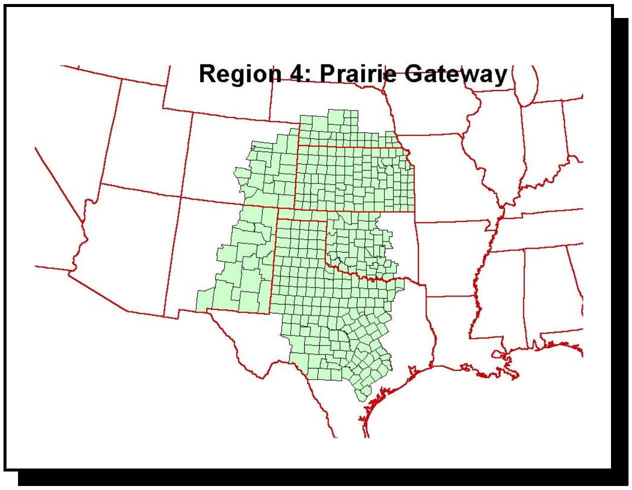
II. Regional Assessments

D. Region 4 - Prairie Gateway Assessment

1. Executive Summary

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

Pesticide	Residential Use Scenarios	OP Drinking Water Scenarios
Acephate	Golf Courses, Ornamental Gardens	Cotton
Azinphos-methyl	None	Cotton
Bensulide	Golf courses, Lawns	None
Chlorpyrifos	None	Corn, Cotton, Sorghum, Alfalfa
DDVP	Lawn Applications, Indoor Uses	None
Dicrotophos	None	Cotton
Dimethoate	None	Cotton, Corn, Wheat
Disulfoton	Ornamental Gardens	None
Ethyl Parathion	None	Alfalfa
Fenamiphos	Golf Courses	None
Malathion	Public Health, Lawn Applications, Golf Courses, Ornamental Gardens, Fruit and Vegetable Gardens	Cotton
Methyl-parathion	None	Cotton, Alfalfa
Phorate	None	Cotton
Tebupirimphos	None	Corn
Terbufos	None	Corn
Tribufos	None	Cotton
Trichlorfon	Lawn Applications, Golf Courses	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 Prairie Gateway 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 Prairie Gateway region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Prairie Gateway 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 exposure from hand-to-mouth activity by children and inhalation exposure by all age groups. These patterns occur for all population sub-groups, although actual risks appear to be higher for children than for adults regardless of the population percentile considered.

2. Development of Residential Exposure Aspects of Prairie Gateway Region

In developing this component 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.

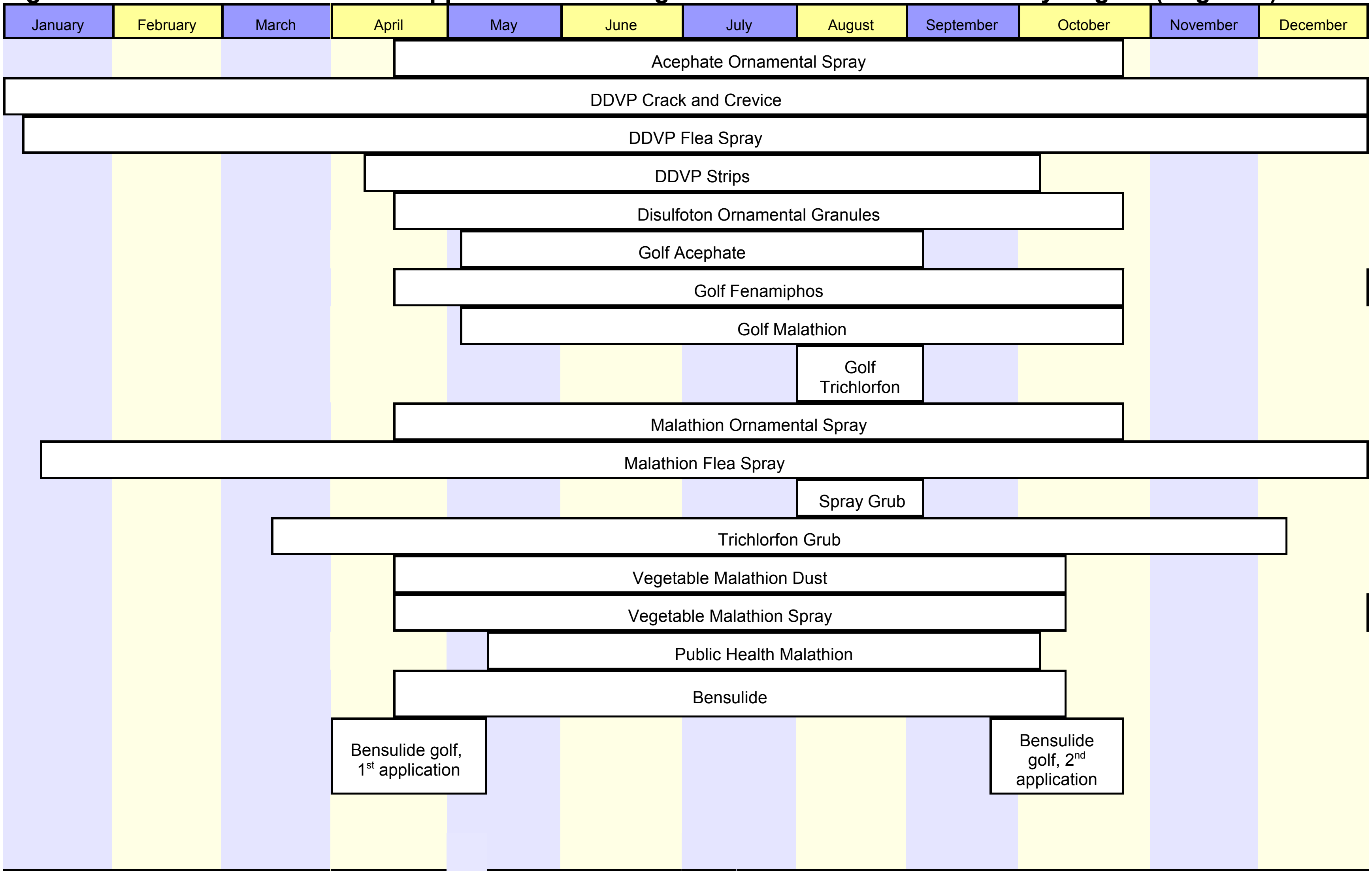
The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and proprietary data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part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

Table II.D.2. Use Scenarios and Calendex Input Parameters for Prairie Gateway Residential Exposure Assessment

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A or other	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	April-Oct.	--	100	7	1	dermal, inhalation
	Golf Courses	NA	5	1/yr	May-Sept.	100	--	1.83	10	dermal
Bensulide	Golf Courses	granular	12.5	2/yr	April-Aug. Sept.-Oct.	100	--	4.27	14	dermal
	Lawns	hose end spray		2/yr	April-Oct.	9	91	11	1 14	inhalation, oral, dermal
DDVP	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	6	1	inhalation
	Lawns	spray	NA	2/yr	Jan-Dec.	9	91	1	20 1	inhalation, oral
	Pest Strips	strip	NA	3/yr	April-July July-Oct.	100	--	2.5	90	inhalation
Disulfoton	Ornamentals	granular	8.7	3/yr	April-Oct.	--	100	7	1	dermal, inhalation
Fenamiphos	Golf Courses	NA	116	1/yr	April-Oct.	100	--	1	2 1	dermal, oral
Malathion	Lawns	hose end spray	5 lb ai	2/yr	Jan-Dec.	9	91	3	4	dermal, inhalation, oral
	Public Health Mosquitoes	NA	NA	10/yr	May-Oct.	100	--	55.4	2	dermal, oral
	Golf Courses	NA	5	1/yr	May-Oct.	100	--	1.22	4	dermal
	Ornamentals	hand pump spray	0.94-2 lb/A	4/yr	April-Oct.	--	100	3.7	1	dermal, inhalation
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	April-Oct.	--	100	1.1	14	dermal, inhalation

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A or other	Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
		hand pump sprayer	1.5 lb/A	5/yr	April-Oct.	--	100	1.11	14	dermal, inhalation
Trichlorfon	Golf Courses	NA	8 lb ai	1/yr	July-Sept.	100	--	1.22	1	dermal
	Lawns Granular	rotary spreader	8 lb ai	1/yr	March-Dec.	8	92	1	2	dermal, inhalation, oral
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	July-Sept.	9	91	1	2 7	dermal, inhalation, oral

Figure II.D.1 Residential Scenario Application and Usage Schedules for Prairie Gateway Region (Region 4)



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 vegetable gardening scenarios in eastern regions 1, 2, 3, 4, 5, 6, 9, and 12, data from a residue dissipation study conducted in Pennsylvania was used. Multiple residue measurements collected up to 7 days after treatment were made. 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 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 spray-able formulations were collected for the “day of” and the “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 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 Prairie Gateway 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 Prairie Gateway. 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 Prairie Gateway 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 Central Hills of Texas used for the drinking water assessment for the Prairie Gateway, (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 Prairie Gateway 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 the Central Hill Region of Texas for Drinking Water Assessment

OPP selected the area around Williamson, Milam, Bell, Falls, Hill, McLennan, Navarro, and Ellis counties in east-central Texas as the specific location to represent the region based on organophosphorus (OP) pesticide usage within the Prairie Gateway 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 this Central Hills region of Texas will represent one of the more vulnerable sources of drinking water in the region.

Total OP usage is relatively high in the region, where, in 1997, approximately 7.8 million pounds (ai) of OPs were applied in on agricultural crops. Cotton (39% of total OP use in the region), corn (26%), alfalfa (15%), and wheat (9%) accounted for nearly 90% of OP usage in the Prairie Gateway (Table II.D.3). Other OP-use crops in the region include sorghum and pecans.

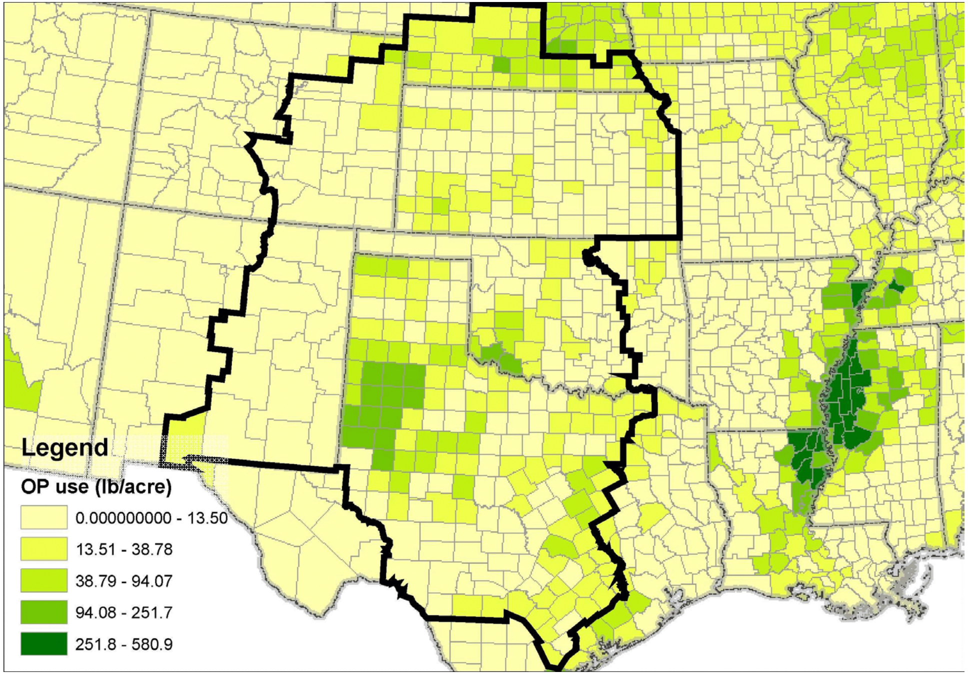
Table II.D.3. General Overview of OP Usage in the Prairie Gateway

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Cotton	Texas, Oklahoma	3,072,000	39
Corn	Nebraska and Kansas, with additional use in central Texas	2,079,000	26
Alfalfa	Higher use in the northern part of the region	1,199,000	15
Wheat	Kansas, western Oklahoma	726,000	9
Sorghum	Throughout the region	401,000	5
Pecans	Texas	204,000	3
		7,864,000	97

(1) Source: NCFAP, 1997.

The highest OP use area occurs in western Texas (Figure II.D.2), with cotton as the dominant OP-use crop. Other areas of relatively high OP use include southern Nebraska, at the northern end of the Prairie Gateway, southwestern Oklahoma, and the Central Hills of Texas. Cotton is also the dominant OP-use crop in southwestern Oklahoma. Corn, alfalfa, and sorghum are the dominant OP-use crops in southern Nebraska. Corn, cotton, alfalfa, and sorghum were dominant in the Central Hills of Texas. As described below, OPP focused on the Central Hills region of Texas for its drinking water assessment because of the overlap between high OP usage and vulnerability of surface water sources of drinking water.

Figure II.D.2. Total OP usage (pounds per area) in the Prairie Gateway (source: NCFAP, 1997)



In the Central Hills of Texas (represented by Bell, Ellis, Falls, Hill, McLellan, Milam, Navarro, and Williamson counties), OP use on corn, cotton, alfalfa, sorghum, and wheat accounted for 95% of total agricultural use (Table II.D.4). As discussed below, the drinking water assessment for this region focused on OP use on these crops.

Table II.D.4. OP Usage on Agricultural Crops in East-Central Texas (Williamson, Milam, Bell, Falls, Hill, McLennan, Navarro, and Ellis Counties)

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, extending from eastern Kansas south into central Oklahoma and Texas (Figure II.D.3). Additional surface water intakes are found along the western edge of the Prairie Gateway, in central Colorado. Many large metropolitan areas in the Prairie Gateway, such as Oklahoma City and Tulsa, OK, and Dallas, Fort Worth, Houston, and Austin, TX, are supplied largely or entirely by surface water.

Surface water sources of drinking water in the eastern portion of the region are more vulnerable to runoff (Figure II.D.3). Watersheds with the greatest runoff potential in the region are found in the southeastern part of the Prairie Gateway in central Texas. Of the three relatively high OP use areas, surface water sources of drinking water in the Central Hills area of Texas are the most potentially vulnerable to pesticide runoff. Fewer surface water sources of drinking water occur in the west Texas and southern Nebraska use areas; these areas are also less prone to runoff.

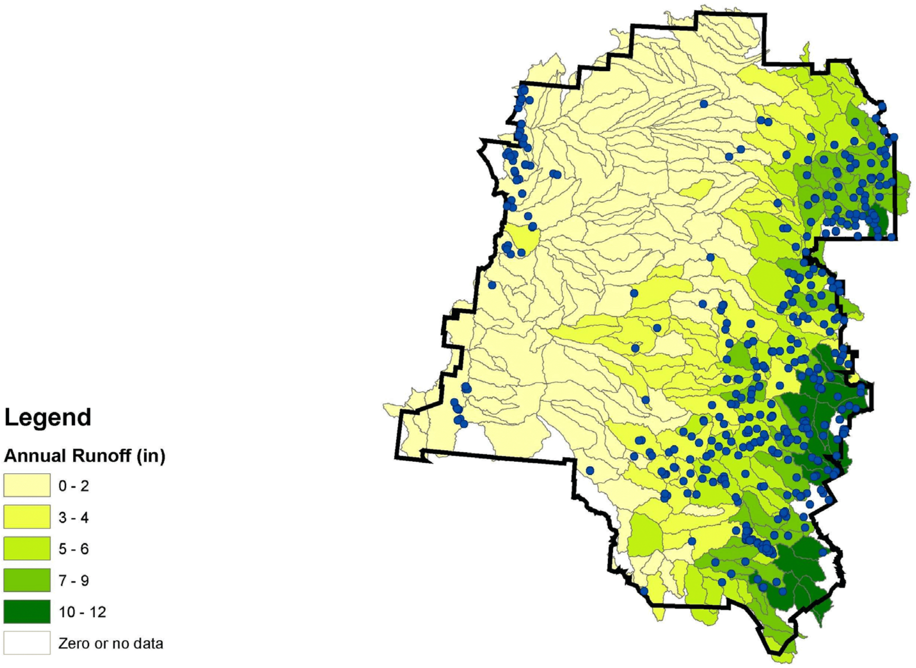


Figure II.D.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Prairie Gateway Region

Ground water serves as a drinking water source for about 42 percent of the population of Oklahoma and Texas, including San Antonio and El Paso, 86 percent of the population of Nebraska, and 52 percent of people in Kansas (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 Prairie Gateway is the major influence on the relative vulnerability of ground-water sources of drinking water in the region (Figure II.D.4). Unconsolidated surficial sand and gravel aquifers are the most important source of ground water used as drinking water in the Prairie Gateway. Aquifers in these alluvial or glacial sediments (http://capp.water.usgs.gov/gwa/ch_d/gif/D013.GIF) average 90 to 100 feet in thickness, with a saturated thickness ranging from 50 to 80 feet. These shallow sand and gravel aquifers are vulnerable to pesticide contamination.

The city of San Antonio derives its water mainly from the bedrock Edwards aquifer. Although this aquifer is confined throughout most of its extent, streams and precipitation recharge it quickly at its fractured and faulted outcrop. The less permeable Trinity aquifer, which overlies the Edwards, is the main source of water for the Texas Hill Country near San Antonio.

The High Plains aquifer, which is also an unconsolidated sand and gravel aquifer under water-table conditions, is a much more important source of ground-water, overall. However, because of high levels of suspended sediment, sodium, and fluoride, it is used primarily as a source of irrigation water. In 1990, less than 3% of the water withdrawn from the High Plains aquifer was used for public supply (Water Atlas).

The depth to water in the High Plains aquifer is shallow (less than 200 feet in Kansas and Nebraska, often <100 feet elsewhere), and is usually hydraulically connected with the overlying unconsolidated surficial aquifers, where they occur. Because of this, the High Plains is also vulnerable to contamination. The High Plains underlies parts of all the states in the Prairie Gateway, as well as parts of South Dakota and Wyoming. The aquifer is often called the Ogallala in Texas and Oklahoma.

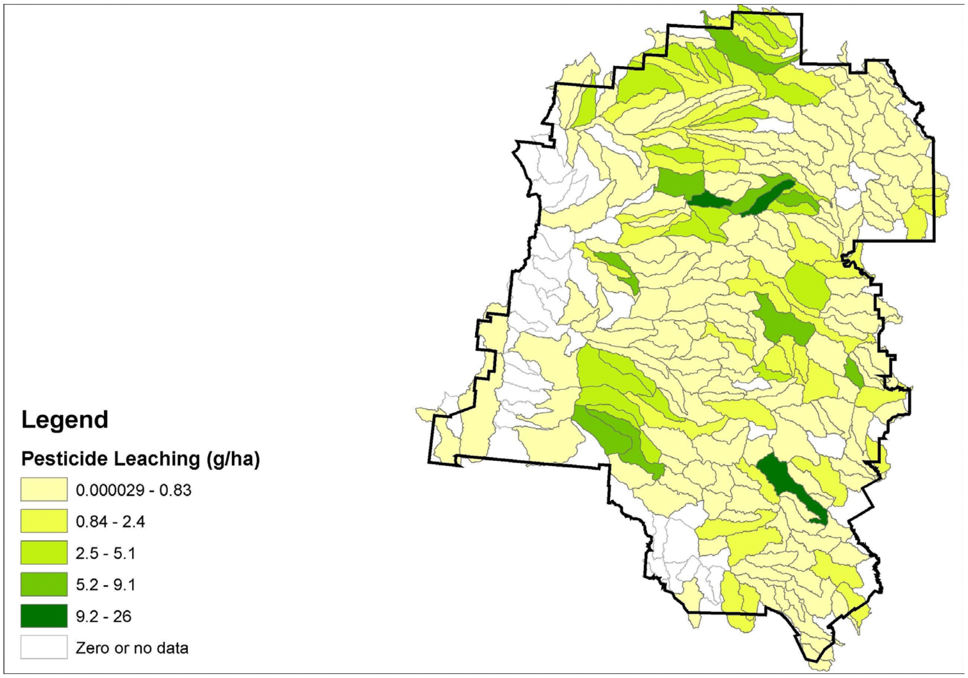


Figure II.D.4. Vulnerability of ground water resources to pesticide leaching in the Prairie Gateway, adapted from USDA (Kellogg, 1998)

Of the three high OP use areas identified in the Prairie Gateway, only the Central Hills area has a significant number of vulnerable surface water sources of drinking water. All three use areas have ground-water sources of drinking water that could be potentially impacted by OP usage. 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. Based on the weight of evidence, the Agency believes that a surface water assessment based in the Central Hills of Texas is representative of the more vulnerable areas within the Prairie Gateway region. 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 Prairie Gateway 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.D.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.D.5. OP-Crop Combinations Included in the Prairie Gateway 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.D.5 displays 35 years of predicted OP cumulative concentrations for the Prairie Gateway drinking water assessment. This chart depicts a single peak occurring each year, with year 35 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.

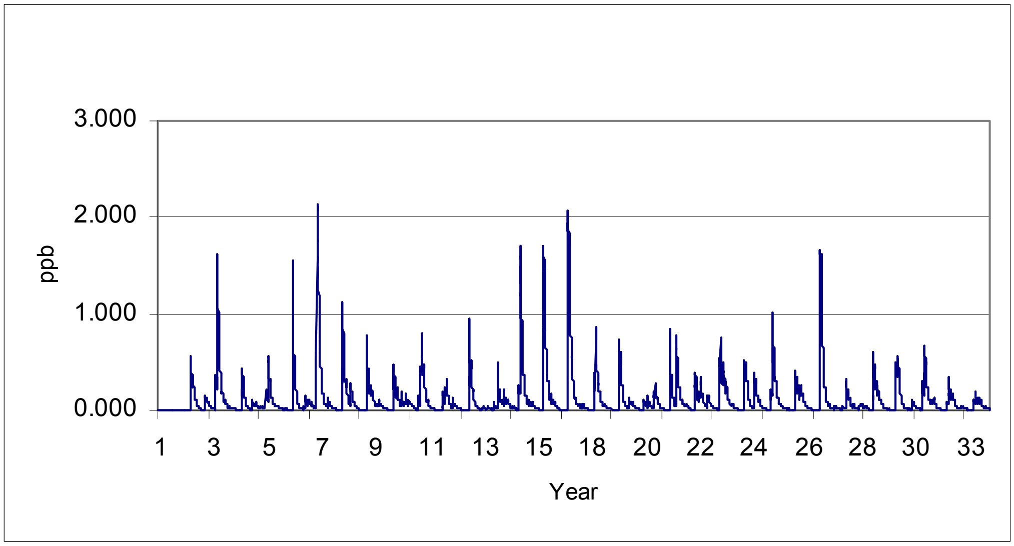


Figure II.D.5. Cumulative OP Distribution in Water in the Prairie Gateway (Methamidophos equivalents)

Figure II.D.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.

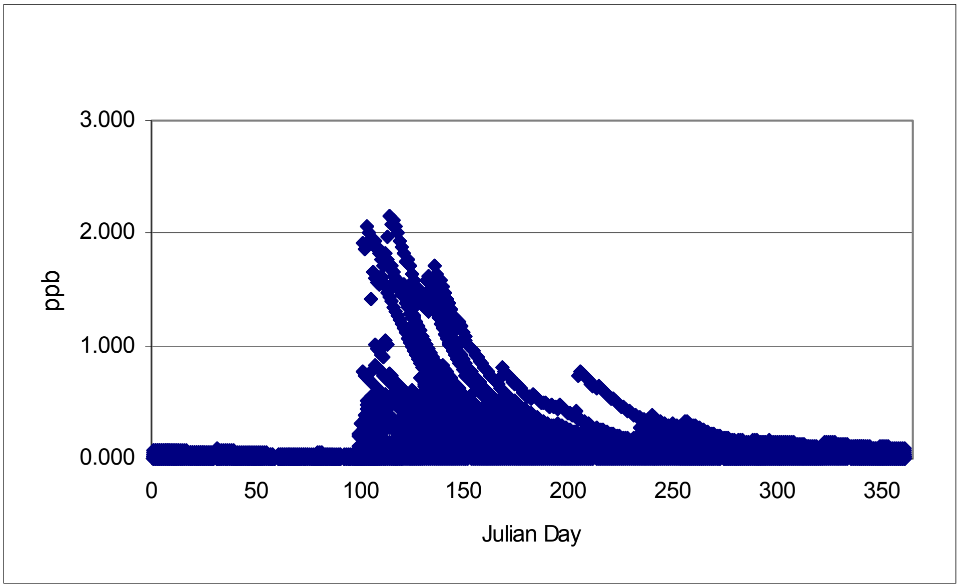


Figure II.D.6. Cumulative OP Distribution in Water (Methamidophos Equivalents) in the Prairie Gateway, summarized on a daily basis over 35 years

Figure II.D.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.

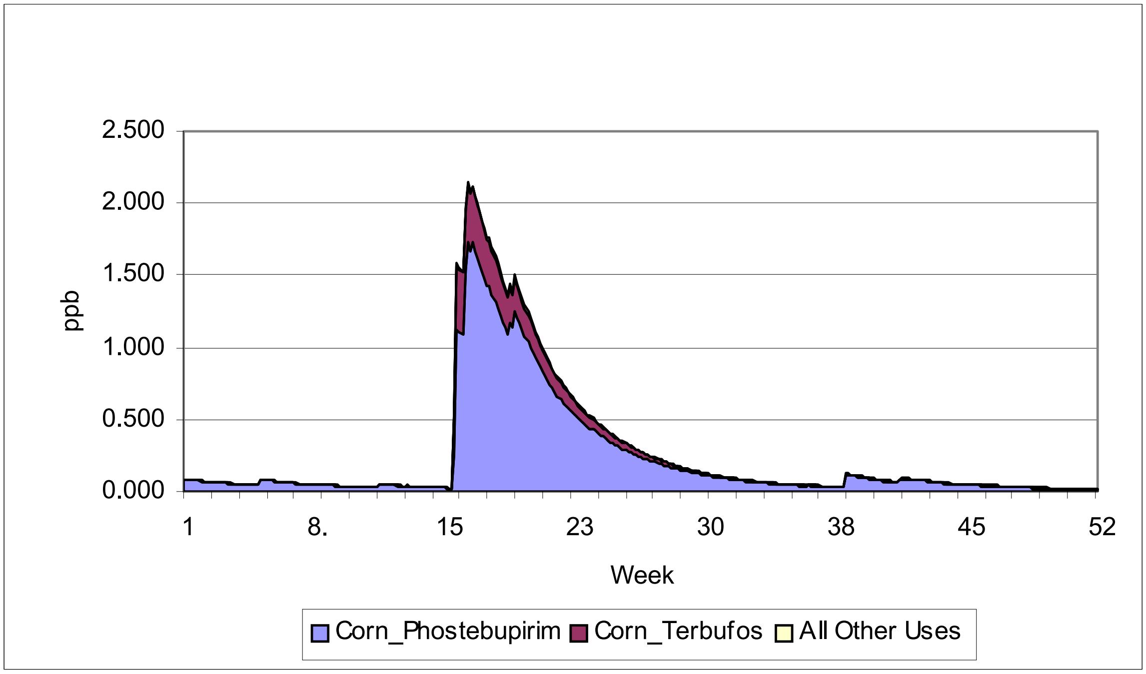


Figure II.D.7. Cumulative OP Distribution for an Example Year (Year 7) in the Prairie Gateway Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents

c. A Comparison of Monitoring Data versus Modeling Results

A comparison of estimated concentrations for individual OP pesticides (Table II.D.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.D.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 Prairie Gateway

Monitoring data are available from USGS NAWQA program and from several state 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. Although aquifers in the Prairie Gateway are somewhat susceptible to contamination, only rare detections of diazinon and chlorpyrifos are reported in the available monitoring data.

The Prairie Gateway includes three USGS National Water Quality Assessment (**NAWQA**) study units, summarized below.

In the **Central Nebraska Basins (CNBR) NAWQA** study unit, ground water is the major source of drinking water. The major source of ground water, the Platte River alluvial aquifer, is hydraulically connected with the North Platte River, both through discharge to the river and increased recharge from the river due to pumping from the aquifer. Sampling included single samples from 11 shallow wells installed in this aquifer. No active OP was detected in ground-water in this limited study (fonofos was detected twice).

A second ground-water study included 61 wells installed in two clusters: one in a recharge area in a meadow near corn fields, and another in and north of a public-supply wellfield on Indian Island in the Platte River near Grand Island. The intention was to study land-use effects on shallow ground-water along the flow path. This study was useful in further showing that the alluvial aquifer shows increasing influence from the Platte River from upstream to downstream. While it did measure pesticide concentrations at a wellfield designed to be protected from agricultural ground-water contamination, it was not designed to evaluate acute exposure to pesticides. No OPs were detected in this study.

OPs were included at four fixed surface-water sampling sites on the Platte River and its tributaries. These were located in areas of heavy corn production. All were sampled monthly, but two of these also were sampled more intensively in the spring and summer of 1992 (including 12 weeks of alternate-day sampling). These two were located in the glaciated area in the eastern, downstream portion of the study unit.

Chlorpyrifos, diazinon and malathion were the most frequently detected OPs. Diazinon was detected mostly in urban or mix-use streams, while at least of the detections of the other two occurred in agricultural streams. Chlorpyrifos had the highest single concentration detected of the three in agricultural streams, at 0.13 µg/l. Methyl parathion, azinphos-methyl and terbufos were detected in less than 3% of samples. A detection of 0.27 µg/l terbufos was the highest concentration detected for any OP.

The **Trinity River Basin (TRIN)** study unit is the NAWQA monitoring program closest to the Central Hills area used for the regional drinking water assessment. More than 90% of water in this basin is supplied by surface water, mostly in reservoirs (USGS Circular 1171). Much of the agricultural land is used for grazing cattle.

Diazinon, chlorpyrifos and malathion were detected in 97%, 71% and 32% of urban samples, respectively.The maximum concentration of diazinon in urban samples was 2.3 µg/l. Diazinon was also detected frequently in agricultural samples (46%) and rangeland streams (38.5%), with a maximum detection of 0.16 ug/l. Azinphos-methyl, methyl parathion and disulfoton were detected in less than 3% of agricultural samples. Of these azinphos had the highest maximum concentration, 0.55 µg/l.

Ground-water sampling was done at outcrop areas of the four major aquifers in the study unit; confining units or minor aquifers are present at the surface (outcrop) over more than half of the area of the TRIN. Diazinon was detected in nearly half of the samples drawn from the 24 wells in the Trinity aquifer outcrop. However, half of the wells also had salinity higher than acceptable for potable water. The maximum concentration of diazinon in ground water was about 0.1 ug/l. It is not clear whether these detections were associated with urban or agricultural applications of diazinon.

The **South-Central Texas (SCTX) NAWQA** study unit includes the city of San Antonio. Ground water is the predominant source of drinking water in this area. The water is mostly derived from the Edwards Aquifer, which is one of the most productive in the world. The Edwards aquifer is recharged by surface water where precipitation and streams meet the fractured and faulted Edwards at its outcrop. This hydraulic connection makes stream and river-water quality important for the Edwards aquifer, which supplies about 70% of water withdrawn in the study unit. The Trinity aquifer is locally important in the Hill Country in the north of SCTX, but is generally less productive than the

Edwards.

Ground-water monitoring included domestic wells in the area where surface-water and precipitation recharge the Edwards aquifer, public supply wells in the confined part of the Edwards aquifer, and domestic wells from the less permeable Trinity aquifer. Diazinon was the only OP detected, three times in shallow urban ground water, once in a major aquifer sample, each time <0.1 ug/l. No agricultural ground-water samples were collected.

Three surface-water sampling sites were located at urban and agricultural streams. These were sampled weekly to monthly from January, 1997 to March, 1998. Diazinon was detected in 38% of agricultural samples with a maximum concentration of 0.059 ug/l. Chlorpyrifos (max 0.008 ug/l) was detected in 21% of agricultural samples, and malathion in 9% of all samples (max 0.142 ug/l).

Only a few **state monitoring programs** have included any OP pesticides in their programs. In **Kansas**, only diazinon has been detected in their routine ambient surface water quality sampling network. Since 1995, 44 detections were found at 16 urban or golf course sites, with detections ranging from 0.19 to 1.5 micrograms/liter. A Kansas Department of Agriculture study of chemigation wells is designed “to assess and monitor groundwater quality by obtaining water samples at selected chemigation sites located at agricultural irrigation wells.” In sampling from 1987 to 2000, chlorpyrifos was detected three times at concentrations of 1.9, 3.5 and 4.2 ppb (LOD = 0.5 µg/l). Dimethoate, disulfoton and methyl parathion were included in sampling, but were not detected above detection levels of 2.0, 0.5 and 1.0 µg/l, respectively.

As described in the Heartland region section, **Nebraska** has no record of OP detections in its “Quality-Assessed Agricultural Contaminant Database for Nebraska Ground Water.” OPs are not included in surface-water monitoring in Nebraska.

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 (i.e., a distribution of exposures for each of the 365 days of the year) 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 Prairie Gateway population (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.L.2-1 through III.L.2-5 in Appendix L present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the Prairie Gateway population (95th, 97.5th, 99th, 99.5th, and 99.9th). Figure III.L.2-6 through Figure III.L.2-10, Figure III.L.2-11 through Figure III.L.2-15, and Figure III.L.2-16 through Figure III.L.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 MOE’s) 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 Prairie Gateway 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

(Figures III.L.2-1 through III.L.2-5): At the 95th percentile exposures, the hand-to-mouth route from residential applications is the major contributor to the overall exposure. There are increases in drinking water concentrations during Julian days 100 to 160 which corresponds to April applications of phostebupirim and to terbufos to corn. Drinking water at this percentile, however, does not contribute substantial exposures. Dermal exposure also appears at this percentile, but as a small contributor (ca. 1%) to total exposure. At the higher percentiles, the exposure profile and relative contributions are similar to those at the 95th percentile. The residential exposures (via hand-to-mouth activity) remain a dominant portion of the total exposure profile. This corresponds to lawn use of bensulide, malathion and trichlorfon. By the 99.5th percentile, one sees that the inhalation pathway through residential exposures begin to appear, but exposures through this pathway remain secondary to those through hand-to-mouth activity. Drinking water exposures continue to remain low and do not contribute in any significant manner to the overall risk and continue to be a small fraction (< ca. 1%) of total exposure.

b. Children 3-5 years old

(Figures III.L.2-6 through III.L.2-10). As with Children 1-2, the hand-to-mouth route from residential applications is the major contributor to the overall exposure to the OP pesticides in this region at the 95th percentile exposures. As noted before, there are increases in drinking water concentrations from Julian days 100 to 160 which corresponds to April applications of phostebuprim and terbufos to corn. Exposure from drinking water at this percentile, however, do not contribute to substantial exposures. Dermal exposure also appears at this percentile, but is a small contributor (ca. 1%) to total exposure. At the higher percentiles, the exposure profile and relative contributions are similar to those at the 95th percentile. The residential exposures (via hand-to-mouth activity) remain a dominant portion of the total exposure profile. This corresponds to lawn use of bensulide, malathion, and trichlorfon. By the 99th percentile, the inhalation pathway through residential exposures appears, but exposures through this pathway remain secondary to those through hand-to-mouth activity. Drinking water exposures continue to remain low and do not contribute in any significant manner to the overall risk and continue to be a small fraction (< ca. 1%) of total exposure.

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

(Figures III.L.2-11 through III.L.2-15 and Figures III.L.2-16 through III.L.2-20) At the 95th percentile exposures, the food and water route is the major contributor to the overall exposure to the OP pesticides in this region. We note that there are increases in drinking water concentrations Julian days 100 to 160 which corresponds to April applications of phostebupirim and to terbufos to corn. Drinking water or food at this percentile, however, does not contribute to substantial exposures. Dermal exposure also appears at this percentile, but as a small contributor (ca. 1%) to total exposure. At the higher percentiles, residential inhalation exposures appear and later become a dominant portion of the total exposure profile. Drinking water exposures continue to remain low and do not contribute in any significant manner to the overall risk and, along with residential dermal exposures, continue to be a small fraction (< ca. 1%) of total exposure.