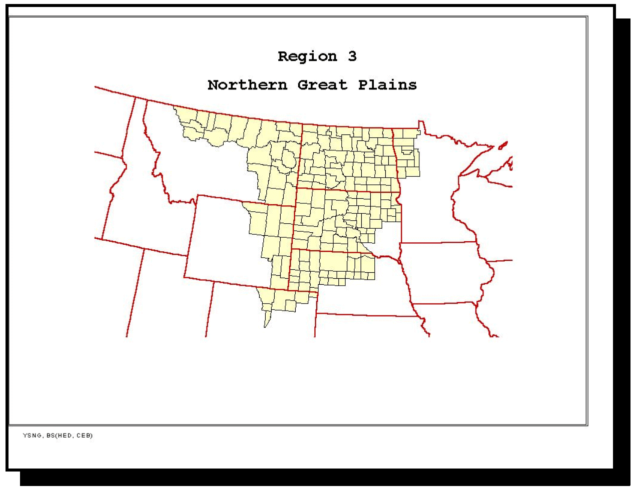
II. Regional Assessments

C. Region 3 - Northern Great Plains Assessment

1. Executive Summary



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

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenarios
Acephate	Ornamental Gardens	None
Azinphos-methyl	None	Potato
Bensulide	Golf Courses	None
Chlorpyrifos	None	Sugarbeet, Wheat
DDVP	Lawn applications, Indoor uses	None

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenarios
Dimethoate	None	Potato
Disulfoton	Ornamental Gardens	None
Malathion	Lawn Applications, Home Fruit & Vegetable Gardens, Ornamental Gardens	None
Phorate	None	Sugarbeet
Terbufos	None	Sugarbeet
Trichlorfon	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 Northern Great Plains 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 Northern Great Plains region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Northern Great Plains 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 Northern Great Plains Region

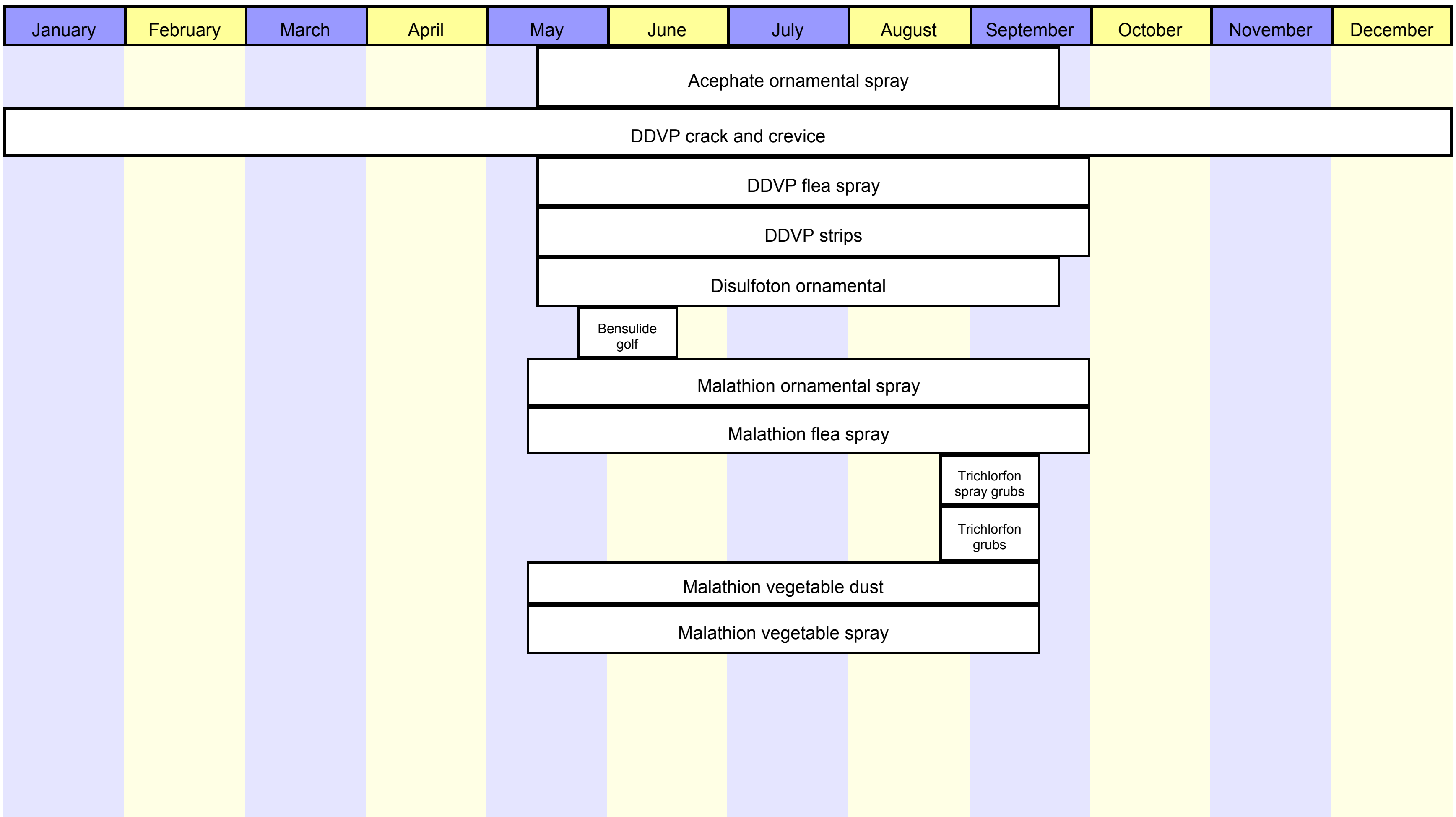
In developing this aspect of the assessment, the residential exposure component of Calendex was used to evaluate predicted exposures from residential uses. Except for golf course uses, this assessment is limited to the home as are most current single chemical assessments. The residential component of 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 Northern Great Plains. 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.C.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.C.2 which summarizes all relevant region-specific scenarios.

Table II.C.2. Use Scenarios and Calendex Input Parameters for Northern Great Plains 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	Ornamentals	hand pump sprayer	0.934-2	4/yr	May-Sept.	--	100	5	1	dermal, inhalation
Bensulide	Golf Courses	NA	12.5	1/yr	May-June	100	--	4.88	14	dermal
DDVP	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	6	7	inhalation
	Lawns	spray	NA	2/yr	May-Oct.	15	85	1	20 4	inhalation oral
	Pest Strips	strip	NA	1/yr	May-Oct.	NA	100	2.5	90	inhalation
Disulfoton	Ornamentals	granular	8.7	3/yr	May-Sept.	--	100	7	1	dermal, inhalation
Malathion	Lawns	hose end spray	5 lb ai	2/yr	May-Oct.	15	85	2	4	dermal, inhalation, oral
	Ornamentals	hand pump spray	0.94-2 lb/A	4/yr	May-Oct.	--	100	3.7	1	dermal, inhalation
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	May-Sept.	--	100	1.1	14	dermal, inhalation
		hand pump sprayer	1.5 lb/A	5/yr	May-Sept.	--	100	1.2	14	dermal, inhalation
Trichlorfon	Lawns Granular	rotary spreader	8 lb ai	1/yr	Aug-Sept.	15	85	2	2	dermal, inhalation, oral
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	Aug-Sept.	15	85	2	2	dermal, inhalation, oral

Figure II.C.1 Residential Scenario Application and Usage Schedules for the Northern Great Plains Region (Region 3)



a. Dissipation Data Sources and Assumptions

i. 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.

ii. 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.

For vegetables in eastern regions 1,2,3,4,5,6,9, and 12, data from a residue dissipation study conducted in Pennsylvania was used in which multiple residue measurements collected up to 7 days after treatment were available. A residue value selected from a uniform distribution bounded by the high and low residue measurements 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.

iii. 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 proportionately 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 Northern Great Plains 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 Northern Great Plains. 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 Northern Great Plains regional assessment for drinking water exposure with respect to cumulative exposure to the OP pesticides. The discussion centers on four main aspects of the assessment: (1) the selection criteria for the specific location in the Red River Valley (Minnesota and North Dakota) used for the drinking water assessment for the Northern Great Plains, (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 Northern Great Plains assessment with actual surface water monitoring data for the region, and (4) a summary of water monitoring data used for site selection and evaluation of the estimated drinking water concentrations for the region.

a. Selection of southeastern Pennsylvania for Drinking Water Assessment

OPP selected the Red River Valley in eastern North Dakota and western Minnesota as the specific location to represent the region based on organophosphorus (OP) pesticide usage within the Northern Great Plains region (the region) in relation to the source, location, and vulnerability of the drinking water sources in the region, and on available monitoring data for the region. An evaluation of OP usage, drinking water sources, vulnerability of those sources to OP pesticide contamination, and available monitoring data 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 the Red River Valley will represent one of the more vulnerable sources of drinking water in the region.

Overall OP usage in the Northern Great Plains is low, with the majority of OP use in the eastern part of the region, adjacent to the Northern Crescent and Heartland regions. The major OP use crops in the Northern Great Plains are corn (38% of total OP use in the entire region), wheat (26%), sugar beets (16%), alfalfa (9%), and potatoes (7%) (Table II.C.3). In 1997, approximately 2.2 million pounds (ai) of OPs were applied in on agricultural crops in this region.

Table II.C.3. General Overview of OP Usage in the Northern Great Plains

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Corn	Throughout region, with higher intensities in the east	833,000	38%
Wheat	Throughout region, with higher intensities in the north	555,000	26%
Sugar beets	Red River Valley	354,000	16%
Alfalfa	Throughout region	201,000	9%
Potatoes	Red River Valley	145,000	7%
Sunflower	Eastern half of region	55,000	2%
Total		2.2 Million	98%

(1) Source: NCFAP, 1997.

Figure II.C.2 shows the areas of relatively high OP-use in the Northern Great Plains. These high-use areas are primarily concentrated in the eastern edge of the region, with the highest use counties (Polk, Norman, and Clay counties in MN, and Walsh, Grand Forks, and Pembina counties in ND) located in the Red River Valley.

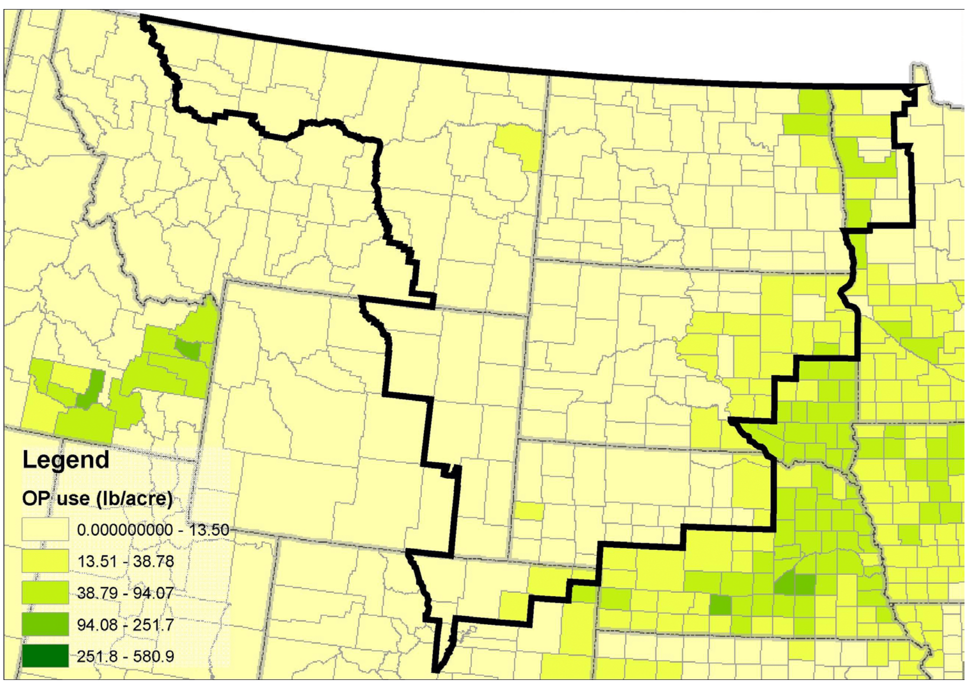


Figure II.C.2. Total OP usage (pounds per area) in the Northern Great Plains (source: NCFAP, 1997)

In the area covering Polk, Norman, and Clay counties in MN, and Walsh, Grand Forks, and Pembina counties in ND, OP use on sugar beets and potatoes accounted for approximately 92% of total agricultural use. The latest NASS usage data found that six OP pesticide-crop combinations accounted for 96% of total OP usage in these counties (Table II.C.4). Although OP use on corn accounted for the largest percentage of total OP use throughout the region, NASS reported no OP usage on corn in either Minnesota or North Dakota in the latest survey year. As discussed below, the uses in Table II.C.4 were used to develop the drinking water assessment for this region.

Table II.C.4. OP Usage on Agricultural Crops in the Red River Valley

OP Usage/ Agricultural Crops				Cropland Acreage, Red River Valley Assessment Area	
Crop Group	**Crops**	**OP Usage**	**Percent of Total OP Use**	**Acres**	**Pct of total Cropland**
Vegetables, tuber	Sugar beets	Chlorpyrifos, phorate, terbufos	59	101,000	3 (1-5)
	Potatoes	Azinphos methyl, dimethoate	33	345,500	9 (7-11)
Grains	Wheat	Chlorpyrifos	4	1,502,100	39 (35-43)
Total			96	1,948,600	55 (52-59)

Pesticide use based latest data collected by USDA National Agricultural Statistics Service (NASS). Acreage estimates based on ND and MN Agricultural Statistics Service. The range of percent of total cropland reflect differences reported in each state. Details on the sources of usage information are found in Appendix III.E.7.

Surface water sources of drinking water are scattered throughout the region (Figure II.C.3). Surface water, including the Red River, is a major source of public drinking water supply in the Red River Valley. Average annual runoff in the region is generally low, with the Red River Valley having the highest runoff potential within the region. The highest runoff areas are located just east of the assessment area; however, the surface water intakes are also located more to the west of the most vulnerable runoff areas. It is important to note that the surface water intake locations shown on the map are based on preliminary data which are still undergoing quality control/quality assurance evaluations. Thus, some intakes may not show up on this map; the locations of other intakes may be off. However, this does provide a general picture of the location of surface water intakes in relation to runoff vulnerability and OP usage.

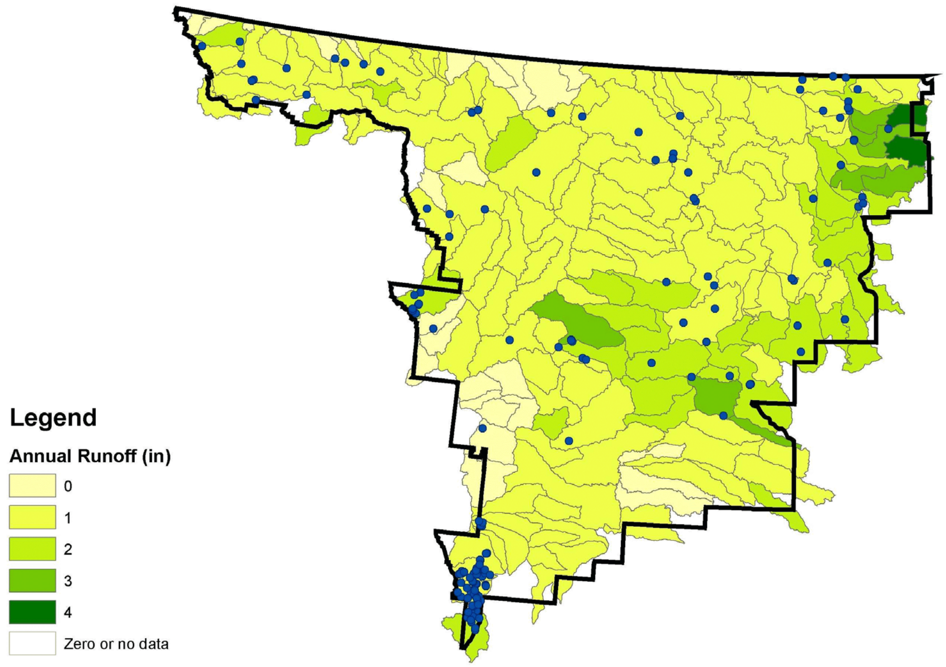


Figure II.C.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Northern Great Plains Region.

Ground water is an important source of drinking water in many parts of the Northern Great Plains. It is obtained primarily from wells in aquifers that consist of mostly unconsolidated sand and gravel, and from wells in semiconsolidated- and consolidated-rock aquifers, chiefly sandstone and limestone (USGS Water Atlas HA-730-I). State monitoring programs in this region have focused on shallow, vulnerable ground water supply. Most of the Northern Great Plains has a low vulnerability to pesticide leaching, in large part due to both low pesticide usage and low rainfall in the region. The most vulnerable areas are found in the southern end (Figure II.C.4). For the most part, this coincides with low OP usage in the region.

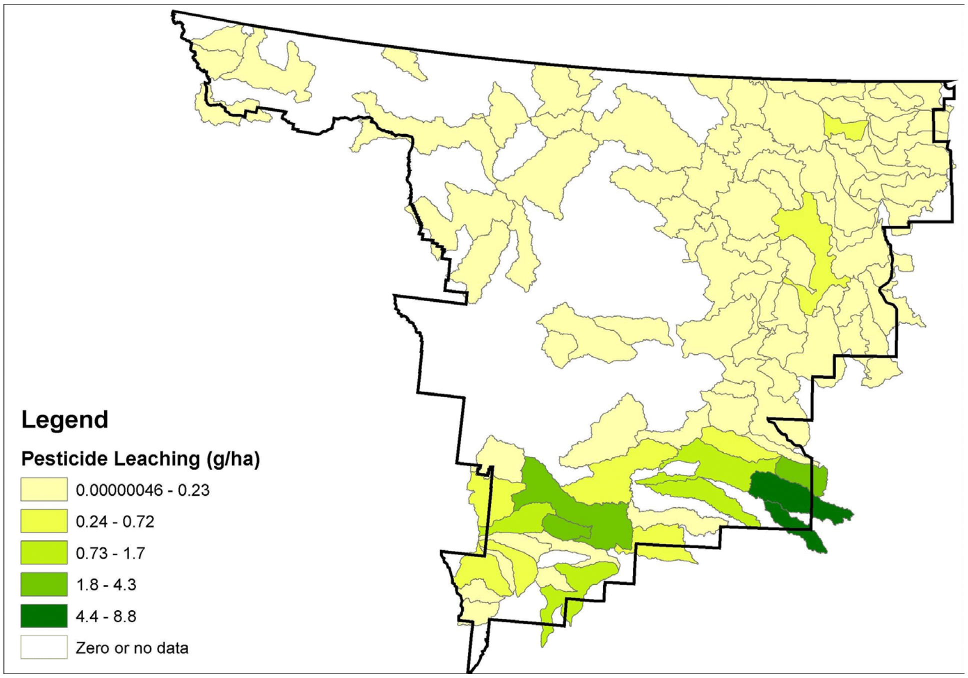


Figure II.C.4. Vulnerability of ground water resources to pesticide leaching in the Northern Great Plains, adapted from USDA (Kellogg, 1998)

When OP usage, drinking water sources, vulnerability of those sources to OP pesticide contamination, and available monitoring data (described below) are considered together, the surface water sources of drinking water are likely to be more vulnerable than ground water sources. A surface water assessment based in the Red River Valley is representative of the more vulnerable drinking water sources within the Northern Great Plains region. Although monitoring data are only available primarily for the eastern end of the region, a comparison of the monitoring indicate that the surface-water exposure assessment should be considered a conservative surrogate for the portion of the population deriving its drinking water from ground water.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Northern Great Plains cumulative assessment using PRZM-EXAMS output with various input parameters that are specific, where possible, to the Red River Valley. Table II.C.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. As noted earlier, these uses represent roughly 96% of agricultural use of OP pesticides in the Red River Valley.

Table III.C.5. OP-Crop Combinations Included in the Northern Great Plains 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)
Azinphos-methyl	Potato	11-19	0.39-0.48	Aerial; Foliar	July 31	Jul1-Aug30
Dimethoate	Potato	23-24	0.27	Aerial; Foliar	July 31	Jul1-Aug30
Chlorpyrifos	Sugarbeet	9-13	0.98-1.25	Ground; Planting	May 10	Apr22-May30 (Apr 30-May 30)
Phorate	Sugarbeet	0-4	0-1.03	Ground; Planting	May 10	Apr22-May30 (Apr 30-May 30)
Terbufos	Sugarbeet	51-69	1.75-1.97	Ground; Planting	May 10	Apr22-May30 (Apr 30-May 30)
Chlorpyrifos	Wheat	4	0.5	Aerial; Foliar	July 3	Jun15-Jul21

Total Cropland PCA for the Northern Great Plains Region: 0.82
Total cropland with registered OP use in the Red River Valley: 59% (ND) to 52% (MN)
Cumulative OP PCA for the region (regional PCA x % of crops with OP use): 0.48 (ND) to 0.42 (MN)
Weather data used to simulate rainfall (meteorological file): Met56.met (Fargo, ND)

Table III.C.5 shows a range in percent of acres treated and application rates. This range represents differences in information reported for each state. The higher values were reported for North Dakota. As noted in the main document, these ranges are more likely due to differences in data collected at the state-level rather than actual differences between adjacent counties in the Red River Valley. The Agency based its assessment on the North Dakota rates.

Figure II.C.5 displays 35 years of predicted OP cumulative concentrations for the Northern Great Plains drinking water assessment. This chart depicts a single peak occurring each year, with year 33 having a higher peak than others. These variations are the result of year-to-year differences in precipitation from the weather data for the region. The OP cumulative concentration levels exceeded 1 ppb in methamidophos equivalents in three of the thirty-five years simulated.

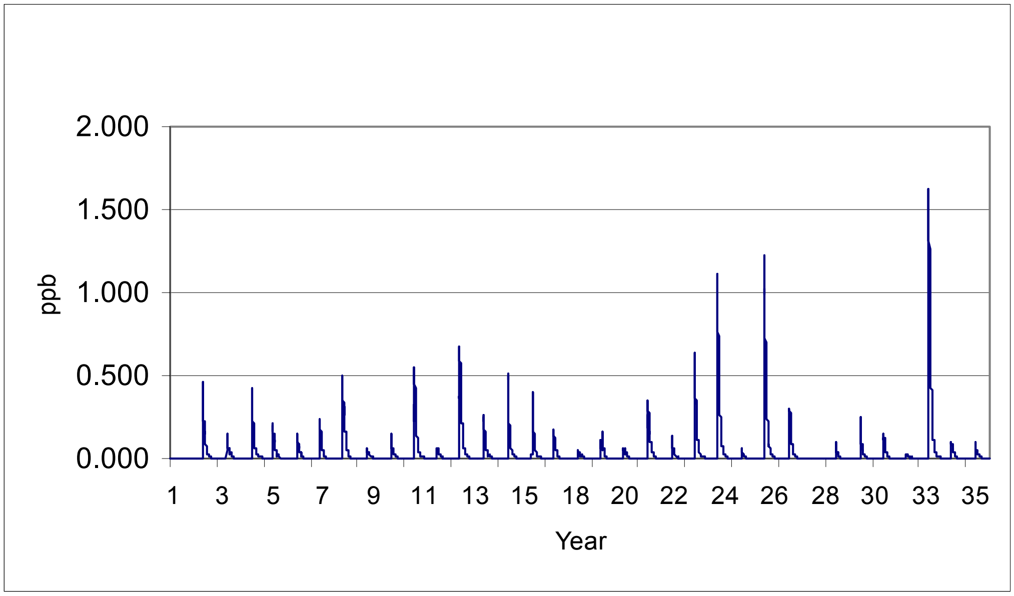


Figure II.C.5. Cumulative OP Distribution in Water in the Northern Great Plains (Methamidophos equivalents)

Figure II.C.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 around day 150.

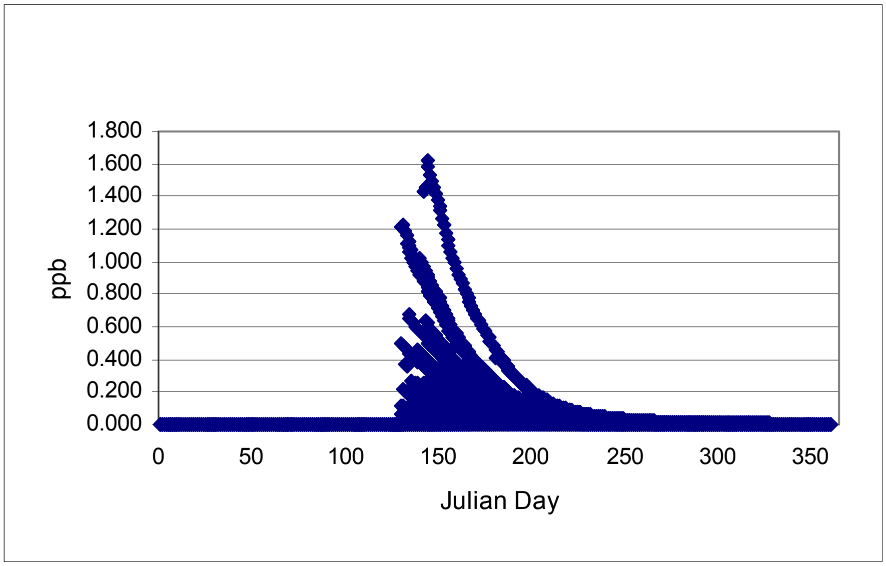


Figure II.C.6. Cumulative OP Distribution in Water (Methamidophos Equivalents) in the Northern Great Plains, summarized on a daily basis over 35 years

Figure II.C.7 depicts the predicted OP cumulative concentration for uses that made significant contributions to during Year 33, the year in which the highest modeled concentration occurred. Terbufos use on sugarbeets is the primary use contributing to that peak. Terbufos was applied to corn on May 10th (week 19). 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.

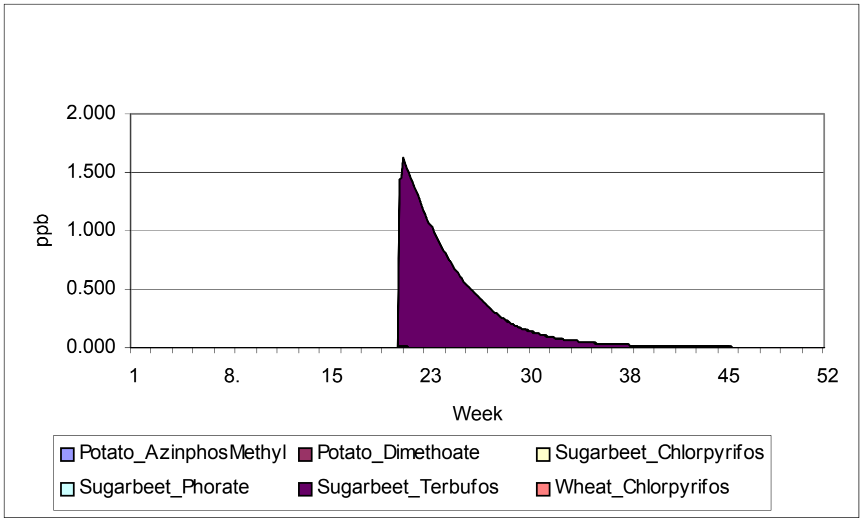


Figure II.C.7. Cumulative OP Distribution for an Example Year (Year 33) in the Northern Great Plains Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents

c. A Comparison of Monitoring Data versus Modeling Results

A comparison of estimated concentrations for individual OP pesticides (Table II.C.6) with NAWQA monitoring (summarized below and in Appendix III.E.1) indicate that the predicted concentrations of OPs in surface water in the Red River Valley are within the same range as reported monitoring date, with the exception of azinphos methyl and terbufos. The highest reported monitoring concentrations for azinphos methyl were two times greater than the peak model concentration. The model estimates for terbufos are much greater than monitoring data. However, the model estimates include the more persistent and mobile sulfone and sulfoxide residues, while the monitoring only represents the parent concentrations.

Table II.C.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	Potato	0.049	0.022	0.012	0.007	0.004	0.003	0.001
Chlorpyrifos	Sugarbeet, Wheat	0.047	0.026	0.015	0.011	0.006	0.005	0.001
Dimethoate	Potato	0.038	0.007	0.003	0.001	0.000	0.000	0.000
Phorate	Sugar beet	0.056	0.003	0.000	0.000	0.000	0.000	0.000
Terbufos	Sugar beet	1.91	0.591	0.188	0.079	0.020	0.011	0.002
OP Cumulative Concentrations (in Methamidophos equivalents, ppb) RPF=25		1.62	0.499	0.159	0.068	0.020	0.011	0.002

It is important to note that the estimated 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.

d. Summary of Available Monitoring Data for the Northern Great Plains

The Northern Great Plains, as a whole, is not an area prone to runoff (http://capp.water.usgs.gov/gwa/ch_i/gif/I005.GIF), although recently (1997 and 2001) the Red River of the North has flooded, causing extensive damage. The Red River of the North Basin is more prone to runoff during normal conditions than the interior of North Dakota and South Dakota. This basin, which was included in the NAWQA program as a study site, is the high OP-use area chosen for the PRZM-EXAMS surface water modeling scenario.

About 81% of the land area in the Red River of the North basin is agricultural, with 64% in cropland. It is located along the borders of eastern North Dakota and South Dakota, and western Minnesota. Surface water, including the Red River, is a major source of public drinking water supply. However, while ground water is somewhat less important for public supply, domestic water supply in rural areas is obtained predominantly from glacial sand and gravel aquifers (USGS Circular 1169). State monitoring programs in this region have focused on shallow, vulnerable ground water supply.

Available monitoring in the Northern Great Plains include the USGS NAWQA program and some state monitoring.

The ground-water monitoring program in the **Red River of the North Basin (REDN) NAWQA** study unit included a single sample from 69 surficial sand and gravel aquifers. In addition, monitoring wells were screened near the aquifer in surficial aquifers underlying irrigated cropland. Finally, a set of 19 wells in a ground-water flow study which included analysis for age dating constituents. The authors concluded that domestic drinking water wells, which have an average age since recharge of more than 20 years, would be less susceptible to contamination than the monitoring wells included in the study, which generally had recharge ages of 1 to 10 years.

Stoner, et al., 1998 concluded that “water withdrawn from most drinking-water wells was recharged through land areas greater than 1 mile upgradient” The authors report that “in general, ground-water older than 1958 contained no evidence of contamination by pesticides.” This does not guarantee that drinking water will remain free of pesticides. Contaminants in more recently recharged water may reach drinking water supplies with time.

Stream-water sampling included a study of intensive agriculture areas, in which 5 stations were sampled at least monthly and during runoff events between 1993 and 1995. Chlorpyrifos is the OP most often detected in the REDN study unit. Chlorpyrifos was detected in 14 samples, but only five of these were samples from streams identified as “agricultural” (maximum concentration 0.031 ug/l). The nine other chlorpyrifos detections, and the three reported diazinon detections, were from “mixed land-use” (MLU) streams, and may not represent agricultural contamination.

Table II.C.7 Active OPs Detected in Surface Water

OP	Agricultural	Mixed Land Use	Max. Concentration (ug/L)
Azinphos Methyl	1	2	0.117
Malathion	3	11	0.321
Disulfoton		1	0.08
Ethoprop	1	2	0.099
Methyl Parathion		3	0.114
Phorate		1	0.078
Terbufos	1	2	0.008

Malathion is the only OP which was detected in ground water. This single detection was at a concentration below 0.01 ug/l. this sample was taken from the unconsolidated glacial aquifer. No pesticides of any kind (including herbicides) were detected in five samples from buried glacial aquifers or six samples from older bedrock aquifers (Cowdery, 1998).

The **Upper Mississippi River Basin (UMIS) NAWQA** study unit includes a very small portion of eastern South Dakota, but no samples were taken from this area. This study unit is considered in the Northern Crescent section. Sampling in the **Central Nebraska Basins (CNBR) NAWQA** study unit occurred mostly within the Prairie Gateway Farm Resource Region, and is considered in that section of this report.

Only a few states in the Northern Great Plains have included OP pesticides in their monitoring programs (see Appendix III.E.2 for details of the state monitoring programs). **Montana** reported a single detection of malathion in its Domestic Rural Monitoring Program. A concentration of 4.8 ppb occurred in a 35-foot well drilled into “a cobbly or gravelly loam” in May 1999. A sample from the same well in June was estimated at 0.017 ppb (LOQ = 0.4), and there was no detection in July, October or December. MDA is not certain that the single detection reflected normal agricultural use.

The **North Dakota** Department of Health’s Ambient Groundwater Monitoring Program includes five OPs: chlorpyrifos, diazinon, ethyl parathion, methyl parathion and malathion. There have been OP detections in six wells over that time:

Table II.C.8 North Dakota Department of Health Well Monitoring

Well #	Date Sampled	Analyte	Concentration	Sample Type
15105504AAA	6/23/93	Ethyl Parathion	1.833 ug/l	Regular
15105504AAA	9/29/93	None	--	Regular
15305532AAA	6/23/93	Ethyl Parathion	0.274 ug/L	Regular
15305532AAA	6/23/93	Ethyl Parathion	0.322 ug/L	Duplicate
15305532AAA	5/11/94	None	--	Regular
13705228CAA	5/04/99	Malathion	0.379 ug/L	Regular
13705228CAA	5/04/99	Malathion	0.460 ug/L	Duplicate
13705228CAA	9/21/99	None	--	Regular
14708011CAA	7/11/00	Malathion	0.171 ug/L	Regular
14708011CAA	1/30/01	None	--	Regular
15410113AAB	7/18/01	None	--	Regular
15410113AAB	9/13/01	Malathion	0.340 ug/L	Regular
16305620BDC	6/26/01	None	--	Regular
16305620BDC	9/11/01	Diazinon	0.100 ug/L	Regular

The **South Dakota** “Statewide Ground Water Quality Network” included six OPs: chlorpyrifos, ethoprop, fonofos, parathion, phorate and terbufos. Fonofos and parathion are currently in the process of voluntary cancellation. Chlorpyrifos was not detected in 231 analyses. Ethoprop was not detected in 160 analyses. Phorate was not detected in 230 analyses. Terbufos was not detected in 246 analyses.

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 (i.e., distribution of exposures for each of the 365 days of the year) 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 at various total exposure levels for different subgroups of the Northern Great Plains population (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.K.2-1 through III.K.2-5 in Appendix K present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the Northern Great Plains population (95th, 97.5th, 99th, 99.5th, and 99.9th). Figure III.K.2-6 through Figure III.K.2-10, Figure III. K. 2-11 through III.K.2-15, and Figure III.K.2-16 through III.K.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 courses 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 Northern Great Plains population at the 95th percentile exposures throughout the year. Each "component" of this 95th percentile total exposure for children 1-2 (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.K.2-1 through Figure III.K.2-5): At the 95th percentile, exposures from the residential applications of OP pesticides do not contribute to the overall exposure to the pesticides in this region. 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 crack and crevice and pest strip treatments. Exposure from drinking water at this percentile also does not contribute to substantial exposure: the increases in drinking water concentrations during Julian days 130 to 160 correspond to May applications of terbuphos to sugarbeets. 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 products. By the 99th percentile and above, one sees that residential exposures via inhalation pathway from these uses 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 99.9th percentile dermal and/or hand-to-mouth exposures begin to appear in but continue to be a small fraction (<1%) of total exposure.

b. Children 3-5 years old

(Figure III.K.2-6 through Figure III.K.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 in this region 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 crack and crevice and pest strip treatments. As indicated before, there are increases in drinking water concentrations Julian days 130 to 160 which corresponds to May applications of terbuphos to sugarbeets. Nevertheless, exposure from drinking water at this percentile also 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 increasingly dominant portion of the total exposure profile. This corresponds to use of DDVP products. By the 99th percentile and above, one sees that residential exposures via inhalation pathway from these uses 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 99.9th percentile, dermal and/or hand-to-mouth exposures begin to appear but continue to be a small fraction (<1%) of total exposure.

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

(Figure III.K.2-11 through Figure III.K.2-15 and Figure III.K.2-16 through III.K.2-20) At the 95th percentile exposures from the residential applications of OP pesticides do not contribute to the overall exposure to the pesticides in this region. 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. Exposure from drinking water at this percentile also does 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 products. By the 99th percentile and above, one sees that residential exposures via inhalation pathway from these uses of 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. Dermal exposures begin to appear at the 97.5th percentile but continue to be a small fraction (< ca. 1%) of total exposure.