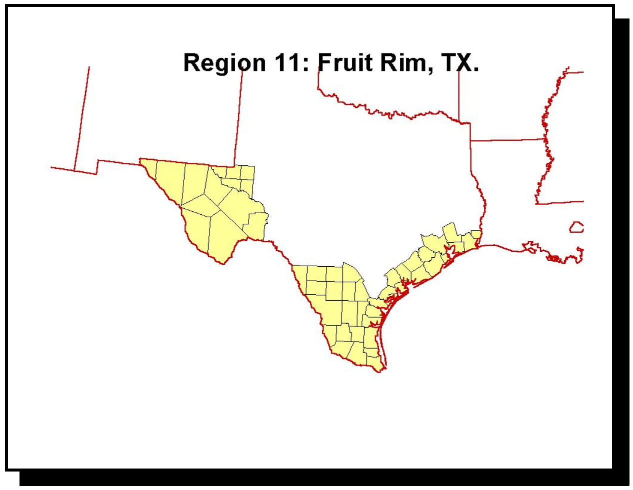
II. Regional Assessments

L. Region 11 - Fruitful Rim TX Assessment

1. Executive Summary

This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Fruitful Rim TX (area shown to right). Information is included in this module only if it is specific to the Fruitful Rim TX, or is necessary for clarifying the results of the Fruitful Rim TX 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.L.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.L.1. Pesticides and Use Sites/Scenarios Considered in Fruitful Rim TX Residential/Non-Occupational and Drinking Water Assessment

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Acephate	Golf Courses, Ornamental Gardens	Cotton
Azinphos-methyl	None	Cotton
Bensulide	Golf Courses	None
Chlorpyrifos	None	Corn, Cotton, Sorghum, Alfalfa

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
DDVP	Indoor uses	None
Dicrotophos	None	Cotton
Dimethoate	None	Cotton, Corn, Wheat
Disulfoton	Ornamental Gardens	None
Fenamiphos	Golf Courses	None
Malathion	Lawn Applications, Golf Courses, Home Fruit & Vegetable Gardens, Ornamental Gardens, Public Health	Cotton
Methyl-parathion	None	Cotton, Alfalfa
Phorate	None	Cotton
Phostebupirim	None	Corn
Terbufos	None	Corn
Trichlorfon	Golf Courses, Lawn applications	None
Tribuphos	None	Cotton

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 Fruitful Rim, TX to 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 Fruitful Rim TX region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Fruitful Rim TX 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 and (for children) oral exposure through hand-to-mouth. 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 Fruitful Rim TX Region 11

In developing this aspectt 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, public health uses, and indoor uses. These scenarios were selected because they are expected to be the most prominent contributors to exposure in this region. 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.

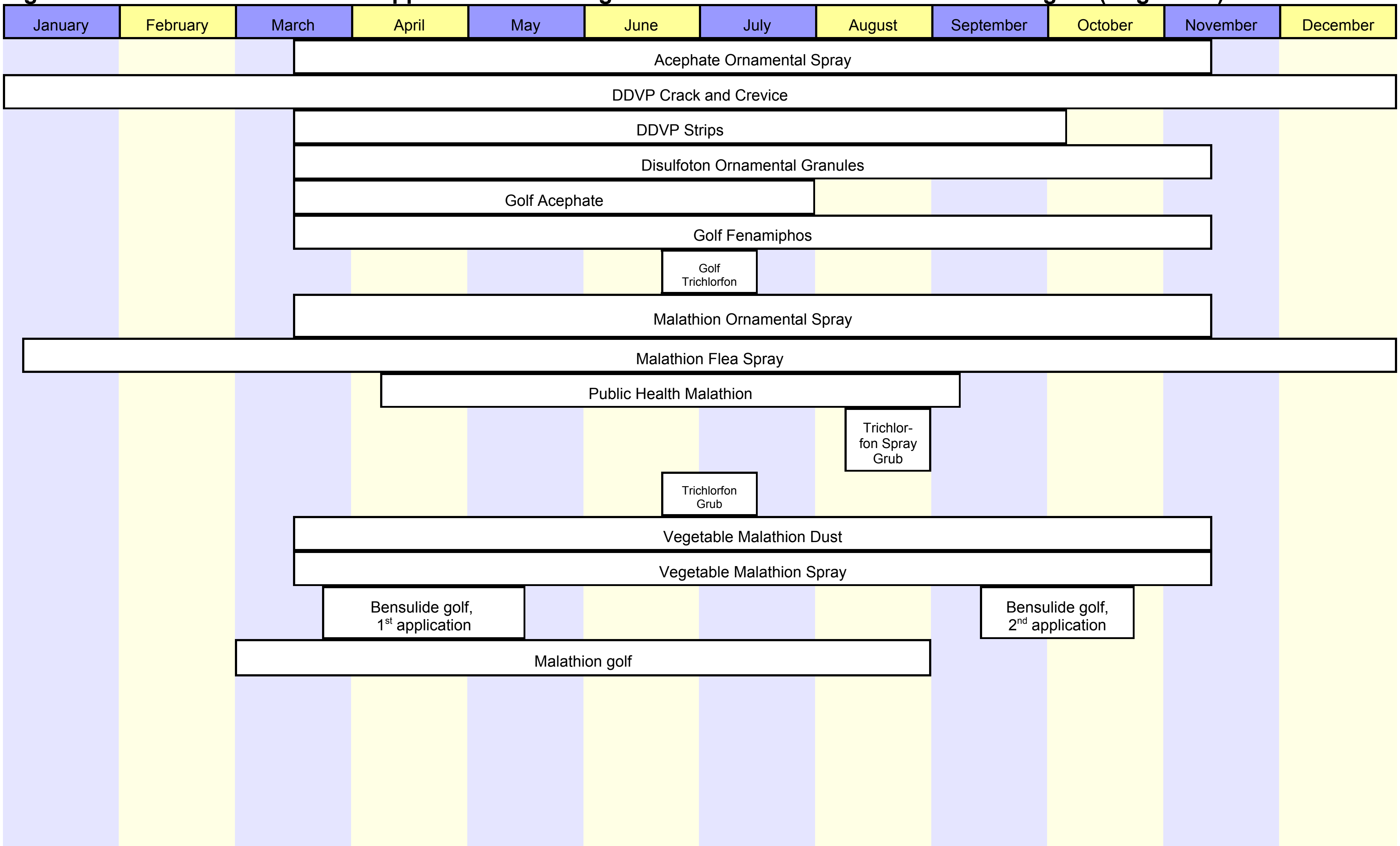
The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part I of this report. However, a variety of additional region-specific ancillary data was required for this assessment of the Fruitful Rim TX. 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.L.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.L.2 which summarizes all relevant region-specific scenarios.

Table II.L.2. Use Scenarios and Calendex Input Parameters for Fruitful Rim TX Residential Exposure Assessment

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A	Maximum Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
Acephate	Golf Courses	NA	5	2/yr	March-July	100	--	1.83	10	dermal
	Ornamentals	hand pump sprayer	0.934-2	4/yr	March-Nov.	--	100	6	10	dermal, inhalation
Bensulide	Golf Courses	NA	12.5	2/yr	April-May	100	--	1.83	14	dermal
DDVP	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	8	1	inhalation
	Pest Strips	strip	NA	2/yr	March-Oct.	NA	100	2.5	90	inhalation
Disulfoton	Ornamentals	granular	8.7	3/yr	March-Nov.	--	100	7	1	dermal, inhalation
Fenamiphos	Golf Courses	NA	116	1/yr	March-Nov.	100	--	1	2	dermal
Malathion	Golf Courses	NA	NA	1/yr	March-Aug.	100	--	1	4	dermal
	Lawns	hose end spray	5 lb ai	2/yr	Jan-Dec.	9	91	3	4 1	dermal, oral inhalation
	Ornamentals	hand pump spray	0.94-2 lb/A	4/yr	March-Nov.	--	100	3.7	1	dermal, inhalation
	Public Health Mosquitoes	aerial & ground	NA	11/yr	April-Sept.	100	--	100	2	dermal, oral
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	March-Nov.	--	100	1.1	14 1	dermal, inhalation
		hand pump sprayer	1.5 lb/A	5/yr	March-Nov.	--	100	1.1	14 1	dermal inhalation
Trichlorfon	Golf Courses	NA	8 lb ai	1/yr	June-July	100	--	1.22	2	dermal
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	June-July	9	91	1	1 2	inhalation dermal, oral

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A	Maximum Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
	Lawns Granular	rotary spreader	8 lb ai	1/yr	August	9	91	1	1 2	inhalation dermal, oral

Figure II.L.1 Residential Scenario Application and Usage Schedules for the Fruitful Rim TX Region (Region 11)



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 treatments.

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 California (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 uniform distribution bounded by 1.5 and 3 to account for wet hand transfer.

For the vegetable gardening scenarios in western regions, a residue dissipation study was conducted with multiple residue measurements collected up to 14 days after treatment in California. A uniform distribution was used for each day after the application. The study was conducted a one pound ai per acre. The residues were adjusted upwards 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 following the 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 sprayable formulations were collected for the “day of” and “day following” the application. A uniform distribution bounded by the low and high residue measurements was used, with these residue values adjusted upwards to simulate the higher active ingredient concentrations in use (i.e., adjusted to 0.5% and 1% for granular and sprayable 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 Texas Fruitful Rim 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 Texas Fruitful Rim. 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 Texas Fruitful Rim regional assessment for drinking water exposure with respect to cumulative exposure to the OP pesticides. The combination of OP usage and relative vulnerability of surface water sources of drinking water to OP contamination focused on several counties in the eastern arm of the Texas Fruitful Rim. Because of general similarities in OP use crops and vulnerability, the Agency used the same water exposure assessment it conducted for the Prairie Gateway in the Central Hills of Texas as a surrogate for the Texas Fruitful Rim. The discussion compares the OP usage and relative drinking water vulnerability of the Texas Fruitful Rim with that of the Central Hills of Texas. Additional information on the Central Hills area can be found in the Prairie Gateway regional assessment (II.D).

a. Selection of the Central Hill Region of Texas As a Surrogate for the Drinking Water Assessment

OP usage in the Texas Fruitful Rim is concentrated primarily in southeastern Texas. Because of similarities in use patterns and vulnerability of drinking water sources, the Agency used the Central Hills of Texas for both the Texas Fruitful Rim and the Prairie Gateway Regions. Details on the Central Hills area can be found in the Prairie Gateway regional assessment (II.D). This discussion focuses on the applicability of the Central Hills assessment as a health-protective surrogate for the Texas Fruitful Rim.

Overall OP usage is focused in the eastern end of the region, where, in 1997, approximately one million pounds (ai) of OPs were applied in on agricultural crops. Cotton (38% of total OP use in the region), sorghum (18%), corn (11%), and alfalfa (10%) are the major OP use crops in the Texas Fruitful Rim (Table II.L.3).

Table II.L.3. General Overview of OP Usage in the Texas Fruitful Rim

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Cotton	Southeast Texas	390,000	38
Sorghum	Southeast Texas	184,000	18
Corn	Southeast Texas	109,000	11
Alfalfa	West and Southeast Texas	98,000	10
Onions	Lower Rio Grande Valley	75,000	7
Other Vegetables	Lower Rio Grande Valley	41,000	4
Citrus		43,000	4
Rice	Northern end of region	40,000	4
Pecans	Texas	29,000	3
		1,033,000	99

(1) Source: NCFAP, 1997.

The high OP use areas occur in the lower Rio Grande Valley in the southern tip of Texas and in the eastern arm which includes several counties north of the Rio Grande valley (Figure II.L.2). OP use on vegetables is focused primarily in the lower Rio Grande Valley. Cotton, corn, sorghum, and alfalfa are the dominant OP use crops in the eastern counties to the north of the Rio Grande Valley. OP use on rice is confined to the northern end of the region. The suite of OP-use crops in the eastern counties running from Nueces County in the south to Fort Bend County in the north are similar to those of the Central Hills of Texas.

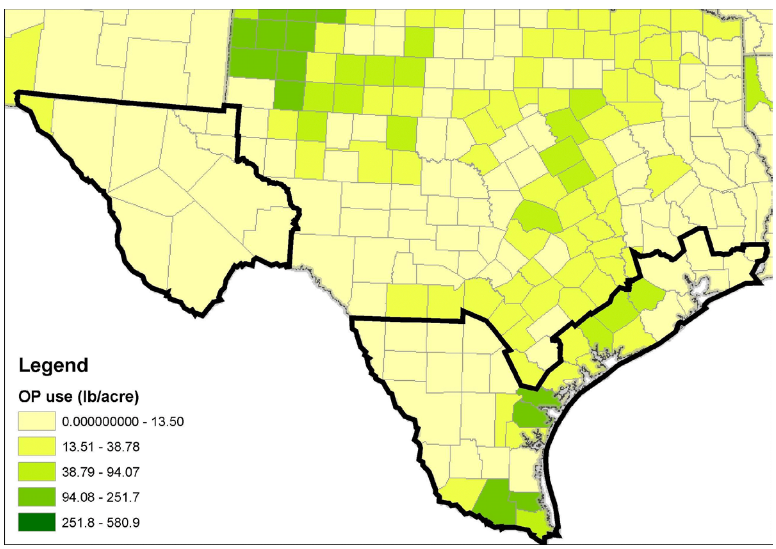


Figure II.L.2. Total OP usage (pounds per area) in the Texas Fruitful Rim (source: NCFAP, 1997)

In the Central Hills of Texas, OP use on corn, cotton, alfalfa, sorghum, and wheat accounted for 95% of total agricultural use (Table II.L.4). Except for wheat, this is a similar suite of OP-use crops found in the eastern arm of the Texas Fruitful Rim.

Table II.L.4. OP Usage on Agricultural Crops in East-Central Texas.

OP Usage/ Agricultural Crops				Cropland Acreage, Assessment Area	
Crop Group	**Crops**	**OP Usage**	**Percent of Total OP Use**	**Acres**	**Pct of total Cropland**
Alfalfa	Alfalfa hay	76,000	23	2,500	0.1
Corn	Corn	111,000	33	405,000	20
Cotton	Cotton	81,000	24	131,000	6
Sorghum	Sorghum	36,000	11	200,000	10
Wheat	Wheat	14,000	4	249,000	12
			95	988,000	48

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

Surface water sources of drinking water are common in the eastern portion of the region, and particularly in the Lower Rio Grande Valley (Figure II.L.3). Surface water sources of drinking water in the eastern portion of the region are more vulnerable to runoff. Watersheds with the greatest runoff potential in the region are found in the northeastern part of the Texas Fruitful Rim.

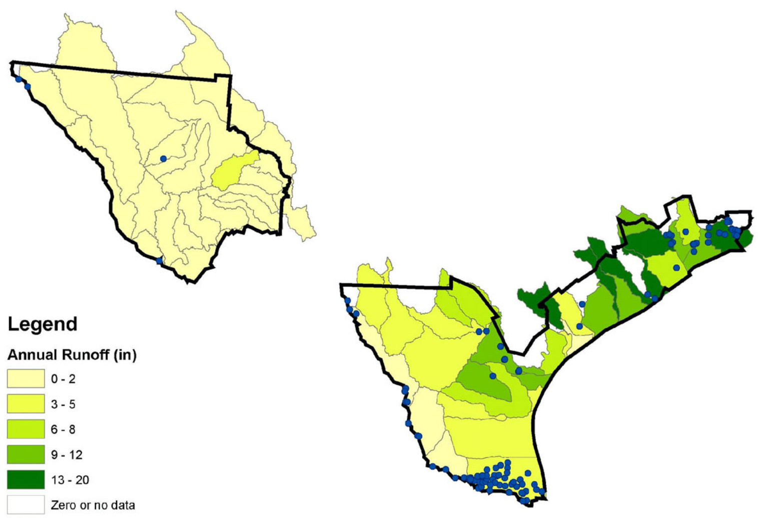


Figure II.L.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Texas Fruitful Rim Region

Ground water serves as a drinking water source for about 42 percent of the population of Texas (http://capp.water.usgs.gov/gwa/ch_d/gif/Dtab1.GIF). Ground water is the main source of drinking water for people in rural areas throughout these states.

The geology of the major aquifers in the Texas Fruitful Rim and Prairie Gateway is discussed in the Prairie Gateway regional assessment (II.D). In general the same areas in the region that are vulnerable to pesticide contamination by runoff are also vulnerable to pesticide contamination by leaching (Figure II.L.4).

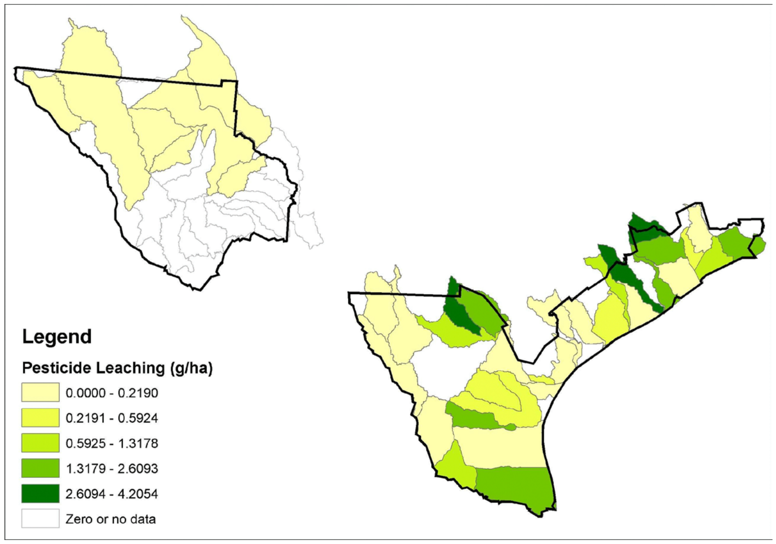


Figure II.L.4. Vulnerability of ground water resources to pesticide leaching in the Texas Fruitful Rim, adapted from USDA (Kellogg, 1998)

Based on vulnerability to runoff, surface water sources of drinking water in the high-use counties in the eastern arm of the Fruitful Rim, to the north of the Rio Grande counties, are likely to be the most potentially impacted by OP usage in the region. Although available monitoring data is not extensive throughout the entire region, an evaluation of this data, discussed below, indicates that surface water sources of drinking water are likely to be more vulnerable than ground water sources. Due to similarities in OP-use patterns and vulnerability of surface water sources, the Agency used the Central Hills of Texas, the site of its drinking water assessment for the Prairie Gateway, as a surrogate for the Texas Fruitful Rim region.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Texas Fruitful Rim cumulative assessment using PRZM-EXAMS output with various input parameters that are specific, where possible, to the Central Hills region in east Texas. Table II.L.5 presents pesticide use statistics for the OP-crop combinations which were 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 can be found in Appendix III.E.8. Based on the latest available USDA National Agricultural Statistics Service (NASS) usage data, these OP-use combinations represent roughly 95 percent of agricultural use of OP pesticides in east-central Texas.

Table II.L.5. OP-Crop Combinations Included in the Texas Fruitful Rim 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	June 16	May15-Jul15
Methyl parathion	Alfalfa	3	0.19	Foliar	June 16	May15-Jul15
Chlorpyrifos	Corn	4	0.76	Ground; Planting	April 9	Feb28-May15 (Mar 20 - Apr 29)
Dimethoate	Corn	5	0.43	Aerial; Foliar	July 1	Jun1-Aug1
Phostebupirim	Corn	8	0.08	Ground; Planting	April 9	Feb28-May15 (Mar 20-Apr 29)
Terbufos	Corn	12	0.82	Ground; Planting	April 9	Feb28-May15 (Mar 20-Apr 29)
Acephate	Cotton	6	0.57	Ground; Foliar	May 1, May 21	May1-Jun 10
Azinphos-methyl	Cotton	4	0.27	Ground; Foliar	May 20	May20-Oct1
				Aerial; Foliar	July 26	May20-Oct1
Chlorpyrifos	Cotton	5	0.64	Aerial; Foliar	Jun 15, Jul 16	Jun15-Aug15
Dicrotophos	Cotton	5	0.14	Ground; Foliar	May 1, May 24	May1-Jun15
Malathion	Cotton	41	1.02	Ground; Foliar	May 15	May 15-Oct 15
				Aerial; Foliar	Jun 6,Jun 28, Jul 20, Aug. 11, Sep. 2, Sep. 24	
Methyl parathion	Cotton	6	0.64	Ground; Foliar	May 15	May 15-Oct 15
				Aerial; Foliar	July 31	
Phorate	Cotton	4	0.44	Ground; Planting	April 13	Mar20-Jun1 (Apr 1-Apr 25)
Dimethoate	Cotton	2	0.24	Ground; Foliar	May 1, May 24	May1-Jun15
Tribufos	Cotton	11	0.51	Aerial; Foliar	Nov. 1	Aug10-Dec28 (Oct 1 - Dec 2)
Chlorpyrifos	Sorghum	5	0.44	Aerial; Foliar	May 2	Apr1-Jun1
Dimethoate	Wheat	5	0.28	Aerial; Foliar	Nov. 8	Oct15-Dec1

Figure II.L.5 displays 35 years of predicted OP cumulative concentrations for the Texas Fruitful Rim drinking water assessment. This chart depicts a single peak occurring each year, with year 7 having a higher peak than other years. The OP cumulative concentration levels exceeded 2 ppb in methamidophos equivalents during two of the 35 years modeled.

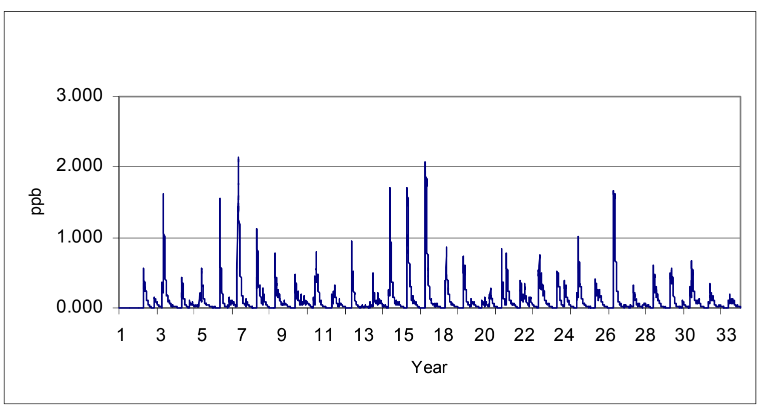


Figure II.L.5. Cumulative OP Distribution in Water in the Texas Fruitful Rim (Methamidophos equivalents)

Figure II.L.6 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 120.

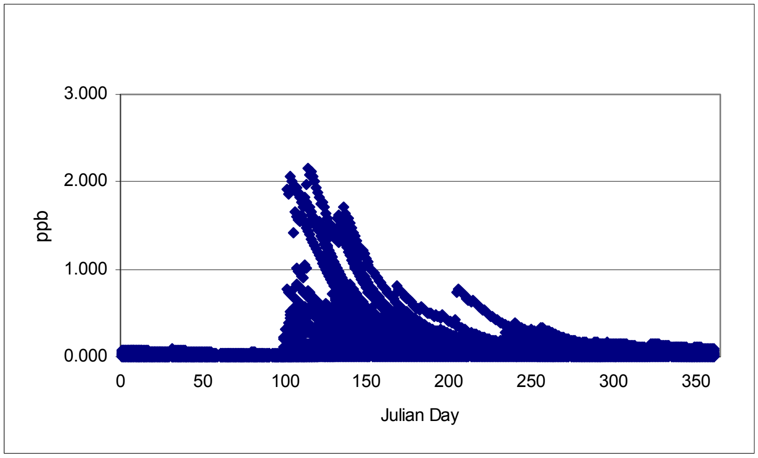


Figure II.L.6. Cumulative OP Distribution in Water (Methamidophos Equivalents) in the Texas Fruitful Rim, summarized on a daily basis over 35 years

Figure II.L.7 depicts the predicted OP cumulative concentration for uses that made significant contributions to during Year 7, the year in which the highest modeled concentration occurred. Phostebupirim and terbufos use on corn are the primary contributors to that peak. Both insecticides are applied to corn during the second week of April (week 15). 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. In the case of phostebupirim, a surrogate relative potency factor that was roughly two to three orders of magnitude greater than other OPs used on corn, greatly impacted its relative contribution to the cumulative OP load.

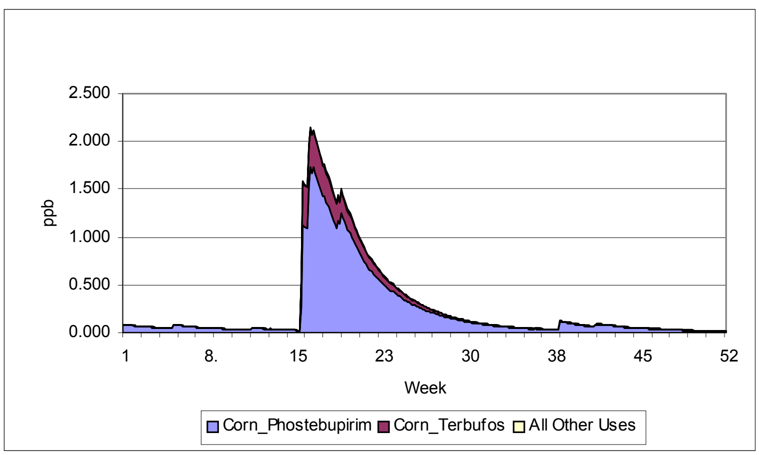


Figure II.L.7. Cumulative OP Distribution for an Example Year (Year 7) in the Texas Fruitful Rim Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents

c. A Comparison of Monitoring Data versus Modeling Results

A comparison of estimated concentrations for individual OP pesticides (Table II.L.6) with NAWQA monitoring (summarized below and in Appendix III.E.1) indicate that, except for terbufos, the NAWQA monitoring for the Trinity River Basin had higher detections than were found in the predicted concentrations of OPs in surface water in the Central Hills of Texas. The highest detection of azinphos methyl in the monitoring was 50 times greater than the estimated maximum concentration. For methyl parathion, the highest monitoring detect was an order of magnitude greater than the estimated maximum concentration. Although in-depth analysis of usage and sources of potential contamination have not been made, it is possible that the methyl parathion discrepancies may reflect differences resulting from uses that have been canceled and are not reflected in the modeling. For chlorpyrifos and malathion, the highest monitoring detect was twice as great as the highest estimated concentration. These differences are not great, and may reflect contributions from urban uses. The estimated concentrations for terbufos include parent terbufos plus the sulfoxide and sulfone transformation products while NAWQA only analyzed for the less persistent and less mobile parent.

Table II.L.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	Cotton	2.4e-02	9.7e-03	4.6e-03	3.0e-03	3.0e-03	1.5e-03	4.8e-04
Chlorpyrifos	Alfalfa,Corn, Cotton, Sorghum	1.3e-01	5.9e-02	2.9e-02	1.8e-02	1.8e-02	8.4e-03	3.5e-03
Dicrotophos	Cotton	3.9e-02	7.9e-03	2.4e-03	9.3e-04	9.3e-04	6.7e-05	2.6e-06
Dimethoate	Corn,Cotton, Wheat	6.5e-02	2.1e-02	7.0e-03	4.1e-03	4.1e-03	1.6e-03	3.3e-04
Malathion	Cotton	1.5e+00	8.2e-02	3.4e-02	1.5e-02	1.5e-02	1.8e-03	6.1e-06
Methamidophos	Cotton	4.6e-02	8.5e-04	3.1e-05	1.1e-06	1.1e-06	3.1e-10	1.4e-11
MethylParathion	Alfalfa, Cotton	6.8e-02	1.5e-02	4.4e-03	2.4e-03	2.4e-03	5.3e-04	3.3e-05
Phorate	Cotton	4.2e-02	3.8e-03	1.2e-04	2.0e-06	2.0e-06	1.7e-11	2.0e-13
Phostebupirim	Corn	6.9e-02	3.2e-02	1.4e-02	8.9e-03	8.9e-03	3.7e-03	1.4e-03
Terbufos	Corn	1.4e+00	4.9e-01	1.7e-01	7.9e-02	7.9e-02	8.6e-03	4.4e-04
Tribufos	Cotton	6.1e-02	3.6e-02	2.3e-02	1.9e-02	1.9e-02	1.3e-02	9.4e-03
OP Cumulative Concentrations (in Methamidophos Equivalents, ppb) (RPF=25)		2.1e+00	1.2e+00	4.8e-01	3.1e-01	1.6e-01	1.2e-01	4.0e-02

Although diazinon has been frequently detected in the Trinity River Basin, particularly in urban streams, the latest NASS surveys indicate little or no agricultural uses of diazinon in the Central Hills area. Detections of diazinon in the Trinity River Basin may reflect residential uses which are being canceled or uses on other crops during the sampling period that are not reflected in current use surveys.

In evaluating these comparisons, it is important to realize that 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. 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. The main document provides a characterization of what the water exposure estimates represent and includes an analysis of the factors that most influence these estimated concentrations.

d. Summary of Available Monitoring Data for the Texas Fruitful Rim

Monitoring data are available from USGS NAWQA and NASQAN programs. Chlorpyrifos, diazinon and malathion were the most frequently detected OPs in surface water; methyl parathion, azinphos-methyl, disulfoton, and terbufos were detected less frequently in surface water. The Texas Fruitful Rim includes portions of two USGS National Water Quality Assessment (**NAWQA**) study units: **Trinity River Basin** and **South-Central Texas**. These are summarized in the Prairie Gateway regional assessment (II.D). Additional details can be found in Appendix III.E.1.

The USGS National Stream Quality Assessment Network (**NASQAN**) program includes eight sampling sites in the Rio Grande watershed. Two of these eight, the Arroyo Colorado at Harlingen, Texas and Rio Grande near Brownsville, Texas, are located in the main agricultural area along the Rio Grande. They also were the two sites with the detection of the most OP insecticides in sampling from 1996 to 1999. Together, these two “reflect the total outflow of the Rio Grande to the Laguna Madre and the Gulf of Mexico (http://water.usgs.gov/nasqan/progdocs/factsheets/riogfact/engl.html).”

Seven of the nine active OPs included as analytes were detected in the Arroyo Colorado. Methyl parathion was detected in 20% of the 45 samples with a maximum concentration of 1.7 ug/l. Azinphos-methyl was detected in 26%, with a maximum concentration of 1.23 ppb. Diazinon was detected in 89% (maximum concentration 0.37 ug/l), chlorpyrifos in 41% (max. 0.220 ug/l) and malathion in 19% (max 0.840 ug/l). Ethoprop and phorate were detected in one sample each, at 0.1 ug/l or less. The frequency and magnitude of the detections may be related to the use of the Arroyo Colorado. In its description of the sampling station, the USGS states that:

On the U.S. side of the basin downstream of Anzalduas Dam, almost all the water withdrawn from the Arroyo Colorado or the Rio Grande for irrigation and municipal purposes is returned to the Arroyo Colorado.

While the concentrations detected at this site a relatively high, return of water from irrigation and residential areas is not an unusual source of contamination.

The Rio Grande at Brownsville site has less frequent detection of fewer pesticides. Methyl parathion was detected in 10% of 32 samples, with a maximum detection of 0.084 ug/l. Azinphos methyl was detected in 6%, with a maximum concentration of 0.01 ug/l. Diazinon, chlorpyrifos and malathion were detected less often as well (e.g. diazinon in 52% of samples), with maximum concentrations below 0.1 ug/l. However, the detection of any concentration of the OPs in this major river are significant, given its volume.

As noted by the USGS, the Rio Grande is less contaminated upstream than at these downstream stations. Only one sample from the six upstream sites had a detection of an OP other than diazinon, chlorpyrifos and malathion (terbufos at 0.016 ug/l near El Paso). Three sampling sites had detections of diazinon only, at a frequency of 24% or less. However, at the station on the Rio Grande at Laredo, Texas, diazinon was detected in 81% of samples collected. The USGS described the reach of the river represented by this station as having “large centers of population and industry that could affect water quality.” The detections of diazinon, chlorpyrifos and malathion at this station may then be reflective of urban or suburban use.

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 95^{th} percentile values can be plotted, with 95^{th} 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 or level through lawn application) seen and compared. Abrupt changes in the slope 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 Fruitful Rim– Texas population (e.g, those at the 95^{th} percentile vs. 99^{th} percentiles of exposure).

Figures III.T.2-1 through III.T.2-5 in Appendix T present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the Fruitful Rim – Texas population (95 th , 97.5 th , 99 th , 99.5 th , and 99.9 th). Figure III.T.2-6 through Figure III.T.2-10, Figure III.T.2-11 through Figure III.T.2-15 and Figure III.T.2-16 through Figure III.T.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., 95 th , 97.5 th , 99 th , 99.5 th , and 99.9 th). 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 95^{th} percentile graphs for children 1-2 years old, the 95 th 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

Fruitful Rim TX 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

(Figure III.T.2-1 through Figure III.T.2-5): During the spring/summer months, oral hand-to-mouth exposures are the primary contributors to exposure at the 95th percentile. The principle contributor to this exposure is from the lawn applications of trichlorfon during this time period. Although increased exposures through drinking water are seen near Julian day 100 through Julian day 160 (due primarily to application of phostebupirim and terbufos on corn), drinking water does not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasing portion of the total exposure profile but remain secondary to oral hand-to-mouth exposures. Only by the 99.5th percentile does inhalation exposure begin to approach those arising from oral hand-to-mouth activity. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures from lawn uses are apparent in the overall risk picture throughout all the percentiles examined, but remain a small fraction (generally <0.1% to 1%) of total exposure.

b. Children 3-5 years old

(Figure III.T.2-6 through Figure III.T.2-10): As with Children 1-2, oral hand-to-mouth exposures are the primary contributors to exposure at the 95th percentile during the spring/summer months. The principle contributor to this exposure is from the lawn applications of trichlorfon during this time period. Although increased exposures through drinking water are seen near Julian day 100 through Julian day 160 (due primarily to application of phostebupirim and terbufos on corn), drinking water does not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasing portion of the total exposure profile but remain secondary to oral hand-to-mouth exposures. Only by the 99.5th percentile does inhalation exposure approach that arising from oral hand-to-mouth activity. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures from lawn uses are apparent in the overall risk picture throughout all the percentiles examined, but remain a small fraction (generally <0.1% to 1%) of total exposure.

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

(Figure III.T.2-11 through Figure III.T.2-15 and Figure III.T.2-16 through III.T.2-20) At the 95th percentile exposures from the residential applications of OP pesticides do not contribute substantially to the overall exposure. This is true for all of the routes of exposure examined: dermal exposure from lawn and garden applications and inhalation exposure from lawn, golf, and gardening activities and indoor crack and crevice and pest strip treatments. Drinking water exposures are also low and, although exposures are near to that of food at this percentile, these do not contribute to substantial exposure. 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 for an increasing fraction of the year. This corresponds to use of DDVP products. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures, while apparent as early as the 95th percentile, do not become significant in the overall risk picture at any percentile, remaining a small fraction (generally <1%) of total exposure.