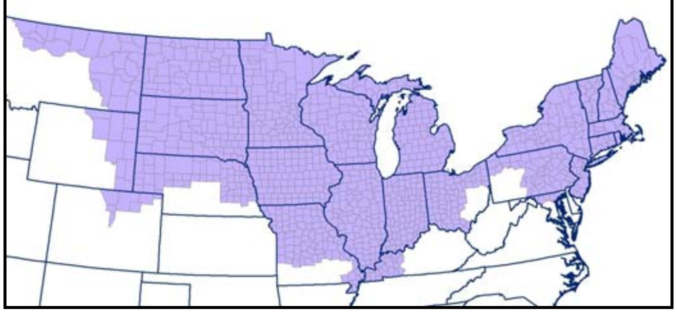
II. Regional Assessments

D. Region D - Northeast/North Central Assessment

1. Executive Summary

Region D. Northeast/North Central



This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Northeast/North Central (area shown to the right). Information is included in this module only if it is specific to the Northeast/North Central, or is necessary for clarifying the results of the Northeast/North Central 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 Northeast/North Central Residential/Non-Occupational and Drinking Water Assessment

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenarios
Acephate	Ornamentals	None
Azinphos Methyl	None	Potato
Bensulide	Golf Courses	None
Chlorpyrifos	None	Sugarbeet, Wheat
DDVP	Pest Strips	None
Dimethoate	None	Potato
Disulfoton	Ornamentals	None

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenarios
Malathion	Ornamentals, Vegetable Gardens, Public Health	None
Naled	Public Health	None
Phorate	None	Sugarbeet
Phosmet	None	Apples, Peaches, Pears
TCVP	Pet Uses	None
Terbufos	None	Sugarbeet
Trichlorfon	Golf Course, Lawns	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 Northeast/North Central 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 Northeast/North Central region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Northeast/North Central 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 exposure, residential exposures are the major source of risk - in particular inhalation exposure from use of DDVP pest strips. These patterns occur for all population sub-groups, although potential risks appear to be higher for children than for adults regardless of the percentile considered.

2. Development of Residential Exposure Aspects of Northeast/North Central 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, public health uses, pet uses, and pest strips. 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 Northeast/North Central region. 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 Northeast/North Central Residential Exposure Assessment

Chemical	Use Scenario	Application Method	Amt. Applied lb ai/A	Max. No./ Frequency Of Apps.	App. Schedule	% Use LCO	% Use HO	% Users	Residue Persistence (Days)	Routes of Exposure
Acephate	Ornamental	hand pump sprayer	0.9-2	4/yr, 2 wks. Between Apps.	Mar.-Sept. 11-38 wks.	--	100	3	1	inhalation(a), dermal(a)
Bensulide	Golf Course	NA	12.5	2/yr, 30 wks. Between Apps.	Apr.-May and Sept.-Oct.	100	--	1	14	dermal(p)
DDVP	Pest Strip	closet strip	NA	16 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	2	120	inhalation(p)
		cupboard strip	NA	16 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	2	120	inhalation(p)
Disulfoton	Ornamental	granular	8.7	3/yr, 6 wks. Between Apps.	May-Sept. 20-39 wks.	--	100	2	1	inhalation(a), dermal(a)
Malathion	Ornamental	hand pump spray	0.9-2	2/yr, 2 wks. Between Apps.	Mar.-Oct. 10-44 wks.	--	100	4	1	inhalation(a), dermal(a)
	Public Health	aerial and ground	NA	9/yr, 2 wks. Between Apps.	May-Oct. 20-42 wks.	100	--	38	2	oral(p), dermal(p)
	Vegetable Garden	hand pump sprayer	1.5	5/yr, 2 wks. Between Apps.	Mar.-Oct. 10-44 wks.	--	100	1	1 7	inhalation(a), dermal(a)(p)
Naled	Public Health	aerial and ground	NA	5/yr, 2 wks. Between Apps.	May-Aug. 20-34 wks.	100	--	20	2	oral(p), dermal(p)
TCVP	Pet Aerosol	aerosol spray	2.4×10^{-5}- 3.3×10^{-5} lb ai/lb dog	3/yr, 8 wks. Between Apps.	Apr.-Sept. 14-35 wks.	–	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)
	Pet Powder	shaker can	4.6×10^{-5}- 5.5×10^{-5} lb ai/lb dog	3/yr, 8 wks. Between Apps.	Apr.-Sept. 14-35 wks.	–	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)
	Pet Spray	hand pump sprayer	2.0×10^{-5}- 2.2×10^{-5} lb ai/lb dog	3/yr, 8 wks. Between Apps.	Apr.-Sept. 14-35 wks.	–	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)

Chemical	Use Scenario	Application Method	Amt. Applied lb ai/A	Max. No./ Frequency Of Apps.	App. Schedule	% Use LCO	% Use HO	% Users	Residue Persistence (Days)	Routes of Exposure
Trichlorfon	Golf Course	NA	8	1/yr	Jul.-Oct. 30-40 wks.	100	--	9	2	dermal(p)
	Lawn Granular	rotary spreader	8	1/yr	Jul.-Oct. 30-40 wks.	19	81	1	1 2	inhalation(a), oral(p), dermal(a)(p)
	Lawn Spray	NA	8	1/yr	Jul.-Oct. 30-40 wks.	100	--	2	2	oral(p), dermal(p)

Figure II.D.1 Residential Scenario Application and Usage Schedules for the Northeast/North Central Region (Region D)

<table>
<tr><th>January</th><th>February</th><th>March</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>September</th><th>October</th><th>November</th><th>December</th></tr>
<tr><td></td><td></td><td colspan="7">Acephate Ornamental Spray</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Bensulide Golf</td><td></td><td></td><td></td><td colspan="2">Bensulide Golf</td><td></td><td></td></tr>
<tr><td colspan="12">DDVP Pest Strip (Closet)</td></tr>
<tr><td colspan="12">DDVP Pest Strip (Cupboard)</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="5">Disulfoton Ornamental Granular</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="8">Malathion Ornamental Spray</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="6">Malathion Public Health</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="8">Malathion Vegetable Spray</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Naled</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="6">TCVP Aerosol Spray</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="6">TCVP Powder</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="6">TCVP Hand Pump Spray</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Trichlorfon Golf</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Trichlorfon Granular</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Trichlorfon Spray</td><td></td><td></td></tr>
</table>

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 dissipation study was conducted with multiple residue measurements collected up to 7 days after treatment in Pennsylvania. This was used for vegetable gardening in Regions A, D, E, F, and G. 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.

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. This was used for the lawn post-application exposure scenarios. For dermal exposure scenarios, 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 also reflect actual measurements including those based on directions to water in the product. 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 assessing non-dietary ingestion for children.

3. Development of Water Exposure Aspects of Northeast/North Central 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 North/North Central Region. This region combines the Northern Great Plains, Heartland, and Northern Crescent regions from the preliminary assessment. The selection process considers OP use and relative potencies of those OP pesticides and the location, nature, and vulnerability of drinking water sources. The methods used to identify a specific location within the region are described in the main document (Section I.E). The following discussion provides the details specific to this regional assessment for OP cumulative drinking water exposure. The discussion centers on four main aspects of the assessment: (1) the selection of the Red River Valley (Minnesota and North Dakota) for the drinking water assessment, including comparisons among the three preliminary regional assessments, (2) predicted cumulative concentrations of OPs in surface water for those OP-crop uses included in this regional assessment, (3) comparison of the predicted concentrations used in the regional assessment with 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 Red River Valley for Drinking Water Assessment

In the preliminary OP cumulative risk assessment, OPP identified representative vulnerable surface water sources of drinking water in the Red River Valley in eastern North Dakota and western Minnesota (the original Northern Great Plains region), central Illinois (Heartland), and south-central Pennsylvania (Northern Crescent). Appendix III.E.10 describes the original USDA Farm Resource Regions (Northern Great Plains, Heartland, Northern Crescent) and Section I.E contrasts these regions with the revised regions used in this assessment. OPP selected these sites because the relatively high OP pesticide usage coincided with vulnerable drinking water sources, suggesting that these locations would be among the most vulnerable of their respective regions. 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.

OP usage areas extend from the eastern end of the Northern Great Plains region, through the Heartland (corn belt) states into western NY and southeast PA (Figure II.D.2). Relatively high OP-use areas within the region include the Red River Valley (centering in Polk, Norman, and Clay counties in MN, and Walsh, Grand Forks, and Pembina counties in ND); a band running from northeastern Nebraska eastward through northern Iowa and central Illinois and Iowa; the eastern shore of Lake Michigan; the southern shore of Lake Ontario in northwest New York; and south-central Pennsylvania.

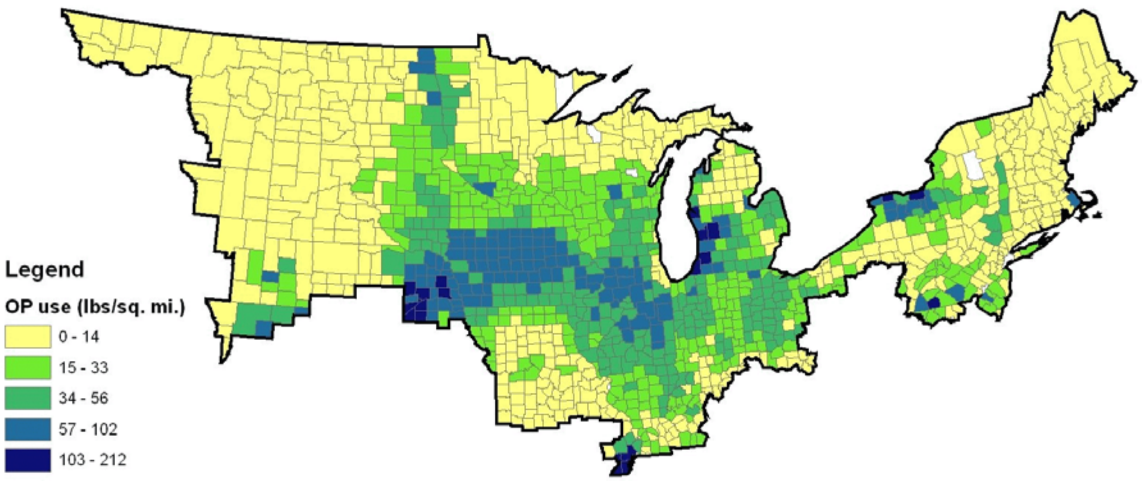


Figure II.D.2. Total OP usage (pounds per area) in the Northeast/North Central Region (source: NCFAP, 1997)

The major OP use crop in the region is corn (70% of total OP use in the entire region), with the majority of that use focused in the Heartland region (Table II.D.3). Other OP uses show strong regional trends. For instance, OP use on wheat, sugarbeets, and potatoes is confined to the Northern Great Plains while OP use on fruit orchards is centered in the Northern Crescent.

Table II.D.3. General overview of OP usage in the Northeast/North Central Region

Crops	Overall Northeast/ North Central Region		Northern Great Plains portion of region		Heartland portion of region		Northern Crescent portion of region	
	Ttl lb OP Used	Pct of Use	Ttl lb OP Used	Pct of Use	Ttl lb OP Used	Pct of Use	Ttl lb OP Used	Pct of Use
Corn	9,449,000	70%	833,000	38%	7,098,000	93%	1,518,000	41%
Wheat	555,000	4%	555,000	25%				
Sugar beets	354,000	3%	354,000	16%				
Alfalfa	825,000	6%	201,000	9%	216,000	3%	408,000	11%
Potatoes	145,000	1%	145,000	7%				
Sunflower	55,000	<1%	55,000	3%				
Orchard (fruit)	1,172,000	9%			84,000	1%	1,088,000	29%
Vegetables (legume)	131,000	1%			32,000	0%	99,000	3%
Vegetables (cucurbits)	67,000	<1%					67,000	2%
Vegetables	106,000	1%					106,000	3%

(other)								
Total	13,507,000	95%	2,200,000	97%	7,600,000	98%	3,707,000	89%

(1) Source: NCFAP, 1997.

Surface water sources of drinking water are dominant in eastern half of the region and across the southern Heartland (Figure II.D.3). Runoff vulnerability is generally greater in the south and east. The Great Lakes are a significant source of drinking water but, because of their large volume, are less vulnerable to pesticide contamination than the reservoirs in the region. Surface water, including the Red River, is a major source of drinking water in the Red River Valley. While average annual runoff in the western portion of the region is generally low, the Red River Valley is more vulnerable than nearby water sources.

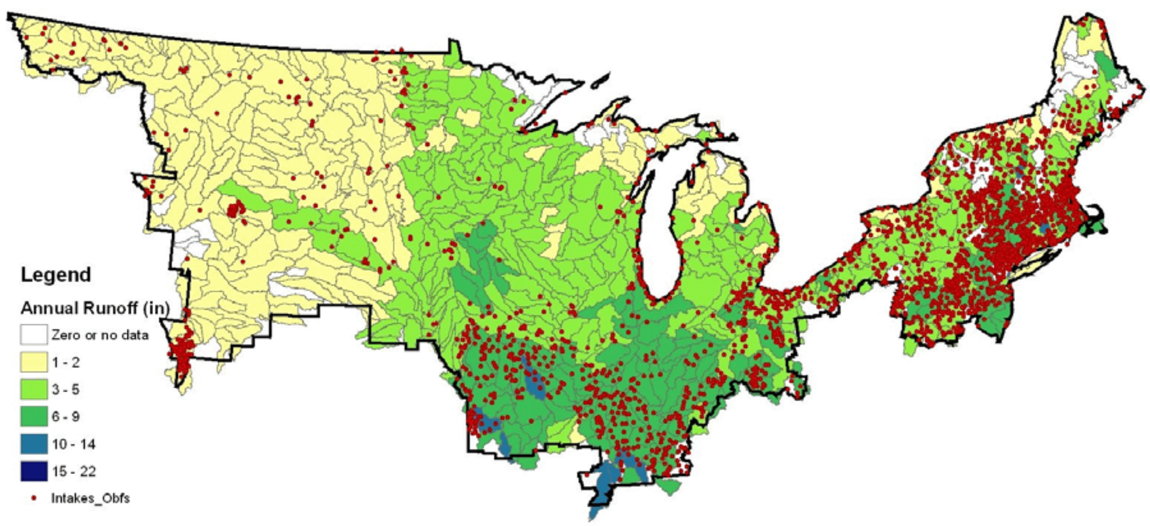


Figure II.D.3. Locations of surface water intakes of drinking water in relation to average annual runoff in the Northeast/North Central Region.

Ground-water in the western (Northern Great Plains) portion of the region 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). Most of this area has a low vulnerability to pesticide leaching, in large part due to both low pesticide usage and low rainfall in the region (Figure II.D.4). The most vulnerable areas in the southwestern end coincide with low OP usage.

Across the central (Heartland) portion of the region, the most vulnerable areas to pesticide leaching occur in north/central Illinois, northern Indiana, eastern Nebraska, and the southern portion of the region extending into Kentucky (Figure II.D.4). Surficial glacial outwash deposits supply more than 50% of ground water withdrawn in Illinois, Indiana, and Ohio (USGS Water Atlas HA-730-K). Outwash deposits form important aquifers where they are comprised of coarse sand and gravel. In some locations these deposits are present at the surface as water-table aquifers. In other areas they are present as lenses buried by thick deposits of finer silts and clays. These confined aquifers are less susceptible to contamination by human activities. Most of the bedrock aquifers in the Heartland are confined, with important exceptions like the Iowan karst. Pesticide contamination will be very unlikely in water drawn from this aquifer where it is confined. Where the confining unit has been removed by erosion, the upper part of the aquifer system is in direct contact with the overlying surficial aquifer system in north-central Illinois and southeastern Wisconsin. Where the two systems are in contact, ground-water pumping has induced greater recharge from the shallower system.

Ground water sources in southern Michigan and central Wisconsin are potentially more vulnerable to contamination from pesticide leaching. However, OP pesticides are detected less frequently and at lower concentrations in ground water in this region than in surface water.

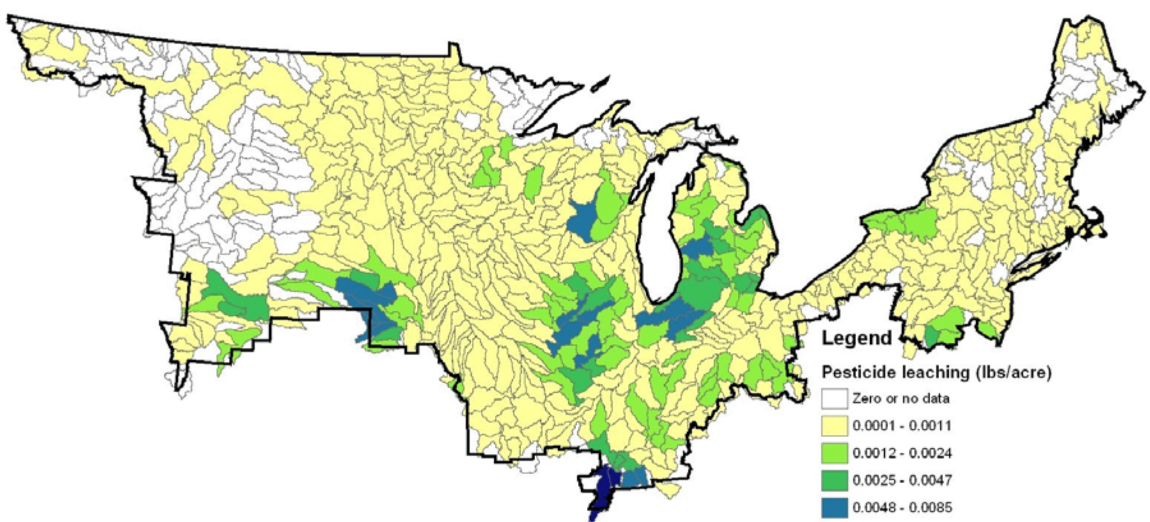


Figure II.D.4. Vulnerability of ground water resources to pesticide leaching in the Northeast/North Central Region, adapted from USDA (Kellogg, 1998).

When OP usage, drinking water sources, vulnerability of those sources to OP pesticide contamination, and available monitoring data are considered together, the surface water sources of drinking water are likely to be more vulnerable than ground water sources. Of the three sites selected in the preliminary assessment to represent vulnerable drinking water sources, the Red River Valley (ND, MN) had the highest cumulative OP distribution at all percentiles above the median, followed by central Illinois and, with lowest concentrations, south-central Pennsylvania. Terbufos and phorate, which had relatively high RPF values, dominated the cumulative OP load in the Red River Valley. This was reflected in NAWQA monitoring, where sites in the Red River Basin had the highest concentrations and frequencies of terbufos (RPF of 0.85) and phorate (0.39), while the Central Illinois River Basin had the highest concentrations and frequencies of chlorpyrifos (0.06).

In the counties on either side of the Red River – 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 (Table II.D.4). NASS reported no OP usage on corn in either Minnesota or North Dakota in the latest survey year.

Table II.D.4. OP use on agricultural crops in the Red River Valley

OP Usage/ Agricultural Crops				Cropland Acreage, Red River Valley Assessment Area	
Crop Group	**Crops**	**OP Usage x 1000 lb**	**Percent of Total OP Use**	**Acres x 1000**	**Pct of total Cropland**
Vegetables, tuber	Sugar beets	422	87	101	5
	Potatoes	15	3	345.5	11
Grains	Wheat	30	6	1,502	43
Total			96	1,948.5	59

Pesticide use based latest data collected by USDA National Agricultural Statistics Service (NASS) for Walsh, Grand Forks, and Pembina counties, ND, and Polk, Norman, and clay counties, MN. Acreage estimates based on ND and MN Agricultural Statistics Service. Details on the sources of usage information are found in Appendix III.E.7.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Northern Great Plains cumulative assessment using PRZM-EXAMS with input parameters specific to the Red River Valley. Table II.D.5 summarizes pesticide use information for the OP-crop combinations which used 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. These uses represent roughly 96% of agricultural use of OP pesticides in the Red River Valley.

Table III.D.5. OP-Crop combinations and application information for the Northeastern/North Central 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	19	0.48	Aerial; Foliar	July 31	Jul1-Aug30
Dimethoate	Potato	24	0.27	Aerial;Foliar	July 31	Jul1-Aug30
Chlorpyrifos	Sugarbeet	13	1.25	Ground; Planting	May 10	Apr22-May30 (Apr 30-May 30)
Phorate	Sugarbeet	4	1.03	Ground; Planting	May 10	Apr22-May30 (Apr 30-May 30)
Terbufos	Sugarbeet	69	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)
Cumulative OP PCA for the region (regional PCA x % of crops with OP use): 0.48 (ND)
Weather data used to simulate rainfall (meteorological file): Met56.met (Fargo, ND)

Terbufos, which accounted for three-fourths of total OP use in the assessment area (375,000 lb), had estimated concentrations one to two orders of magnitude greater than any of the other OPs in the cumulative load in the 75th and higher percentiles (Table II.D.6). OP cumulative concentrations were greater than 1ppb at the 99th percentile.

Table II.D.6. Predicted percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Northeast/North Central Region.

Chemical	Crop/Use	Concentrations in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
AzinphosMethyl	Potato	4.9e-02	2.2e-02	1.2e-02	7.2e-03	4.2e-03	3.1e-03	7.0e-04
Chlorpyrifos	Sugarbeet, Wheat	4.7e-02	2.6e-02	1.5e-02	1.1e-02	6.2e-03	4.7e-03	1.4e-03
Dimethoate	Potato	3.8e-02	7.4e-03	2.8e-03	1.1e-03	2.2e-04	1.2e-04	1.6e-05
Phorate	Sugar beet	5.6e-02	2.5e-03	7.9e-05	2.8e-06	2.9e-09	8.2e-11	3.8e-13
Terbufos	Sugar beet	1.9e+00	5.9e-01	1.9e-01	7.9e-02	2.0e-02	1.1e-02	1.7e-03
OP Cumulative Concentrations in Methamidophos equivalents		4.9e+00	1.5e+00	4.8e-01	2.0e-01	5.5e-02	3.0e-02	5.5e-03

Figure II.D.5 displays 35 years of predicted OP cumulative concentrations for the Northeast/North Central regional drinking water assessment. Estimated cumulative OP concentrations, in methamidophos equivalents, exceeded 2.5 ppb less than 10 percent of the time (3 times in 35 years of varying weather patterns). In most years, concentrations remained below 1.5 ppb in methamidophos equivalents.

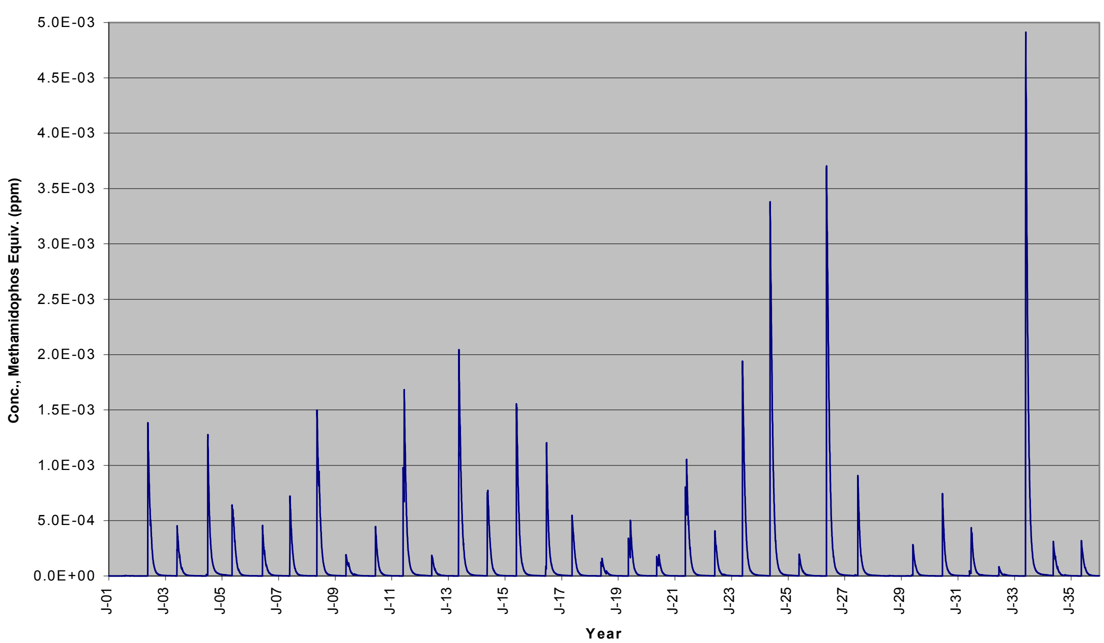


Figure II.D.5. Cumulative OP distribution in water in the Northeast/North Central Region, 35 years of weather patterns.

Figure II.D.6 overlays all 35 years of predicted values in the same year span. The highest peak concentrations occurred in mid- to late-May.

Considerable variation both in magnitude and timing of the peaks resulted from the timing of runoff-producing rainfalls in relation to timing of application.

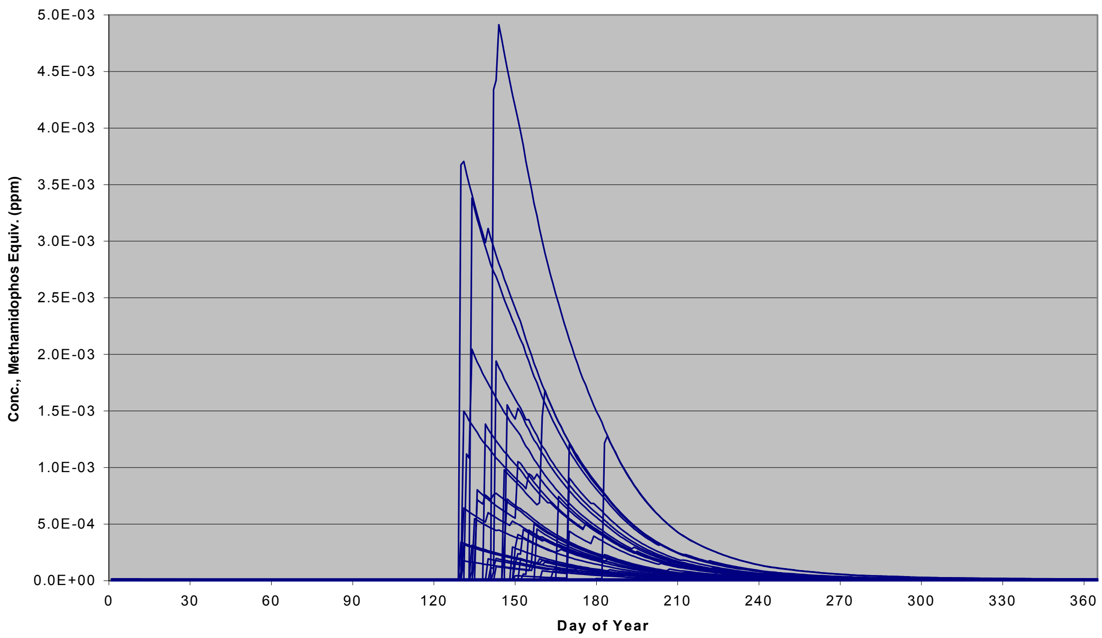


Figure II.D.6. Variations in yearly patterns of cumulative OP concentrations in water in the Northeast/North Central Region (35 years of weather patterns).

Terbufos, applied to sugarbeets in mid-May, is the primary contributor to the predicted cumulative OP load in the regional assessment (Figure II.D.7). It is important to note that these relative contributions reflect both individual chemical concentrations in water and the RPF of each of the OP chemicals found in the water.

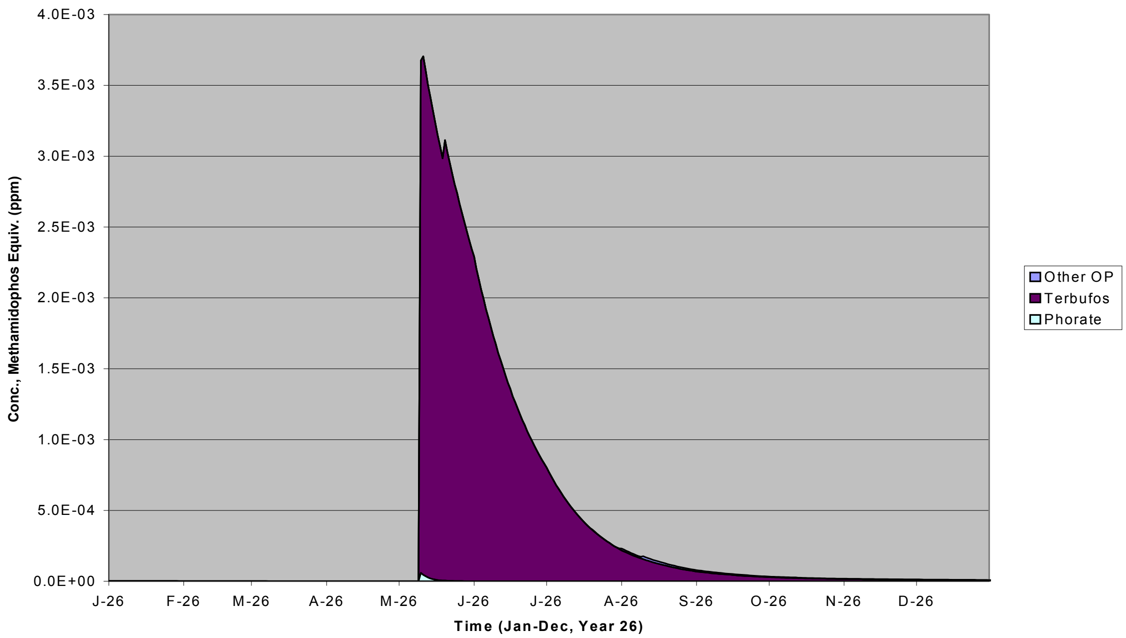


Figure II.D.7. Cumulative OP distribution for year 16 showing relative contributions of individual OPs in the Northeast/North Central Region.

While terbufos had the highest RPF of the OP pesticides included in this regional assessment, it also had the highest estimated concentrations because of its high total use (Figure II.D.8).

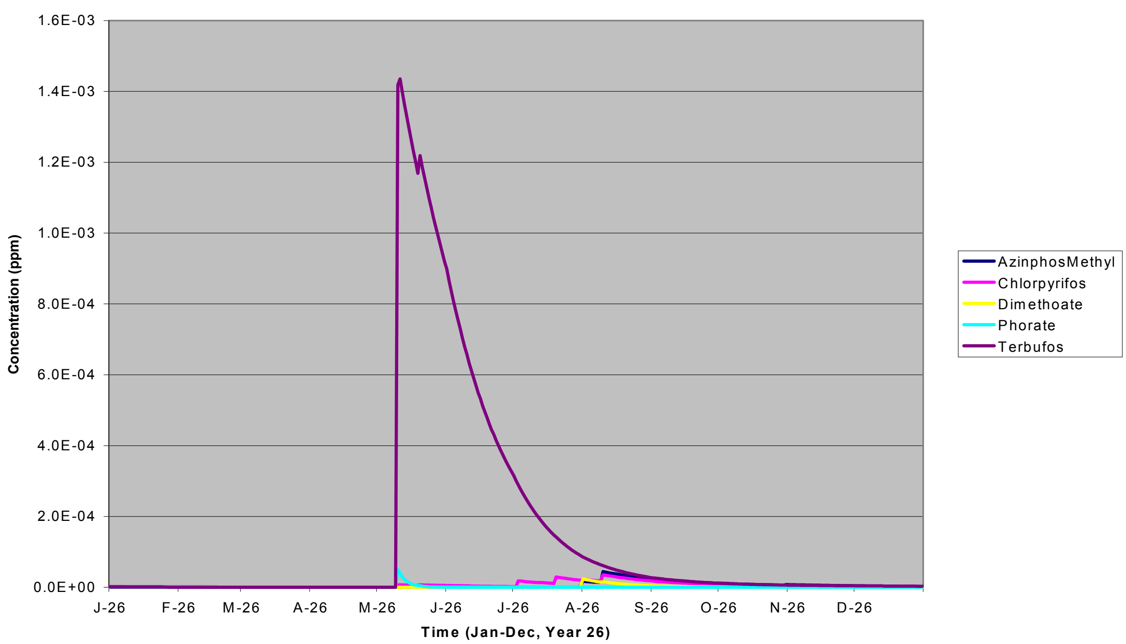


Figure II.D.8. Concentrations of selected OPs year 16 for the Northeast/ North Central Region.

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 the predicted maximum and 99th percentile concentrations of chlorpyrifos, azinphos methyl, and phorate were similar to monitoring detections in the Red River Basin. The highest reported detection for terbufos was equivalent to the estimated 90th percentile concentration. However, the model estimates include the more persistent and mobile sulfone and sulfoxide residues, while the monitoring only represents the parent concentrations.

In the preliminary assessment, the estimated peak and upper percentile concentrations of chlorpyrifos in the Heartland region (central Illinois) were roughly equivalent to the concentrations detected in the agricultural watersheds of the Lower Illinois River Basin (LIRB) while the maximum estimated concentration of total terbufos residues (parent plus toxic sulfoxide and sulfone transformation products) was an order of magnitude greater than the maximum detection reported for the parent terbufos (without the transformation products) in the LIRB. The maximum detection of terbufos in NAWQA fell between the 90th and 95th percentile of estimated concentrations to total terbufos residues. Between 80 and 90 percent of the estimated terbufos concentrations were below the analytical level of detection.

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.

While six of the reservoirs included in the USGS-EPA reservoir study are located in the Northeast/North Central region, none occur in the vicinity of the Red River Valley. Nor do the reservoir watersheds represent the nature of OP uses found in the Red River Valley. Lake Mitchell (SD), Higginsville Reservoir (MO), and Blue Marsh Reservoir (PA) are in areas of relatively low OP use. Eagle Creek Reservoir (IN) and East Fork Lake (OH) are in moderate OP-use areas dominated by corn-soybean agriculture. LeRoy Reservoir (NY) is in a relatively high OP use area, with pasture dominating the agricultural land use. Due to drought conditions in OH, NY, and PA during the first year of sampling, pesticide concentrations tended to be lower than normally found (Blomquist et al, 2001). Therefore, direct comparisons between estimated OP concentrations and detections reported in these reservoirs are not necessarily relevant. Details of the reservoir study, with a summary of OP detections, is found in Appendix III.E.3.

d. Summary of Available Monitoring Data for the Northeast/ North Central Region

The Northeast/ North Central Region spans a large geographic area and includes a diverse range in hydrologic conditions. Several NAWQA and state monitoring studies help characterize the range in measured OP concentrations in water sources across the region.

i. USGS NAWQA Monitoring Studies

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. Additional ground-water monitoring covered surficial aquifers underlying irrigated cropland and a water flow-study to estimate the age of contaminants in the ground water. The authors concluded that domestic drinking water wells, with an average recharge age of more than 20 years, are less susceptible to contamination than the monitoring wells included in the study, which generally had recharge ages of 1 to 10 years.

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, the most often detected OP in the REDN study unit, was detected in 14 samples – 5 from agricultural streams (maximum concentration 0.031 ug/l) and 9 from mixed land-use streams. The three reported diazinon detections were also from mixed land-use streams and may not represent agricultural contamination. Other OP pesticides detected in the REDN study unit include malathion (14 detects, 0.3 ug/L maximum detection), azinphos methyl, methyl parathion, and ethoprop (each with 3 detects and a maximum concentration of 0.1 ug/L), phorate and disulfoton (each with one detection of 0.08 ug/L), and terbufos (3 detections with a maximum of 0.008 ug/L).

Malathion is the only OP which was detected in ground water. This single detection from an unconsolidated glacial aquifer, was at a concentration less than 0.01 ug/l. 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).

A number of monitoring studies have been performed in the corn-dominated Heartland region. The most commonly detected OP pesticides in these studies were diazinon, chlorpyrifos, malathion, and fonofos. The highest detections and frequency of detections for both diazinon and malathion occurred in urban/residential watersheds. Chlorpyrifos was detected at higher concentrations and more frequently in agricultural watersheds in Illinois and in urban/residential watersheds in Indiana. All fonofos uses and the residential uses of chlorpyrifos and diazinon are being phased out and, thus, are not included in the cumulative water exposure assessment. While the water exposure assessment did not account for residential contributions of malathion in the cumulative load, malathion has a small relative potency factor (0.0003) and the resultant contribution of residential sources of malathion is not expected to contribute significantly to the overall drinking water exposure.

The White River Basin (IN) tended to have the greatest frequency of detections and the Eastern Iowa Basins the lowest frequency. The high frequency of detections in the White River Basin was influenced by the urban/residential uses of OP pesticides in that basin – in particular, chlorpyrifos, diazinon, and malathion. The Lower Illinois River Basin had the highest detects and greatest frequency of detections for chlorpyrifos and terbufos in agricultural-dominated watersheds.

The **NAWQA Lower Illinois River Basin (LIRB) study** unit includes the high OP-use counties of central Illinois which serve as the location for the regional drinking water assessment. The study area is located central Illinois, within intense corn and soybean row-crop agriculture. Sampling in this study occurred between 1995 and 1998. Surface-water sampling was conducted in "two watersheds with greater than 90 percent row-crop agriculture and the basin inflow and outflow sites (Circular1209)."

Chlorpyrifos and diazinon were the OPs most often detected in surface water, with peak concentrations detected in July and August. Diazinon was detected in 30% of samples overall (75 detections), but in <5% of agricultural streams (8 detections), with a maximum agricultural concentration of 0.07 ug/l. By contrast, 29 of the 37 detections of chlorpyrifos were in agricultural streams (18% of samples from agricultural areas), with a maximum concentration of 0.30 ug/l. Malathion (four detections, maximum 0.03 ug/l), methyl parathion (1 detection, 0.2 ug/l), and terbufos (3 detections, 0.03 ug/l) were also detected in surface water. All but one detection of malathion were in streams draining agricultural areas.

Only one detection of diazinon (0.01 ug/l) was reported for all OPs in ground water. This detection occurred in one of 60 samples taken from domestic and public supply wells in "major aquifers" in the study unit. No OPs were detected in a land-use study in which "very shallow monitoring wells" were sampled in areas of corn and soybean production. The ground water that was sampled from the 57 wells was generally less than 10 years old.

The **White River Basin (WHIT)** study unit is located in central and southern Indiana. Agriculture accounts for 70% of land use in the study unit, with corn and soy as the predominant crops. Sampling took place between 1992 and 1996.

Diazinon, chlorpyrifos and malathion were the OPs most extensively detected in surface water. Diazinon was extensively (25%) detected in streams draining agricultural areas, with a maximum detection of 0.4 ug/l. When urban and mixed land-use samples are included, diazinon was detected at even greater frequency and concentration (54%, max 1.1 ug/l in 801 urban stream samples). The same was true for chlorpyrifos (agricultural max 0.12 ug/l) and malathion (overall max 0.67 ug/l), which were detected at half the frequency in surface water draining agricultural areas alone than in the whole data set.

Azinphos methyl (8 detections), methyl parathion, ethoprop, terbufos and disulfoton were the other active OPs detected in surface water, in descending order of frequency. Of these, only ethoprop had a detection above 0.1 ug/l (one sample at 0.14 ug/l). Terbufos was detected at concentrations of 0.013 and 0.016 ug/l.

While the White River is an important source of drinking water, 55% of people in the White River Basin rely on ground water for their drinking water. About half of the population deriving drinking water from ground water do so from private domestic wells. Ground-water samples were taken once from 94 wells (both from confined aquifers and unconfined glacial outwash aquifers) in both urban and agricultural areas. Forty-nine of these outwash wells, and nine deeper outwash wells, were sampled to further assess the water-quality of this aquifer. In addition, a small number of wells, lysimeters and tile drains were sampled in a flow-path study. OPs were not detected in ground water in the WHIT study unit.

The **Eastern Iowa (EIWA) study unit** comprises most of eastern Iowa, and a very small portion of southern Minnesota. Agriculture accounts for 90% of land use in the study unit.

Chlorpyrifos was detected in 7 percent of agricultural streams, and 6 percent of mixed land-use streams. Diazinon (2 samples, .005 and .006) and malathion (9 samples, max 0.078) were also detected in surface water. By contrast, herbicides atrazine and malathion were detected in every surface water sample collected.

Ground water is the major source of fresh water supply in the study unit. Ground-water studies included 124 wells (half domestic wells, half monitoring wells) that drew from the surficial alluvial aquifers, and the older bedrock aquifers. The bedrock aquifers sampled were mostly deep, and somewhat protected from surface contamination by surficial materials. However, samples were also taken from the Iowan karst, which is covered by little or no overburden, and is particularly vulnerable to contamination due to solution porosity. Chlorpyrifos (urban and agricultural) and malathion (1 urban well sample) were detected in shallow alluvial aquifer. They were not detected in the deeper carbonate aquifer. Chlorpyrifos was detected in 16 and 10 percent of shallow ground-water wells in agricultural and urban areas, respectively, much more than the 1 % national average.

Although the topography and drinking water sources of the Northern Crescent varies throughout the region, the results of available monitoring are similar to those from other regions. Chlorpyrifos and diazinon are widely detected in urban and agricultural streams, with detections of malathion somewhat less common. However, in tree fruit areas such as central Pennsylvania, azinphos-methyl was detected as well. Other OPs, such as ethoprop and terbufos, were infrequently detected in surface water.

Diazinon, chlorpyrifos and malathion were the only OPs detected in ground water, although rarely. This is in spite of State monitoring that concentrated on ground water, and several NAWQA monitoring studies that concentrated on shallow ground water in vulnerable agricultural areas. Ground water is an important source of drinking water in Vermont, New Hampshire and Maine, but less so in New York, Connecticut, Massachusetts, and Rhode Island, where a large majority of the population is supplied by surface water (USGS Water Atlas HA-730-M).

The Great Lakes represent a significant drinking water supply in the Northern Crescent, but water monitoring of the lakes has not concentrated on OP contamination. According to the State of Ohio's State of the Lake Report, for instance, 31 water-treatment plants on the north shore of Ohio draw water from Lake Erie (see http://www.epa.state.oh.us/oleo/leqi/14.pdf). These systems have not analyzed for OPs to this point, as such analysis was not required by the Safe Drinking Water Act.

These systems are likely to look for triazines once a month in the summer, and quarterly otherwise. Ohio EPA undertook a "pesticide special study" between 1995 and 1999, but also looked only for herbicides (see http://www.epa.state.oh.us/ddagw/pestspst.html). Cities like Cleveland and Toledo get their water from intakes a couple of miles into Lake Erie. Therefore, they rarely detect pesticides other than small levels of atrazine at times. Smaller communities might have their intakes somewhat closer to shore (Todd Kelleher, Ohio EPA Dept. of Drinking and Ground Waters, personal communication). Modeling results from PRZM and EXAMS for the OPs should be considered a conservative exposure estimate for populations deriving drinking water from the Great Lakes.

The EPA and Canada have identified portions of the Great Lakes that are considered "Areas of Concern" as part of the Great Lakes Water Quality Agreement. These can be seen through the EPA web page at http://www.epa.gov/glnpo/aoc/map.html . Forty-three sites (26 in the US) on the shores of the Great Lakes have been identified as AOCs for reasons such as fish tumors, bird or animal deformities or reproductive problems, restrictions on dredging, and restrictions on drinking water consumption, among others (full list at http://www.ijc.org/focus/listdelist/). The pollutants of concern identified for the AOCs include organochlorine insecticides, but not OPs. Other concerns include heavy metals, PCBs, polynuclear aromatic hydrocarbons, and sedimentation. Some of the action plans for AOCs include management practices to avoid continued non-point pollution, including pesticides in agricultural runoff.

The **Lake Erie-Lake Saint Clair Drainages (LERI) NAWQA** study unit assessed the water quality of streams draining to these lakes in parts of Michigan, Ohio, Indiana, New York and Pennsylvania. Although historic industrial pollution on the shores of the Great Lakes has led to the identification of the AOCs mentioned above, about 75% of the area included in this study unit is dedicated to agricultural use. Insecticides were included in weekly to monthly sampling at 4 sites from 1996 to 1998. The streams sampled drain watersheds with areas from 310 to 6330 square miles.

Chlorpyrifos and diazinon were extensively detected in agricultural, mixed land-use and urban stream samples. Both were more frequently detected in urban samples than agricultural samples (36% vs 13% for chlorpyrifos, 70% vs 23% for diazinon). The maximum agricultural stream concentration of chlorpyrifos was about 0.4 ug/l. The maximum agricultural stream concentration of diazinon was 0.1 ug/l. Malathion and methyl parathion are also listed as infrequent contaminants in this study.

Ground-water monitoring in this study unit was concentrated in eastern Michigan. Thirty monitoring wells were located in agricultural areas. Some of these monitoring wells were installed alongside 18 deeper domestic wells (average 93 feet versus about 30 feet). Similar co-installation was done west of Detroit to assess mixed-use and urban ground water. Less contamination occurred in the domestic wells, one-third of which had water which according to tracers recharged before 1953. However, the single OP detection in ground water, a detection of about 0.05 ug/l of diazinon, occurred in a domestic drinking-water well. As age-dating of ground-water supply advances throughout the Nation, the Agency will better be able to assess which ground-water supplies are most likely to be affected by recent human activities.

Eighty percent of the population of the **Hudson River Basin (HDSN) NAWQA** study unit, which is located almost completely in New York, derives its drinking water from surface water supply. People drawing water from domestic wells do so mostly from unconsolidated surficial glacial and post-glacial aquifers. The region has more land devoted to forest than agriculture (62% versus 25%).

Surface-water monitoring for OPs in this study unit was limited to the 46 fixed sampling sites distributed through the basin. Diazinon was extensively detected (16%), with a maximum concentration of 0.697 ug/l. While the highest detection of diazinon was from an agricultural stream, fewer than 20% of the samples with detections of diazinon were from agricultural streams. Chlorprifos was detected in little more than 1% of agricultural streams, with a maximum detection of 0.024 ug/l. Malathion was detected in 6% of urban streams, with a maximum detection of 0.13 ug/l.

Diazinon and malathion were detected in ground water in this study unit. The monitoring program included single samples from shallow (<50 feet deep) monitoring wells (26 urban, 18 agricultural) in the unconsolidated glacial and post-glacial deposits, and domestic wells throughout the region ranging in depth from 7 to more than 100 feet deep. Diazinon was detected domestic and urban wells (2% of all wellls, max detection <0.1 ug/l). Malathion was detected in about 5% of domestic wells (1% overall, max concentration <0.05 ug/l).

The **Connecticut, Housatonic and Thames River Basins (CONN) NAWQA** study unit includes parts of Connecticut, Massachusetts, New Hampshire, New York, and Vermont, and includes only 12 % agricultural land (most is forested and undeveloped). Surface water is the predominant drinking water supply, although 924 thusand of the 4.5 million people in the region had domestic wells in 1990 (USGS Circular 1155).

The fixed site surface water sampling program in this study included 12 sites around the basin sampled about 15 times per year. In addition, a single intensive urban stream site was sampled about 40 times per year in 1993 and 1994. Diazinon was frequently detected in surface water, including a 92% frequency in urban stream samples. Chlorpyrifos (max concentration <0.1 ug/l) and disulfoton (max concentration <0.01 ug/l) were detected in 1% and <1% of samples, respectively. Malathion, however, was detected in 4% of samples, with a maximum concentration of 7.5 ug/l. This detection did not occur in an agricultural stream.

Although other insecticides such as carbofuran and permethrin were detected in ground water, and although diazinon was detected extensively in surface water, no OPs were detected in ground water in this study unit. The monitoring network included 163 wells sampled once each, with 120 of these in surficial aquifers.

The **New Jersey-Long Island Coastal Drainages (LINJ) NAWQA** study unit includes mixed-use and urban stream samples, and agricultural, mixed use and urban ground water samples. Only seven surface water samples were collected in a stream considered to drain solely agricultural land.

An nearly equivalent number of people in the LINJ study unit derive their drinking water from surface water as from surficial aquifers. The surficial aquifers in both the southern half of New Jersey and Long Island are coarse grained soils which are susceptible to pesticide contamination.

Chlorpyrifos and diazinon were detected extensively in urban and mixed use surface water samples. Urban uses of chlorpyrifos and diazinon are currently being phased out. Only three of the urban and mixed land-use surface-water sampling sites had more than 50% agricultural land use. It is not possible to distinguish chlorpyrifos and diazinon in these samples derived from agricultural or urban/suburban use. Neither chlorpyrifos nor diazinon were detected in ground water.

The population of the **Lower Susquehanna River Basin (LSUS) NAWQA** study unit, which is located in south-central Pennsylvania and northeasternmost Maryland, derives 75% of its public water supply from surface-water sources. Public supply in this region served 1.2 million people in 1992. Another 800,000 derived their drinking water from private domestic wells. The land use in the majority of this region is equally divided between agricultural and forested land (47% each- USGS Circular 1168).

The LSUS is a study unit with relatively high frequency of OPs in surface water. Many of these correspond with tree fruit uses simulated in PRZM-EXAMS modeling for this region. Azinphos-methyl, for instance, was detected in 9% of agricultural stream samples, with a maximum concentration of 0.4 ug/l. Chlorpyrifos was detected in about 18% of agricultural streams (maximum concentration 0.09 ug/l), and diazinon was detected in little over 5% in agricultural streams (maximum concentration 0.055 ug/l). Methyl parathion, which will no longer be used on tree fruits, was detected in 2 agricultural stream samples, with a maximum concentration of 0.063 ug/l.In the LSUS, 187 sites sampled were once, 3 sites sampled intensively from 1993 to 1995.

Other OPs not included in the simulation modeling for the Northern Crescent were detected in the LSUS study. Malathion was detected in 8% of urban samples, and 3% of agricultural samples, with a maximum concentration of 0.129 ug/l. Ethoprop was detected in 1.4% of samples (8 detections), with a maximum concentration of 0.052 ug/l.

The ground-water monitoring program in the LSUS study unit included 159 wells, 152 of which were domestic supply wells, mostly <200 feet deep. The project report states that, “Samples from these wells generally contain water that has infiltrated through the ground in recent years and therefore could be used to indicate whether land-use practices have affected ground-water quality.” Many herbicides were in fact detected in these wells, as well as insecticides such as carbaryl and carbofuran. Diazinon, however, is the only OP detected in ground water. It was detected in 2 samples at concentrations <0.01 ug/l.

The **Western Lake Michigan Drainage (WMIC) NAWQA** study unit provides further data on OP contamination in the Great Lakes region, covering eastern Wisconsin and part of the Upper Peninsula of Michigan. Agriculture accounts for 37% of the land use in this region, while 50% is forested. Drinking water is predominantly derived from surface-water supplies in this area, mostly from Lakes Michigan and Winnebago.

Pesticides were included as analytes at three intensive stream sampling sites, and at 145 other sampling sites in agricultural, urban and mixed land-use areas. Diazinon was the OP most detected in this region (5%), with detections ranging to about 0.05 ug/l. Chlorpyrifos, phorate, malathion and methyl parathion were detected in no more than 3 samples each. The maximum detection among these was a phorate detection of about 0.1 ug/l.

Ground water networks included 56 shallow monitoring wells installed in unconsolidated surficial deposits, and 29 domestic, institutional or public supply wells completed in underlying bedrock. Each of these wells was sampled a single time between 1993 and 1995, and no OPs were detected in any of the ground-water samples.

The **Upper Mississippi River Basin NAWQA** study unit is located predominantly in Minnesota, with a small number of samples taken as well in Wisonsin and Iowa.

Although stream-water samples were collected from streams representing various land uses, urban streams accounted for nearly all of the OP detections in surface water in this study unit. Diazinon was detected in 9% of urban stream samples, and 48% of mixed land-use samples (maximum concentration 0.3 ug/l), but in none of the 50 agricultural stream samples collected. Similarly, chlorpyrifos was detected in 32% of urban streams, but not in any agricultural samples. Malathion was detected in 11% of urban samples (maximum concentration 0.08 ug/l), but only a single agricultural sample. Two detections of ethoprop (maximum concentration 0.02 ug/l) represent the only other OP detections in agricultural streams.

Diazinon was detected in four ground-water samples taken from wells in “major aquifers.” The maximum concentration detected was greater than 10 ug/l, which represented the highest concentration of diazinon in ground water detected in the NAWQA program.

ii. State Monitoring

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: ethyl parathion twice in 1993 (ranging from 0.3 to 1.8 ug/l); malathion three times between 1999 and 2001 (ranging from 0.2 to 0.5 ug/l); and diazinon once in 2001 (at 0.1 ug/l).

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.

In the first three years of **Indiana**’s “Surface Water Quality Assessment Program,” only one OP, tetrachlorvinphos, was detected in the three years of sampling.

In **Iowa**, chlorpyrifos, ethoprop, fonofos, phorate, terbufos, dimethoate, diazinon, malathion, and parathion were included in the Statewide Rural Well-Water Study. None of the OPs were detected in this study. After the conclusion of the SWRL study, private wells continued to be monitored as part of Iowa's Grants to Counties program, but not for pesticides. In Iowa’s Ambient Surface Water Monitoring program, only one detection of parathion and two detections of chlorpyrifos have occurred since 1999. Concentrations detected were low, in the 0.05 ppb range.

Nebraska’s “Quality-Assessed Agricultural Contaminant Database for Nebraska Ground Water,” had no reported detections for chlorpyrifos, diazinon, disulfoton, ethion, malathion, methyl parathion, phorate, or terbufos. The levels of detection are generally below 1 ppb.

In **Connecticut**, Judith Singer provided data from a USGS report which cover the Connecticut, Housatonic, and Thames Rivers from 1969 to 1992. The tables she provided indicate that diazinon was detected in 3 surface water samples from 0.01 to 0.03 ppb (detection limit reported as 10 ppb).

Chlorpyrifos, diazinon, and phorate were detected once each at 0.01 ppb, and a single detection of "total diazinon" occurred at 0.07 ppb.

Scott Blaier of the **Delaware** Department of Agriculture indicated that chlorpyrifos was detected one year in domestic and monitoring wells. As part of the PMP program, chlorpyrifos was included in 1998. The top of the well screen of 70% of the "domestic and agricultural wells" sampled was between 16 and 35 feet. Top of screen for 80 percent of the monitoring wells was shallower than 15 feet.

Chlorpyrifos was detected in a single well (LOD = 0.22 ppb) at a concentration of 0.75 ppb. This was a domestic well screened between 33 and 38 feet. From, "The Occurrence and Distribution of Several Agricultural Pesticides in Delaware's Shallow Ground Water", 2000 (http://www.udel.edu/dgs/pub/RI61.pdf).

The **Maine** Department of Agriculture samples drinking water wells no more than 1/4-mile down-gradient of an active use site. Analytes are chosen based on local sales data. Sampling in 1994 and 1999, included azinphos methyl, diazinon, chlorpyrifos, ethoprop, and phosmet. No OPs were detected in 1999. One detection of diazinon in 1994 (7.4 ppb) was determined to be the result of a homeowner putting diazinon around her well head to get rid of ants. Ethoprop was detected in one well at 0.075 ppb. No followup to that detection was conducted.

Surface-water monitoring in Maine has included azinphos methyl, chlorpyrifos, diazinon, ethoprop, malathion, and phosmet. Most surface-water monitoring in Maine is in response to the endangered species designation for Atlantic salmon. "Blueberries are the most intensively grown commodity in the salmon watershed." Only phosmet has been detected to date in surface water, with a maximum detection of 0.52 ppb (3 detections). In this study, surface water samples were collected less than 2 hours after a phosmet application. Sampling continues in that watershed, except for ethoprop.

David Bolton of the **Maryland** Geological Survey provided summary tables from the MGS Report of Investigations number 66, "Ground-Water Quality in the Piedmont Region of Baltimore County, Maryland." Analysis in this rural region included 12 OPs, 10 of which are still registered. Seven of the 10 current OPs were not detected in ground water. Phorate was detected at a maximum concentration of 0.01 ug/l, ethoprop at 0.004 ug/l, and diazinon at 0.003 ug/l.

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. 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. 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 evaluated as a function of time. That is, for example, a 365-day series of 95th percentile values can be arrayed, 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" 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 Northeast/North Central output distribution (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.M.2-1 through III.M.2-8 in Appendix M present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles (95, 99, 99.5, and 99.9 percentiles) of the Northeast/North Central output distribution. Figure III.M.2-9 through Figure III.M.2-16 present these same figures for Children 3-5. Data for Adults 20-49 and Adults 50+ are presented in Appendix III.M.3. The following paragraphs describe, in additional detail, the exposure profiles for each of these age groups for the 99.9th and 95th percentile. Briefly, these figures present a series of time courses of exposure (expressed as MOEs) for various age groups at various percentiles of exposure. For example, for the 95th

percentile MOEs 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 – arrayed as a function of time. The result is a "time course" (or "profile") of exposures representing that portion of the Northeast/North Central output distribution at the 95th percentile exposures throughout the year. In addition, the MOEs are shown for each pathway or route (e.g., oral ingestion through food, oral ingestion through hand-to-mouth activity, inhalation, dermal, etc.) for each of a variety of percentiles. 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

Single Day Analysis (Figure III.M.2-1 through Figure III.M.2-4): At the 99.9th percentile, total MOEs are in the range of ~ 10-60 with exposures through the inhalation pathway from DDVP pest strip use (MOE of ~ 10-100) acting as the dominant contributors. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), other routes – such as dermal and hand-to-mouth exposure from lawn treatment applications and exposure from drinking water – do not contribute to substantial exposure. MOEs through water exposures remain above 100 throughout the year, peaking at approximately Julian Day 130 (due to terbuphos use on sugarbeets). MOEs for dermal and hand-to-mouth exposures remain substantially above 100 throughout the year, as well.

Seven Day Rolling Average Analysis (Figure III.M.2-5 through Figure III.M.2-8): At the 99.9th percentile, total MOEs are in the range of ~ 20-70 with exposures through the inhalation pathway from DDVP pest strip use acting as the only substantial contributor to this total. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), MOEs through water exposures remain above 100 throughout the year, peaking at approximately Julian Day 130 (as described above). Other routes – such as dermal and hand-to-mouth exposure from lawn treatment applications – do not contribute to substantial exposure, with MOEs remaining at greater than 1000 throughout the year.

b. Children 3-5 years old

Single Day Analysis (Figure III.M.2-9 through Figure III.M.2-12): At the 99.9th percentile, Total MOEs are in the range of ~ 10-60 with exposures through the inhalation pathway from DDVP pest strip use acting as the dominant contributors. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), dermal and hand-to-mouth exposure from lawn treatment applications and exposure from drinking water do not contribute to substantial exposure. MOEs associated with drinking water remain greater than 100 throughout the year and dermal and hand-to-mouth exposures are associated with MOEs that generally remain above ca. 1000.

Seven Day Rolling Average Analysis (Figure III.M.2-13 through Figure III.M.2-16): Total MOEs considering a seven-day rolling average are in the range of ~ 40 to 70 at the 99.9th percentile. The main contributor to these exposures is inhalation exposure through DDVP pest strips. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), other routes – such as dermal and hand-to-mouth exposure from lawn treatment applications and exposure from drinking water – do not contribute to substantial exposure with MOEs remaining well above 100.

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

Single Day Analysis (Appendix III.M.3) At the 99.9th percentile, Total MOE are in the range of ~ 20 - 170 for these age groups. Inhalation exposures from the use of DDVP pest strips is the significant contributors to this Total MOE. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), drinking water exposures remain low and at no time produce MOEs of less than 100. Dermal exposures appear throughout the year, but are consistently only a small fraction of total exposure with MOE greater than 1000.

Seven Day Rolling Average Analysis (Appendix III.M.3) At the 99.9th percentile, Total MOE are in the range of ~ 100 - 200 for these age groups. Inhalation exposures from the use of DDVP pest strips is the significant contributor to this Total MOEs. At the 95th percentile, total MOEs are well above 100 and no exposure through the use of these pest strips is present. It is important to express these exposures as a *range* of MOEs because there may be variability across the seasons. For all percentiles examined (i.e., 95th through 99.9th), drinking water exposures remain low with MOEs substantially greater than 100. Dermal exposures appear throughout the year, but are consistently only a small fraction of total exposure with MOE remaining greater than 1000 throughout the year.