusted use), with 19 townships at less than 0.1x (9025 lbs/year adjusted use). The DAS SOFEA model was utilized to evaluate this proposal. Input to the SOFEA model was based on Ventura-specific use from 2003-2005 and five years of meteorological data from Ventura. Two mobility scenarios were simulated: Low Mobility (person spends entire life within the highest township), Intermediate Mobility (person's home in highest township, but travels around throughout the other 3x3 township area). For Low Mobility the lower and upper bound 95th tile risk exceeded the 1E-5 reference level for males and females. The upper bounds were 28% and 26% higher than the reference level, respectively. For Intermediate Mobility the upper and lower bounds straddled the 1.E-5 95th percentile reference level for males and females. The upper bounds were 18%-19% higher than the reference level.

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Table 4. Bounded risk estimates for Ventura township cap proposal (Wesenbeeck 2005) showing upper and lower bound with low and intermediate mobility scenarios.

	Male		Female	
	<u>Lower Bound</u>	<u>Upper Bound</u>	<u>Lower Bound</u>	<u>Upper Bound</u>
Low	1.06E-05	1.28E-05	1.04E-05	1.26E-05
Intermediate Mobility	.95E-05	1.18E-05	.96E-05	1.19E-05



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## Appendix 1. Glossary and acronyms

**CDMS:** California Data Management Systems. A company that contracts with DAS to keep track of application of products that contain 1,3-d. CDMS data refers to use reports similar to the Pesticide Use Report maintained by DPR.

**Crystal Ball:** The version I used is Crystal Ball 2000 Professional Edition V5.2. This software works in conjunction with Excel (and hence, SOFEA and HEE5CB) for the inputting of probability distributions and subsequent sampling of those distributions. This process is called Monte Carlo sampling. Part of the notion behind SOFEA is to enable the input of key probability distributions based on historical use patterns which reflect actual use patterns. For example, a frequency distribution of application dates is often a bimodal distribution with peaks in spring and fall. This distribution is defined into a particular cell in the PDF Parameters work sheet and when SOFEA runs, the first phase of the process is to resample that cell to randomly choose field sizes which are used to construct a synthetic database of applications. Each application is assigned a field size, an application date and application rate based on sampling the probability distributions which have been input. In this way, ISCST3 control files reflect actual use patterns. For HEE5CB, Crystal Ball enables inputting the concentration distributions that are the outputs from SOFEA. Crystal Ball then samples from those distributions, as well as distributions for other exposure-related parameters.

**Exponents and Powers of 10:** The reference level of  $1.0 \times 10^{-5}$  is shown in Excel and other sources as 1.0E-5, where it is understood that “E-5” means  $\times 10^{-5}$ . So, for example, 0.98E-5 represents  $0.98 \times 10^{-5}$ .

**HEE5CB:** The acronym stems from High End Exposure version 5, Crystal Ball (Powell 2006). An exposure simulation model which estimates non-occupational exposure (Sanborn and Powell 1994, Powell 2006). It uses as input concentration distributions from SOFEA.

**ISCST3:** Industrial Source Complex Short Term. This is a U.S. Environmental Protection Agency model for estimating air concentrations based on field flux. The version used with SOFEA is a specially modified version which allows for the specification of buffer zones, which act to exclude on-field and nearby receptors from direct emissions from on-field and nearby sources, which fall within the buffer zone (Johnson 2001).

**Julian Application Date:** The application date converted from month/day/year designation to the calendar day of the year. For example, February 1 is Julian Day 32.

**LADD:** Lifetime Average Daily Dosage for 70 years.

**Section Weights:** Within each township, a set of numbers from 0 to 1 which are related to the propensity for use to occur in that section. The sum of the weights within each township is equal to 1.0 and these weights influence the assignment of field locations in SOFEA. Higher weights increase the number of fields located within the section and conversely, lower weights decrease the frequency that field locations are assigned to a particular section. The figure to the right shows the weights that were used for township #5 in Ventura. Complete weights are shown in Appendix 4.

**Figure A 1 Section weights for Ventura township #5.**

0.04	0.03	0	0.03	0.01	0.08
0.03	0.07	0.04	0.1	0.06	0.01
0	0.04	0.05	0	0.06	0
0.02	0.07	0.06	0.09	0	0.01
0.01	0	0	0	0	0
0	0	0.06	0.02	0	0

**SOFEA:** Soil Fumigant Exposure Assessment Tool Copyright 2004, Steve Cryer. SOFEA

was modified for corrections to buffer zone scheme by Dr. Bruce Johnson. SOFEA consists of approximately 10,000 lines of Visual Basic code. The VB code runs a specially modified ISCST3 which calculates air concentrations based on input files created by the VB code. The VB code uses Excel as an interface and consists of 19 worksheets. The VB code creates control files based on inputs assigned to various worksheets by the user. These control files are used to run the ISCST3 model. After running ISCST3, the VB code reads the output files generated by ISCST3, and incorporates and analyzes this output. The purpose of creating this modeling tool was to examine specific situations where some townships may experience use larger than the township cap, while others may be below and how these various levels of use affect the exposure. Within the context of this memorandum, worksheets are occasionally referenced where input variables are inserted to set up a model run. For example, "PDF Parameters! B96:F104" refers to the worksheet called PDF Parameters and within that worksheet to the rectangular area with the upper left cell at B96 and the lower right cell at F104.

**Township Cap:** This is a concept that a township area (6 miles x 6 miles) will have a restriction on the total yearly 1,3-d use. This restriction is currently 90,250 lbs of adjusted use. Permit conditions specify various adjustment factors which increase the applied pounds of 1,3-d in order to account for emission differences between application methods. The model allows for input of factors in terms of this restriction. For example, 1.5x township cap means  $1.5 \times 90,250 = 135,375$  adjusted pounds per year.

**Upper and Lower Bounds:** A procedure described in Johnson and Powell (2005) for determining the upper and lower bound concentration distributions for long term exposure assessment to 1,3-d. See Appendix 2 for detailed explanation.

## Appendix 2. Detailed explanation of Upper and Lower Bounds. (Based on Johnson and Powell 2005)

Our simulation strategy with SOFEA was to bracket the values of interest with a lower and upper bound. A lower bound could be determined by simulating each weather year separately (but with the control file otherwise the same). These ten years of simulations would be combined by averaging the ten concentrations at each receptor. This method of finding the average is equivalent to what SOFEA would calculate were it to run for ten years and use each weather year once. However, it is also equivalent to having zero repeat field applications. Repeat-field applications would increase the concentrations at the upper percentiles. Aside from section weight constraints, every simulation year would be independent from every other year. After finding the average at each receptor, then these receptor averages are combined to form a concentration distribution. This distribution would be a lower bound for the upper percentiles because repeat-field applications (which are nonexistent in these ten years of simulations) would tend to give even higher concentrations than when there are no repeat-field applications.

An upper-bound can be found using the same ten one-year simulations by averaging the distributions. At each percentile, the ten corresponding concentration measurements would be averaged. The spatial element is completely ignored in this averaging procedure. A single year of simulation is like having the same fields treated year after year with exactly the same weather. Therefore, the upper end of a concentration distribution which arises from a single year of simulation would be expected to be higher than the upper end of a concentration distribution which was based on multiple years of simulation in which half of the annual crop (i.e. not TV) fields moved around every year. By taking the average of the ten one-year distributions, we get an estimate of the concentration variability around the 95th percentile for this upper-bounding condition.

To help understand these two ways of finding an average, we have created Figure A1. This figure depicts a small 4x4 grid of points, which totals 16 receptor positions. In the course of simulation, the model uses these location points to measure the atmospheric concentrations.

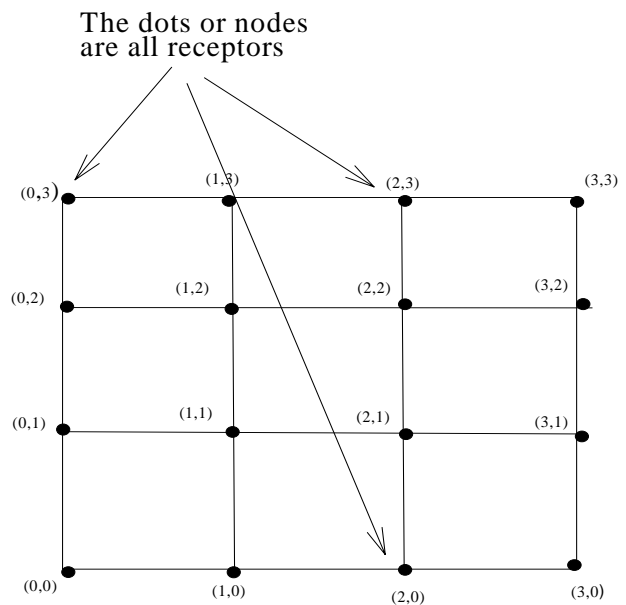


Figure A1. 16 receptor example grid.

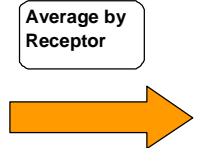
Sources are fields, which are located through the grid as squares (not shown). We have created some artificial data, as though there were three, one-year simulations estimating concentrations at each receptor.

These artificial simulation results are depicted in Table A1. Three individual years of estimated concentrations are shown in the upper left portion of the table, along with the location of the corresponding receptor. The calculations to the right show the procedure for determining the receptor average and associated cumulative concentration distribution.

First the average at each receptor over years is found. Then this set of concentrations is sorted and the cumulative percentile is determined. When sources move around from year to year, this method will yield lower concentrations at the upper percentiles. Over years each receptor may see high and low concentrations, which reflect the moving around of the sources. For example, receptor (1,0) gets 0.9, 1.0, and 0.2.

**Table A1. Artificial example of receptor averaging versus percentile**  
 Concentration (ug/m3)

Receptor	Year 1	Year 2	Year 3	Average By Receptor	(Sorted) Concentration (ug/m3)	Cumulative Percentile (%)
(0,0)	1.1	1.5	1	1.2	0.1	6
(1,0)	0.9	1	0.2	0.7	0.2	13
(2,0)	0.2	0.2	0.7	0.4	0.3	19
(3,0)	0.1	0.2	0.5	0.3	0.3	25
(0,1)	0.9	0.5	0.2	0.5	0.3	31
(1,1)	1.4	1	1.2	1.2	0.4	38
(2,1)	0.5	0.4	0.5	0.5	0.4	44
(3,1)	0.1	0.1	0.2	0.1	0.5	50
(0,2)	0.4	0.6	0.5	0.5	0.5	56
(1,2)	0.6	0.5	0.2	0.4	0.5	63
(2,2)	0.8	0.5	0.2	0.5	0.5	69
(3,2)	0.1	0.2	1.3	0.5	0.5	75
(0,3)	0.2	0.2	1.3	0.6	0.6	81
(1,3)	0.2	0.3	0.5	0.3	0.7	88
(2,3)	0.3	0.3	0.3	0.3	1.2	94
(3,3)	0.3	0.1	0.2	0.2	1.2	100



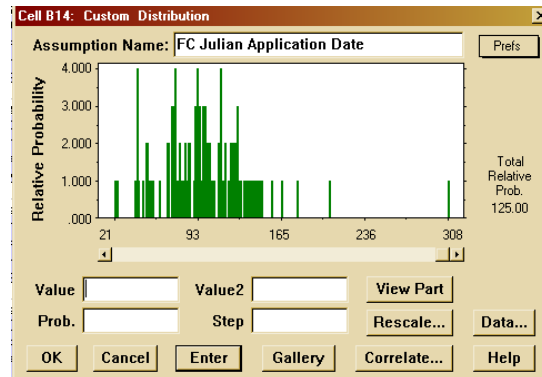
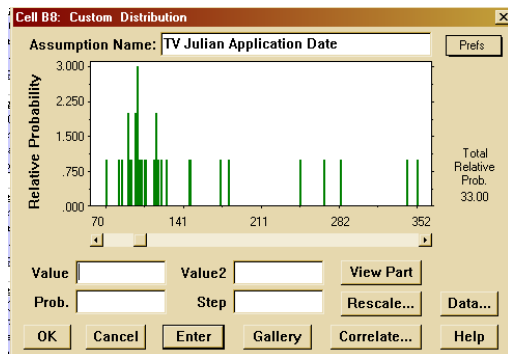
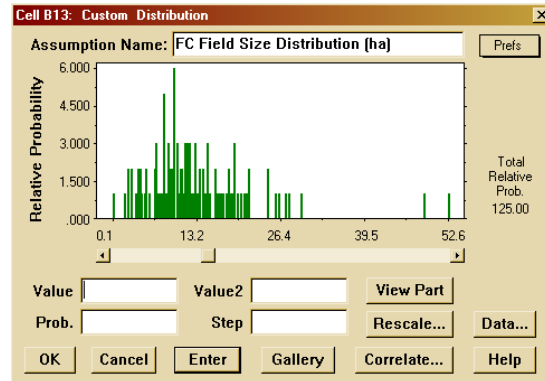
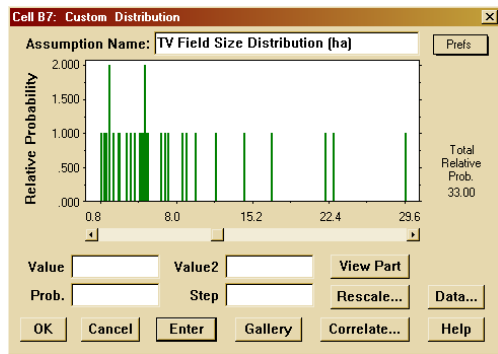
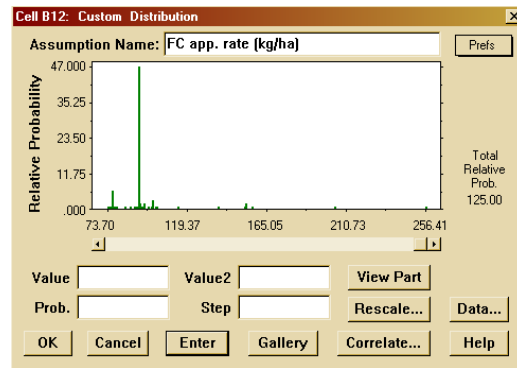
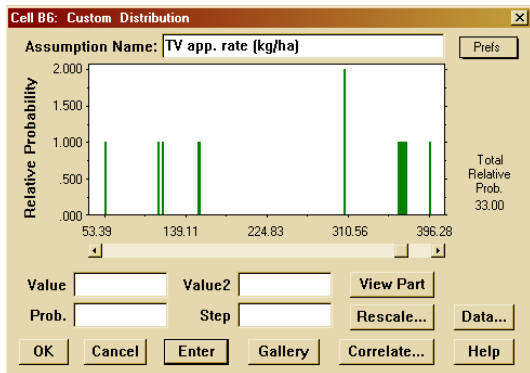
(sorted) Year 1	(sorted) Year 2	(sorted) Year 3	Average Concentration at each percentile (ug/m3)	Cumulative Percentile (%)
0.1	0.1	0.2	0.1	6
0.1	0.1	0.2	0.1	13
0.1	0.2	0.2	0.2	19
0.2	0.2	0.2	0.2	25
0.2	0.2	0.2	0.2	31
0.2	0.2	0.2	0.2	38
0.3	0.3	0.3	0.3	44
0.3	0.3	0.5	0.4	50
0.4	0.4	0.5	0.4	56
0.5	0.5	0.5	0.5	63
0.6	0.5	0.5	0.5	69
0.8	0.5	0.7	0.7	75
0.9	0.6	1	0.8	81
0.9	1	1.2	1.0	88
1.1	1	1.3	1.1	94
1.4	1.5	1.3	1.4	100

Thus in year three, this receptor saw a reduced concentration. When those concentrations are averaged together, the low year reduces the average.

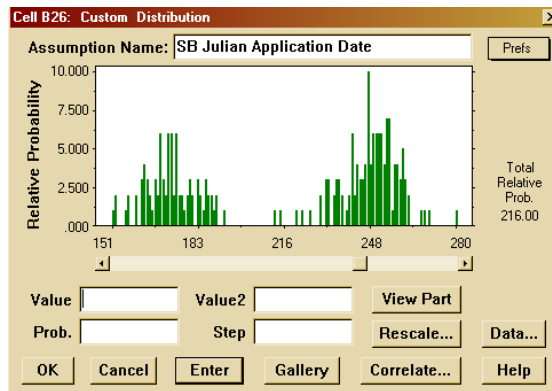
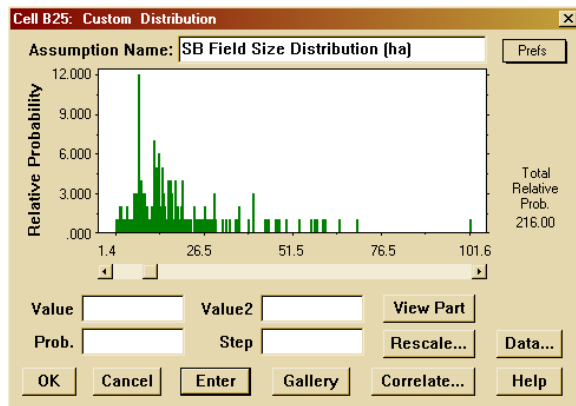
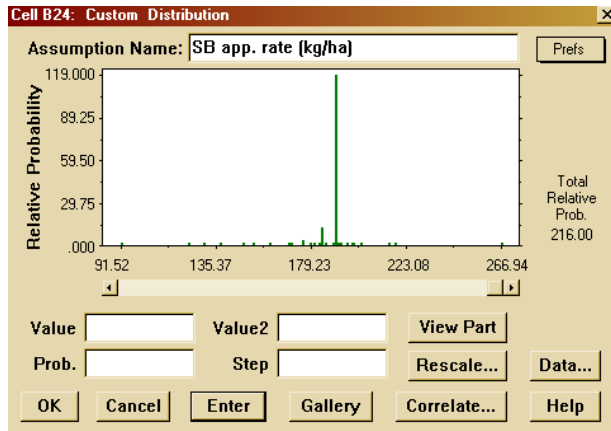
In the percentile averaging procedure, higher concentrations tend to track with the higher concentrations, even though they may have occurred in different spatial locations. The lower left portion of Table A1 below the data matrix illustrates how percentile averages are found. Each year of concentrations is sorted from lowest to highest. Each concentration at each percentile is then averaged. Consequently, higher concentrations are averaged with higher concentrations. The highest concentrations each year stay together in forming the average. In the example, these highest concentrations were 1.4, 1.5, and 1.3 along the bottom row of the lower left data table. Consequently, the highest percentile concentration under the “average by receptor” method is 1.2 compared to 1.4 under the “average by percentile” method.

In the case at hand, the “average by receptor” method (also sometimes called “spatial average”) will be used as a lower-bound for the distribution because it reflects the “movement” of sources in relation to receptors from year to year, with no fields being repeat-treated. The “average by percentile” method will be used as an upper-bound for the distribution because in some sense it represents concentrations that would be higher than expected over the long term because it does not allow for “movement” of the sources. High concentrations are averaged with high concentrations regardless of their spatial location.

### Appendix 3. Primary distributions used for Ventura simulation







**Appendix 4. Section weights for Ventura simulation**

0.000	0.000	0.000	0.000	0.011	0.032	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.000
0.014	0.000	0.012	0.000	0.000	0.017	0.231	0.000	0.035	0.012	0.000	0.039	0.063	0.000	0.052	0.124	0.000	0.052
0.036	0.000	0.000	0.000	0.096	0.113	0.000	0.000	0.000	0.000	0.000	0.018	0.011	0.237	0.012	0.000	0.000	0.000
0.035	0.021	0.028	0.000	0.064	0.027	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033	0.094	0.000	0.000
0.072	0.047	0.000	0.012	0.014	0.125	0.074	0.142	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.035
0.065	0.071	0.017	0.000	0.015	0.057	0.023	0.035	0.020	0.105	0.040	0.074	0.134	0.067	0.000	0.000	0.000	0.000
0.018	0.049	0.000	0.000	0.130	0.020	0.040	0.025	0.000	0.026	0.011	0.084	0.000	0.000	0.070	0.000	0.000	0.000
0.032	0.000	0.000	0.010	0.061	0.079	0.026	0.073	0.044	0.103	0.062	0.013	0.063	0.000	0.052	0.124	0.000	0.052
0.000	0.000	0.000	0.000	0.000	0.059	0.000	0.037	0.046	0.000	0.065	0.000	0.011	0.237	0.012	0.000	0.000	0.000
0.000	0.000	0.000	0.066	0.054	0.059	0.021	0.071	0.060	0.091	0.000	0.013	0.000	0.000	0.033	0.094	0.000	0.000
0.000	0.000	0.000	0.031	0.041	0.205	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.035
0.000	0.000	0.000	0.000	0.000	0.085	0.000	0.000	0.056	0.022	0.000	0.000	0.134	0.067	0.000	0.000	0.000	0.000
0.018	0.049	0.000	0.000	0.130	0.020	0.040	0.025	0.000	0.026	0.011	0.084	0.000	0.000	0.070	0.000	0.000	0.000
0.032	0.000	0.000	0.010	0.061	0.079	0.026	0.073	0.044	0.103	0.062	0.013	0.063	0.000	0.052	0.124	0.000	0.052
0.000	0.000	0.000	0.000	0.000	0.059	0.000	0.037	0.046	0.000	0.065	0.000	0.011	0.237	0.012	0.000	0.000	0.000
0.000	0.000	0.000	0.066	0.054	0.059	0.021	0.071	0.060	0.091	0.000	0.013	0.000	0.000	0.033	0.094	0.000	0.000
0.000	0.000	0.000	0.031	0.041	0.205	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.035
0.000	0.000	0.000	0.000	0.000	0.085	0.000	0.000	0.056	0.022	0.000	0.000	0.134	0.067	0.000	0.000	0.000	0.000

**ANNUAL CROPS**

**Loop 1**

0.000	0.081	0.173	0.083	0.051	0.000	0.011	0.026	0.028	0.147	0.127	0.014	0.050	0.000	0.134	0.113	0.017	0.017
0.000	0.000	0.026	0.052	0.000	0.014	0.000	0.093	0.128	0.044	0.037	0.065	0.084	0.080	0.051	0.061	0.013	0.049
0.000	0.043	0.084	0.039	0.000	0.119	0.038	0.026	0.072	0.052	0.016	0.000	0.011	0.000	0.022	0.000	0.029	0.000
0.016	0.000	0.000	0.000	0.000	0.165	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058	0.068	0.000
0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.038	0.000	0.014	0.020
0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.013	0.014	0.045	0.000	0.000
0.464	0.000	0.000	0.000	0.000	0.188	0.000	0.000	0.000	0.000	0.000	0.041	0.050	0.000	0.134	0.113	0.017	0.017
0.000	0.000	0.000	0.000	0.000	0.000	0.059	0.045	0.000	0.030	0.000	0.140	0.084	0.080	0.051	0.061	0.013	0.049
0.000	0.000	0.000	0.000	0.000	0.000	0.158	0.091	0.000	0.000	0.000	0.000	0.011	0.000	0.022	0.000	0.029	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.037	0.000	0.000	0.086	0.000	0.000	0.000	0.000	0.058	0.068	0.000
0.000	0.000	0.000	0.000	0.348	0.000	0.090	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.038	0.000	0.014	0.020
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.157	0.000	0.000	0.000	0.013	0.014	0.045	0.000	0.000
0.464	0.000	0.000	0.000	0.000	0.188	0.000	0.000	0.000	0.000	0.000	0.041	0.050	0.000	0.134	0.113	0.017	0.017
0.000	0.000	0.000	0.000	0.000	0.000	0.059	0.045	0.000	0.030	0.000	0.140	0.084	0.080	0.051	0.061	0.013	0.049
0.000	0.000	0.000	0.000	0.000	0.000	0.158	0.091	0.000	0.000	0.000	0.000	0.011	0.000	0.022	0.000	0.029	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.037	0.000	0.000	0.086	0.000	0.000	0.000	0.000	0.058	0.068	0.000
0.000	0.000	0.000	0.000	0.348	0.000	0.090	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.038	0.000	0.014	0.020
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.157	0.000	0.000	0.000	0.013	0.014	0.045	0.000	0.000

**Loop 1**

**PERENNIAL CROPS**

**Table A51. File listing and file location (I=modelcoord).**

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I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\MAK3X3VENT.lst	1/26/2007	49 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\MAK3X3VENT.map	1/26/2007	78 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\MAK3X3VENT.obj	1/26/2007	49 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\MAK3X3VENT.ydg	1/26/2007	7 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\OUT	1/26/2007	2 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\PER9.OUT	1/26/2007	2 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\VENTANN.OUT	1/26/2007	2 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\VENTPER.OUT	1/26/2007	2 KB
I:\gamma0501\caps-ventura\venturausepattern\section-weight\GETWEIGHT\ventweights.xls	1/26/2007	23 KB

**SOFEA runs: J1312-J1316 and J1321-J1325**

**Exposure runs: exp0046-49 for determining high township**

**Exposure runs: exp0050-53 for estimating high/low mobility, upper/lower bounds**

**MAK3X3VENT.FOR put together section weights in easy-to-use format for Ventura.**



# Department of Pesticide Regulation



Mary-Ann Warmerdam  
Director

## MEMORANDUM

Arnold Schwarzenegger  
Governor

TO: Tobi L. Jones, Ph.D., Assistant Director  
Division of Registration and Health Evaluation

FROM: Bruce Johnson, Ph.D., Research Scientist III  
Environmental Monitoring Branch  
(916) 324-4106

*Original signed by*

DATE: April 20, 2007

SUBJECT: MINOR TYPOGRAPHICAL ERROR IN MARCH 27, 2007 VENTURA  
SIMULATION REPORT

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On page 4 in Johnson (2007), in the first paragraph, the sentence reads: "When the realized percentages from J1321–J1325 and J1312–J1316 were averaged, the result was 0.2313, 0.6717, and 0.964, respectively." The latter number should be 0.0964. These are the realized fractions of "crops" from ten runs under the Dow AgroSciences-proposed scenario for Ventura. This typographical error has no effect on any conclusions in the report and the relevant discussion is written as though the number was 0.0964.

cc: Randy Segawa, Agriculture Program Supervisor IV  
Terrell Barry, Ph.D., Research Scientist III  
Ian Reeve, Ph.D., Associate Toxicologist  
Joseph P. Frank, Ph.D., Senior Toxicologist



Tobi L. Jones, Ph.D.  
April 20, 2007  
Page 2

## **Reference**

Johnson, Bruce. 2007. Memorandum to Tobi L. Jones, Ph.D., on “Simulation of Concentrations and Exposure Associated with Dow AgroSciences-Proposed Township Caps for Ventura County for 1,3-Dichloropropene” dated March 27, 2007.