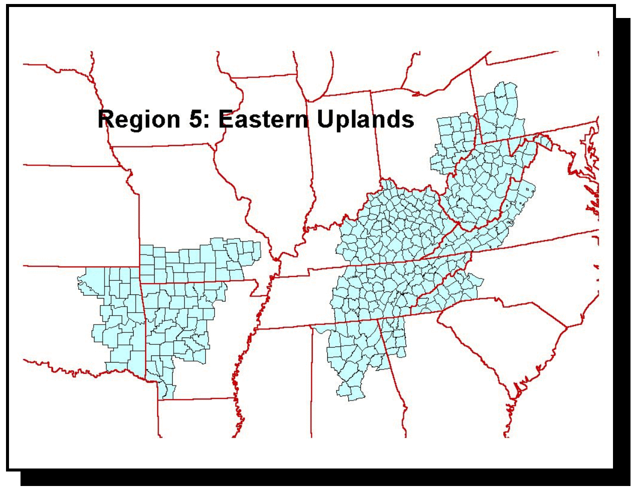
II. Regional Assessments

E. Region 5 - Eastern Uplands Assessment

1. Executive Summary

This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Eastern Uplands (area shown to right). Information is included in this module only if it is specific to the Eastern Uplands, or is necessary for clarifying the results of the Eastern Uplands assessment. A comprehensive description of the OP cumulative assessment comprises the body of the main document; background and other supporting information for this regional assessment can be found there.



This module focuses on the two components of the OP cumulative assessment which are likely to have the greatest regional variability: drinking water and residential exposures. Dietary food exposure is likely to have significantly less regional variability, and is assumed to be nationally uniform. An extensive discussion of food exposure is included in the main document. Pesticides and uses which were considered in the drinking water and residential assessments are summarized in Table II.E.1 below. The OP uses included in the drinking water assessment generally accounted for 95% or more of the total OPs applied in that selected area. Various uses that account for a relatively low percent of the total amount applied in that area were not included in the assessment.

Table II.E.1. Pesticides and Use Sites/Scenarios Considered in Eastern Uplands Residential/Non-Occupational and Drinking Water Assessment

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Acephate	Golf Courses, Ornamental Gardens	None
Azinphos-methyl	None	Apple
Bensulide	Golf Courses	None
Chlorpyrifos	None	Apple, Alfalfa, Corn
DDVP	Indoor uses, Lawn Applications	None

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Dimethoate	None	Apple
Disulfoton	Ornamental Gardens	None
Fenamiphos	Golf Courses	None
Malathion	Lawn Applications, Golf Courses, Home Fruit & Vegetables, Ornamental Gardens	None
Methyl-parathion	None	Alfalfa
Phosmet	None	Apple
Terbufos	None	Corn
Trichlorfon	Golf Courses, Lawn applications	None

This module will first address residential exposures. The residential section describes the reasons for selecting or excluding various use scenarios from the assessment, followed by a description of region-specific inputs. Detailed information regarding the selection of generic data inputs common to all the residential assessments (e.g., contact rates, transfer coefficients, and breathing rate distributions, etc.) are included in the main document.

Drinking water exposures are discussed next. This will include criteria for the selection of a sub-region within the Eastern Uplands tor model drinking water residues, followed by modeling results, and finally characterization of the available monitoring data which support use of the modeling results. This assessment accounted for all OP uses within the selected location that are anticipated to contribute significantly to drinking water exposure.

Finally a characterization of the overall risks for the Eastern Uplands region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Eastern Uplands show a similar pattern to those observed for other regions. Drinking water does not contribute to the risk picture in any significant way at the upper percentiles of exposure. At these higher percentiles of population exposure, residential exposures are the major source of risk - in particular inhalation exposure. These patterns occur for all population sub-groups, although potential risks appear to be higher for children than for adults regardless of the population percentile considered.

2. Development of Residential Exposure Aspects of Eastern Upland Region

In developing this aspect of the assessment, the residential exposure component of Calendex was used to evaluate predicted exposures from residential uses. Except for golf course uses, this assessment is limited to the home as are most current single chemical assessments. The residential component of the assessment incorporates dermal, inhalation, and non-dietary ingestion exposure routes which result from applications made to residential lawns (dermal and non-dietary ingestion), golf courses, ornamental gardens, home fruit and vegetable gardens, and indoor uses. These scenarios were selected because they are expected to be the most prominent contributors to exposure in this region. Public health uses were not expected to be a significant contributor to cumulative risk in this region, and were therefore not included in this assessment. Additional details regarding the selection of the scenario-pesticide pairs can be found in Part I of this document. OPP believes that the majority of exposures (and all significant exposures)in this region have been addressed by the scenarios selected.

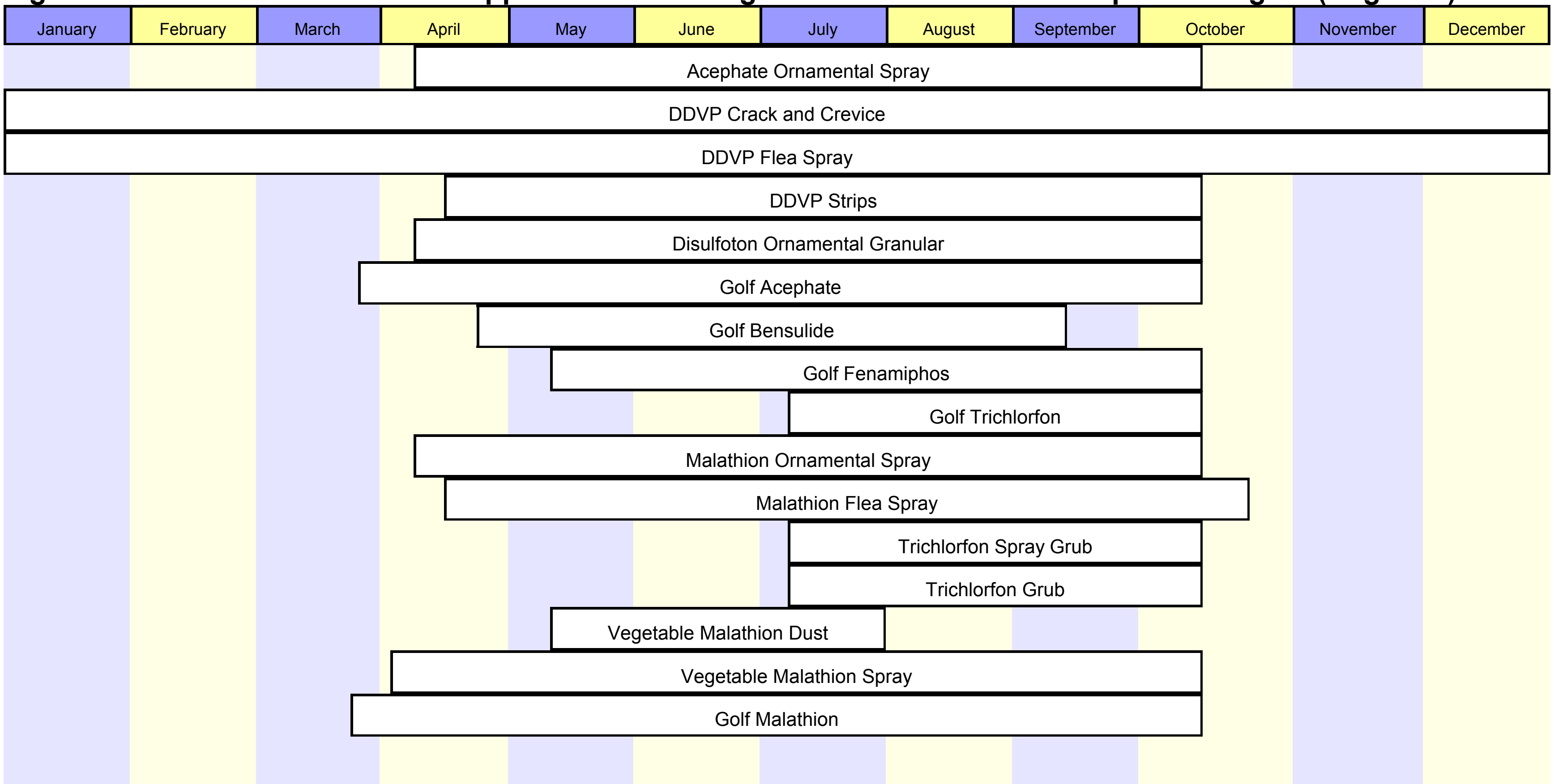
The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part I of this report. However, a variety of additional region-specific ancillary data was required for this assessment of the Eastern Uplands. This information includes region-specific data on pesticide application rates and timing, pesticide use practices, and seasonal applications patterns, among others. The Gaant chart shown in Figure II.E.1 displays and summarizes the various region-specific residential applications and their timing (including repeated applications) over the course of a year which were used in this assessment. Specific information and further details regarding these scenarios, the Calendex input parameters, and the pesticides for which these scenarios were used are presented in Table II.E.2 which summarizes all relevant region-specific scenarios.

Table II.E.2. Use Scenarios and Calendex Input Parameters for Eastern Uplands (Region 5) Residential Exposure Assessment

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A or other	Maximum Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
Acephate	Golf Courses	NA	5	1/yr	March-Oct.	100	--	1.22	10	dermal
	Ornamentals	hand pump sprayer	0.934-2	4/yr	April-Oct.	--	100	6	1	dermal, inhalation
Bensulide	Golf Courses	NA	12.5	2/yr	April-Sept.	100	--	4.27	14	dermal
DDVP	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	8	1	inhalation
	Lawns	spray	NA	1/wk	Jan-Dec.	19	81	1.54	1	inhalation oral
	Pest Strips	strip	NA	3/yr	April-Jun Jun-Oct.	NA	100	2.5	90	inhalation
Disulfoton	Ornamentals	granular	8.7	3/yr	April-Oct.	--	100	1	1	dermal, inhalation
Fenamiphos	Golf Courses	NA	116	1/yr	May-Oct.	100	--	1	1	dermal
Malathion	Lawns	hose end spray	5 lb ai	2/yr	April-Oct.	9	91	3	4 1	dermal, oral inhalation
	Ornamentals	hand pump spray	0.94-2 lb/A	4/yr	April-Oct.	--	100	3.7	1	dermal, inhalation
	Golf Courses	spray	5	1/yr	Mar-Oct.	100	--	1	4	dermal
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	May-Aug.	--	100	0.84	14	dermal, inhalation
		hand pump sprayer	1.5 lb/A	5/yr	April-Oct.	--	100	1.11	7 1	dermal inhalation
Trichlorfon	Golf Courses	NA	8 lb ai	1/yr	July-Oct.	100	--	1	2	dermal
	Lawns Granular	rotary spreader	8 lb ai	1/yr	July-Oct.	9	91	1	1 2	inhalation, dermal, oral

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A or other	Maximum Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	July-Oct.(HO) Jul-Sept (LCO)	9	91	1	1 2	inhalation, dermal, oral

Figure II.E.1 Residential Scenario Application and Usage Schedules for Eastern Uplands Region (Region 5)



a. Dissipation Data Sources and Assumptions

i. Acephate

A residue dissipation study was conducted on Bahia grass in Florida with multiple residue measurements collected for 10 days after treatment (Days 0, 1, 2, 3, 5, 7, and 10 days). No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual residue measurements. The uniform distribution reflects a range of spray and granular measurements.

ii. Bensulide

A residue dissipation study was conducted with multiple residue measurements collected for up to 14 days after treatment. For each day following application, a residue value from a uniform distribution bounded by the low and high measurements was selected (the day zero distribution consisted of measurements collected immediately after application and 0.42 day after treatment). No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual measurements. Residues measured at day 7 were assumed to be available and to persist to day 10 and day 10 measurements to persist to day 14.

iii. Malathion

A residue degradation study was based on a 3-day study conducted on a cool-season grass in Missouri, North Carolina, and Pennsylvania (application rate of 5 lb ai/acre). These measured residue values were entered into the Calendex software as a time series distribution of 4 values (Days 0, 1, 2, and 3). For use on home lawns for assessing non-dietary ingestion for children, these values were multiplied by a value selected from a uniform distribution bounded by 1.5 and 3 to account for wet hand transfer.

A residue dissipation study was conducted with multiple residue measurements collected up to 7 days after treatment in Pennsylvania. This was used for vegetable gardening in eastern regions 1,2,3,4,5,6,9, and 12. A value selected from a uniform distribution bounded by the low and high measurements was used for each day after the application. Since the study was conducted at a one pound ai per acre treatment rate, the residues were adjusted upwards by a 1.5 factor to account for the 1.5 pound ai per acre rate for vegetables.

iv. Fenamiphos

Snyder et al., 1999 collected residue dissipation data on the “day of” and ”day after” application of fenamiphos on a golf course. Only mean measurements were collected.

v. Trichlorfon

Residue values from a residue degradation study for the granular and spray-able formulations were collected for the “day of” and “day following” the application. A uniform distribution bounded by the high and low residue measurements was used, with these residue values adjusted proportionately upwards to account for higher active ingredient concentrations in use (to 0.5% and 1% for granular and spray-able formulations respectively). These distributions reflect actual measurements including those based on directions to water in the product. For use on home lawns for assessing non-dietary ingestion for children, these values were multiplied by a value selected from a uniform distribution bounded by 1.5 and 3 to account for wet hand transfer.

3. Development of Water Exposure Aspects of Eastern Uplands Region

Because of the localized nature of drinking water exposure, the water exposure component of this assessment focused on a specific geographic area within the Eastern Uplands. The selection process considers OP usage, the locations and nature of the drinking water sources, and the vulnerability of those sources to pesticide contamination. An extensive discussion of the methods used to identify a specific location within the region is included in the main document. The following discussion provides the details specific to the Eastern Uplands regional assessment for cumulative drinking water exposure to the OP pesticides. The discussion centers on four main aspects of the assessment: (1) the selection criteria for the specific location in western North Carolina used for the drinking water assessment for the Eastern Uplands, (2) highlights of the results of the model outputs (predicted cumulative concentrations of OPs in surface water) for those OP-crop uses included in this regional assessment, (3) a summary and comparison of the predicted concentrations used in the Eastern Uplands assessment with actual surface water monitoring data for the region, and (4) a summary of recent water monitoring data used for site selection and evaluation of the estimated drinking water concentrations for the region.

a. Selection of Henderson County North Carolina for Drinking Water Assessment

OPP selected Henderson County, located in western North Carolina, as the specific location to represent the Eastern Uplands region based on organophosphorus (OP) pesticide usage in relation to the source, location, and vulnerability of the drinking water sources in the region, and on available monitoring data for the region. This evaluation indicates that (1) surface water sources of drinking water are likely to be more vulnerable than ground water sources, and (2) a surface water assessment based in western North Carolina will represent one of the more vulnerable sources of drinking water in the region.

Overall OP usage is relatively low in the Eastern Uplands. Approximately 1.5 million pounds (ai) of OPs are applied annually in this region. Within the region, high OP-use areas occur along the southeastern, southern, and southwestern edges of the region where the major OP use crops are alfalfa/hay (36% of total OP use in the entire region), tobacco (32%), cotton (10%), corn (10%), and orchards (10%) (Table II.E.3).

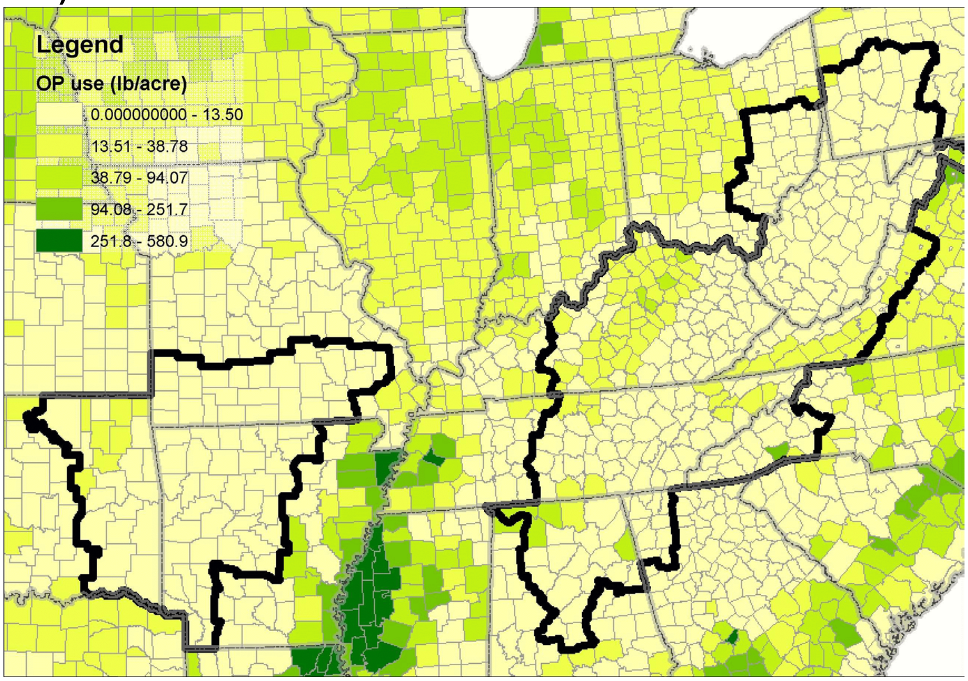
Table II.E.3. General Overview of OP Usage in the Eastern Uplands

Crops	Primary Production Areas	Total Pounds Applied [1]	Percent of Total OP Use [1]
Alfalfa/hay	Throughout Region	491.000	36%
Tobacco	Kentucky	436,000	32%
Cotton	Alabama	131,000	10%
Corn, Sweet Corn	Throughout Region	131.000	10%
Apples	North Carolina	128,000	10%
Total		1.5 Million	98%

(1) Source: NCFAP, 1997.

Figure II.E.2 highlights three relatively high OP-use areas in northern Kentucky, northern Alabama, and western North Carolina. While alfalfa and corn can be found throughout the Eastern Uplands, other major OP-use crops, particularly apples, cotton, and tobacco, are concentrated in different parts of the region.

Figure II.E.2. Total OP usage (pounds per area) in the Eastern Uplands (source: NCFAP, 1997)



In western North Carolina (centering around Henderson County), approximately 93% of total agricultural use of OPs is on apples. Corn accounts for about 4%, while alfalfa accounts for less than 1%. The top eight uses are azinphos methyl, chlorpyrifos, dimethoate, and phosmet on apples, chlorpyrifos and terbufos on corn, and chlorpyrifos and methyl parathion on alfalfa. These uses comprise approximately 98% of total OP usage in the county (Table II.E.4). As discussed below, these eight uses were used to develop the drinking water assessment for this region.

Table II.E.4. OP Usage on Agricultural Crops in Western North Carolina (Henderson County)

OP Usage/ Agricultural Crops				Cropland Acreage, Henderson Co., NC	
Crop Group	**Crops**	**OP Usage**	**Percent of Total OP Use**	**Acres**	**Pct of total Cropland**
Orchard	Apple, Peach	azinphos methyl, chlorpyrifos, dimethoate, phosmet	93%	7,000	25%
Corn	Corn, Sweet Corn	chlorpyrifos, terbufos	4%	4,400	16%
Alfalfa	Alfalfa/hay	chlorpyrifos, methyl parathion	1%	6,800	25%
Total			98%	18,200	66%

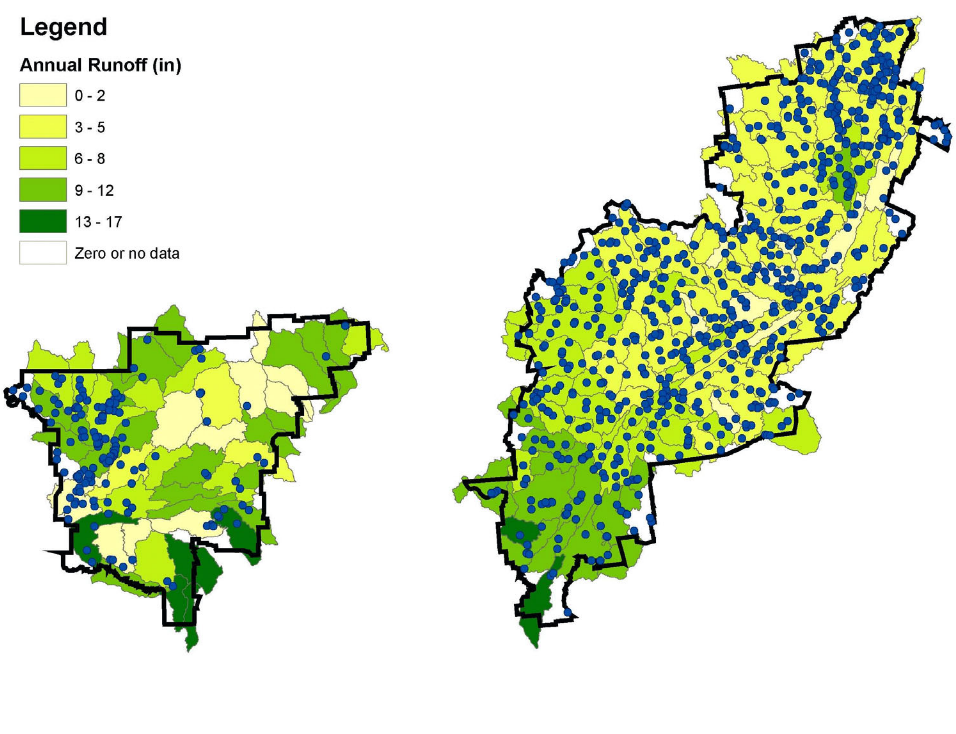
Pesticide use based latest data collected by USDA National Agricultural Statistics Service (NASS). Acreage estimates are based on NC Department of Agriculture & Consumer services. Details on the sources of usage information are found in Appendix III.E.8.

The majority of OP usage in northern Kentucky is on tobacco; cotton accounts for the majority of usage in Alabama; and orchards (apples) account for the majority of OP usage in western North Carolina. While northern Kentucky also has a high percent of land in agriculture, fewer than 10,000 acres of tobacco were planted in any single county, with soybeans, corn, alfalfa and pasture accounting for the majority of the total crop land. Furthermore, OP use in Kentucky is believed to have fallen considerably with the general decline in domestic tobacco production: approximately 500,000 acres were planted in the US in 2000, down from over 800,000 acres planted in 1997. [USDA Historical Track Records, May 2001, http://www.usda.gov/nass/pubs/trackrec/trackrec2001.pdf].

The cropping and OP usage in the southern tip of the Eastern Uplands region in Alabama is more similar to that of the Southern Seaboard and Mississippi Portal regions than it is to the rest of the Eastern Uplands region. OPP believes that the drinking water assessments for these other regions sufficiently characterize the potential impacts of OP use on cotton and on the cotton-corn-alfalfa cropping pattern found in Alabama.

In general, the vulnerability of the surface water sources of drinking water to pesticide runoff increases from north to south within the region (Figure II.E.3). While OP concentrations in surface water sources in northern Kentucky and/or the uplands portion of Alabama may be greater, they are not expected to be significantly greater (e.g., not varying by more than an order of magnitude).

Figure II.E.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Eastern Uplands Region.



Although the US Geological Survey estimates that up to one-third of the population in some parts of the Eastern Upland region receive their drinking water from domestic (private) wells (USGS NAWQA UTEN study), an evaluation of available ground-water monitoring data (primarily from the NAWQA studies discussed below) indicate that fewer OP pesticides were detected in ground water, and these detections were at lower concentrations than those found in surface water. Thus, as noted in the main document, an assessment based on surface-water sources of drinking water is expected to be protective of that portion of the population that gets its drinking water from ground water.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Eastern Uplands cumulative assessment using PRZM-EXAMS output with various input parameters that are specific, where possible, to Henderson County, NC. Table II.E.5 presents pesticide use statistics for the eight specific crop-chemical scenarios modeled in this regional assessment. Chemical-, application- and site-specific inputs into the assessments are found in Appendices III.E.5-7. Sources of usage information are documented in Appendix III.E.8. Based on the latest available USDA National Agricultural Statistics Service (NASS) usage data, these eight uses represent the majority of OP usage in Henderson County, NC.

Table II.E.5. OP-Crop Combinations Included in the Eastern Uplands Assessment, With Application Information Used in the Assessment

Chemical	Crop/ Use	Pct. Acres Treated	App. Rate, lb ai/A	App Meth/ Timing	Application Date(s)	Range in Dates (most active dates)
Chlorpyrifos	Alfalfa	10	0.55	Foliar	15-Jul	May 1-Sep 1
Methyl parathion	Alfalfa	3	0.19	Foliar	15-Jul	May 1-Sep 1
Terbufos	Corn	38	1.14	Ground; Planting	April 17	Apr 1-May 20 (Apr 10 - Apr 25)
Chlorpyrifos	Corn	8	1.17	Ground; Planting	April 17	Apr 1-May 20 (Apr 10 - Apr 25)
Azinphos-methyl	Apple	54	0.59	Ground; Foliar	May 1, June 10, Jul 20	May 1-Aug 31
Chlorpyrifos	Apple	40	0.91	Ground; Green Tip-Foliar	Apr 1, May 8, Jun 15, Jul 23	Apr 1-Aug 31
Dimethoate	Apple	21	0.74	Ground; Foliar	June 1	May 1-Jul 30
Phosmet	Apple	43	1.5	Ground; Foliar	May 1, July 7	May 1-Sep 21

Figure II.E.4 displays 35 years of predicted OP cumulative concentrations for the Eastern Uplands drinking water assessment. This chart depicts a single peak occurring each year, with year 3 having a higher peak than other years. The OP cumulative concentration levels exceeded 2 ppb in methamidophos equivalents during one (Year 3) of the 35 years modeled.

Figure II.E.4. Cumulative OP Distribution in Water in the Eastern Uplands, adjusted for relative potency factors and cumulative adjustment factors

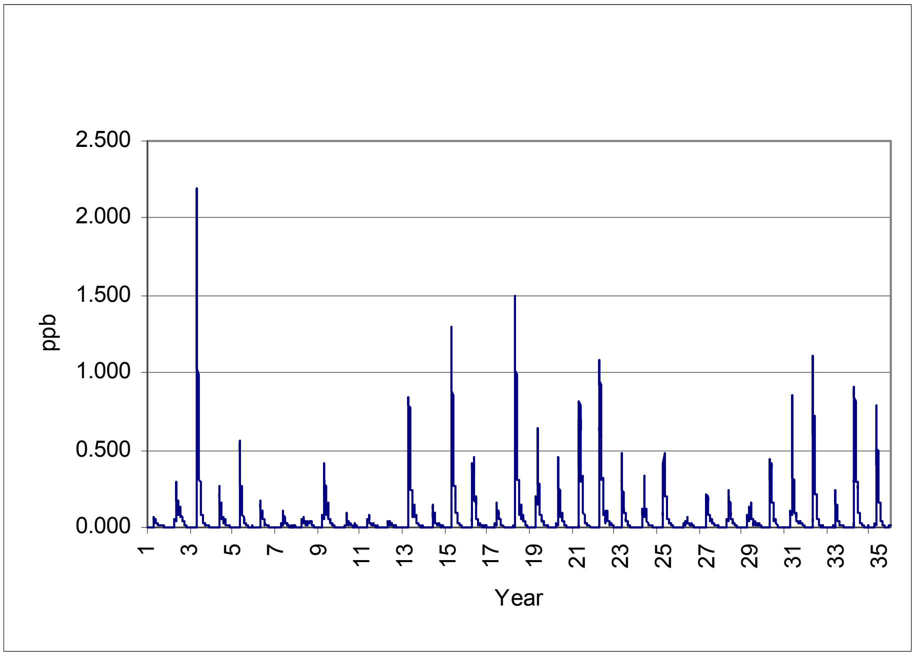


Figure II.E.5 overlays all 35 years of predicted values over the Julian calendar. Here, for example, each of the 35 yearly values associated with February 1st (i.e., Julian Day 32) are graphed such that the spread of concentration associated with February 1st (over all years) can readily be seen. This chart indicates that OP concentrations follow a recurring pattern each year, with a peak occurring about day 110 (ending of April).

Figure II.E.5. Cumulative OP distribution in water in the Eastern Uplands, summarized on a daily basis over 35 years

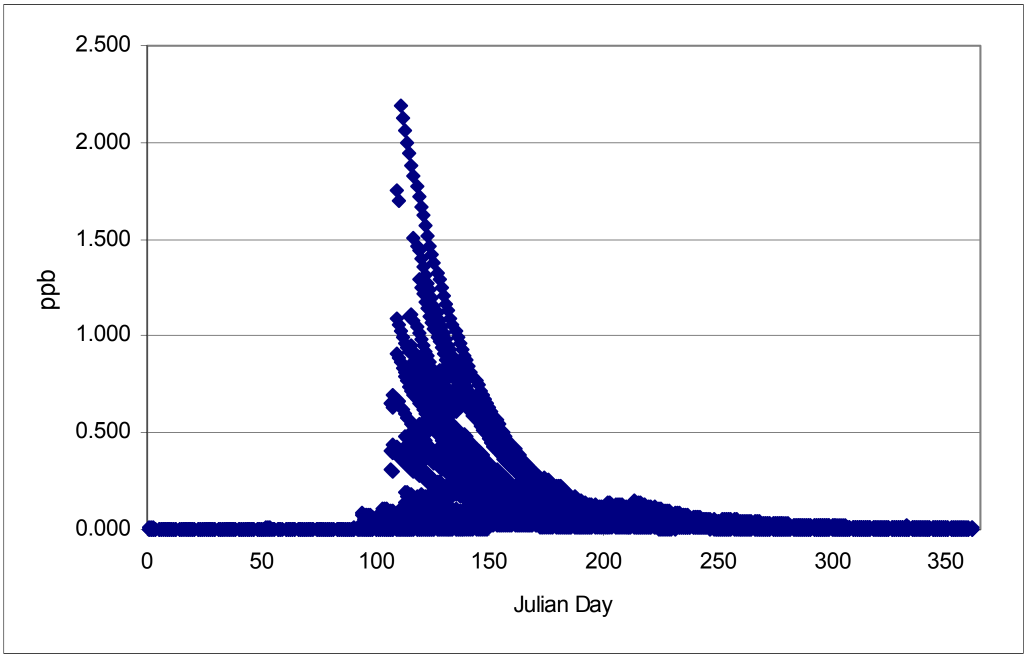
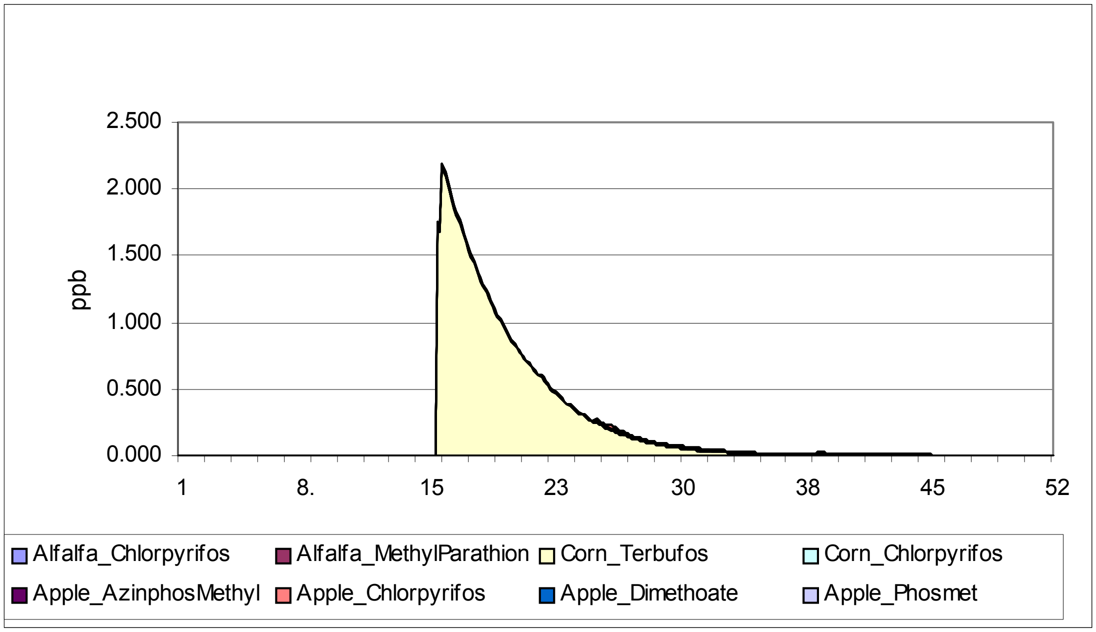


Figure II.E.6 depicts the OP cumulative concentration for uses that made significant contributions during Year 3, the year in which the highest concentration occurred. Terbufos use on corn was the primary contributor to that peak. Terbufos is applied to corn during the third week of April. It is important to note that these concentrations are converted to methamidophos equivalents based on relative potency factors. Thus, the relative contributions are the result of both individual chemical concentrations in water and the relative potency factor of each of the OP chemicals found in the water.

Figure II.E.6. Cumulative OP Distribution for a Representative Year (Year 3) in the Eastern Upland Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents



c. A Comparison of Monitoring Data versus Modeling Results

A comparison of estimated concentrations for individual OP pesticides (Table II.E.6) with NAWQA monitoring indicate that the predicted concentrations of OPs in surface water in Henderson County, although conservative (high end to upper bound), correlate reasonably well with available monitoring data for the region. Although the estimated cumulative OP concentrations used in the exposure assessment represent concentrations that would occur in a reservoir, and not in the streams and rivers represented by the NAWQA sampling, a comparison of the PRZM/EXAMS OP concentrations with NAWQA data show good correlation even if the data sets don't represent identical surface water sources.

Table II.E.6 provides percentiles of concentration from distributions for each of the individual OP pesticides included in the surface water assessment for the region. The concentrations of these individual pesticides were subsequently converted to methamidophos equivalents to produce the cumulative concentrations seen above. These individual pesticide concentrations are the most appropriate to compare to the NAWQA and other monitoring results. A brief summary of the monitoring data is found in following section; additional details on the NAWQA results are in Appendix III.E.1.

Table II.E.6. Percentile Concentrations of Individual OP Pesticides and of the Cumulative OP Distribution, 35 Years of Weather

Chemical	Crop/Use	Concentrations in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
AzinphosMethyl	Apple	0.939	0.466	0.200	0.124	0.071	0.055	0.015
Chlorpyrifos	Alfalfa, apple, corn	1.094	0.481	0.254	0.177	0.106	0.085	0.032
Dimethoate	Apple	0.081	0.016	0.005	0.002	0.000	0.000	0.000
MethylParathion	Alfalfa	0.002	0.001	0.000	0.000	0.000	0.000	0.000
Phosmet	Apple	0.307	0.015	0.000	0.000	0.000	0.000	0.000
Terbufos	Corn	2.569	0.861	0.319	0.133	0.030	0.014	0.001
OP Cumulative Concentrations (in Methamidophos Equivalents, ppb)		2.190	0.756	0.300	0.139	0.051	0.035	0.007

The estimated peak and upper percentile concentrations of chlorpyrifos and azinphos-methyl were roughly an order of magnitude greater than concentrations detected in agricultural watersheds in the NAWQA monitoring studies in the region. While no detectable concentrations of dimethoate or phosmet were found in the NAWQA studies, the vast majority (95 to 99%) of the modeled concentrations were below the analytical levels of detection for those pesticides. Approximately 75% of the estimated terbufos concentrations were below the analytical level of detection; however, these estimates include parent terbufos plus the sulfoxide and sulfone transformation products while NAWQA only analyzed for the less persistent and less mobile parent.

The sampling frequency of the NAWQA study (sample intervals of 1 to 2 weeks apart or less frequent) was not designed to capture peak concentrations, so it is unlikely that the monitoring data will include true peak concentrations. This may account partially for the order of magnitude difference in the model results for peak concentration versus the peak concentrations monitored. In addition, the majority of the surface water samples taken in the closest NAWQA study unit (Upper Tennessee River Basin) were in the Valley and Ridge province, north of Henderson County, NC. This is an area of lesser OP use. The orchards of Henderson County are in the Blue Ridge province, a more mountainous area that is more vulnerable to runoff. Fewer NAWQA sample sites were concentrated in this region.

d. Summary of Available Monitoring Data for the Eastern Uplands

The USGS NAWQA study is the only extensive source of surface-water monitoring data covering multiple OP pesticides in the region. Three NAWQA study units are located within the Eastern Upland region. Results of these monitoring studies indicate that the eastern portion of the Eastern Uplands, centered around western North Carolina, generally has a higher concentrations and frequencies of detection of OP pesticides than does the central or northern portions of the region. No similar monitoring studies can be found for the western portion of the Eastern Uplands, which include northern and eastern Kentucky and the uplands portions of Alabama.

Of the nine OP pesticides from the NAWQA study that are part of the cumulative OP assessment, only chlorpyrifos, diazinon, and malathion were detected in more than one percent of the samples. Ethoprop and azinphos methyl were detected infrequently.

The following summarizes these available NAWQA study results for surface water:

The **NAWQA Upper Tennessee River Basin (UTEN) study** unit includes Henderson County, North Carolina, the OP high-use area chosen for the Eastern Uplands surface-water modeling. The study area is located primarily in western North Carolina, eastern Tennessee, and southwest Virginia. Sampling occurred between 1995 and 1999.

Surface-water monitoring was concentrated in the unregulated portions of the Tennessee River, which is extensively dammed for generation of hydroelectric power. Chlorpyrifos (10% of samples), diazinon (12%) and malathion are the only OPs detected in 428 samples taken biweekly between March and November, 1996. The maximum concentration of diazinon reported was 0.59 ug/l. The frequency of detection for diazinon was greater for sampling locations identified as "mixed land use" while the frequency of detection for chlorpyrifos was greater from "agricultural" sampling sites.

The **Kanawha-New River Basin (KANA)** NAWQA study site, located primarily in south-central West Virginia and southwest Virginia, represents a less agricultural region with less OP use. Chlorpyrifos, diazinon and malathion were detected in the KANA study. Diazinon and malathion were detected in surface water.

The **Allegheny and Monongahela River Basins (ALMN)** study unit is located in northeastern West Virginia and western Pennsylvania. Agriculture accounts for only 30% of land use in the study unit, "commonly low-intensity pasture, dairy and hay." Diazinon and chlorpyrifos are the only active OPs detected in this monitoring program. Diazinon was detected at two of 18 agricultural stream samples, and in seven of 26 (31%) urban stream samples, with maximum concentrations of about 0.1 ug/l. Chlorpyrifos is also reported as having been detected in surface water. Surface water is the main source of drinking water in the Pittsburgh region.

While surface water is the dominant source of drinking water for public water supplies, domestic (private) wells are a significant source of drinking water in some areas within the region. An evaluation of available ground-water monitoring data found few detections of OPs in ground water. Three NAWQA study sites: the Upper Tennessee River, the Kanawha-New River, and Allegheny-Monogahela River sites are in locations representative of the Eastern Upland region. Ground-water samples from wells, springs, and major aquifers at these sites showed no detections of OP pesticides in the Upper Tennessee River site (0 %), chlorpyrifos in 1 of 60 samples (< 2%) and diazinon in 6 of 58 samples (~ 10%). These pesticides were detected at maximum concentrations of $\leq$0.007 ppb. Among Kentucky, North Carolina, Pennsylvania and Tennessee state ground-water monitoring programs, Pennsylvania and Kentucky reported maximum chlorpyrifos concentrations of 0.29 and 7.1 ppb, respectively. Detections of diazinon (0.17 ppb) and malathion (0.32 ppb) were reported by Kentucky. Overall, the percentage of detections (the number of samples with positive detects of OP pesticides) and the concentrations of OP pesticides in domestic wells used for drinking water were low.

Since the NAWQA monitoring data discussed above indicate that surface water residues are detected at greater frequencies and at higher levels than ground water residues, and since most eastern uplands residents obtain their drinking water from surface water sources, OPP determined that surface water-sources of drinking water and not ground water should be the basis of the cumulative exposure assessment for OP pesticide in drinking water.

4. Results of Cumulative Assessment

Analyses and interpretation of the outputs of a cumulative distribution rely heavily upon examination of the results for changing patterns of exposure. To this end, graphical presentation of the data provides a useful method of examining the outputs for patterns and was selected here to be the most appropriate means of presenting the results of this cumulative assessment. Briefly, the cumulative assessment generates multiple potential exposures for each hypothetical individual in the assessment for each of the 365 days in a year. Because multiple calculations for each individual in the CSFII population panel are conducted for each day of the year, a distribution of daily exposures is available for each route and source of exposure throughout the entire year. Each of these generated exposures is internally consistent – that is, each generated exposure appropriately considers temporal, spatial, and demographic factors such that "mismatching" (such as combining a winter drinking water exposure with an exposure that would occur through a spring lawn application) is precluded. In addition, a simultaneous calculation of MOEs for the combined risk from all routes is performed, permitting the estimation of distributions of the various percentiles of total risk across the year. As demonstrated in the graphical presentations of analytical outputs for this section, results are displayed as MOEs with the various pathways, routes, and the total exposures arrayed across the year as a time series (or time profile). Any given percentile of these (daily) exposures can be selected and plotted as a function of time. That is, for example, a 365-day series of 95th percentile values can be plotted, with 95th percentile exposures for each day of the year (January 1, January 2, etc) shown. The result can be regarded as a "time-based exposure profile plot" in which periods of higher exposures (evidenced by low 'Margins of Exposure') and lower exposures (evidenced by high 'Margins of Exposure') can be discerned. Patterns can be observed and interpreted and exposures by different routes and pathways (e.g., dermal route through lawn application) seen and compared. Abrupt changes in the slope or levels of such a profile may indicate some combination of exposure conditions resulting in an altered risk profile due to a variety of factors. Factors may include increased pest pressure and subsequent home pesticide use, or increased use in an agricultural setting that may result in increased concentrations in water. Alternatively, a relatively stable exposure profile indicates that exposure from a given source or combination of sources is stable across time and the sources of risk may be less obvious. Different percentiles can be compared to ascertain which routes or pathways tend to be more significant contributors to total exposure for different subgroups of the eastern uplands population (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.M.2-1 through III.M.2-5 in Appendix M present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the eastern uplands population (95th, 97.5th, 99th, 99.5th, and 99.9th). Figure III.M.2-6 through Figure III.M.2-10, and Figure III.M.2-11 through Figure III.M.2-15 and Figure III.M.2-16 through Figure III.M.2-20 present these same figures for Children 3-5, Adults 20-49, and Adults 50+, respectively. The following paragraphs describe, in additional detail, the exposure profiles for each of these population age groups for these percentiles (i.e., 95th, 97.5th, 99th, 99.5th, and 99.9th). Briefly, these figures present a series of time course of exposure (expressed as MOEs) for various age groups at various percentiles of exposure for the population comprising that age group. For example, for the 95th percentile graphs for children 1-2 years old, the 95th percentile (total) exposure for children 1-2 is estimated for each of the 365 days of the year, with each of these (total) exposures – expressed in terms of MOE's – plotted as a function of time. The result is a "time course" (or "profile") of exposures representing that portion of the eastern uplands population at the 95th percentile exposures throughout the year. Each "component" of this 95th percentile total exposure (i.e., the dermal, inhalation, non-dietary oral, food, and water, etc. "component" exposures which, together, make up the total exposure) can also be seen – each as its own individual time profile plot. This discussion represents the unmitigated exposures (i.e., exposures which have not been attempted to be reduced by discontinuing specific uses of pesticides) and no attempt is made in this assessment to evaluate potential mitigation options. The following paragraphs describe the findings and conclusions from each of the assessments performed.

a. Children 1-2 years old

(Figures III.M.2-1 through III.M.2-5): At the 95th percentile, exposures from the residential applications of OP pesticides do not contribute to the overall exposure. This is true for all of the routes of exposure examined: dermal and hand-to-mouth exposure from lawn treatment applications and inhalation exposure from indoor crack and crevice and pest strip treatments. Exposure from drinking water at this percentile also does not contribute to substantial exposure. It is interesting to note that there are increases in drinking water concentrations Julian days 100 to 150 which corresponds to April and May applications of terbuphos to corn and, to a lesser extent, application of chlorpyrifos and azinphos methyl to apples. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasingly dominant portion of the total exposure profile. This corresponds to use of DDVP pest strips and crack and crevice treatments. By the 99th percentile and above, residential exposures via inhalation pathway from the use of these DDVP products are the most significant contributors to the overall risk picture throughout the year. This is not true for drinking water exposures. These continue to be low and do not contribute in any significant manner to the overall risk picture. By the 99.5th percentile dermal and/or hand-to-mouth exposures from lawn uses begin to appear in the overall risk picture but continue to be a small fraction (<1%) of total exposure.

b. Children 3-5 years old

(Figure III.M.2-6 through Figure III.M.2-10): As with children 1-2, exposures from the residential applications of OP pesticides do not contribute to the overall exposure to the pesticides at the 95th percentile. This is true for all of the routes of exposure examined: dermal and hand-to-mouth exposure from lawn treatment applications and inhalation exposure from indoor crack and crevice and pest strip treatments. As indicated before, there are increases in drinking water concentrations during Julian days 100 to 150 which corresponds to April and May applications of terbuphos to corn and, to a lesser extent, application of chlorpyrifos and azinphos methyl to apples. However, these do not lead to substantial exposures. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasingly dominant portion of the total exposure profile. This corresponds to use of DDVP pest strips and crack and crevice treatments. By the 99th percentile and above, residential exposures via the inhalation pathway from the use of these DDVP products are the most significant contributors to the overall risk picture throughout the year. This is not true for drinking water exposures. These continue to be low and do not contribute in any significant manner to the overall risk picture. By the 99.5th percentile dermal and/or hand-to-mouth exposures from lawn uses appear in the overall risk picture but continue to be a small fraction (<1%) of total exposure.

c. Adults, 20-49 and Adults 50+ years old

(Figure III.M.2-11 through Figure III.M.2-15 and Figure III.M.2-16 through Figure III.M.2-20): At the 95th percentile, exposures from the residential applications of OP pesticides do not contribute to the overall exposure. This is true for all of the routes of exposure examined: dermal exposure from lawn and garden and golf course treatment applications and inhalation exposure from lawn and gardening activities and indoor crack and crevice and pest strip treatments. The increases in drinking water concentrations on Julian days 100 to 150, which corresponds to April and May applications of terbuphos to corn and, to a lesser extent, application of chlorpyrifos and azinphos methyl to apples, do not contribute to substantial exposure. At the higher percentiles, the exposure profile and relative contributions begin to change. The residential inhalation exposures become an increasingly dominant portion of the total exposure profile. This corresponds to use of DDVP pest strips and crack and crevice treatments. By the 99th percentile and above, residential exposures via inhalation pathway from the use of these DDVP products are consistently the most significant contributors to the overall risk picture. This is not true for drinking water exposures. These continue to be low and do not contribute in any significant manner to the overall risk picture. By the 99.5th percentile, dermal exposures begin to appear in the overall risk picture but continue to be a small fraction (< ca. 1%) of total exposure.