III. Appendices

E. Water Appendices

1. Water Exposure Assessment: Summary of Organophosphorous (OP) Occurrence in Ambient Waters from the USGS NAWQA Program

This appendix summarizes the USGS National Water Quality Assessment (NAWQA) program study units for each of the regions. The tables summarize the results of detections for nine OP pesticides which were included in the cumulative OP assessment. Additional information on each of the NAWQA study units can be found through the US Geological Survey (USGS) web site.

a. The Heartland

Eight NAWQA study sites are located within the Heartland; data is currently available for five of these study units.

i. NAWQA Lower Illinois River Basin (LIRB)

This study unit includes central Illinois, the OP high-use area chosen for the Heartland surface-water modeling scenario. The study area is located central Illinois, and is an area of intense corn and soybean row-crop agriculture. Sampling in this study occurred between 1995 and 1998, and included nine OP insecticides.

Surface-water sampling was conducted in “two watersheds with greater than 90 percent row-crop agriculture and the basin inflow and outflow sites (Circular1209).” The heavily agricultural nature of the study area is reflected in the frequency of herbicide detection in the study; atrazine, metolachlor and cyanazine were detected in every surface-water sample taken. Samples in this portion of the study were collected weekly to monthly between January, 1996 and June 1998.

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 0.071 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 0.027 ug/l), methyl parathion (1 detection, 0.211 ug/l), and terbufos (3 detections, max 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.

ii. White River Basin (WHIT)

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. As in the LIRB, atrazine and metolachlor were detected in all samples. 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 0.41 ug/l. When urban and mixed land-use samples are included, however, diazinon was detected at even greater frequency and concentration (54.4%, 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 (1 detection) 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, the OP with the highest RPF value, 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.

iii. Eastern Iowa (EIWA)

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.

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. These represent the first and second most important sources of drinking water in the study unit. 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.

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.

iv. Upper Mississippi River Basin

This study unit includes only a small portion of the Heartland Farm Resource Region (part of southern Minnesota). This is an agricultural region that relies on ground water for its drinking water source. However, the agricultural ground-water study occurs north of the Heartland region. Diazinon was detected extensively in urban and mixed streams in this study unit. However, the intensive monitoring site at the small agricultural stream within the Heartland region did not have any diazinon detections. The Upper Mississippi River Basin considered in more detail for the Northern Crescent Farm Resource Region.

v. Upper Illinois River Basin (UIRB)

Data are not yet available for the Upper Illinois River Basin (UIRB) study unit, in which sampling began in 1997. Almost 85% of water used in this region is drawn from Lake Michigan. However, 93% of water not derived from Lake Michigan comes from ground-water sources. Fifty-four percent of the ground water extracted is from surficial deposits, and 46% from bedrock aquifers. Some bedrock aquifers, as in the vicinity of Chicago, are quite deep, and contain ground water which recharged many years ago (fix- see Silurian, Cambrian paper).

The USGS has also not published data for the **Greater and Little**

Miami River Basins NAWQA study unit, in which sampling also began in 1997.

Table III.E.1-1 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Heartland

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methy lparathion	phorate	terbufos
		Concentation (ug/L)								
Lower Illinois R. Basin										
All Locations	Maximum	0.300	0.071	0.021	0.005	0.027	0.500	0.211	0.011	0.030
	99th	0.263	0.038	0.021	0.005	0.027	0.087	0.006	0.011	0.017
	95th	0.083	0.029	0.017	0.003	0.006	0.024	0.006	0.002	0.013
	90th	0.040	0.021	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.007	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.010	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	15.5%	30.6%	0.0%	0.0%	1.6%	0.0%	0.4%	0.0%	1.2%
Agriculture	Maximum	0.300	0.017	0.021	0.005	0.027	0.5	0.211	0.011	0.030
	99th	0.300	0.011	0.018	0.004	0.015	0.050	0.006	0.005	0.018
	95th	0.117	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.050	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.010	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	18.0%	4.8%	0.0%	0.0%	1.8%	0.0%	0.6%	0.0%	1.8%
Mixed	Maximum	0.090	0.071	0.021	0.005	0.027	0.300	0.006	0.011	0.017
	99th	0.067	0.054	0.021	0.005	0.027	0.142	0.006	0.011	0.017
	95th	0.042	0.037	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.024	0.031	0.017	0.003	0.005	0.050	0.006	0.002	0.013
	80th	0.005	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.022	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.4%	83.8%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%
Eastern Iowa										
All Locations	Maximum	0.400	0.057	0.021	0.004	0.078	0.800	0.006	0.011	0.017
	99th	0.070	0.007	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.010	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.3%	3.4%	0.0%	0.4%	1.1%	0.0%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.400	0.006	0.021	0.005	0.078	0.1	0.006	0.011	0.017
	99th	0.039	0.005	0.021	0.005	0.027	0.054	0.006	0.011	0.017
	95th	0.009	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	6.4%	0.7%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.400	0.057	0.021	0.005	0.027	0.800	0.006	0.011	0.017
	99th	0.122	0.011	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.013	0.005	0.017	0.003	0.005	0.006	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methy lparathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.0%	6.4%	0.0%	0.8%	0.8%	0.0%	0.0%	0.0%	0.0%
White River Basin										
All Locations	Maximum	0.300	1.100	0.050	0.14	0.670	0.046	0.011	0.060	0.016
	99th	0.080	0.380	0.050	0.015	0.050	0.050	0.015	0.020	0.050
	95th	0.025	0.130	0.021	0.005	0.027	0.015	0.006	0.011	0.017
	90th	0.015	0.058	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	80th	0.009	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.006	0.017	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	23.1%	54.4%	0.1%	1.2%	9.9%	1.0%	0.4%	0.0%	0.2%
Agricultural	Maximum	0.120	0.410	0.021	0.014	0.330	0.046	0.010	0.060	0.013
	99th	0.065	0.123	0.021	0.005	0.027	0.046	0.006	0.011	0.017
	95th	0.014	0.024	0.017	0.003	0.013	0.002	0.006	0.002	0.013
	90th	0.006	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.9%	24.0%	0.0%	0.3%	5.1%	1.6%	0.6%	0.0%	0.3%
Mixed	Maximum	0.180	0.180	0.050	0.015	0.033	0.007	0.011	0.060	0.016
	99th	0.128	0.066	0.050	0.015	0.027	0.050	0.015	0.020	0.050
	95th	0.045	0.034	0.050	0.005	0.015	0.015	0.006	0.020	0.050
	90th	0.018	0.023	0.021	0.005	0.005	0.010	0.006	0.011	0.017
	80th	0.010	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.007	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.4%	62.8%	0.3%	1.0%	2.9%	0.3%	0.3%	0.0%	0.3%
Urban	Maximum	0.300	1.100	0.021	0.140	0.670	0.011	0.006	0.060	0.017
	99th	0.088	0.600	0.021	0.019	0.405	0.011	0.006	0.060	0.017
	95th	0.026	0.358	0.017	0.005	0.046	0.016	0.006	0.011	0.013
	90th	0.020	0.240	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.014	0.136	0.017	0.003	0.014	0.001	0.006	0.002	0.013
	75th	0.012	0.100	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	50th	0.005	0.043	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	55.1%	93.8%	0.0%	3.4%	30.7%	1.1%	0.0%	0.0%	0.0%

b. Northern Crescent

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. An additional 14 wells were sampled for a flowpath.

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.

Table III.E.1-2 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Northern Cresent

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Lower Susquehanna River Basin										
All Locations	Maximum	0.090	0.060	0.034	0.052	0.129	0.409	0.063	0.016	0.030
	99th	0.030	0.025	0.034	0.017	0.025	0.117	0.012	0.004	0.026
	95th	0.011	0.011	0.017	0.006	0.010	0.018	0.006	0.002	0.013
	90th	0.008	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.0%	8.4%	0.0%	1.4%	3.5%	5.5%	0.8%	0.0%	0.2%
Agriculture	Maximum	0.090	0.055	0.034	0.039	0.025	0.409	0.063	0.004	0.026
	99th	0.032	0.015	0.034	0.028	0.017	0.127	0.012	0.004	0.026
	95th	0.011	0.004	0.017	0.006	0.009	0.073	0.006	0.002	0.013
	90th	0.008	0.002	0.017	0.003	0.005	0.002	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.6%	5.3%	0.0%	2.4%	3.3%	9.1%	0.8%	0.0%	0.0%
Urban	Maximum	0.047	0.060	0.034	0.052	0.129	0.044	0.041	0.016	0.026
	99th	0.024	0.034	0.033	0.016	0.04016	0.04214	0.040	0.004	0.025
	95th	0.014	0.021	0.017	0.003	0.013	0.001	0.006	0.002	0.013
	90th	0.010	0.013	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.5%	18.3%	0.0%	0.9%	8.3%	1.9%	1.8%	0.0%	0.0%
Mixed	Maximum	0.082	0.051	0.034	0.006	0.027	0.220	0.012	0.011	0.030
	99th	0.033	0.017	0.034	0.006	0.027	0.096	0.012	0.011	0.027
	95th	0.010	0.005	0.034	0.006	0.010	0.050	0.012	0.004	0.026
	90th	0.008	0.004	0.021	0.005	0.010	0.002	0.006	0.004	0.017
	80th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	8.1%	8.1%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	1.2%
Long Island/ New Jersey										
All Locations	Maximum	0.064	0.300	0.021	0.005	0.078	0.039	0.006	0.011	0.033
	99th	0.038	0.211	0.021	0.005	0.027	0.039	0.006	0.011	0.017
	95th	0.019	0.089	0.017	0.004	0.025	0.027	0.006	0.002	0.017
	90th	0.010	0.048	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	80th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.015	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	24.6%	52.6%	0.0%	0.0%	7.6%	1.2%	0.0%	0.0%	0.4%
Agricultural	Maximum	0.030	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	99th	0.027	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	95th	0.014	0.006	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.005	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.064	0.300	0.021	0.005	0.078	0.039	0.006	0.011	0.033
	99th	0.040	0.232	0.021	0.005	0.027	0.039	0.006	0.011	0.018
	95th	0.021	0.113	0.017	0.003	0.020	0.007	0.006	0.002	0.013
	90th	0.015	0.060	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	80th	0.008	0.028	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	32.6%	59.1%	0.0%	0.0%	11.4%	2.3%	0.0%	0.0%	0.8%
Mixed	Maximum	0.040	0.103	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.037	0.101	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.009	0.070	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.007	0.043	0.021	0.005	0.027	0.050	0.006	0.011	0.017

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.005	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.4%	60.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hudson River Basin										
All Locations	Maximum	0.060	0.697	0.021	0.005	0.130	0.05	0.006	0.011	0.017
	99th	0.017	0.130	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	95th	0.005	0.052	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.032	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.010	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.5%	28.2%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%
Agricultural Cropland	Maximum	0.024	0.697	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	99th	0.013	0.054	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.004	0.021	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	1.3%	10.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban Residential	Maximum	0.060	0.550	0.021	0.005	0.13	0.05	0.006	0.011	0.017
	99th	0.016	0.237	0.021	0.005	0.0979	0.05	0.006	0.011	0.017
	95th	0.005	0.119	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.076	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.045	0.017	0.003	0.015	0.001	0.006	0.002	0.013
	75th	0.004	0.039	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.015	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.8%	60.6%	0.0%	0.0%	5.8%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum det	0.024	0.093	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.017	0.064	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.028	0.017	0.003	0.011	0.002	0.006	0.002	0.013
	90th	0.004	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.9%	34.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Delmarva Peninsula (1999-2001)										

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
All Locations	Maximum det	0.014	0.005	0.021	0.005	0.034	0.05	0.006	0.011	0.017
	99th	0.009	0.005	0.021	0.005	0.029	0.05	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	75th	0.005	0.004	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.1%	7.9%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%

c. Northern Great Plains

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

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

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

Other active OPs detected in surface water were:

OP	Agricultural	Mixed Land Use	Maximum concentration (ug/L)
malathion	3	11	0.321
disulfoton		1	0.08
ethoprop	1	2	0.099

methyl parathion		3	0.114
phorate		1	0.078
terbufos		1	0.008
azinphos methyl	1	2	0.117

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

Data for the **Yellowstone Basin (YELL)** study unit are not yet available. While much of the land in this study unit is in the Basin and Range Farm Resource Region, parts of Montana and Wyoming are in the Northern Great Plains FRR. Rangeland is the dominant land cover, with about 43 percent of the study unit consisting of subhumid grassland and semiarid grazing land. The remaining land uses and land cover include grazed and ungrazed forest (19%), grazed desert shrubland (16%), mostly cropland and grazed cropland (non-irrigated: 11%; irrigated: 5%), grazed open woodland (5%), and alpine and lakes (1%). Major land-use industries in the study unit include coal and metals mining, oil and gas production, and agriculture.

The **Upper Mississippi River Basin (UMIS) NAWQA** study unit includes a very small portion of eastern South Dakota, but no samples were taken from this area. This study unit is considered in the Northern Crescent section.

Sampling in the **Central Nebraska Basins (CNBR) NAWQA** study unit occurred mostly within the Prairie Gateway Farm Resource Region, and is considered in that section of this report.

Table III.E.1-3 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Northern Great Plains

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Red River Basin										
All Locations	Maximum	0.087	0.104	0.080	0.099	0.290	0.117	0.114	0.078	0.080
	99th	0.020	0.004	<0.017	0.004	0.020	<0.001	0.010	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	4.5%	1.0%	0.3%	0.6%	3.5%	0.6%	1.0%	0.3%	0.3%
Agriculture	Maximum	0.031	<0.005	<0.020	0.004	0.290	0.01	<0.010	<0.020	<0.013
	99th	0.018	<0.002	<0.017	<0.004	0.016	<0.003	<0.006	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	2.8%	0.0%	0.0%	0.6%	1.7%	0.6%	0.0%	0.0%	0.0%
Mixed	Maximum	0.087	0.104	0.080	0.0992	0.107	0.117	0.114	0.078	0.080
	99th	0.028	0.009	<0.017	<0.003	0.036	<0.001	0.068	<0.012	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	0.009	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	7.2%	2.4%	0.8%	0.8%	6.3%	0.8%	2.4%	0.8%	0.8%
Upper Mississippi River Basin										
All Locations	Maximum	0.060	0.190	<0.021	0.020	0.0543	0.0148	<0.006	<0.011	<0.017
	99th	0.007	0.102	<0.021	<0.005	0.042	<0.137	<0.006	<0.011	<0.017
	95th	<0.004	0.053	<0.017	<0.003	<0.015	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	0.022	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	0.007	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	1.7%	24.3%	0.0%	0.6%	3.2%	0.3%	0.0%	0.0%	0.0%
Agricultural	Maximum	<0.060	<0.005	<0.021	0.020	0.0061	<0.050	<0.006	<0.011	<0.017
	99th	<0.020	<0.005	<0.021	0.009	0.150	<0.050	<0.006	<0.011	<0.017
	95th	<0.004	<0.002	<0.017	<0.004	<0.027	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	0.0%	0.0%	0.0%	2.7%	1.4%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.064	0.300	<0.021	<0.005	0.078	0.039	<0.006	<0.011	0.033
	99th	0.040	0.232	<0.021	<0.005	0.027	0.039	<0.006	<0.011	0.018
	95th	0.021	0.113	<0.017	<0.003	0.020	<0.007	<0.006	<0.002	<0.013
	90th	0.015	0.060	<0.017	<0.003	0.010	<0.001	<0.006	<0.002	<0.013
	80th	0.008	0.028	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	0.005	0.020	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	32.6%	59.1%	0.0%	0.0%	11.4%	2.3%	0.0%	0.0%	0.8%
Mixed	Maximum	0.006	0.009	<0.021	<0.005	0.0051	0.400	<0.006	<0.011	<0.017
	99th	0.005	0.008	<0.021	<0.005	<0.027	0.200	<0.006	<0.011	<0.017
	95th	<0.004	0.006	<0.017	<0.003	<0.005	<0.040	<0.006	<0.002	<0.013
	90th	<0.004	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	2.0%	13.2%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%

d. Prairie Gateway and Texas Fruitful Rim

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.

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 of Texas, the high-use area the Agency chose for the PRZM EXAMS surface-water modeling scenario. 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).

NAWQA study units have been identified for four other major basins: the **Canadian-Cimarron River Basins, Kansas River Basin, Middle Arkansas River Basin** and **Southern High Plains**. However, work has not begun in these study units, and starting dates have not been scheduled.

Table III.E.1-4 Magnitude and Frequency of Occurrence of OP Pesticides

Analyzed in the NAWQA Study for Study Units Found in the Prairie Gateway

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Trinity River Basin										
All Locations	Maximum	0.110	2.300	0.05	0.018	0.380	0.55	0.230	0.016	0.018
	99th	0.069	1.186	0.059	0.012	0.144	0.135	0.044	0.011	0.016
	95th	0.033	0.396	0.017	0.003	0.030	0.001	0.006	0.002	0.013
	90th	0.017	0.186	0.017	0.003	0.014	0.001	0.006	0.002	0.013
	80th	0.009	0.061	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.037	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.7%	61.3%	0.6%	0.0%	9.2%	1.6%	1.6%	0.0%	0.0%
Agriculture	Maximum	0.048	0.160	0.05	0.012	0.038	0.55	0.230	0.011	0.013
	99th	0.012	0.110	0.060	0.012	0.026	0.437	0.044	0.011	0.013
	95th	0.009	0.024	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.016	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	9.4%	46.2%	0.6%	0.0%	2.9%	1.8%	2.9%	0.0%	0.0%
Range	Maximum	0.004	0.037	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.036	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.032	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.024	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.110	2.300	0.021	0.018	0.38	0.14	0.051	0.016	0.018
	99th	0.089	2.040	0.018	0.017	0.237	0.114	0.050	0.016	0.017
	95th	0.068	1.175	0.017	0.003	0.140	0.053	0.006	0.002	0.013
	90th	0.050	0.665	0.017	0.003	0.068	0.001	0.006	0.002	0.013
	80th	0.032	0.420	0.017	0.003	0.029	0.001	0.006	0.002	0.013
	75th	0.027	0.375	0.017	0.003	0.022	0.001	0.006	0.002	0.013
	50th	0.011	0.140	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	71.2%	97.0%	0.0%	0.0%	31.8%	3.0%	0.0%	0.0%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Mixed	Maximum	0.022	0.340	0.021	0.005	0.0339	0.050	0.006	0.011	0.017
	99th	0.020	0.271	0.020	0.004	0.031	0.037	0.006	0.009	0.016
	95th	0.014	0.075	0.017	0.003	0.022	0.001	0.006	0.002	0.013
	90th	0.010	0.072	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	80th	0.005	0.053	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.048	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.030	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	22.2%	92.6%	0.0%	0.0%	11.1%	0.0%	0.0%	0.0%	0.0%
South-Central Texas										
All Locations	Maximum	0.105	0.527	0.0651	0.128	0.142	0.18	0.132	0.083	0.109
	99th	0.010	0.210	0.021	0.008	0.084	0.050	0.006	0.011	0.017
	95th	0.007	0.095	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.063	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	80th	0.004	0.029	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	19.2%	56.0%	0.5%	0.5%	9.3%	0.6%	0.5%	0.5%	1.1%
Agriculture	Maximum	0.008	0.059	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	99th	0.007	0.047	0.017	0.003	0.007	0.001	0.006	0.002	0.013
	95th	0.006	0.017	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.005	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	20.6%	38.2%	0.0%	0.0%	8.8%	0.0%	0.0%	0.0%	2.9%
Range	Maximum	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.005	0.004	0.019	0.004	0.018	0.030	0.006	0.007	0.015
	75th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.010	0.527	0.021	0.005	0.107	0.05	0.006	0.011	0.017
	99th	0.010	0.430	0.021	0.005	0.0925	0.05	0.006	0.011	0.017
	95th	0.009	0.176	0.021	0.005	0.029	0.050	0.006	0.011	0.017
	90th	0.006	0.138	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.005	0.072	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	75th	0.005	0.069	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	29.4%	76.5%	0.0%	0.0%	19.6%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.105	0.159	0.065	0.128	0.142	0.180	0.132	0.083	0.109
	99th	0.028	0.123	0.029	0.041	0.049	0.076	0.030	0.025	0.034
	95th	0.006	0.052	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.040	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.028	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.022	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	15.9%	59.8%	1.2%	1.2%	4.9%	1.2%	1.2%	1.2%	1.2%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Central Nebraska										
All Locations	Maximum	0.140	0.039	0.021	0.021	0.054	0.0078	0.061	0.019	0.270
	99th	0.109	0.023	0.021	0.005	0.027	0.050	0.025	0.011	0.020
	95th	0.035	0.012	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.018	0.006	0.017	0.003	0.007	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	21.6%	23.2%	0.0%	0.0%	6.1%	0.6%	2.8%	0.0%	0.8%
Agriculture	Maximum	0.130	0.014	0.021	0.021	0.054	0.003	0.061	0.019	0.190
	99th	0.109	0.011	0.021	0.007	0.027	0.052	0.055	0.012	0.020
	95th	0.032	0.005	0.017	0.005	0.017	0.040	0.006	0.011	0.017
	90th	0.020	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.007	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.9%	8.6%	0.0%	0.0%	5.9%	0.5%	2.7%	0.0%	0.5%
Mixed	Maximum	0.140	0.0394	0.021	0.005	0.0444	0.050	0.028	0.011	0.270
	99th	0.109	0.025334	0.021	0.005	0.029	0.050	0.022	0.011	0.019
	95th	0.047	0.01454	0.017	0.003	0.020	0.001	0.006	0.010	0.013
	90th	0.016	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.8%	39.9%	0.0%	0.0%	5.5%	0.0%	3.1%	0.0%	1.2%

e. Eastern Uplands

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

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

No OPs were detected in ground-water sampling for the Upper Tennessee River (UTEN) NAWQA study. Thirty monitoring wells were located next to

tobacco fields, while 30 additional wells and 35 springs were randomly selected from around the Valley and Ridge portion of the study site. Each well or spring was sampled a single time. Domestic wells are the main source of drinking water for one-third of the popluation in the UTEN study region.

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

Chlorpyrifos was detected in one of 60 domestic or supply wells in the Kanawha-New River (KANA) NAWQA study at a concentration of 0.004 ppb. Thirty of the wells were located in the mountainous coal-mining Appalachian Plateau physiographic province in West Virginia. Chlorpyrifos was detected in a well in the relatively more agricultural Blue Ridge physiographic province, in the southern portion of the study unit. Domestic wells are reported to supply drinking water to thirty percent of the population in the KANA study unit.

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

Diazinon was also detected in ground water in six of 58 samples from major aquifers in the Allegheny-Monongahela River (ALMN) NAWQA study, with a maximum concentration of 0.007 ppb. Domestic wells are reported by the USGS as the major source of drinking water for people living in rural areas of the ALMN study unit.

Table III.E.1-5 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Eastern Uplands

Land Use	Value	chlor-pyrifos	diazinon	disulfoton	ethoprop	mala-thion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentration, ug/L								
Upper Tennessee River Basin										
All Locations	Maximum	0.033	0.590 [1]	<0.021	0.018	0.046 [1]	0.0386	<0.006	<0.011	<0.017
	95th	0.005	0.005	<0.017	<0.003	<0.005	<0.050	<0.006	<0.002	<0.013
	90th	0.005	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	10.1%	12.1%	0.0%	0.4%	1.4%	0.2%	0.0%	0.0%	0.0%
Agriculture	Maximum	0.033	0.006	<0.021	<0.005	0.015	<0.11	<0.006	<0.011	<0.017
	95th	0.006	0.004	<0.017	<0.003	<0.008	<0.050	<0.006	<0.002	<0.013

Land Use	Value	chlor-pyrifos	diazinon	disulfoton	ethoprop	mala-thion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentration, ug/L								
	90th	0.005	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	13.2%	3.9%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%
Forestry	Maximum	0.012	0.066	<0.021	0.018	0.015	0.0386	<0.006	0.011	0.017
	95th	0.005	0.008	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	90th	<0.005	0.005	<0.017	<0.003	<0.005	<0.005	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	5.0%	16.3%	0.0%	1.3%	1.3%	1.3%	0.0%	0.0%	0.0%
Mixed	Maximum	0.014	0.040	<0.021	0.015	0.0061	<0.700	<0.006	<0.011	<0.017
	95th	0.005	0.005	<0.017	<0.003	<0.005	<0.200	<0.006	<0.002	<0.013
	90th	<0.004	0.005	<0.017	<0.003	<0.005	<0.034	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	8.6%	14.8%	0.0%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%
(1) The maximum concentrations of diazinon and malathion occurred at a sample site located in a watershed influenced by mining. Sample sites representing watersheds with mining land uses were not broken out separately in this summary table.										
Kanawha-New River Basin										
All Locations	Maximum	0.004	0.004	<0.017	<0.003	0.005	<0.06	<0.006	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	4.4%	1.5%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%
NOTE: Because of the low number of samples (68 samples were analyzed for OPs) and the low frequency of detects, monitoring data for this study unit were not broken down by land use within the watershed.										
Allegheny and Monongahela River Basin										
All Locations	Maximum	0.010	0.097	<0.017	<0.003	<0.020	0.033	<0.006	<0.002	<0.013
	95th	<0.004	0.027	<0.017	<0.003	<0.005	<0.010	<0.006	<0.002	<0.013
	90th	<0.004	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	0.003	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	7.4%	27.2%	0.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%
Agriculture	Maximum	0.010	0.094	<0.017	<0.003	<0.005	0.033	<0.006	<0.002	<0.013
	95th	0.009	0.016	<0.017	<0.003	<0.005	<0.220	<0.006	<0.002	<0.013
	90th	0.005	0.003	<0.017	<0.003	<0.005	<0.066	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	21.1%	10.5%	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%
Urban	Maximum	<0.004	0.097	<0.017	<0.003	<0.005	<0.8	<0.006	<0.002	<0.013
	95th	<0.004	0.051	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	0.027	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	6.5%	35.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	<0.004	0.010	<0.017	<0.003	<0.02	<0.010	<0.006	<0.002	<0.013
	95th	<0.004	0.006	<0.017	<0.003	<0.010	<0.006	<0.006	<0.002	<0.013
	90th	<0.004	0.005	<0.017	<0.003	<0.010	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	0.0%	23.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

f. Southern Seaboard

The **Albemarle-Pamlico Drainage Basin (ALBE) NAWQA** study unit is located primarily in the Piedmont and Coastal Plain physiographic provinces of southeastern Virginia and northeastern North Carolina. Nearly equivalent portions of the population derived drinking water from surface water and ground water in 1990, with one-third of the population drawing water from domestic wells.

Shallow wells (< 50 feet) in unconsolidated surficial aquifers were sampled because they were most likely to be vulnerable to contamination. Several public supply wells were also included to see if pumping drew contamination from the surficial wells. Diazinon was detected in 7% of ground-water samples, and chlorpyrifos in a single ground-water sample. The USGS Circular 1157 indicates that both were detected in the agricultural (corn-soybean) land-use study, but does not indicate whether some of the diazinon detections occurred in the Virginia Beach urban land-use study. The maximum concentration of diazinon in ground water was about 0.1 ug/l. The single detection of chlorpyrifos was <0.01 ug/l.

Diazinon (9.5%) and chlorpyrifos (13.9%) were the OPs most frequently detected in agricultural streams, although both were more often detected in mixed land-use streams. Diazinon was detected at a maximum concentration of 0.11 ug/l in these streams, and chlorpyrifos at a maximum of 0.058 ug/l. Malathion was detected in 7.7% of all samples, with a maximum detection of 0.055 ug/l. Ethoprop was detected in 4.4% of all samples, with a maximum detection of 0.8 ug/l in an agricultural stream. Phorate and azinphos methyl were detected in little more than 1% of samples each, with maximum concentrations of about 0.03 ug/l. Terbufos was detected in a single mixed land-use sample at 0.01 ug/l. Surface water was collected at four intensive sampling sites, and 66 other stream sites sampled one to six times in the study.

The **Apalachicola-Chattahoochee-Flint River Basin (ACFB) NAWQA** study site extends from north of Atlanta along the Georgia-Alabama border through the Florida panhandle to the Gulf of Mexico. The northern portion of the study unit is in the Piedmont physiographic province, and the southern portion in the Coastal Plain. Ninety-three percent of the population in the Piedmont derived drinking water from surface water in 1990, while surface water and ground water served nearly equivalent populations in the Coastal Plain. Nearly half of the ground water in the basin was supplied by the vulnerable, karst limestone, Upper Floridan aquifer.

Pesticides were most frequently detected in the karst recharge areas of the Upper Floridan aquifer, but OPs were rarely detected. USGS Circular 1164 indicates that chlorpyrifos and terbufos were both detected once at about 0.01 µg/l, but the dataset available on the study unit world wide web

page does not include these detections. Diazinon was detected twice in the urban land-use study. Malathion was detected once in the agricultural land-use study at a concentration of 0.011 µg/l.

Diazinon, chlorpyrifos and malathion were frequently detected in this study unit, but almost exclusively in urban or suburban stream samples. Malathion was detected in an urban stream with a maximum concentration of 0.14 µg/l. Ethoprop was detected twice in urban or suburban streams, and once in an agricultural stream (maximum concentration 0.021 µg/l). Azinphos-methyl, disulfoton and terbufos were detected once each in urban or suburban streams, at concentrations of 0.018 µg/l or less.

The **Potomac River Basin (POTO) NAWQA** study unit is comprised of parts of Virginia, West Virginia, Maryland, Pennsylvania and the District of Columbia. Surface water is the dominant source of drinking water in this basin, although nearly 800,000 people in the basin relied on domestic wells in 1990.

Surface-water sites included for intensive sites sampled 24 times a year for two years in agricultural and urban areas. Twenty-three tributaries with watersheds of greater than 100 square miles were sampled once each, and 25 to 39 tributaries with smaller basins were sampled once each for three years. Diazinon was the most detected OP, found in 24% of samples, with a maximum concentration of 1.4 ug/l.Chlorpyrifos was detected in 8% of samples, with a maximum concentration of 0.041 ug/l. Methyl parathion was detected in 2% of samples, but some portion of these detections might be due to since-cancelled orchard uses. Malathion, ethoprop and azinphos methyl were also detected in fewer than 5% of samples.

Ground-water was sampled one time from each of 48 wells in the Piedmont and physiographic province from the Washington DC metropolitan area through central Maryland. Another 54 agricultural and 3 forest region wells were sampled once each to the west in the Valley and Ridge physiographic region. Chlorpyrifos is described as an important agricultural chemical in the Potomac River Basin, with use on corn, alfalfa and apples. It was detected in two ground-water samples, with a maximum concentration of about 0.05 ug/l. Diazinon was detected in ground water three times, with a maximum concentration of about 0.01 ug/l, and malathion once at <0.005 ug/l. Neither is listed as a major agricultural chemical in the region.

The **Santee River Basin and Coastal Drainages (SANT) NAWQA** study unit includes much of South Carolina, and extends into southwestern North Carolina. Eighty-six percent of drinking water in this region is from rivers and reservoirs, although rural regions which are not on public supply rely on domestic wells. In the north of the study unit, the relatively undeveloped land in the Blue Ridge physiographic province has little affect on water quality. However, development is more extensive in the Piedmont, and the rivers

which provide drinking water are well-regulated, as 85% of water use is for the production of energy. Toward the coast, slow-moving rivers in the Coastal Plain run through marshland and row-crop farmland.

Analysis for pesticides was included in intensive (3 sites) and fixed-site (13 sites) surface water studies over a range of land uses, and at 16 urban sampling sites. Chlorpyrifos, diazinon and malathion were the only OPs detected more than once. All three were detected in more than half of urban samples, but only chlorpyrifos (60%) was detected in more than 10 % of agricultural samples. Chlorpyrifos was detected at a maximum concentration of 0.03 µg/l in an agricultural stream, and malathion at 0.216 in an urban stream. Methyl parathion was detected once in an urban stream at 0.013 µg/l.

Ground-water studies included single samples from 90 public supply, domestic, irrigation and industrial wells from throughout the study unit. Thirty wells each were sampled from the Piedmont, Sandhills and Floridan aquifers. Of the three, the Sandhills is the most vulnerable, as the Piedmont and Floridan underlie weathered bedrock and a clay confining layer, respectively. An agricultural land use study included single samples from 30 wells in row-crop areas, and an urban land-use study included single samples from 30 wells in commercial and residential areas.

Diazinon was detected in a single agricultural well at around 0.005 µg/l, and in a well from the Sandhills aquifer at about 0.06 µg/l. Chlorpyrifos and diazinon were detected in 2 and 3 urban wells, respectively. No other OPs were detected in ground water.

The **Delmarva Peninsula (DLMV) NAWQA** study unit began sampling in 1999. Preliminary data include detections of chlorpyrifos, diazinon and malathion. Sampling is scheduled to be completed in 2001.

Sampling in the **Mobile River and Tributaries (MOBL) NAWQA** study unit began in 1997. Data from this study is not yet available.

Table III.E.1-6 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Southern Seaboard

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Albemarle										
All Locations	Maximum	0.058	0.110	0.021	0.800	0.067	0.031	0.020	0.033	0.01
	99th	0.020	0.066	0.021	0.013	0.044	0.031	0.006	0.024	0.017
	95th	0.008	0.013	0.017	0.005	0.021	0.020	0.006	0.010	0.013
	90th	0.005	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.6%	28.1%	0.0%	4.4%	7.7%	1.1%	0.0%	1.4%	0.3%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Agriculture	Maximum	0.058	0.110	0.017	0.800	0.055	0.013	0.006	0.019	0.013
	99th	0.034	0.073	0.017	0.021	0.010	0.001	0.006	0.019	0.013
	95th	0.009	0.008	0.017	0.003	0.005	0.001	0.006	0.010	0.013
	90th	0.006	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	13.9%	9.5%	0.0%	5.0%	3.0%	1.0%	0.0%	2.0%	0.0%
Mixed	Maximum	0.030	0.110	0.021	0.014	0.067	0.031	0.020	0.033	0.01
	99th	0.012	0.044	0.021	0.010	0.046	0.031	0.006	0.011	0.017
	95th	0.007	0.018	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.012	0.017	0.005	0.023	0.024	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.3%	54.2%	0.0%	3.9%	13.7%	1.3%	0.0%	0.7%	0.7%
Santee River										
All Locations	Maximum	0.095	0.323	0.021	0.005	0.216	0.039	0.013	0.011	0.017
	99th	0.062	0.116	0.021	0.005	0.097	0.039	0.006	0.011	0.017
	95th	0.022	0.031	0.021	0.005	0.029	0.050	0.006	0.011	0.017
	90th	0.014	0.020	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.007	0.008	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	75th	0.006	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	39.9%	24.3%	0.0%	0.0%	15.9%	0.0%	0.4%	0.0%	0.0%
Agriculture	Maximum	0.030	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	99th	0.027	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	95th	0.014	0.006	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.005	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%
Forest	Maximum	0.007	0.015	0.017	0.003	0.018	0.001	0.006	0.002	0.013
	99th	0.006	0.010	0.017	0.003	0.01306	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	Frequency	2.6%	2.6%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.095	0.323	0.021	0.005	0.216	0.05	0.0125	0.011	0.017
	99th	0.084	0.298	0.021	0.005	0.18518	0.05	0.008	0.011	0.017
	95th	0.022	0.102	0.021	0.005	0.089	0.050	0.006	0.011	0.017
	90th	0.015	0.048	0.017	0.003	0.059	0.001	0.006	0.002	0.013
	80th	0.011	0.032	0.017	0.003	0.028	0.001	0.006	0.002	0.013
	75th	0.010	0.030	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	50th	0.005	0.018	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	Frequency	67.6%	80.9%	0.0%	0.0%	48.5%	0.0%	1.5%	0.0%	0.0%
Mixed	Maximum	0.006	0.015	0.021	0.005	0.0886	0.050	0.006	0.011	0.017
	99th	0.005	0.011	0.021	0.005	0.049	0.050	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	1.5%	7.7%	0.0%	0.0%	6.2%	0.0%	0.0%	0.0%	0.0%
All Locations	Maximum	0.170	2.800	0.018	0.021	0.140	0.11	0.006	0.011	0.017
	99th	0.059	0.255	0.021	0.005	0.045	0.05	0.006	0.011	0.017
	95th	0.016	0.063	0.017	0.005	0.027	0.050	0.006	0.002	0.013
	90th	0.011	0.032	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	80th	0.005	0.016	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.6%	46.5%	0.2%	0.5%	6.7%	0.2%	0.0%	0.0%	0.2%
Agricultural Cropland	Maximum	0.099	0.012	0.021	0.010	0.009	0.05	0.006	0.011	0.017
	99th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.6%	0.6%	0.0%	0.6%	1.3%	0.0%	0.0%	0.0%	0.0%
Urban Residential	Maximum	0.170	2.800	0.018	0.021	0.14	0.11	0.006	0.011	0.017
	99th	0.085	0.366	0.021	0.008	0.06669	0.05	0.006	0.011	0.017
	95th	0.040	0.124	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	90th	0.020	0.067	0.017	0.003	0.017	0.001	0.006	0.002	0.013
	80th	0.011	0.033	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.010	0.029	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequenc	50.0%	81.9%	0.4%	0.9%	11.6%	0.4%	0.0%	0.0%	0.4%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	y									
Mixed	Maximum	0.018	0.103	0.021	0.005	0.044	0.300	0.006	0.011	0.017
	99th	0.014	0.063	0.021	0.005	0.035	0.070	0.006	0.011	0.017
	95th	0.010	0.029	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.008	0.019	0.017	0.003	0.016	0.001	0.006	0.002	0.013
	80th	0.005	0.013	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequenc y	21.8%	52.8%	0.0%	0.0%	6.3%	0.0%	0.0%	0.0%	0.0%
Georgia portion of GA-FL coastal Plain										
All Locations	Maximum	0.028	0.097	0.021	0.018	0.226	0.166	0.200	0.003	0.018
	99th	0.017	0.068	0.021	0.010	0.027	0.073	0.006	0.011	0.017
	95th	0.007	0.010	0.017	0.005	0.026	0.050	0.006	0.002	0.013
	90th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequenc y	8.9%	11.6%	0.3%	4.0%	5.2%	0.6%	0.0%	0.3%	0.3%
Agricultural	Maximum	0.021	0.025	0.021	0.018	0.025	0.166	0.200	0.003	0.018
	99th	0.014	0.007	0.021	0.009	0.025	0.079	0.006	0.011	0.017
	95th	0.006	0.002	0.017	0.005	0.007	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequenc y	6.7%	1.4%	0.5%	3.3%	2.9%	1.0%	0.0%	0.5%	0.5%
Mixed	Maximum	0.028	0.097	0.021	0.015	0.226	0.3	0.050	0.020	0.017
	99th	0.018	0.087	0.021	0.012	0.033	0.05	0.032	0.011	0.017
	95th	0.008	0.026	0.021	0.006	0.027	0.050	0.006	0.011	0.017
	90th	0.006	0.011	0.017	0.005	0.017	0.001	0.006	0.002	0.013
	80th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequenc y	13.5%	31.5%	0.0%	5.4%	9.9%	0.0%	0.0%	0.0%	0.0%

g. Southwest Fruitful Rim

The **Sacramento River Basin (SACR) NAWQA** study site includes the Sacramento Valley in the Fruitful Rim, SW. The Sacramento River is the largest river in the State of California, and is a highly managed water body

which meets the needs of the more than one million people in the Sacramento area. The USGS indicates that while the concentrations of OP insecticides in agricultural and urban streams in this region “sometimes exceed amounts that are toxic to zooplankton in laboratory tests, the toxicity is greatly reduced or eliminated when concentrations of these pesticides are diluted by the Sacramento River” (USGS Water Resources Circular 1215).

Surface-water monitoring included 3 intensive sampling sites, including the Colusa Basin Drain, which in the late 1980s had elevated concentrations of methyl parathion and malathion detected. Since that time, a program to reduce spray drift and increase paddy-water holding time has reduced detected concentrations dramatically. A description of this program is included in the State Monitoring Appendix. An urban intensive study site was also sampled.

In the SACR study, chlorpyrifos, diazinon, malathion and azinphos-methyl were detected in surface water. Diazinon was detected in 71% of agricultural samples, and 35% of mixed land-use samples, with a maximum concentration of slightly over 0.1 ug/l. Chlorpyrifos was detected in 29% of agiricultural samples, and a single mixed land-use sample, with a maximum concentration detected of about 0.05 ug/l. Malathion was detected in 53% of urban samples and 33% of agricultural samples, with a maximum detection of nearly 1 ug/l.

An aquifer study in the SACR included single samples of 31 domestic wells in the southeastern Sacramento Valley, where the Sacramento Valley aquifer is an important domestic and irrigation water source. Ground water in some other parts of the Sacramento Valley are not potable, due to elevated levels of fluoride and boron. A rice land-use study included single samples from 28 monitoring wells installed near the water table beneath or near rice fields. Finally, 19 urban monitoring wells were sampled once each from the surficial, unconfined aquifer. No OPs were detected in ground water from any of these studies.

The **San Joaquin-Tulare Basins (SANJ) NAWQA** study site includes the southern Central Valley of California. Surface water accounts for more overall water use than ground water, but ground water is the predominant source of drinking water in this region (USGS Water Resources Circular 1159). Irrigation accounts for the greatest amount of water use, and is also the greatest source of aquifer recharge, which can lead to contamination of ground water with agricultural chemicals.

Ground-water monitoring in the SANJ included single samples from 30 domestic wells around the eastern portion of the valley. Monitoring also included in single samples from 20 domestic wells and 10 monitoring wells each in almond, vineyard and row crop land-use ground-water studies. More than 50% of the monitoring wells in each of these studies was within a quarter-mile of cropped fields. Chlorpyrifos, malathion and diazinon were detected in one, two and three ground water samples, respectively. One detection of

malathion at 0.1 ug/l was the highest OP concentration detected in ground water.

The SANJ report specifically mentions that “high concentrations of organophosphate insecticides, resulting from application to some orchards during the winter, are of particular concern” (USGS Water Resources Circular 1159). Surface-water monitoring included biweekly to monthly sampling at intensive agricultural, rangeland and urban sites in 1993. Another 23 sites were sampled once at low flow in urban and agricultural areas.

Diazinon was detected in 71% of samples taken, with a maximum concentration of 3.8 ug/l. Chlorpyrifos was detected in 52 % of samples, with a maximum concentration of about 0.5 ug/l. Azinphos methyl was also extensively (12%) detected, with a maximum concentration of about 1.0 ug/l. Malathion was detected in 8% of samples, with a maximum concentration between 0.5 and 1.0 ug/l. Ethoprop, disulfoton, methyl parathion and terbufos were detected in fewer than 1% of samples analyzed.

The maximum concentrations of chlorpyrifos were detected in samples taken around the winter application season.

The USGS San Joaquin River Basin study included a study designed to determine sampling frequency needed to characterize the occurrence and distribution of pesticides in surface water in a semiarid agricultural region such as the SJRB. Results indicated that sampling three times per week is more likely to detect higher concentrations than once per week as indicated by the larger variance about the median for the more frequent sampling. Sampling once per week is sufficient if only the median concentration is important.

The **Central Arizona Basins (CAZB) NAWQA** study unit is located in southern and central Arizona. The dominant source of drinking water in central Arizona are deep basin aquifers, some of which may have been recharged thousands of years ago. At the very least, 55% of wells tested in the Central Arizona Basins NAWQA study area (CAZB) were recharged before 1953 (USGS Water Resources Circular 1213).

The main aquifers in the Central Arizona region were formed by the sedimentary infilling of structural depressions typical of the Basin and Range physiographic province. These sediments, which range in thickness from a few thousand to as much as 10,000 feet, have led to a topography of broad, sloping plains interrupted by sharply rising mountains (USGS Professional Paper 1406-A). Natural recharge to these aquifers occurs mainly in the foothills of the mountain ranges, where rainfall is greater, and through infiltration from larger rivers. The USGS Regional Aquifer-System Analysis program identified 72 separate basin aquifers that are “virtually independent hydrologic entities that share common geologic and hydrologic characteristics.”

Alluvial deposits in the vicinity of major streams in Arizona range in thickness up to about 300 feet, and where locally saturated serve as aquifers. Chlorpyrifos was detected in a single sample from a shallow monitoring well in the CAZB study unit, but no OP was detected in samples from wells installed in the deeper aquifers. Although a single sampling of a well network is not definitive in determining the likelihood of pesticide contamination, the depth of the aquifers, combined with the very low rainfall for the region, result in very slow recharge rates which may delay contamination by OP residues for a long time.

In the CAZB report, the USGS notes that domestic wells drawing from below confining clay beds are protected to a large extent from surface contamination. However, the older water from below this layer could be contaminated in the future if large-scale water induces downward flow through the clay layer, or through breaches through the clay layer by well-drilling. For the present, however, the Arizona portion of the Southwest Fruitful Rim should be conservatively represented by monitoring and modeling assessments for California.

Increased water withdrawal in Arizona that occurred with population growth from the middle 20th century has greatly exceeded recharge, and has led to depletion of aquifers. In addition to the loss of water that had been stored in the aquifer for hundreds of years, the withdrawal has led to compaction of pore spaces in some depleted portions of the aquifer. This has led to land subsidence in some places, and even to crevassing at the land surface.

In order to avoid permanent damage to the storage capacity of the aquifer, and to meet water needs for the long term, city and state water authorities have put in place plans to replace water taken from aquifer storage through artificial recharge.

Surface-water monitoring in this region included two intensive sampling sites from agricultural streams, and three other fixed sites which were sampled quarterly. Diazinon was detected in 97% of samples, and chlorpyrifos in 94%, all below 0.5 ug/l. malathion was detected in 26% of samples at similar concentrations. Disulfoton was detected once at nearly 1 ug/l. Azinphos methyl, methyl parathion and phorate are also reported to have been detected in surface water.

However, while these mixed agricultural/urban streams may be effected ecologically by this contamination, they are not used as drinking water sources. The two streams (Buckeye Canal and Hassayampa River) are typical of most in the region, in that flow is maintained through addition of treated wastewater effluent and irrigation return water.

Table III.E.1-7 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed

in the NAWQA Study for Study Units Found in the South Southwest Fruitful Rim

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
San Joaquin-Tulare Basins										
All Locations	Maximum	0.340	9.050	0.060	0.029	0.390	1.000	0.090	<0.06	0.100
	99th	0.182	1.148	<0.021	0.011	0.068	0.210	0.021	<0.018	0.018
	95th	0.053	0.340	<0.021	<0.005	0.027	0.056	<0.006	<0.011	<0.017
	90th	0.030	0.170	<0.021	<0.005	0.027	0.050	<0.006	<0.011	<0.017
	80th	0.015	0.080	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	75th	0.012	0.055	<0.017	<0.003	<0.015	<0.050	<0.006	<0.003	<0.013
	50th	0.005	0.016	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	61.3%	83.9%	0.1%	1.2%	13.8%	10.5%	0.3%	0.0%	0.3%
Agricultural	Maximum	0.340	9.050	<0.050	0.029	0.390	1.000	0.090	<0.06	0.100
	99th	0.258	2.180	<0.021	0.018	0.126	0.276	0.056	<0.047	0.020
	95th	0.085	0.360	<0.021	<0.005	0.027	0.099	<0.006	<0.011	<0.017
	90th	0.042	0.160	<0.021	<0.005	0.027	0.060	<0.006	<0.011	<0.017
	80th	0.025	0.082	<0.017	<0.003	<0.009	0.050	<0.006	<0.003	<0.013
	75th	0.019	0.066	<0.017	<0.003	<0.005	0.045	<0.006	<0.002	<0.013
	50th	0.008	0.020	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	66.9%	85.3%	0.0%	2.9%	12.6%	24.6%	0.6%	0.0%	0.3%
Mixed	Maximum	0.260	2.900	<0.021	0.010	0.160	0.400	0.018	<0.06	0.024
	99th	0.069	0.764	<0.021	<0.005	0.037	0.059	<0.006	<0.011	<0.017
	95th	0.030	0.230	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	90th	0.017	0.150	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	80th	0.011	0.067	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	75th	0.009	0.047	<0.021	<0.005	<0.019	<0.050	<0.006	<0.011	<0.017
	50th	0.005	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.017
	Frequency	57.4%	82.9%	0.0%	0.3%	12.2%	3.2%	0.2%	0.0%	0.3%
Sacramento R. Basin										
All Locations	Maximum	0.045	1.380	<0.021	<0.005	0.634	0.500	<0.006	<0.011	<0.017
	99th	0.033	0.780	<0.021	<0.005	0.139	0.237	<0.006	<0.011	<0.017
	95th	0.019	0.425	<0.021	<0.005	0.054	<0.050	<0.006	<0.011	<0.017
	90th	0.015	0.296	<0.021	<0.005	0.028	<0.050	<0.006	<0.011	<0.017
	80th	0.007	0.177	<0.017	<0.003	0.027	<0.017	<0.006	<0.002	<0.013
	75th	0.005	0.089	<0.017	<0.003	0.027	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.009	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	26.5%	67.7%	0.0%	0.0%	25.2%	1.3%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.016	0.106	<0.021	<0.005	0.054	<0.050	<0.006	<0.011	<0.017
	99th	0.016	0.103	<0.021	<0.005	0.053	<0.050	<0.006	<0.011	<0.017
	95th	0.016	0.082	<0.021	<0.005	0.036	<0.050	<0.006	<0.011	<0.017
	90th	0.014	0.063	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	80th	0.008	0.034	<0.017	<0.003	0.027	<0.001	<0.006	<0.002	<0.013
	75th	0.005	0.030	<0.017	<0.003	0.023	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.008	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	26.5%	76.5%	0.0%	0.0%	29.4%	0.0%	0.0%	0.0%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
					Concentation (ug/L)					
Urban	Maximum	0.045	1.380	<0.021	<0.005	0.634	0.500	<0.006	<0.011	<0.017
	99th	0.041	1.186	<0.021	<0.005	0.458	0.464	<0.006	<0.011	<0.017
	95th	0.032	0.751	<0.021	<0.005	0.137	0.159	<0.006	<0.011	<0.017
	90th	0.026	0.563	<0.017	<0.003	0.083	<0.062	<0.006	<0.002	<0.013
	80th	0.020	0.434	<0.017	<0.003	0.055	<0.024	<0.006	<0.002	<0.013
	75th	0.017	0.410	<0.017	<0.003	0.048	<0.001	<0.006	<0.002	<0.013
	50th	0.009	0.275	<0.017	<0.003	0.015	<0.001	<0.006	<0.002	<0.013
	Frequency	78.4%	100.0%	0.0%	0.0%	56.8%	2.7%	0.0%	0.0%	0.0%
Mixed	Maximum	0.006	0.154	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	99th	0.005	0.071	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	95th	<0.005	0.049	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	90th	<0.005	0.035	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	80th	<0.005	0.015	<0.019	<0.004	<0.024	<0.028	<0.006	<0.006	<0.015
	75th	<0.004	0.011	<0.017	<0.003	<0.01	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.003	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	3.6%	50.0%	0.0%	0.0%	9.5%	1.2%	0.0%	0.0%	0.0%
Central Arizona Basin										
All Locations	Maximum	0.154	0.207	0.826	<0.005	0.270	0.300	0.521	0.080	<0.017
	99th	0.152	0.132	0.775	<0.005	0.256	0.242	0.503	0.013	<0.017
	95th	0.067	0.111	0.021	<0.005	0.243	0.091	0.256	0.011	<0.017
	90th	0.047	0.102	<0.018	<0.003	0.118	0.050	0.036	<0.010	<0.013
	80th	0.029	0.082	<0.017	<0.003	0.027	0.006	<0.006	<0.002	<0.013
	75th	0.025	0.077	<0.017	<0.003	0.015	<0.001	<0.006	<0.002	<0.013
	50th	0.016	0.056	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	82.7%	82.7%	4.1%	0.0%	24.5%	1.0%	9.2%	5.1%	0.0%
Agricultural	Maximum	0.154	0.207	0.826	<0.003	0.270	0.300	0.521	0.080	<0.013
	99th	0.153	0.170	0.801	<0.003	0.263	0.204	0.512	0.047	<0.013
	95th	0.122	0.083	0.747	<0.003	0.252	<0.074	0.453	0.011	<0.013
	90th	0.067	0.079	<0.017	<0.003	0.160	<0.032	0.259	0.004	<0.013
	80th	0.047	0.070	<0.017	<0.003	0.017	<0.001	0.036	<0.002	<0.013
	75th	0.038	0.058	<0.017	<0.003	0.013	<0.001	<0.006	<0.002	<0.013
	50th	0.020	0.037	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	93.8%	89.6%	8.3%	0.0%	29.2%	2.1%	18.8%	10.4%	0.0%
Mixed	Maximum	0.043	0.123	<0.017	<0.003	0.243	<0.24	<0.006	<0.002	<0.013
	99th	0.039	0.119	<0.017	<0.003	0.213	<0.226	<0.006	<0.002	<0.013
	95th	0.032	0.112	<0.017	<0.003	0.131	<0.12	<0.006	<0.002	<0.013
	90th	0.029	0.110	<0.017	<0.003	0.119	<0.048	<0.006	<0.002	<0.013
	80th	0.025	0.103	<0.017	<0.003	0.018	<0.001	<0.006	<0.002	<0.013
	75th	0.024	0.100	<0.017	<0.003	0.006	<0.001	<0.006	<0.002	<0.013
	50th	0.017	0.074	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	94.6%	100.0%	0.0%	0.0%	27.0%	0.0%	0.0%	0.0%	0.0%

h. Mississippi Portal

The **Mississippi Embayment NAWQA** study unit extends from northeast Louisiana along the Mississippi River as it forms the borders of Mississippi, Arkansas, Tennessee and Missouri. The USGS description of the region states that 62% is used for agriculture, up to 90% in areas of intensive row-crop agriculture. About 94% of drinking water supplies in this study unit were derived from ground water in 1995 (USGS Circular 1208).

As mentioned above, none of the nine active OPs included as analytes were detected in ground water studies in this study unit. Thirty public-supply wells screened in the deep Tertiary aquifers, which represent the most important drinking water source in the study unit, were sampled once each in 1996. Fifty-four irrigation wells in surficial sedimentary aquifers were also sampled a single time. Another 32 wells screened in the shallow, unconfined Memphis aquifer, but this is not an area of significant OP use.

Surface-water sampling resulted in the detection of multiple OPs. Sampling programs included three agricultural streams, one mixed use stream, and one urban stream sampled at least biweekly for two years. In addition, 38 sites from “streams that drained all major crop types grown in the Study Unit” were sampled once each (USGS Circular 1208).

Diazinon and chlorpyrifos were detected in 96% and 100% of urban stream samples, respectively. They were detected in 4% and 6% of agricultural stream samples. Malathion was detected in 56% of urban, 36% of mixed use, and 11% of agricultural samples, with a maximum concentration of 0.616 ug/l (agricultural).

Other OPs were detected in surface water as well. Methyl-parathion was detected in 10% of samples, with a maximum concentration of 0.422 ug/l. Azinphos-methyl was detected in 5 samples, with a maximum detected concentration of 1.0 ug/l. Disulfoton was detected in three samples, with a maximum detection of 0.213 ug/l. Phorate was detected once at 0.2, ethoprop once at 0.206 ug/l, and terbufos twice, with a maximum concentration of 0.173 ug/l.

i. USGS Cotton Pesticide Study

The U.S. Geological Survey (USGS) Organic Geochemistry Research Group (OGRG) designed a cotton pesticide monitoring study, the results of which are published as the May 1998 USGS Fact Sheet 022-98, “Occurrence of Cotton Pesticides in Surface Water of the Mississippi Embayment.” The OGRG collected weekly samples at 8 fixed sites, and collected single samples at another 56 sites in 1996.

Seven different OPs were detected in this study above a detection limit of 0.01 ug/l
(http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.022-98.fig.8.gif).

Dicrotophos was detected in 35% of samples, methyl parathion in 18%, and profenofos and malathion in 12%. Sulprofos, chlorpyrifos and azinphos-methyl were also detected. The 90th percentile concentration detected for all OPs was 0.3 ug/l or less.

The high rate of detection in this study correlates to high use of these OPs on cotton. Methyl parathion, profenofos and dicrotophos are applied extensively to cotton. The OGRG reported that although profenofos was used three times as much as dicrotophos, dicrotophos was much more frequently detected. This is consistent with the shorter persistence of profenofos.

Table III.E.1-8 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Mississippi Portal

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Mississippi Embayment										
All Locations	Maximum	0.251	1.050	0.213	0.206	0.616	1.000	0.422	0.244	0.173
	99th	0.134	0.376	0.021	0.005	0.488	0.521	0.274	0.011	0.017
	95th	0.041	0.125	0.021	0.005	0.147	0.146	0.082	0.011	0.017
	90th	0.019	0.010	0.017	0.003	0.047	0.050	0.022	0.002	0.013
	80th	0.005	0.003	0.017	0.003	0.017	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	13.2%	14.3%	0.9%	0.3%	26.2%	1.5%	10.1%	0.3%	0.6%
Agriculture	Maximum	0.200	0.020	0.071	0.005	0.616	0.0654	0.422	0.011	0.017
	99th	0.049	0.017	0.021	0.005	0.311	0.500	0.285	0.011	0.017
	95th	0.010	0.005	0.017	0.003	0.062	0.106	0.108	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.020	0.020	0.044	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.2%	4.2%	0.9%	0.0%	15.6%	0.5%	10.4%	0.0%	0.0%
Urban	Maximum	0.251	1.050	0.021	0.005	0.560	0.0427	0.061	0.011	0.017
	99th	0.223	0.897	0.021	0.005	0.511	0.0427	0.058	0.011	0.016
	95th	0.133	0.451	0.020	0.004	0.334	0.048	0.035	0.008	0.013
	90th	0.089	0.380	0.017	0.003	0.173	0.018	0.006	0.002	0.013
	80th	0.077	0.342	0.017	0.003	0.072	0.001	0.006	0.002	0.013
	75th	0.069	0.319	0.017	0.003	0.050	0.001	0.006	0.002	0.013
	50th	0.036	0.154	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	Frequency	92.9%	96.4%	0.0%	0.0%	57.1%	3.7%	7.1%	0.0%	3.6%
Mixed	Maximum	0.186	0.242	0.213	0.206	0.560	0.900	0.312	0.244	0.173
	99th	0.052	0.042	0.036	0.021	0.526	0.630	0.126	0.030	0.029
	95th	0.011	0.010	0.021	0.005	0.217	0.300	0.055	0.011	0.017
	90th	0.005	0.006	0.020	0.005	0.095	0.120	0.020	0.009	0.017
	80th	0.004	0.004	0.017	0.003	0.027	0.050	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.024	0.029	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	7.5%	12.9%	1.1%	1.1%	41.9%	3.3%	10.8%	1.1%	1.1%

i. Northwest Fruitful Rim

The Fruitful Rim, NW is a region which includes several areas of high OP use, including the Willamette and Yakima Valleys in Oregon and Washington, and the Snake River Basin in Idaho. The Willamette Valley is a temperate region where many major and specialty crops are grown with and without irrigation. The agricultural area of the Yakima Valley is in a more arid location east of the Cascades, and is a region of intensive irrigation. The Snake River Valley is also a semi-arid region, where irrigation withdrawals make Idaho one of the most water-consumptive states in the Nation. The NAWQA program has study units in all three areas, but the Yakima River Basin study began in 1999, and monitoring data from this study unit are not yet available.

Due to its reliance on surface water as a drinking water source, the high use of a number of OPs, and its vulnerability to contamination, the Willamette Valley was chosen as the representative region for PRZM-EXAMS exposure modeling for the Fruitful Rim, NW. The Snake River Valley is an important potato-growing and OP use region, but it relies almost exclusively on ground water for drinking-water supplies. As described below, ground water in the Snake River Valley is vulnerable to contamination. However, monitoring data both in the Snake River Valley and nationwide suggest that surface-water sources are more vulnerable to OP contamination than ground-water sources.

The great majority of the surface water in the Fruitful Rim NW drains to the Columbia River. The Columbia is a highly managed water body, and constitutes an important source of electricity and irrigation water.

The **Willamette Basin (WILL) NAWQA** study unit is located in western Oregon. This is the high-use, high vulnerability region selected to represent the Fruitful Rim, NW through PRZM-EXAMS simulation modeling. Twenty-two percent of land in this basin is devoted to agriculture, and another 70% to forestry. The cities of Portland, Salem and Eugene are located within this study unit. In 1990, 70% of Oregon’s population lived in the Willamette Basin (USGS Circular 1161).

Surface water is the predominant source of drinking water in the area. The city of Portland derives its water from the pristine Bull Run Watershed, and is not even required to filter its water. However, water resources in the agricultural Willamette Valley are vulnerable to contamination from agricultural chemicals. Data from the WILL include some of the highest OP concentrations in the NAWQA program.

Four intensive stream-sampling sites were sampled monthly in urban and agricultural areas. Another 44 stream stations throughout the study unit were sampled once each in 1993 and 1994. Azinphos methyl, ethoprop, diazinon, malathion and chlorpyrifos were the active OPs detected in surface water of the WILL.

The highest OP concentrations in this study unit were detected in Zollner Creek, which drains a basin 99% devoted to agriculture. Forty-three pesticides in all were detected at this sampling station. Azinphos methyl was detected in 32% of samples at this site, with a maximum concentration of **7.35 ug/l.** Ethoprop was detected in 75% of Zollner Creek samples, with a maximum detection of 1.95 ug/l. Diazinon and chlorpyrifos were detected in 72% and 65% of samples, with maximum detections of 1.28 and 0.40 ug/l, respectively. The highest concentration of malathion detected in the WILL, 0.24 ug/l, was also detected in Zollner Creek.

Zollner Creek is not a direct source of drinking water. However, it illustrates the possibility of high acute concentrations and OP co-occurrence possible if sampling is undertaken near use sites. Twenty-six of the samples taken from the Zollner Creek had detections of 4 OPs, and five samples had 5 OPs detected together. The NAWQA program does not include monitoring targeted to drinking water intakes downstream from heavy OP use areas. Zollner Creek data indicates that if such a scenario exists, exposure to multiple OPs may be possible.

Ground-water studies in the WILL were designed to assess the quality of vulnerable resources. Seventy shallow domestic wells in alluvial aquifers were sampled once each, as were 53 monitoring wells in the alluvial aquifer located in irrigated and non-irrigated farmland regions. Ten further urban wells were installed near Portland, and sampled once each. Terbufos was the only OP detected, once at <0.01 ug/l.

The **Central Columbia Plateau (CCPT) NAWQA** study unit is located almost completely in the arid region of eastern Washington, spilling over into western Idaho. I is an area with extensive dryland agriculture, with irrigation from the Columbia Basin Irrigation Project in the west, and intermittent areas of ground-water irrigation. Much of the area has few, if any, natural perennial streams. The area is much less prone to surface runoff than the Willamette Valley, which was the region for surface-water modeling scenarios for the cumulative assessment.

Eighty-four percent of drinking-water supply in this region comes from ground water. However, irrigation has changed the local hydrology over the last 50 years. In the western portion of the study unit (Quincy-Pasco subunit), water from the Columbia Basin Irrigation Project has caused a rise in the water table of 50 to 500 feet. Discharge to surface-water bodies is such that NAWQA recommends sampling of irrigation wasteways as a way to monitor trends in atrazine and nitrate concentrations in this region’s ground water. Ground-water withdrawals in the North-Central subunit, by contrast, has caused up to a 150-foot decline in the water table in some places.

Ground-water studies included monitoring of ground water near irrigated row crops, orchards, and dryland grains. All three studies included both

domestic wells and monitoring wells near fields (generally within 100 feet for row crops and orchards, and edge-of-field for grains). Azinphos-methyl, chlorpyrifos and methyl parathion were all detected in ground water in the CCPT. Azinphos methyl was detected four times (1%) in the orchard study, with a maximum concentration of about 0.2 ug/l. Methyl parathion was detected twice in the same study (max 0.07 ug/l), but orchard uses of methyl parathion are being phased out (Roberts and Jones, 1996).

Many more people (more than three times as many) get their drinking water from public supply wells than domestic wells. Samples from five of more than 100 public supply wells sampled in this program were contaminated by a DDT degradate, but not newer pesticides, which suggests that the wells are drawing from older water. The USGS notes, however, that “similar pesticides at similar concentrations have been detected in public supply wells,” suggesting that the fractured basalt aquifer could have pathways of quicker recharge locally.

In addition to fixed sites throughout the study unit, the CCPT included four intensive sites sampling areas of potato, potato and corn, orchard,and wheat culture. **This targeted sampling resulted in greater than average agricultural detection of OPs in surface water**. Every OP included as an analyte was detected in at least one surface-water sample. For instance, azinphos methyl was detected in 16.4% of agricultural samples, with a maximum concentration of 0.5 ug/l. Ethoprop was detected in 9.2% of agricultural samples, with a maximum concentration of 0.22 ug/l. Chlorpyrifos was detected in 27% of agricultural samples, with a maximum concentration of 0.12 ug/l. Diazinon, malathion, methyl parathion, phorate and terbufos were all detected in 6% of samples or fewer, with maximum concentrations of <0.1 ug/l.

Every OP was also detected in stream samples described as “mixed use.” While the frequency of detection overall was less than in agricultural streams, the maximum concentrations were higher. For instance, the maximum concentration of disulfoton in these streams was **3.8 ug/l.** The rest of the OPs were detected at < 1.0 ug/l, but mostly with maximum concentrations of above 0.1 ug/l.

Therefore, higher frequencies and concentrations of OPs were found by targeted monitoring in this semi-arid area, just as they were at the Zollner Creek in the Willamette Valley.

Only 6% of land in the **Puget Sound Basin (PUGT) NAWQA** study unit is dedicated to agriculture. Drinking water in this region is drawn about equally from surface-water and ground-water sources.

No OPs were detected in three ground-water monitoring programs sampling from the Fraser aquifer in the “Puget Lowlands.” The Fraser is a

shallow, unconfined, glacial aquifer which underlies the main agricultural region in the study unit. The monitoring program included:

- ❏ 30 domestic wells throughout the Puget Lowlands
- ❏ 27 monitoring wells in residential areas
- ❏ 22 wells (21 domestic supply and 1 public supply) in regions of intensive row crop agriculture (such as raspberries).

In addition, 78 public supply wells throughout the entire study unit were sampled a single time. No OP was detected in these wells, either.

Surface-water studies in the PUGT included 4 intensive study sites (2 agricultural, 1 urban, 1 mixed-use) that were sampled weekly to monthly for a year (two for urban samples). In addition, 13 urban and residential sites were sampled 2 to 4 times each in response to detections of diazinon and other urban-use chemicals.

Diazinon was detected in 47% of agricultural surface-water samples , with a maximum concentration of 0.113 ug/l. Diazinon was detected in 84% of urban stream samples. Chlorpyrifos was only detected in urban or mixed-use samples. The only other OPs detected were malathion (1 of 20 detections from agricultural use, maximum concentration 0.087 ug/l) and ethoprop (3 detections, maximum 0.019 ug/l).

Data from the **Upper Snake River Basin (USNK) NAWQA** study unit are described below in the description of this high OP-use region.

As mentioned above, data are not yet available from the Yakima River Basin NAWQA study unit.

i. Ground-Water Assessment of Southeastern Idaho

The Snake River Valley is an important OP use area, predominantly on potatoes. However, ground-water is the predominant source of drinking water for the potato-growing region of southeastern Idaho (USGS NAWQA Circular 1208). Ground-water models which can predict potential daily exposures of pesticides in drinking water are not available. The hydrology of the Snake River Basin is such that ground water is vulnerable to contamination. However, monitoring for a limited number of OPs suggests that exposure estimates from modeling for the Willamette River Basin should be protective of drinking water in the Snake River Valley.

The Snake River Basin is a narrow area (30 to 75 miles) bounded by mountains thousands of feet high. Agricultural land is concentrated on the Snake River Plain, primarily along the Snake River and near the mouths of

tributary drainage basins. Agricultural land makes up 21% of the area of the plain, while 50% is rangeland, and 23% forested (USGS Circular 1208).

Ground-water accounts for 80% of domestic and public drinking water, it is dwarfed by the use of both surface and ground water for irrigation. Non-irrigation uses of ground-water were 5% of water use in 1980 (Prof Paper 1408-F, pF21).

Local hydrology is dominated by the withdrawal and return of irrigation water, which is required to supplement the average of 8 to 12 inches of rainfall which falls each year. Irrigation is a major source of recharge to the aquifers of the Snake River Basin, and areas where the depth to ground water is shallow are vulnerable to pesticide and nutrient contamination from irrigation return water. Irrigated agriculture in the region is concentrated water table is shallowest, along the channels of the Snake River and other surface water bodies. Several OPs have been detected in ground water at low concentrations, and the potential for drinking-water contamination is significant.

1) Hydrology

Ground water in the Snake River Basin is derived predominantly from unconfined (water table) aquifers. The aquifers in the eastern portion of the basin consist of hundreds or thousands of feet of layered basalt (ancient lava flows). Aquifers in the western portion of the basin consist of a similar thickness of mostly unconsolidated sediment. Younger, surficial alluvium aquifers occur in the vicinity of the major rivers and streams.

Irrigated crops to which OPs are applied are concentrated in the eastern portion of the Snake River Basin. The wells in the fractured, layered basalts are among the most productive in the nation, with some yielding over one million ft^3/day (USGS Professional Paper 1408-B). Because of extensive irrigation, Idaho ranks third in the nation in total water use.

Natural recharge to the basalt aquifer was from rainfall along the margins of the plain, and seepage from streams (Prof Paper 1408-F). However, by 1980, development of the aquifer and controlled use of surface water caused an estimated 67% of recharge to be from irrigation return water. This has led in some areas to water table rises significant enough to require artificial drainage. It has also led to increased flow from large springs which empty downstream from the banks of the Snake River. These springs are the major natural discharge of ground water in the eastern portion of the basin.

Surface-water flow is also greatly altered by irrigation. The

Shoshone Falls, for instance, can be reduced to a trickle during irrigation season (USGS Circular 1160). Dams in the river have created reservoirs used for irrigation water and hydroelectric power. Unlined irrigation canals further divert water from the river, then lose a significant amount of their flow to ground water.

2) Monitoring

The USGS NAWQA program undertook a monitoring program in the Upper Snake River Basin (USNK) between 1992 and 1995. Nine OPs were included in the analysis (diazinon, ethoprop, malathion, phorate, disulfoton, terbufos, methyl parathion and the since-cancelled fonofos and parathion). Diazinon, ethoprop, fonofos, malathion and phorate were detected at the two surface water sampling points at concentrations <0.1 ppb.

None of these insecticides were detected in ground-water samples collected once at 207 sites. Sampling was concentrated in the central reach of the Snake River, between the towns of Burley and Hagerman. The USGS sampled 105 wells (mostly domestic wells) in four “local land-use studies” located in this important potato and sugarbeet-growing region. There were another 43 domestic, irrigation, stock and public supply wells over many depths throughout the rest of the Snake river plain, and another 39 in tributary valleys.

While OPs were not detected in the NAWQA wells, some pesticides (mostly triazine herbicides) were detected extensively in ground water. Three or more pesticides were detected in 41% of domestic and irrigation wells in agricultural lands sampled in the Twin Falls and Burley areas. At least one pesticide was detected in 86% of the wells in the Minidoka local land use study area, which had the shallowest mean well depth (40 feet).

Two OPs were detected in ground-water in very limited monitoring which occurred before the NAWQA program began. (Rupert, 1994). In preparation for the NAWQA study, the USGS reviewed its “miscellaneous studies database” and found that pesticide analyses were undertaken between 1987 and 1991 in the upper Snake River Basin. Malathion was detected in 1989 above the reporting level of <0.1 ppb in three of 114 samples from 89 wells. The concentrations measured ranged from 0.01 to 0.02 ppb. Diazinon was detected in 1989 above the reporting level of <0.1 ppb in four of 114 samples from 89 wells. The concentrations measured ranged from 0.01 to 0.03 ppb. Wells in which pesticides were detected had a mean depth to water of 215 ft, and those in which pesticides were not detected had a mean depth to water of 376 feet.

Nitrate studies before and during the NAWQA USNK study have confirmed that shallower wells in the UNSK region are more likely to be contaminated with agricultural chemicals than deeper wells. The areas with the depth to water of <100 feet correspond to the most important agricultural areas, which are generally along the Snake River and its tributaries. Nitrate has been found in 10 to 25% of wells (mostly domestic and public supply) mentioned in the NAWQA study.

3) Conclusion

Drinking water in the Snake River plain is vulnerable to contamination from agricultural chemicals. Agricultural areas where OPs are used correspond to areas where the water table (and therefore drinking water) is shallowest (<100 feet). In addition, irrigation water is the major source of ground-water recharge in the area, bringing pesticides and nutrients to drinking-water supplies. The NAWQA USNK monitoring program has detected common contamination of ground-water with herbicides and nutrients.

However, OPs were not detected in NAWQA monitoring wells, and little other data describes OP contamination of ground water in the area. The number of OPs for which monitoring is available is limited. Although OP contamination of ground water in this region is possible, available data does not allow a detailed assessment of possible exposure.

Table III.E.1-9 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Northwest Fruitful Rim

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Willamette River Basin										
All Locations	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017
	99th	0.060	0.192	0.021	0.558	0.029	0.914	0.006	0.011	0.017
	95th	0.023	0.061	0.021	0.099	0.027	0.081	0.006	0.011	0.017
	90th	0.014	0.029	0.017	0.033	0.020	0.050	0.006	0.002	0.013
	80th	0.008	0.013	0.017	0.009	0.005	0.001	0.006	0.002	0.013
	75th	0.006	0.009	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	39.3%	49.9%	0.0%	28.7%	4.5%	9.7%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017
	99th	0.099	0.722	0.021	1.011	0.075	2.289	0.006	0.011	0.017
	95th	0.032	0.136	0.021	0.269	0.027	0.555	0.006	0.011	0.017
	90th	0.018	0.045	0.017	0.115	0.020	0.173	0.006	0.002	0.013
	80th	0.011	0.017	0.017	0.046	0.005	0.040	0.006	0.002	0.013
	75th	0.010	0.013	0.017	0.031	0.005	0.023	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	Frequency	48.0%	59.2%	0.0%	52.3%	6.6%	20.9%	0.0%	0.0%	0.0%
Ag: Zollner Creek only	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017
	99th	0.147	1.167	0.021	1.402	0.136	3.927	0.006	0.011	0.017
	95th	0.036	0.165	0.021	0.421	0.027	0.854	0.006	0.011	0.017

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	90th	0.029	0.119	0.021	0.227	0.027	0.415	0.006	0.011	0.017
	80th	0.017	0.037	0.017	0.099	0.010	0.050	0.006	0.002	0.013
	75th	0.014	0.025	0.017	0.063	0.005	0.050	0.006	0.002	0.013
	50th	0.006	0.010	0.017	0.018	0.005	0.001	0.006	0.002	0.013
	Frequency	64.8%	71.6%	0.0%	75.0%	6.8%	32.2%	0.0%	0.0%	0.0%
Ag Besides Zollner Creek	Maximum	0.032	0.170	0.017	0.054	0.013	0.099	0.006	0.002	0.013
	99th	0.023	0.082	0.017	0.043	0.012	0.077	0.006	0.002	0.013
	95th	0.011	0.010	0.017	0.013	0.007	0.001	0.006	0.002	0.013
	90th	0.009	0.009	0.017	0.006	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.0%	42.2%	0.0%	20.6%	6.3%	4.9%	0.0%	0.0%	0.0%
Forest/ Reference	Maximum	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	99th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.046	0.112	0.021	0.009	0.052	0.171	0.006	0.011	0.017
	99th	0.046	0.105	0.021	0.009	0.042	0.126	0.006	0.011	0.017
	95th	0.040	0.067	0.021	0.007	0.027	0.050	0.006	0.011	0.017
	90th	0.029	0.057	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.020	0.033	0.017	0.005	0.019	0.001	0.006	0.002	0.013
	75th	0.016	0.031	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	50th	0.006	0.023	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	60.0%	97.5%	0.0%	13.2%	10.0%	2.6%	0.0%	0.0%	0.0%
Mixed	Maximum	0.014	0.031	0.021	0.029	0.027	0.050	0.006	0.011	0.017
	99th	0.013	0.023	0.021	0.024	0.027	0.050	0.006	0.011	0.017
	95th	0.007	0.009	0.021	0.013	0.027	0.050	0.006	0.011	0.017
	90th	0.006	0.006	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	38.3%	43.5%	0.0%	14.8%	2.6%	0.9%	0.0%	0.0%	0.0%
Upper Snake River										
All locations	Maximum	0.190	0.095	0.017	0.004	0.020	0.031	0.006	0.012	0.013
	99th	0.011	0.009	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	3.0%	3.4%	0.0%	1.3%	0.4%	0.9%	0.0%	0.4%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Agricultural	Maximum	0.190	0.095	0.017	0.003	0.020	0.031	0.006	0.012	0.013
	99th	0.072	0.041	0.017	0.003	0.005	0.003	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.2%	4.2%	0.0%	0.0%	0.6%	1.2%	0.0%	0.6%	0.0%
Forest/ Reference	Maximum	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.004	0.002	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	1.6%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Central Columbia Plateau										
All locations	Maximum	0.120	0.270	3.810	0.220	0.130	0.500	0.300	0.062	0.096
	99th	0.088	0.059	0.024	0.059	0.027	0.128	0.091	0.011	0.017
	95th	0.022	0.010	0.017	0.005	0.012	0.055	0.006	0.002	0.013
	90th	0.009	0.005	0.017	0.004	0.005	0.040	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.010	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	18.9%	7.7%	2.1%	8.3%	3.5%	9.9%	1.3%	0.5%	0.5%
Agricultural	Maximum	0.120	0.100	0.035	0.220	0.093	0.500	0.094	0.045	0.087
	99th	0.116	0.052	0.022	0.107	0.027	0.134	0.007	0.011	0.017
	95th	0.057	0.005	0.017	0.005	0.011	0.072	0.006	0.002	0.013
	90th	0.016	0.002	0.017	0.004	0.005	0.050	0.006	0.002	0.013
	80th	0.006	0.002	0.017	0.003	0.005	0.013	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	26.7%	6.2%	3.1%	9.2%	5.6%	16.4%	2.1%	0.5%	0.5%
Mixed	Maximum	0.108	0.116	3.810	0.115	0.130	0.257	0.300	0.062	0.096

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	99th	0.043	0.051	0.029	0.033	0.027	0.078	0.158	0.012	0.017
	95th	0.010	0.010	0.021	0.005	0.023	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.017	0.005	0.005	0.030	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	11.4%	11.4%	1.1%	7.4%	1.1%	2.8%	0.6%	0.6%	0.6%
Puget Sound Basin										
All locations	Maximum	0.075	0.501	0.021	0.019	0.087	0.050	0.006	0.011	0.017
	99th	0.029	0.411	0.021	0.006	0.073	0.050	0.006	0.011	0.017
	95th	0.005	0.155	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.107	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.004	0.050	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.031	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.4%	50.7%	0.0%	1.4%	9.4%	0.0%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.004	0.113	0.017	0.013	0.025	0.001	0.006	0.002	0.013
	99th	0.004	0.102	0.017	0.011	0.020	0.001	0.006	0.002	0.013
	95th	0.004	0.066	0.017	0.004	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.053	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	47.1%	0.0%	5.9%	2.9%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.075	0.501	0.021	0.005	0.087	0.050	0.006	0.011	0.017
	99th	0.033	0.486	0.021	0.005	0.078	0.050	0.006	0.011	0.017
	95th	0.015	0.285	0.018	0.003	0.038	0.001	0.006	0.002	0.013
	90th	0.006	0.171	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.004	0.108	0.017	0.003	0.013	0.001	0.006	0.002	0.013
	75th	0.004	0.093	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.031	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.3%	84.2%	0.0%	0.0%	17.9%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.005	0.083	0.021	0.019	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.060	0.021	0.008	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.011	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.007	0.018	0.005	0.009	0.011	0.006	0.004	0.014
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	15.2%	0.0%	1.3%	2.5%	0.0%	0.0%	0.0%	0.0%

j. Southeast (FL) Fruitful Rim

The **Southern Florida (SOFL) NAWQA** study unit includes the Biscayne aquifer, the Everglades, and portions of the Flatwoods and highly vulnerable Central Ridge regions of Florida. The Floridan, surficial and intermediate aquifers are also important sources of drinking water in this study unit. Ground water supplied 94% of water used in the study unit in 1990 (USGS Circular 1207).

Intensive surface water sampling in the SOFL study unit included canals draining mixed use (vegetables), citrus and sugar cane fields. Diazinon and chlorpyrifos were detected at low concentrations in the mixed use canal. Chlorpyrifos(max 0.023ug/l) and malathion (max 0.084 µg/l) were detected in 25% and 20% of samples from the citrus canal, with fewer detections of azinphos-methyl, methyl-parathion and ethoprop. Ethoprop was extensively (32%) detected in the sugarcane canal, with a maximum concentration of 0.279 µg/l. Chlorpyrifos, methyl parathion, diazinon and malathion were detected less frequently, and at lower concentrations. Sugarcane is the most important use for ethoprop. Although the sugarcane canal is not used for drinking water, this targeted monitoring indicates transport of ethoprop from the fields can be expected to occur.

Pesticides were detected in 85% of the wells included in this monitoring program. However, OPs were not among pesticides detected. This is in spite of rapid recharge in shallow, unconifined aquifers. Three ground-water studies (two agricultural and one urban) were performed:

Thirty one wells were installed within the row in the tree drip line of citrus groves in the Flatwoods region of Florida. Almost all the wells were less than 15 feet deep in an area where depth to ground water ranges from two to four feet. All of the wells were sampled once in early summer, 1998 and ten wells were sampled again that fall. The NAWQA SOFL report does not indicate if OP insecticides were applied to the citrus trees before sampling http://srv3sfltpa.er.usgs.gov/gw/cbkbyparm.html .

Thirty public supply wells in the Biscayne aquifer were sampled, with depths ranging from 40 to 150 feet. Each was sampled a single time in 1998. While almost all of the wells had some kind of pesticide contamination, no OP was detected http://srv3sfltpa.er.usgs.gov/gw/psbyparm.html .

Thirty-two wells were sampled once each in the SOFL urban land-use study. Wells were shallow (10 to 50 feet deep). In addition to residential areas, wells at areas such as parks, golf courses and parking lots were included. No OPs, including urban-use pesticides like diazinon and chlorpyrifos, were detected http://srv3sfltpa.er.usgs.gov/gw/urbbyparm.html .

The **Georgia-Florida Coastal Plain (GAFL) NAWQA** study unit extends from central Florida south of Tampa to just north of Atlanta, Georgia. The USGS reports that 80% of the population in this area derives its drinking water

from ground water, and that 94% of that ground water is drawn from the Upper Floridan aquifer. About 25% of this region is devoted to agriculture, and more than half to forestry. Most of the Georgia portion of the study unit is located within the Coastal Inlands Farm resource Region.

No OP was detected in ground-water monitoring in this study unit in three studies:

❏ First study

The agricultural ground-water study is on the edge of the Fruitful Rim, SE and the Coastal Inlands Farm Resource Regions. Twenty-three shallow monitoring wells were installed in an area of intensive row-crop agriculture in Georgia. Crops in this area to which OPs are applied include peanuts, corn and cotton. The study was designed to sample recently recharged ground water in the surficial aquifers. All wells were sampled once in spring 1994, and half of these wells were resampled that summer. Herbicides were detected in 11 wells, but OPs in none.

❏ Second study

The GAFL program included 37 domestic wells in surficial deposits. Eighteen of these were in the Coastal Flatwoods and 19 were in the Southern Coastal Plain physiographic region. Only herbicides were detected in these wells. Previously, from 1985 to 1989, the Florida Department of Environmental Protection sampled 27 GAFL region wells in the Central Ridge region. OPs were not detected in these wells, either.

❏ Third study

A third ground-water study included 32 monitoring wells in urban areas. These wells, which tap the surficial and Upper Floridan aquifers, were sampled once each in 1995.

Surface-water monitoring in the GAFL study unit were located in Georgia, outside of the Fruitful Rim, SE Farm resource Region. Sampling in Florida included intensive sampling from an urban stream in Tallahassee, and a number of fixed stream-sampling stations. Diazinon and chlorpyrifos were detected frequently (54% and 45%) in urban and mixed land-use samples. Malathion was detected in 35% of urban stream samples, but not in mixed land-use samples, with a maximum concentration of 0.2 µg/l. Ethoprop, phorate, azinphos-methyl and diazinon were detected in 3 or fewer agricultural samples each, at concentrations <0.1 µg/l.

Table III.E.1-10 Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study for Study Units Found in the Southeast Fruitful Rim

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
Southern Florida										
All Locations	Maximum	0.023	0.014	0.021	0.279	0.084	0.070	0.060	0.011	0.017
	99th	0.012	0.005	0.021	0.075	0.027	0.050	0.022	0.011	0.017
	95th	0.006	0.002	0.017	0.012	0.026	0.035	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.7%	2.0%	0.0%	10.0%	8.0%	1.6%	2.0%	0.0%	0.0%
Agricultural	Maximum	0.023	0.005	0.021	0.279	0.084	0.070	0.060	0.011	0.017
	99th	0.012	0.005	0.021	0.094	0.027	0.050	0.023	0.011	0.017
	95th	0.006	0.002	0.017	0.014	0.025	0.025	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.5%	0.0%	0.0%	9.0%	8.1%	1.4%	1.8%	0.0%	0.0%
Reference	Maximum	0.004	0.002	0.017	0.003	0.015	0.0421	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.0132	0.034702	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.006	0.00511	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	5.3%	5.3%	0.0%	0.0%	0.0%
Mixed	Maximum	0.005	0.014	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.014	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.013	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.013	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	9.1%	27.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Canal-C111 (Ag)	Maximum	0.023	0.005	0.021	0.005	0.084	0.070	0.040	0.011	0.017
	99th	0.014	0.005	0.021	0.005	0.073	0.053	0.026	0.011	0.017
	95th	0.008	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.006	0.002	0.017	0.003	0.026	0.029	0.006	0.002	0.013
	80th	0.005	0.002	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.6%	0.0%	0.0%	1.2%	19.8%	3.5%	2.3%	0.0%	0.0%
Hillsboro Canal (Ag)	Maximum	0.007	0.005	0.021	0.279	0.027	0.050	0.060	0.011	0.017
	99th	0.006	0.003	0.018	0.215	0.011	0.050	0.024	0.004	0.014
	95th	0.004	0.002	0.017	0.033	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.024	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.011	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.009	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.8%	1.4%	0.0%	32.4%	1.4%	0.0%	4.1%	0.0%	0.0%
US Sugar Outflow (Ag)	Maximum	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Florida Portion of GA-FL Coastal Plain										

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
All Locations	Maximum	0.028	0.276	0.060	0.073	0.204	0.054	0.035	0.031	0.013
	99th	0.024	0.244	0.019	0.012	0.086	0.051	0.035	0.016	0.013
	95th	0.016	0.101	0.017	0.005	0.020	0.001	0.006	0.002	0.013
	90th	0.011	0.084	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	80th	0.008	0.058	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	75th	0.006	0.051	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	45.1%	54.2%	0.0%	3.5%	18.8%	2.1%	0.0%	1.4%	0.0%
Urban/ Residential	Maximum	0.028	0.276	0.017	0.007	0.204	0.001	0.006	0.002	0.013
	99th	0.0265	0.27375	0.017	0.0055	0.117	0.001	0.006	0.002	0.013
	95th	0.01725	0.16325	0.017	0.003	0.0364	0.001	0.006	0.002	0.013
	90th	0.0155	0.1005	0.017	0.003	0.02	0.001	0.006	0.002	0.013
	80th	0.011	0.081	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	75th	0.01	0.07275	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	50th	0.004	0.0445	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	52.6%	92.1%	0.0%	2.6%	35.5%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.006	0.083	0.017	0.073	0.005	0.001	0.006	0.031	0.013
	99th	0.006	0.076	0.017	0.044	0.005	0.001	0.006	0.022	0.013
	95th	0.005	0.038	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.005	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	56.8%	15.9%	0.0%	6.8%	0.0%	0.0%	0.0%	4.5%	0.0%