I. Revised OP Cumulative Risk Assessment

D. Residential OP Cumulative Risk

1. Introduction

The Office of Pesticide Programs (OPP) has used a calendar based model (Calendex™) to address the temporal aspects of the residential use of pesticides in 7 geographic regions throughout the United States. These regions, based on major crop growing areas and their influence on surface and ground water, also present an opportunity to consider the unique climate patterns, pest patterns and potential socioeconomic patterns that influence residential pesticide use and expected exposure.

Calendex™ allows the OPP to delineate the critical timing aspects of seasonal uses of Organophosphate (OP) insecticides that result in exposure to pesticides. Calendex also enables OPP to identify potential co-occurrences from multiple sources. This includes the exposure from home lawn and garden treatments, pesticides used on golf courses and applications made by governmental entities for the control of public health pests such as wide area mosquito sprays.

In nearly all cases, the residential exposure scenarios were developed using proprietary residue and exposure data. Exposure factors such as breathing rates and durations of time spent indoors or outdoors were taken from various references including US EPA/ORD/NERL Consolidated Human Activity Database (CHAD), and the Agency's Exposure Factors Handbook (USEPA, 1997a). In this assessment, the full range of exposure values – expressed as uniform, log-normal or cumulative distributions -- are used, where appropriate, rather than relying solely on measures of central tendency. While the dietary and drinking water assessment address only the oral exposure route, the residential assessment considers the dermal and inhalation exposure routes as well as the oral route based on the mouthing behavior of young children.

EPA registered labels, while useful for establishing site/pest relationships and recommendations for applications, generally cannot provide the temporal aspects of regional pesticide use. Thus, OPP has relied on other sources of pesticide use information, including the National Home and Garden Pesticide Use Survey (NHGPUS) data and information available in State Cooperative Extension Service publications. These data resources were comprehensively used to identify information such as frequency of applications, the type of application equipment used, and the type clothing worn while making those applications. State Cooperative Extension Service recommendations were used to establish regional windows of pesticide applications based on the observed appearance of insects such as white grubs on lawns. For example, the timing for the treatment of white grubs occurs during mid-July in southern Texas (Region F-

Lower Midwest) and mid-August in areas such as New York (Region D – North East/ North Central).

2. Scope of Regional Assessments

The residential and drinking water assessments were developed for 7 distinct geographic Agricultural Production Regions (Figure I.D-1). EPA included ten OP pesticides with residential uses and potential for significant exposures in its assessment. Not included in the cumulative assessment were certain OP uses that result in low exposure and uses for which risk mitigation actions have been taken.

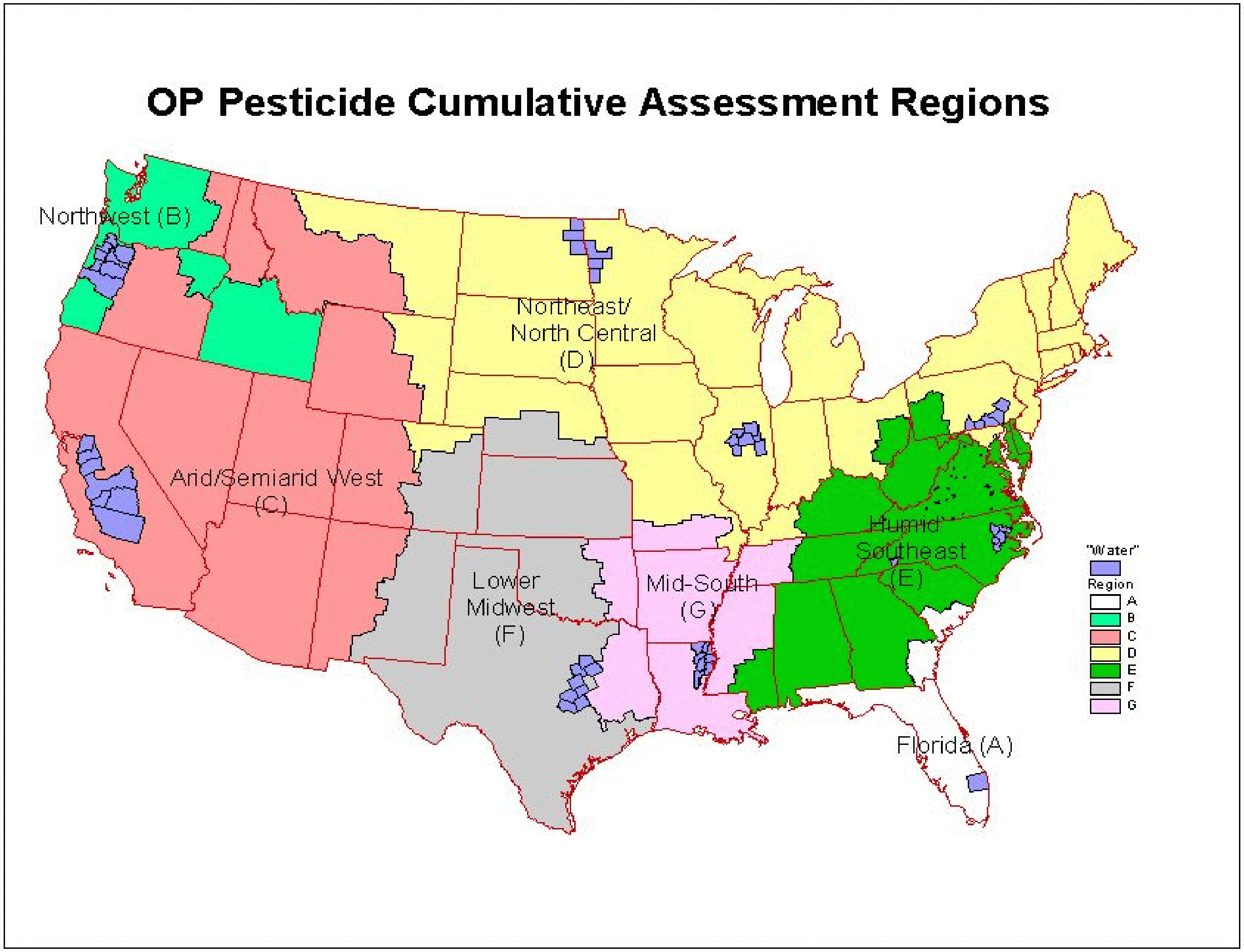
Two OP pesticides are currently registered for use on pets, tetrachlorvinphos (TCVP) (shampoo/dip and flea collar) and Dichlorvos (DDVP) (flea collars). OPP had insufficient data on DDVP or TCVP exposure for flea collar uses to include them in a calendar-based probabilistic assessment. However, OPP did assess TCVP through the shampoo/dip and powder use and these results are incorporated in this cumulative assessment.

Other OP uses were not included because they resulted in low exposures or because their single chemical REDs showed low risk. These low exposure uses include ant baits, paint additives and post application residential exposure from sod farm application of pesticides. Ant baits are contained inside enclosed packages. The treatment of individual fire ant mounds has very low applicator exposure and the reentry or significant play on fire ant mounds is unlikely. Low exposure is expected also because the treatments often take more than one day to produce results.

In case of paint additives, the diazinon additives in outdoor paints result in low potential for exposure because of the complexity of the paint/pesticide matrix as well as the dilution of airborne concentrations in the outdoor environment. For sod farm uses, post application exposure is mitigated by rapid dissipation of residues, residue removal during harvesting (cutting, rolling or stacking), and transportation. Installation of the sod requires considerable site preparation which is followed by watering in, further lowering potential for significant exposure in a post application scenario. OPP believes that children are unlikely to enter the lawn area immediately following the sod installation.

Finally, for wide-area public health treatments, the more significant uses such as fenthion, malathion and naled were included. Chlorpyrifos use for mosquito control was not included because very low exposures were estimated in the single chemical, screening level assessment.

Figure I.D-1. OP Pesticide Cumulative Assessment Regions



YSHG, BS(HED), 2002

3. Residential Scenarios

The Residential Scenarios addressed in this document represent critical OP uses that have the potential for significant exposure or risk when considered in a cumulative assessment. These are:

- Golf course and lawn care applications,
- Home gardens,
- Wide area Public Health sprays,
- Pet Treatments (includes aerosol, liquid, and powder uses.), and
- Impregnated pest strips (limited to closets and cupboards.).

Table I.D-1. Summary of Changes Between December 3, 2001 Preliminary Cumulative Risk Assessment and Revised Cumulative Risk Assessment

Uses Included in the Preliminary Assessment That Have Been Removed from the Final Assessment	
Use Scenario	**Rationale for Change**
DDVP Crack and Crevice	Registrant is presently generating data
DDVP Pest Strips (currently under mitigation)	This assessment was limited to use of a small pest strip in closets and cupboards only. The uses in attics, basements, and garages were not considered in this assessment.
Malathion Lawn Spray	Registrant is no longer supporting this use.
Malathion Golf	Registrant is no longer supporting this use.
Malathion Vegetable Garden Dust	Registrant is no longer supporting this use.
Trichlorfon Lawn Care Spray – Applicator Scenario	This use has been limited to professional application by lawn care operators only. Only post-application scenarios will be considered.
Uses Included in the Final Assessment That Were not Included in the Preliminary Assessment	
Use Scenario	**Rationale for Change**
TCVP Aerosol, Powder, Pump Spray	Pet collars were not included in this assessment and are believed to pose less risk than the aerosol, powder, and pump spray uses considered in this assessment.

a. Golf Course and Lawn Treatments

Golf Course

Five OPs are registered for use on golf course fairways, greens and tees and/or residential lawns. Of the five pesticides, four may be applied on golf courses (Malathion golf course use is no longer supported by the registrant and was thus not included in the assessment). These pesticides are acephate, bensulide, fenamiphos, and trichlorfon. Acephate is used for surface feeding insects, like the chinch bug, which invade primarily warm season grasses such as St. Augustine grass. Bensulide is used for germinating weeds such as crabgrass on fairways, greens, and tees. Fenamiphos is a nematicide and is also watered. Trichlorfon is used for sub surface or thatch dwelling insects such as white grubs.

Lawn Treatments

On lawns, two pesticides may be applied by homeowners or by professional LCO. These pesticides are bensulide and trichlorfon. Bensulide is an herbicide used to control germinating weeds, and trichlorfon is labeled for insects such as white grubs, which damage turf when present in significant numbers. Both of these pesticides need to be watered in for effective control. Malathion is also registered for use on lawns applied as surface sprays to control nuisance pests such as fleas; however, this use is no longer supported by the registrant and was not included in the assessment.

b. Home Gardens

The home garden scenarios include ornamental and edible food gardens (including home fruit orchards). Due to the wide variety of plant/pest relationships that can exist in any given region, it was assumed that applications could be made throughout the growing season for a given area. Acephate and disulfoton are insecticides that have systemic properties and appear to be more widely recommended in the cooperative extension publications. However, malathion continues to be recommended for aphids by most cooperative extension services. In addition to use on ornamental gardens, malathion is also registered for use on home vegetable gardens and orchards.

c. Public Health Uses

Residential exposure from aerial and ground based applications for the control of public health pests made by regional or state personnel was addressed in this assessment. Malathion, fenthion and naled are applied to control mosquitoes. Fenthion is also applied to control black flies.

d. Indoor Uses

DDVP is the sole OP pesticide with indoor registrations. DDVP is used as both a crack and crevice spray and as a pesticide impregnated pest strip for the control of flying insects. Since OPP is currently in negotiations with the registrant regarding the use of DDVP crack and crevice applications, this scenario was not evaluated. The DDVP pest strip scenario, however, was evaluated but was limited to use of smaller strips to control insects in closets and cupboards in which strip replacement occurred every 4 months.

e. Pet Uses

TCVP was evaluated in this assessment as an aerosol, pump, or powder flea and tick treatment for pets. TCVP is also available in impregnated from in pet collars. This assessment considered only TCVP pet treatment using the aerosol, pump, or powder form (and not the impregnated collar form), as these uses are believed to result in equal or higher exposures than the pet collar use. This is based on the assumption that shampooing a dog will result in greater exposure than merely securing a collar around a dog's neck. Post application exposure to the collar is also expected to be lower due to a smaller area being treated (area around the neck rather than the whole body).

4. Exposure Routes Considered

The routes of exposure considered in this cumulative assessment varied depending on certain application and post-application exposure activities which were determined to be age group-specific. The results of exposure are described in detail below:

Post-Application Oral Route of Exposure: Oral ingestion via hand-to-mouth activity of children was the only oral route of exposure considered in the residential portion of this assessment. Specifically, oral hand-to-mouth ingestion was considered only for the age groups Children 1-2 and 3-5 for their activities on treated lawns. OPP acknowledges that there is very limited data on exposure to very young children; in general, however, children ages six and older no longer exhibit mouthing behavior to the degree seen in younger children such as placing hands and /or objects into the mouth. In addition, while OPP recognizes that non-dietary pathways other than through hand-to-mouth activities do exist such as ingestion of soil and mouthing of grass, these latter two pathways are not considered because they had little impact on the exposure assessment when they were addressed in the individual chemical OP risk assessments.

Post-Application Dermal Route of Exposure: The dermal route of exposure was considered for both children and adults; however, the calculation for children adjusted by the appropriate surface area to body weight ratio. Children are considered in a separate group from adults because of the potential for additional exposures that result from a higher skin surface area to body weight ratio. In general children six and older have a surface area to body weight ratios that are similar to adults.

Post-Application Inhalation Route of Exposure: The inhalation route of exposure was considered for adults and children.

5. Data Sources

Three basic types of data were considered in this assessment: pesticide use data, residue concentration and dissipation/decay data, and residue contact and exposure factor data. Together, this information can be used to predict the potential for co-occurrence of exposure events in aggregate and cumulative assessments. These data are described in more detail below and in Table I.D-2 (by application scenario).

Pesticide Use Data: Pesticide use information is critical to establishing windows of potential exposure when using a calendar-based exposure model. This information is needed to predict what pesticide will be used, the amount of pesticide which will be used, when the application will be made, how many times the pesticide will be applied (and for how long), and whether the applicator will be a professional or not. Other data such as frequency of applications, types of application equipment used, and types of clothing worn while making the applications are also used in developing exposure scenarios.

Several references were used to determine the application timing for lawn care pesticides and to estimate the number of pesticide users. To determine the percent of households that employ professional lawn care operators (LCO), the Agency used the 1996-1997 National Gardening Survey (Butterfield, 1997) conducted by the Gallup polling organization. For specific chemicals, regional percent of lawns treated were taken from the National Home and Garden Pesticide Use Survey (NHGPUS) (USEPA, 1992). Two other data sources, Kline Professional Markets for pesticides and Kline Consumer Markets for pesticides, were also used to check/confirm the NHGPUS estimates/data.

Residue Concentration Data: Residue concentration data and associated pesticide decay/dissipation parameters are used to define the sources and magnitude of exposure resulting from human contact.

Exposure Factor (Contact) Data: Exposure factors such as the amount of time spent in an area, whether the exposure is occurring indoors or outdoors, and whether the residue source is a golf course or a lawn (and if the latter, its size) are critical for estimating exposures to a given substance.

For example, an important variable for estimating home-owner applicator exposure is the size of the lawn. OPP considered the average and median lawn sizes reported in a journal article by Vinlove and Torla (1995). The means and medians were ~13,000 ft^2. However, the authors noted problems, interpreting the data since it is based primarily on low income houses and consists of adjustments of the lot size by the house's foundation (footprint) only. The data do not consider other structures such as decks or other green space such as gardens, which can reportedly reduce the lot size by up to 50%. Similar lawn sizes were noted in an extensive survey conducted by the Outdoor Residential Exposure Task Force (ORETF) with similar problems encountered with respect to confounding variables such as decks and other green spaces. For this assessment, OPP used a uniform distribution for lawn size bounded by 500 ft^2 and 15000 ft^2.

Another important variable for addressing post-application exposure from home lawn treatment is the duration of time spent on lawns. In this OP CRA, cumulative distributions of durations on lawns of up to two hours were used to address adult exposure on lawns. These data are presented in Table 15-64 in EPA's Exposure Factors Handbook; however, OPP notes that the percentiles above the 95^{th} have the same values (121 minutes). A similar cumulative distribution was given for children ages one to four. In order to be protective of children and to address the uncertainty of the upper percentiles of the exposure factor data, OPP selected a cumulative distribution from the Exposure Factor Handbook's Table 15-80 with a bound of 3.5 hours for children.

This distribution represents the amount of time spent outdoors. This allows for the time that children spend outdoors not only at home but also in parks and near schools.

6. Lawn Care Exposure Data

a. Lawn Applicator Dermal and Inhalation Exposure Data

Residential applicator exposure was assessed for the applicator scenarios used in this assessment (i.e., commercial/professional applicator exposures were not included in the assessment). Both dermal and inhalation exposures were considered. Briefly, dermal exposures were calculated as the product of the Unit Exposure (mg/lb ai handled), application rate (lbs ai/ft^2), and area treated (ft^2). Unit exposure and area treated were inserted in the calculation as a log normal distribution and uniform distribution respectively, and application rate as a point estimate. Inhalation exposures to applicators were entered in the assessment as a uniform distribution bounded by high and low measured values.

Data concerning Unit Exposures (UE) (through both the dermal and inhalation routes) were generated by the ORETF. Specifically, this data consisted of exposure data from 30 volunteers using a push-type rotary spreader to apply 50 lbs of dacthal product to treat 10,000 ft^2 of turfgrass. Exposure data from these studies were used to generate normalized values expressed as milligrams exposure per pound of active ingredient of a pesticide handled (referred to as UE). Volunteers participating in these exposures studies were adult non-professionals who use pesticides on their own gardens and lawns. Many of the volunteers selected as subjects in these studies were members of garden clubs. All volunteers made their applications without specific instruction from the study investigators. Unit exposures from these studies were available for various clothing scenarios that consider individuals wearing short pants and short sleeved shirts, to long pants and long sleeved shirts. For this assessment, OPP assumed that all applications were performed using short pants.[1] Based on the Unit Exposure values generated in this study, UE's used in this assessment for the dermal and inhalation exposures were as follows: (i) for dermal exposure, a lognormal distribution with arithmetic mean of 0.69 mg/lb ai handled and arithmetic standard deviation of 0.36 mg/lb ai handled, truncated at the estimated 99th percentile of 1.93 mg/lb ai handled and (ii) for inhalation exposure, a uniform distribution bounded by the low and high measures values of 0.00019- and 0.0096 mg/lb ai handled, respectively.

[1] A survey conducted by Doane and Gallup (Johnson et al., 1999) on behalf of the ORETF identified 70% of those who treat their lawns wear short sleeved shirts while applying granular formulations. Likewise, 32% reported wearing short pants while applying granular formulations. Sensitivity analysis performed by OPP demonstrated that significant differences in Unit Exposures existed only between long pants and short pants, and that no significant differences existed between any of the other clothing scenarios (i.e., short- vs. long-sleeves did not impact estimated exposures). However, these significant differences in unit exposure between long pants and shorts had negligible effect on total MOEs, and thus, for this assessment, OPP assumed that all applications were performed using short pants.

Table I.D-1. Pesticides and Use Scenarios Considered in the Residential/Non-Occupational Regional Assessments

Pesticide	Golf Course	Lawn Care	Home Gardens	Public Health	Pest Strip	Pet Uses
Acephate	Used in Regions A, E, F, and G	None	Edible Foods: None Ornamentals: All Regions	None	None	None
Bensulide	Used in Regions A, C, D, E, F, and G	Used in Region F	Edible Foods: None Ornamentals: None	None	None	None
DDVP	None	None	Edible Foods: None Ornamentals: None	None	All Regions	None
Disulfoton	None	None	Edible Foods: None Ornamentals: All Regions	None	None	None
Fenamiphos	Used in Regions A, C, E, F, and G	None	Edible Foods: None Ornamentals: None	None	None	None
Fenthion	None	None	Edible Foods: None Ornamentals: None	Used in Regions A, and G	None	None
Malathion	None	None	Edible Foods: All Regions Ornamentals: All Regions	Used in Regions A, D, E, F, and G	None	None
Naled	None	None	Edible Foods: None Ornamentals: None	Used in Regions A and D	None	None
TCVP	None	None	Edible Foods: None Ornamentals: None	None	None	All Regions
Trichlorfon	Used in Regions C, D, E, F, and G	All Regions	Edible Foods: None Ornamentals: None	None	None	None

The application rate used in the assessment was taken as a point estimate equal to the maximum (label) application rate. For lawn size, OPP selected a uniform distribution of lot sizes ranging from 500 to 15,000 ft^2. This range considers smaller lawns for residences such as town houses. Information in a survey conducted by the ORETF also indicates that many pesticide users make spot treatments of insecticides. The upper bound of 15,000 ft^2 (~1/3 acre) appears reasonable given the type of application equipment assumed to be used by residential applicators (rotary granule spreaders). Information on frequency and timing of applications for pesticides were obtained from Representative Cooperative Extension Service publications and are described in each of the region specific section in Part II of this assessment.

Table I.D-2. Scenario-Specific Residential Exposure Data Inputs

Parameter		Value	Assumptions	Input Format	Data Source
Hand Pump Sprayer for Ornamentals					
Unit Exposure	-inhalation	0.002-0.0142 mg/lb ai handled	hand pump sprayer	Uniform Distribution	ORETF (Merricks, 1997)
	-dermal	mean of 78.2 and a SD of 75.7 mg/lb ai handled	hand pump sprayer	Lognormal Distribution	
Distribution includes wearing short pants and short sleeved shirt and were truncated at the 99th percentile.					
Area Treated		500-2000 ft^2	median home 2250 ft^2 assumed all one floor, with 2.5-10 ft. ornamental bed width	Uniform Distribution	US Census
Application Rate		label directions	rate per gallon treating 500-1000 ft^2	Uniform Distribution	(Merricks, 1997)
Treatments per Season		1-4	two-week intervals (on average based upon survey and label directions)	Cumulative Distribution	ORETF
Malathion on Edible Food Crops/Gardens and Home Orchards					
Area treated		135-8000 ft^2		Log Normal Distribution	ORETF with the National Garden Survey
Time Spent in Garden		0.083 -1 hour		Uniform Distribution	ORETF
Transfer coefficients		100-5000 cm^2/hr	activities=harvesting and maintenance of edible food crops. Accounts for a wide variety of gardens and activities	Uniform Distribution	(Korpalski and Bruce, 2000)
Number of applications		1-5	1 app.=32.6%, 2 app.=36.5%, 3 app.=14.3%, 4 app.=12.2%, 5 app. =4.4%	Cumulative	ORETF with the National Garden Survey

Parameter		Value	Assumptions	Input Format	Data Source
Ornamental Granular Incorporated Treatment-Disulfoton					
Unit Exposure	-inhalation	0.00001 mg/lb ai	Based on 1/2LOQ	point value	(Merricks, 2001)
	-dermal	mean of 0.18 and a SD of 0.29 mg/lb ai (trunc. at 99th%tile)	Distribution assumes the applicator is wearing short pants and short sleeved shirt.	Lognormal distribution	(Merricks, 2001)
Application rate		label		point value	
Frequency of application		1-3	1 app.=63%, 2 app.=32%, 3 app.=5% at six-week intervals		ORETF with the National Garden Survey
DDVP-Pest Strips					
Concentration in Air		0.005- 0.11 mg/m^3 over 120 days	samples taken at 1, 7, 14, 28, 56, and 91 day intervals and adjusted proportionately to account for smaller strips than measured in Collins and DeVries, 1973.	uniform distribution reflecting the range each sample day	Collins and DeVries, 1973

b. Post-application Dermal and Non-Dietary Exposure Data

i. Dermal Exposure-Residue Contact Data

The fate of pesticides applied to turf, and subsequent human contact, is a key variable for assessing post-application dermal exposure and can be an important exposure pathway to consider as part of a cumulative assessment. This exposure pathway was evaluated here in the OP Cumulative Risk Assessment by using data from a number of available studies (described in more detail below). Briefly, post-application dermal exposure (mg pesticide) is calculated by multiplying the transfer coefficient (cm^2/hr) derived from literature and other studies by the time spent on the lawn (hr) and the residue concentration on the lawn (mg/cm^2). For this assessment, the transfer coefficient and the time spent on lawn were represented by a distribution of values while the residue concentration on the lawn was represented by a time series of concentration values (which accounted for residue degradation over time). The transfer coefficients used in this equation were developed by dividing the hourly dermal exposure (µg/hr) obtained from a set of activities by the measurement commonly referred to as turf transferable residues (TTR) (µg/cm^2). Since none of the dermal exposure studies used to estimate hourly exposure in the above chemical specific residue studies permitted direct calculation of the TTR, the transfer coefficients for this assessment were instead for this assessment developed by assuming a transfer efficiency of 0.5% for granular formulations and 1% for spray formulation. This was done for two reasons:

- ❑ to make use of available dermal exposure measurements in the above studies which are not influenced by TTR method, and

- ❑ to make use of the available residue dissipation data for which there are no corresponding dermal exposure transfer coefficients.

The values of 0.5% and 1% are within the range of efficiency for the existing chemical specific TTR data. To account for the additional uncertainty of assuming a certain transfer efficiency to develop the transfer coefficients, TTR data having transfer efficiencies lower than 0.5% (granular) or 1% (spray) were adjusted upwards to make up the difference in efficiency. If the transfer efficiency of the TTR data was higher than 0.5% for granular formulations or 1% for spray formulations, they were not adjusted.

For a more detailed discussion of the relationship of transfer coefficients and TTRs please refer to the “Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment” presented to the FIFRA Scientific Advisory Panel on September 21, 1999.

Using the above-indicated calculation methodology, several exposure studies were used to assess post application dermal exposure to individuals reentering treated lawns. Separate studies are available, and used, for kids and adults. These studies are described in additional detail below:

Children's Exposure: Two studies were used to assess exposure to kids under granular and spray application scenarios. One study (Black,1993) investigated dermal exposure values of young children who are exposed to a non-toxic substance used to represent a spray application scenario. In this study, children performed unscripted activities on turfgrass treated with a non-toxic substance used as a whitening agent in fabrics. The subjects of the study were 14 children aged four to nine years old. The children performing the unstructured activities were provided toys and were observed in the treated area for a period of one half hour. Activities recorded included the following classifications:

- Upright (standing, walking, jumping and running)
- Sitting (straight-up, cross legged, kneeling, crouching and crawling)
- Lying (prone or supine)

Dermal exposure was measured by fluorescent measurement technology described in Fenske et al., (1986). Measurements on various body parts were expressed as μg/body part (e.g., hand, face, etc.) and as concentration ($\mu g/cm^2$). These concentrations were normalized to represent the surface area of children three to four years of age for use with a standardized body weight of 15 kg. Standard surface area values were taken from the Agency's Exposure Factors Handbook.

In a second study (Vaccaro, 1996) in which a granular formulation was used, seven adults performed structured activities intended to mimic a child's activities. These activities included:

- Picnicking
- Sunbathing
- Weeding
- Playing frisbee
- Playing touch football.

The subjects performed these activities for a period of four hours beginning after the turf had dried. Turf had been treated earlier with a granular form of chlorpyrifos and exposure was estimated in the study by monitoring the amount of a chlorpyrifos metabolite – 3,4,5, 6-TCP – excreted over the following period of 6 days. This method directly measures internal dose and was used to back-calculate a generic "to the skin" transfer coefficient by using chemical specific dermal absorption data for chlorpyrifos (Nolan et al., 1993) These data were further adjusted to account for differences in surface area of adults vs. children.

The transfer coefficients (cm^2/hr) for children estimated from these two studies are summarized below in Table I.D-3:

Table I.D-3. Transfer Coefficients for Dermal Exposure to Lawn and Public Health Uses for Children 1-6 Years of Age

Vacarro - Granular (scripted)	Black - Spray (unscripted)
714	2844
1042	3594
1042	3776
1485	4051
1736	4103
2758	4357
4785	4902
	6812
	8395
	8746
	9119
	9885
	10713
	16008

A lognormal distribution was used to fit these transfer coefficients values and an arithmetic mean and standard deviation for each distribution was calculated[2]. Specifically (for children's exposures) the OP cumulative assessment used a distribution for the transfer coefficient defined as a lognormal distribution with an arithmetic mean of 7265 cm^2/hr and a standard deviation of 4621 cm^2/hr for the spray application. For the granular application, the distribution used to define the transfer coefficient was a lognormal distribution with an arithmetic mean of 2225 cm^2/hr with a standard deviation of 2162 cm^2/hr. In each case, the lognormal distribution was truncated at the calculated 99th percentile of the distribution (i.e., 23,769 cm^2/hr for the spray application and 10,623 cm^2/hr for the granular application) in order to avoid a distribution which contained values that were well-beyond those that are deemed reasonable.

Adult Exposures: The Vaccaro study data discussed above were also used to assess exposure to adults under granular and spray application scenarios. These data are presented below in Table I.D-4:

[2] See Appendix 3 of "Guidance for Submission of Probabilistic Human Health Exposure Assessments to the Office of Pesticide Programs [draft dated 11/4/98] available at http://www.epa.gov/docs/fedrgstr/EPA-PEST/1998/November/Day-05/6021.htm for more information.

Table I.D-4. Transfer Coefficients for Dermal Exposure to Lawn and Public Health Uses for Adults 18 Years of Age and Older

Vacarro - Spray (scripted)	Vacarro - Granular (scripted)
3348	1229
6770	2813
7217	2813
8779	4010
9895	4688
11243	7446
13169	12920
13243	

A lognormal distribution was used to fit these transfer coefficients values and an arithmetic mean and standard deviation for each distribution was calculated (see footnote 2 in this chapter). Specifically (for these adult exposures), the OP cumulative assessment used a distribution of values for the transfer coefficient characterized by a lognormal distribution with an arithmetic mean of 9,784 cm^2/hr and a standard deviation of 5,515 cm^2/hr for the spray application. For the granular application, the distribution used for the transfer coefficient was characterized with a lognormal distribution with an arithmetic mean of 6,370 cm^2/hr with a standard deviation of 7,789 cm^2/hr. In each case, the lognormal distribution was truncated at the calculated 99th percentile of the distribution (i.e., 28,907 cm^2/hr for the spray application and 37,250 cm^2/hr for the granular application).

ii. Non-Dietary Exposure Data Hand-to-Mouth Behavior

The assessment also incorporated exposure from hand-to-mouth activity by children on lawns. Briefly, exposure through this pathway is calculated as the product of the following factors: hand-to-mouth contact frequency (hr^{-1}), surface area of inserted hand parts (cm^2), saliva extraction efficiency (unitless), wet hand adjustment factor (unitless), and hours spent on lawn (cumulative distribution)[3].

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[3] The cumulative distribution used for hours spent on lawn by children was obtained from the Exposure Factors Handbook and represents a cumulative distribution for "do-ers" only, i.e., a cumulative distribution <u>for only those children that reported spending at least SOME time on the lawn</u> (i.e., it does not consider that some children on any given day DO NOT spend time on the lawn). Thus, the cumulative distribution assumes that some time is spent on the lawn by each child. To the extent that this overestimates time spent on the lawn, this overestimates exposure by this pathway. On the other hand, this cumulative distribution for time spent on the lawn is not stratified by season. To the extent that children spend time on the lawn during the seasons when applications occur, this may underestimate exposure. On balance, however, OPP believes that the distribution used is a reasonable, yet conservative estimate of time spent on the lawn during the relevant portions of the year.

Surrogate data to evaluate non-dietary ingestion through hand-to-mouth behavior in young children consist, in part, of observations reported in Reed et al., 1999 concerning the frequency of hand-to-mouth activity. This study addressed the mouthing behavior and other observations of children situated indoors, ages three to six at day care (n=20) and children ages two to five at home (n=10). The children were video taped and the frequency of hand-to-mouth events were enumerated after the taping. The hourly frequencies of the hand-to-mouth events reported were a mean of 9.5 events per hour, a 90th percentile of 20 events per hour and a maximum of 26 events per hour. These data were used to construct a uniform distribution to represent the frequency of hand to mouth activity bounded by a low value of 0 events/hr and a high value of 20 events/hour.

The observations reported by Reed, and discussed above, are based on children in real world settings. However, they provide little information regarding the characterization of the hand-to-mouth event, residue transfer efficiency, or extraction efficiency of the residues on the hands by saliva during the mouthing event. For these values, additional assumptions and studies to address the transfer efficiency of turf residues by wet hands are needed. Variables addressing this exposure pathway are discussed in the following below:

- ❏ Based on previous conversations with the SAP, each hand-to-mouth event has been estimated to equal one to three fingers or 6.7-20 cm^2 per event. To account for the fact that a child may touch nothing between successive events, and the fact that the event may not result in insertion of fingers at all (Kissel et al., 1998), a uniform distribution of 0 to 20 cm^2 per event was assigned.

- ❏ Hands wet from saliva are reportedly more efficient at residue transfer than dry hands. A uniform distribution of transfer efficiency multipliers of 1.5 to three times was selected to address the increased efficiency of wet hands. Wet hands had higher transfer efficiencies than dry hands and other TTR methods addressed in a study performed by Clothier et al., 1999. The TTR methods used in the study had similar efficiencies as the chemical specific lawn residue data (TTR data) used in this assessment.

- ❏ To address the removal of residues from the hands by saliva during the mouthing event several studies were considered. The removal efficiency of residues on hands by saliva and other substances (e.g., ethanol) suggests a range of removal efficiencies from 10% to 50% (Geno et al.,1995; Fenske and Lu 1994; Wester and Maibach 1989; Kissel et al.,1998). Thus a uniform distribution of 10% to 50% was used in this assessment.

- ❏ The time spent on the lawn was estimated as a cumulative distribution ranging from 0.25 hours to 3.5 hours. This data was obtained from the Exposure Factors Handbook and represents children aged 1 to 4 years old. To be protective of children and to address the uncertainty of the upper percentiles of the exposure factor data, OPP selected a cumulative distribution from Exposure Factors Handbook Table 15-80 with a bound of 3.5 hours for children. This distribution represents the amount of time spent outdoors. This allows for the time that children spend outdoors not only at home but also in parks and near schools.

The percent contribution to total exposure via non-dietary ingestion continues to be difficult to quantify. This includes the variables discussed above as well as issues regarding the utility of using children's hand-to-mouth frequencies based on indoor activities for outdoor exposure scenarios. There are also differences in mouthing behavior based on active and quiet play with increased mouthing likely to be during activities of quiet play. Limited data evaluated by Groot et al.,1998 suggests there can be longer durations of mouthing activities for children aged six to 12 months (exceeding 160 minutes per day) than children 18 to 36 months (up to 30 minutes per day). However, children in this age group are not likely to be engaged in the higher post application lawn activities which OPP is currently modeling. Additional data for very young children (under the age of two) are needed in addition to delineating the frequency differences between hand-to-mouth events for children engaged in active and quiet play. The Agency recognizes this is an evolving field of study and that additional research is also needed to evaluate the distribution of behaviors across different age ranges with a view towards the influence of factors such as socioeconomic status.

7. Home Garden Applicator and Post Application Exposure Data

The US EPA National Home and Garden Pesticide Use Survey (1992), as well as various proprietary data sources were used to estimate dermal and inhalation exposure of individuals applying OPs to ornamental gardens, fruit and vegetable gardens, and home orchards. In addition, post-application dermal exposures were assessed for individuals harvesting or performing post application maintenance activities in home fruit and vegetable gardens and orchards. Both applicator and post-application scenarios are described in additional detail below.

Applicator Exposures: As described for dermal lawn applicator exposure, dermal exposures to applicators in home garden scenarios were similarly calculated as the product of the Home Garden Unit Exposure (mg/lb ai handled), application rate (lbs ai/ft^2), and area treated (ft^2). Both Unit Exposure and area treated were inserted in the calculation as a distribution, while application rate was entered as a uniform distribution .

For spray applications, Unit Exposure was estimated from a surrogate study with volunteers applying carbaryl to shrubs and trees using a small tank sprayer. This data was used in developing unit exposures for application of acephate and malathion to ornamentals. These data are presented below in Table I.D-5:

Table I.D-5. Applicator Unit Exposures for Using a Hand Pump Sprayer μg/lb ai handled for Ornamental Uses of Acephate and Malathion (also for home Vegetable/fruit Gardens (malathion only)

Replicate	Short-Sleeved Shirt, Short Pants	Inhalation
2	25348.3	2.3
4	51515.8	2.7
6	125828.3	2.0
8	26598.1	2.1
10	354396.6	3.2
12	55550.5	2.9
14	118695.9	2.3
16	173841.6	9.3
18	45160.0	5.7
20	39757.8	9.2
22	46075.7	2.1
24	14886.1	2.3
26	35911.5	2.3
28	81656.0	2.0
30	76548.2	14.2
32	74890.0	6.6
34	46498.0	2.1
36	36582.8	13.4
38	25014.7	2.0
40	63485.8	10.8

For dermal exposures, distributions for Unit Exposure through acephate and malathion ornamental uses (log normal with an arithmetic mean of 78 mg/lb ai handled, a SD of 76 mg/lb ai handled, truncated at 99th percentile value of 372 mg/lb ai handled, for application rate (uniform distribution specific to pesticide being assessed and detailed in Part II of this document), and for area treated (uniform distribution with a minimum value of 500 ft^2, and a maximum value of 2000 ft^2) were used. This latter value is based on US census data indicating a median house area of 2,225 ft^2. For this assessment, it was assumed this area was for one floor having a perimeter of ~200 linear feet. The ornamental beds were assumed to be 2.5 to 10 feet wide.

For granular disulfoton applicator exposures through the dermal route, chemical specific data measuring exposure of individuals using a shaker can of disulfoton granules to the soil around roses followed by soil incorporation are available and were used in the OP CRA. Distributions for dermal unit exposure for applications to shrubs were developed from the following data in Table I.D-6:

Table I.D-6. Dermal Unit Exposures (μg/lb ai handled) for Applicator Using Disulfoton on Shrubs and Flower Beds

Replicate	Shrub
1	134
2	304
3	187
4	150
5	35.3
6	172
7	45.1
8	16.3
9	94.6
10	360
11	41.1
12	245
13	13.9
14	69.9
15	161

Note: all inhalation replicates were non-detect/loq - LOQ = 1.5 μg.

Specifically, a lognormal distribution with an arithmetic mean of 0.18 mg/lb ai handled, a SD of 0.29 mg/lb ai handled, and a truncation point at 1.31 mg/lb ai handled (99th percentile) was used for dermal Unit Exposure and a point estimate was used for application rate. This point estimate for application rate was specific to pesticide of interest and is detailed in Part II of this document. A uniform distribution was used for area treated bounded by a minimum value of 10 ft^2, and a maximum value of 2000 ft^2. As described above, this value is based on US census data indicating a median house area of 2,225 ft^2. For this assessment, it was assumed this area was for one floor having a perimeter of ~200 linear feet. The ornamental beds were assumed to be 2.5 to 10 feet wide.

Based on ORETF-submitted data, applicator inhalation unit exposures were represented by a uniform distribution for acephate and malathion ornamental uses, and as a point estimate for disulfoton ornamental use. Specifically, Unit Exposures for acephate and malathion ornamental uses were represented by a uniform distribution with a lower bound value of 0.002 mg/lb ai handled and an upper bound value of 0.0142 mg/lb ai handled (which represent the minimum and maximum measured values as per Table I.D-5 above) ; application rate was represented by a uniform distribution specific to the pesticide of interest and detailed in Part II of this document; and area treated was considered as a uniform distribution with a minimum value of 500 ft^2, and a maximum value of 2000 ft^2 based on US census data indicating a median house area of 2,225 ft^2. For this assessment, it was assumed this area was for one floor having a perimeter of ~200 linear feet.

For applicator inhalation exposures for disulfoton, point estimates were used for unit exposure (0.00001 mg/lb ai handled) and application rate. The point estimate for inhalation Unit Exposure represents ½ the LOQ, since all measured inhalation unit exposures were less than the analytical limit of quantitation. The point estimate for application rate is specific to disulfoton and detailed in Part II of this document in the regional assessments. A uniform distribution with minimum value of 500 ft^2, and a maximum value of 2000 ft^2 was used to represent area treated. This value is based on US census data indicating a median house area of 2,225 ft^2. For this assessment, it was assumed this area was for one floor having a perimeter of ~200 linear feet.

Post-Application Exposures: Post-application exposure while harvesting or performing post application maintenance activities in home fruit and vegetable gardens and orchards was assessed using a wide range of transfer coefficients to account for the diversity of gardens and types of activities. Specifically, post application exposure was estimated as the product of a transfer coefficient (cm^2/hr), time spent in the activity (hrs), dislodgeable residue concentration (mg/cm^2), and the dermal absorption factor (unitless).

For the above calculation, the transfer coefficient was characterized as a uniform distribution ranging from 100 to 5000 cm^2/hr to account for and reflect a wide range of tasks for gardeners. The time spent harvesting or performing post-application maintenance activities was represented by a uniform distribution ranging from 0.0833 hr/day to 1 hr/day. These estimates of time spent in the garden performing post application activities (as well as the frequency of applications) were based on survey data performed by the Outdoor Residential Exposure Task Force (ORETF). Dislodgeable residue concentrations (expressed in mg/cm^2) were expressed as a time series of values collected from chemical-specific dislodgeable residue data obtained from studies performed in California (for Western regions) and Pennsylvania (for Eastern regions) and detailed in the region specific sections in Part II of this document. Timing and frequency aspects (on both a regional and chemical-specific) of post-application gardening activities were based on information available in representative state cooperative extension service publications, and regional use data was based on information available in the National Home and Garden Pesticide Use Survey and Kline Professional Markets Reports (1997-1998).

8. Golf Courses Post Application Exposure Data

The potential dermal exposure of individuals playing golf on treated golf courses was estimated using chemical-specific turf residue data and transfer coefficients derived from surrogate dermal exposure data. Specifically, post-application exposure to residues from golf courses (in mg) was calculated as the product of transfer coefficient (cm^2/hr), the time spent golfing (hr), and the turf residue value (mg/cm^2). The percent of the population playing golf and the percent of golf courses that are treated with any specified OP was also considered and incorporated into the assessment.

The surrogate data used to derive transfer coefficients were based on two measurements of four individuals playing golf on two golf courses treated with chlorothalonil (Ballee, 1990), and the exposure of golfers (four volunteers) to flurprimidol (Moran et al., 1987). The data are presented below in Table I.D-7:

Table I.D-7. Golfing Transfer Coefficients ($\mu g/cm^2$) for Post Application Dermal Exposure:

Chemical	Transfer Coefficient
Chlorthalonil	391
	329
	561
	547
	592
	533
	385
	508
	756
	522
Flurprimidol	264
	278

For both studies, an assumed transfer efficiency of 1% was used to calculate the transfer coefficients, since the studies were conducted using spray-able formulations. Based on these two studies, a lognormal distribution with an arithmetic mean of 483 cm^2/hr and an arithmetic standard deviation of 185 cm^2/hr was used to represent the transfer coefficient. This distribution was truncated at the calculated 99th percentile value of 1066 cm^2/hr. The exposure duration for individuals playing golf was assumed to be a uniform distribution bounded at the low end by two hours and at the upper end at four hours. The four-hour value was obtained from a 1992 survey conducted by the Center for Golf Course Management.

To establish the percent of individuals playing golf, the above-mentioned 1992 study was used. It was reported here that an average of 12.2% of the population plays golf. To determine the likelihood of playing golf on a treated golf course, percent of golf courses treated data provided by Doane's GolfTrak (1998-1999) was used. These data indicated anywhere from 5 to 85% of golf courses are treated with any specified OP depending upon the identity of the OP and the region of use. Additional details concerning the chemical- and region-specific use patterns used in the estimation of exposures through this pathway are present in Part II of this document.

9. Public Health Post Application Exposure Data

Assessment of post-application exposure to public health sprays was conducted in a manner similar to the method used to assess post-application exposure to lawn chemicals. That is, exposures to residues on lawns were estimated using the same dermal transfer coefficients, hand to mouth variables, and duration of time spent on the lawn. What differs between the public health spray scenario and post application lawn exposure scenario is the source strength of the residues deposited on the lawn from the public health sprays. The amount of residues that contact and may be present on the lawn can be predicted from the application rate for the various public health sprays and the application specifics, such as equipment type and spray nozzle settings. The percent of the application rate that is deposited on lawns following ground applications of public health sprays is based on a study by Tieze, et al. (1995) which measured the percent of the mosquito spray that is deposited on lawns following ground applications. These deposition values ranged from 3.8 to ~5%. For aerial applications, the percent of the application rate that is deposited on lawns were calculated using the spray drift model AgDrift which were reported (an discussed) in the individual risk assessments for malathion, naled and fenthion. These values ranged from approximately 15 to 30%. To address the uncertainty regarding the percent of use by ground equipment and or aerial equipment, a uniform distribution for deposition bounded by 3.8% and 30% was used. Inhalation exposure to public heath mosquitocide use was not addressed since there are no refined models to address this scenario. It is also expected that near-infinite dilution based on the outdoor location mitigates this exposure.

Timing aspects and estimates of percent of use are based on conversations with representatives of Florida Mosquito Abatement Districts (Whichterman) Florida A&M (Dukes) and Health Canada (Dr. Burke) for Black Fly. For other regions having public health spray uses, a spray schedule of once every two weeks was assumed for the summer season. Additional region-specific details regarding the application and timing of treatments and chemical-specific details regarding degradation are presented in Part II of this assessment.

10. Indoor Uses Inhalation Exposure Data

The only OP pesticide registered for indoor use is DDVP. This was assessed as a resin impregnated pest strip limited to unoccupied areas such as closets and cupboards. Exposures through crack and crevice treatments with DDVP were evaluated in the Preliminary Cumulative Risk Assessment, but not evaluate here in the Revised OP Cumulative Risk Assessment (Revised OP Cumulative) since OPP is currently in negotiations with the registrant regarding crack and crevice use.

Furthermore, estimated exposures through the DDVP pest strips were modified in this revised CRA to account for additional mitigation actions being taken and/or negotiated by the Agency. Specifically, use is expected to be limited to unoccupied areas such as closets and cupboards with the corresponding size of the pest strip reduced to account for the smaller spatial volume being treated[4].   Exposure while handling the impregnated pest strips is expected to be minimal.

Thus, only post-application inhalation exposure was estimated for adults and children, with applicator exposure considered negligible and not evaluated.

Briefly, post application inhalation exposures (expressed in mg) were calculated in the OP CRA using the following equation:

$$E = C_{air} \times BMR \times H \times VQ \times MET\_TIME$$

E = Exposure through the inhalation pathway (mg)

C_{air} = residue concentration in air (mg/m^3),

BMR= Basal Metabolic rate (MJ/hr) which is specific to a CSFII individual's age, sex, and weight

H = 0.05 m3/MJ, a constant representing the volume of oxygen consumed (at standard temperature and pressure) in the production of 1 MJ of expended energy.

VQ= 27 (unitless), a conversion factor reflecting the ratio between the amount of air breathed to the amount of oxygen obtained

MET_TIME (hr) which represents a distribution reflecting the sum (over a day) of the product of an unitless activity-specific metabolic factor and the amount of time spent in that activity (summed over all activities in a day).

The residue concentration in air (C_{air}) is represented by a time series of calculated concentrations in homes using reduced -size DDVP pest strips in closets and/or cupboards. Specifically, use of a smaller pest strip was assumed to produce a proportionately smaller air concentration. Thus, the air concentrations in this revised CRA were estimated by multiplying the measured concentration values found under a "whole-house" scenario following use of an 80 gram (as per Collins and DeVries, 1973) by either 0.26 or 0.066 to represent use of Pest Strips of 21 g or 5.25 g size.[5]

The BMR term in the above exposure equation is calculated internally by the Calendex software and represents a point estimate specific to and calculated for each individual in the CSFII based on his self-reported age, sex, and weight. Both H and VQ in the above equation are constants as described above. The

[4] Mitigation actions that are currently being negotiated do permit uses in additional unoccupied areas such as attics, basements, and garages, but for purposes of this cumulative assessment exposures through these uses were not assessed.

[5] (21g or 5.25g)/80g

MET_TIME variable is represented by an age group-specific empirical distribution and accounts for the fact that an individual's breathing rate and the specific activities an individual engages in on any given day are NOT independent. That is, this factor (or term) accounts for the interrelationship that exists between the activities that an individual engages in and the breathing rate with which that activity is connected.[6] The genesis and derivation of this MET_TIME variable is discussed in additional detail below.

The MET_TIME term: As indicated earlier, OPP in the OP Preliminary Risk Assessment assumed *independence* between a person's daily activities, the place in which these activities are conducted, and the amount of time spent in these activities. OPP has refined these assumptions in this Revised CRA by using information on each of the activities that an individual engaged in on that day; as well as the location and duration spent in each micro environment (activity-location combination). Thus, this revised CRA appropriately considers the implicit relationship between a specific activity and its and duration. Specifically, OPP obtained information on time-activity data from the US EPA ORD Consolidated Human Activity Database (CHAD) (http://www.epa.gov/chadnet1/). This is a recently constructed meta-database of time use survey data in which time and activity by each individual survey participant is recorded in a chronological diary format. The database, in total, consists of 22,968 person diary days from 10 different time use surveys; there are 875,339 records in total, with each record containing detailed information for each micro environment (activity-location). Since MET values vary by activity, it is possible to calculate breathing rates for each distinct micro environment (reading the newspaper, preparing meals, eating, cleaning the house, etc.) which are weighted by the amount of time spent in that microenvironment. Therefore, an individual who reported spending 24 hours indoors in bed (illness) will have lower indoor inhalation exposure than if that individual had spent 24 hours indoors engaged in various physical activities (8 hours sleeping, 2 hours preparing meals, 2 hours exercising, etc.). In this manner, the calculated total indoor inhalation would be consistent with the information available in the time use diaries.

OPP generated a set of random MET values for each of the 875,339activities reported by respondents in the CHAD database which were consistent with the CHAD-defined distributional form of the activity category. These distribution functions were developed based on a compilation and review of the published literature. For example, the MET value for 'Sleep or nap' (CHAD activity code 14500) follows a lognormal distribution, with mean 0.9, standard deviation 0.1; minimum 0.8 and maximum 1.1. The MET values for 'Prepare and clean-up

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[6] In the preliminary OP CRA, an average daily indoor 'breathing rate' factor (MET) was assumed for each individual. This MET factor was assumed to be uniformly distributed and bounded by 1 and 2 (i.e., MET ~U(1,2)). The time spent indoors (representing the duration of exposure) was drawn ***independently*** using the empirical distribution published in the Exposure Factors Handbook. That time spent indoors and average breathing factors are related was not explicitly considered. As discussed in the main body of this document, OPP has refined this calculation using the time-use surveys available from CHADS/NHAPES in a more comprehensive manner.

food' (CHAD activity code 11110) are exponentially distributed, with mean 2.8, standard deviation 0.9, minimum of 1.9 and maximum of 4. [7]

OPP then multiplied each generated MET value by the corresponding duration during which that activity was undertaken to maintain any correlation between time spent indoors and corresponding activities. For each individual, this MET x Time variable was summed over all records in that individual's daily diary, in which the activity occurred indoors. This value is used in the equation above to calculate that individual's daily indoor exposure. For each age cohort (Age <1, 1-2, etc), a frequency distribution of this MET x Time variable was calculated. The table I.D-8 below presents these distributions for each of the age cohorts. There was no information on respondent age for 224 of the 22,968 person-days. Included in this distribution were individuals (n=74) who did not report spending any time indoors (perhaps camping, or on vacation). Specifically, the table below represents for each of six age groups (children 0-1 years old, children 1-3 years old, children 4-5 years old, etc.) the cumulative distribution of the MET_TIME variable (e.g., 95% of children 1-3 years old have MET_TIME values of 56 or less, 98% of children in this age group have MET_TIME values of 65 or less, etc.). It was this cumulative distribution that was used for MET_TIME variable in the above equation.

Table I.D-8. Distribution of MET Time Values, By Age Group

Cum Pct	0-1	1-3	4-6	7-12	13-17	18+
N	563	2,171	2,088	3,930	1,192	12,800
25%	26	25	19	16	15	15
50%	33	32	25	20	18	21
75%	41	41	32	25	23	29
90%	50	51	41	32	28	40
95%	54	56	47	37	33	49
98%	59	65	53	44	39	58
99%	65	69	59	49	42	67
100%	70	115	101	84	120	130

Use information for the number of households using DDVP pest strips indoors was taken from the National Home and Garden Pesticide Use Survey, 1991. The use of pest strips was assumed to occur year round with these

[7] The amount of information available for specific activities varied across the different activities. These studies also varied with regards to the methodology and instruments used to measure MET corresponding to the different activities.

replaced once every 16 weeks. Based in part on information provided in the National Home an Garden Survey, two percent of the homes were assumed to use DDVP pest strips. Further, it was assumed that in those homes that used pet strips, one 5.25 g strip was placed in a cupboard and one 21 g strip was placed in a closet.

11. Pet Uses

The Cumulative Risk assessment also considered exposures through flea and tick treatments. There are several products containing TCVP which are available in aerosol, pump spray, and powder form. TCVP is also available in impregnated form in pet collars. Exposure assessments were performed for both applicators and non-applicators (i.e., post-application exposures). For applicators, both dermal and inhalation routes were considered. For post-application exposures, only the dermal and oral (hand-to-mouth) routes were considered. Each of these routes is discussed in additional detail below.

<u>Applicator Exposure Dermal and Inhalation</u>: The data for the applicator assessment scenarios are based on studies submitted to the Agency which involved application of a flea and tick products to dogs. In this OP CRA, applicator exposure was calculated as the product of Unit Exposure (in mg/mg ai handled), application rate (mg ai handled/lb of animal), animal weight (in lbs of animal), and number of pets treated. Each of these terms was represented in the calculation as a distribution. Unit Exposure (in mg/mg ai handled) was represented by a cumulative distributions for powder and aerosol/pump spray formulations. This empirical cumulative distribution is presented in Table I.D-9 for powder an aerosol/pump spray applications

Table I.D-9. TCVP Applicator Unit Exposure (mg/mg ai handled) for Pets

		Powder		Aerosol & Pump Spray	
		Dermal	Inhalation	Dermal	Inhalation
Dog	Pct	(mg/mg ai handled)	(mg/mg ai handled)	(mg/mg ai handled)	(mg/mg ai handled)
1	6.7%	0.0016667	0.0000004	0.0028700	0.0000001
2	13.3%	0.0017328	0.0000005	0.0043400	0.0000080
3	20.0%	0.0021848	0.0000007	0.0050300	0.0000090
4	26.7%	0.0022796	0.0000013	0.0053300	0.0000110
5	33.3%	0.0023325	0.0000025	0.0054400	0.0000150
6	40.0%	0.0023699	0.0000028	0.0056000	0.0000150
7	46.7%	0.0024669	0.0000028	0.0058800	0.0000170
8	53.3%	0.0028417	0.0000049	0.0061700	0.0000230
9	60.0%	0.0030423	0.0000052	0.0077300	0.0000230
10	66.7%	0.0034921	0.0000068	0.0093800	0.0000280
11	73.3%	0.0040102	0.0000081	0.0098400	0.0000280
12	80.0%	0.0040917	0.0000110	0.0099600	0.0000280
13	86.7%	0.0050375	0.0000114	0.0102200	0.0000460
14	93.3%	0.0052139	0.0000220	0.0143200	0.0000470
15	100.0%	0.0149053	0.0000238	0.0270900	0.0000550

Application rate in this equation was represented by a uniform distribution depending upon the formulation, as follows:

- for powder, the application rate was represented by a uniform distribution bounded by 21 and 25 mg ai handled/lb of animal ;
- for aerosol, the application rate was represented by a uniform distribution bounded by 11 and 15 mg ai handled/lb of animal; and
- for pump spray, the application rate was represented by a uniform distribution bounded by 9 and 10 mg ai handled/lb of animal.

Animal weight and number of pets were each represented by a empirical cumulative distribution. Animal weights were drawn from an empirical distribution represented in Table I.D-10 and which ranged from 3 to 148 lbs/pet.

Table I.D-10. Pet Applicator Exposure Variable Dog Weights

Cum. PCT of Dogs	Dog Weight (lbs)
1%	3
10%	11
20%	16
30%	20
40%	23
50%	30
60%	43
70%	55
80%	70
90%	80
95%	89
99%	108
100%	148

Source: Boone, Tyler, Chambers: 1999 SoT Poster session; Carbaryl Study MRID 446584-01; and MRID 446584-01.

Pet owners were assumed to treat between one and four pets of identical size as per the information presented in Table I.D-11.

Table I.D-11. Applicator Exposure Variable Number of Dogs Treated

Cum. PCT of Dog Owner-Apps	Number of Dogs
50%	1
75%	2
90%	3
100%	4

Applicator exposures through the inhalation route were calculated in a similar manner to the applicator dermal exposures described above, except that Unit Exposure (in mg/mg ai handled) were specific to inhalation exposures. These empirical unit exposures through inhalation are also presented in Table I.D.9, above. All other terms relating to application rates, animal weights, and number of pets treated remained as described earlier.

Frequency, timing, and probability of TCVP applications to pets were also considered in the OP Cumulative Risk Assessment. Based on the US EPA Home and Garden Pesticide Use Survey, less than one percent of the homes reported using TCVP products for flea and tick treatment on pets. In addition, this survey reported that between 13 and 19 percent of all households reported using a pet collar for control of fleas and tick. This estimate, however, includes **all** pet insecticide collars, not just those that contain TCVP. These use estimates are consistent with proprietary marketing data published by Kline, Incorporated. Since recent estimates for use of TCVP pet collars are not available, the percent of households applying TCVP flea and tick treatments was set in the OP CRA at 15 percent, and was assumed to be equally split (at 5% each) between each of the three (powder, aerosol, and pump spray) TCVP formulations to account for use of both the flea and tick treatments and the TCVP impregnated collars. This is believed to be protective, since high-end exposures from flea and tick treatments are expected to be higher than high-end exposures from pet collars. The household applicators were assumed to reapply TCVP flea and tick treatments every 8 weeks, with use occurring all year in the Southern regions (A,C, E, F, and G), and between April through mid-August (three applications) in the Northern regions (B and D).

Post-Application Exposure – Dermal and Oral (Hand-to-Mouth): Dermal and oral (hand-to-mouth) post-application exposures from TCVP flea and tick treatments were also considered in the OP CRA. Dermal exposures scenarios were considered to be applicable to both adults and children while non-dietary oral exposure scenarios (oral hand-to-mouth) were assumed to apply only to infants and children ≤6 years old.

Dermal Post-Application exposure: Dermal Post-Application exposure (to adults an children) was calculated as the product of Residue concentration (mg/cm^2), the Transfer Coefficient (in cm^2/hr), and the Time spent (in hrs/day). Residue concentration values on the application day were estimated from the

Day 0 residue measurement from a study conducted by Hartz for TCVP Reregistration purposes. Residues measured on Day 0 (4 hours after treatment) ranged from 0.224 mg to 0.413 ug/cm^2 for the powder formulation, 1.1 to 1.9 ug.cm^2 for the aerosol formulation, and 1.2 to 3.5 ug/cm^2 for the pump spray formulation. This information is presented below in Table I.D.12:

Table I.D-12. Post-Application Residues on Day 0 (day=0.167), (Empirical Distribution)

Obs	Powder (ug/cm^2)	Aerosol (ug/cm^2)	Spray (ug/cm^2)
Applicator A	0.413	1.603	2.433
Applicator B	0.224	1.947	1.348
Applicator C	0.395	1.750	1.416
Applicator D	0.299	1.559	3.595
Applicator E	0.230	1.061	1.267

Memo S. Hanley to D. Fuller, March 22, 2002, Re-Issue: HED's Review of Determination of the Dislogeability of Tetrachlorvinphos (TCVP) from the Fur of Dogs Following the Application of an Insecticide Powder; Pump Spray or Aerosol; MRID 454855-01. C Code 083701; DP Barcode D277543, Submission S597121. Tables 5b, 6b, 7b; 8 and 9 (half life).

These residues were assumed in the OP CRA to persist for a period of 32 days with a half life of 3 days (both as estimated from the submitted study). Thus, residue value inputs for dermal post-application exposures were assumed to be a time-series of concentrations values represented initially by a measured Day 0 value which is dissipated over a 32 day period in a manner consistent with a half-life of 3 days.

The Transfer Coefficient used in this assessment of dermal post-application exposures to adults and children was derived from a carbaryl groomer exposure study in which sixteen different veterinary technicians treated/handled eight dogs each, over a two to five hour time period. These transfer coefficients are presented in Table I.D-13 for adults and children and were derived assuming an average transfer efficiency of 2.97% (calculated as the average transfer efficiency of powder (0.62%), aerosol (3.3%) and pump spray (5%)) and an allometric scaling factor to estimate transfer coefficients specific to children.

Table I.D-13. Post-Application Transfer Coefficients for Dermal Exposure to Pet Fur Residues (Empirical Distribution)[1]

Groomer μg exposure	Duration: hrs	μg/hr	ai deposited $\mu g/cm^2$	Dislodged: 2.97 % efficiency assumed [2] ug/cm^2	Transfer Coefficient (adults) Cm^2/hr	Transfer Coefficient (children) Cm^2/hr[3]
8796	2.88	3054	37.5	1.114	2742	1016
6199	2.58	2403	31.0	0.921	2610	967
1408	3.07	459	18.6	0.552	831	308
2914	2.48	1175	36.4	1.081	1087	403
5667	3.08	1840	32	0.950	1936	717
2527	3.18	795	19	0.564	1409	522
2,348	2.93	801	15.9	0.472	1696	628
2961	2.72	1089	7.75	0.230	4731	1752
1135	4.03	282	14.8	0.440	642	238
14872	3.88	3833	28.8	0.855	4481	1660
1026	3.17	324	16.6	0.493	657	243
13490	4.05	3331	56.98	1.692	1968	729
4275	4.92	869	25	0.743	1170	433
4461	3.45	1293	42.25	1.255	1030	382
1511	3.03	499	8.87	0.263	1894	702
777	3.00	259	48.6	1.443	179	66
				Average	1817	673

[1]Source Carbaryl Groomer Exposure Study (activity - wash/dip/groom). Each vet tech treated/handled 8 dogs: held small dogs w/arms and torso; some dogs climbed on person's shoulders while grooming etc.
[2]Average transfer efficiency 2.97% =(powder (0.62%) + aerosol (3.3%) +pump spray (5%))/3;.
[3]The transfer coefficients derived from this study were adjusted by an allometric scaling factor based on the relative size of children to adults to derive an appropriate transfer coefficient for children Adult:Child surface area ratio - 2.7:1 (avg. Adult 3169: avg child 1174)

Finally, the time spent in this activity was assumed to follow a triangular distribution with minimum value of 0.0333 hours, a most likely value of 0.108 hours, and a maximum value of 1.025 hours (as per Freeman et al, JEAEE, 2001, 11:501-509).

Oral (Hand-to-Mouth) Post-Application Exposure: Post-application exposure through the oral (hand-to-mouth) route was also assessed (for children only) in the OP CRA. Specifically, exposures through the hand-to-mouth route were calculated as the product of the Residue value (in mg/cm^2), the surface finger area (cm^2), the frequency of events (hr-1) and the time spent (hr). The residue value was obtained from TCVP residue studies. Surface finger area (per event) was assumed to follow a uniform distribution bounded by 0 and 20 cm^2. The frequency of events was assumed to follow a triangular distribution with a minimum value of 0.4 hr-1, a most likely value of 9 hr-1, and a maximum value of 26 hr-1. The time spent with the pet was assumed to follow the same distribution described above for dermal post-application exposures.

As under the Dermal and Inhalation Exposure Scenarios discussed above, applications were assumed to re-occur every 8 weeks, with use occurring all year in the Southern regions (A,C, E, F, and G), and between April through mid-August (three applications) in the Northern regions (B and D).

12. In Summary

In summary, this assessment relied upon the best available data from all sources that could be identified. Sources included chemical specific and task force generated data, as well as data from the scientific literature. When available, regional distinct residue dissipation data were used for the lawn and garden uses. Additional Region-specific information is presented in Part II of this document.