Chapter 13: Metolachlor

A chapter from:

Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2)

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Abbreviations

a.i.	Active Ingredient
CAS	Chemical Abstracts Service
CCL 2	Second Contaminant Candidate List
CWS	Community Water System
CWSS	Community Water System Survey
ESA	Ethane Sulfonic Acid
HRL	Health Reference Level
MRL	Minimum Reporting Level
MTBE	Methyl tertiary-butyl ether
NAWQA	National Water Quality Assessment
NCFAP	National Center for Food and Agricultural Policy
NOAEL	No Observed Adverse Effect Level
NPS	National Pesticide Survey
OA	Oxalic Acid
PGWDB	Pesticides in Ground Water Database
PWS	Public Water System
RfD	Reference Dose
RL	Reporting Limit
SDWA	Safe Drinking Water Act
SOC	Synthetic Organic Compound
UCM	Unregulated Contaminant Monitoring
UF	Uncertainty Factor
USGS	United States Geological Survey

13 Metolachlor

13.1 Definition

Metolachlor is a synthetic organic compound (SOC) with a Chemical Abstracts Service (CAS) registry number of 51218-45-2. Metolachlor is given the following chemical name: 2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide (USEPA, 1995). As a compound containing one chiral carbon atom, metolachlor can exist as either of a pair of enantiomers, designated R- and S-. In cases where the isomers are present in equal proportion, the mixture is referred to as racemic. Most of the information available for metolachlor pertains to the racemic mixture; however, in certain cases, enantiomer-specific information is presented. Trade names for metolachlor include Dual, Bicep, Codal, Cotoran multi, Milocep, Primagram, Primextra, Pennant, and Ontrack 8E (USEPA, 2000 as cited in HSDB, 2004).

13.1.1 Properties and Sources

Metolachlor is an odorless liquid that is clear to white in color when isolated or tan when in formulations (Budavari, 1996; Tomlin, 1997 both as cited in HSDB, 2004). Metolachlor belongs to the chloroacetanilide class of herbicides and works through the inhibition of protein synthesis. It is used on a variety of crops, including corn, soybeans, and sorghum, as well as for hedgerows and landscape plantings (USEPA, 1995). Metolachlor is often used in formulations with other pesticides (particularly herbicides) including atrazine, cyanazine, and fluometuron (Extoxnet, 1993).

Metolachlor is largely manufactured by the Monsanto Company and by the Ciba-Geigy Corporation (SRI International, 2000 as cited in HSDB, 2004; Extoxnet, 1993). It is most often produced as a wettable powder. Metolachlor is miscible with benzene, toluene, xylene, dimethylformamide, ethylene dichloride, cyclohexanone, methanol, and dichloromethane (Tomlin, 1997 as cited in HSDB, 2004). Other physical and chemical properties of metolachlor are listed in Exhibit 13-1.

Exhibit 13-1: Physical and Chemical Properties of Metolachlor

Identification	
CAS number	51218-45-2
Molecular Formula	$C_{15}H_{22}ClNO_2$
Physical and Chemical Properties	
Boiling Point	100 °C at 0.001 mm Hg [1]
Melting Point	- 62.1 °C [2]
Molecular Weight	283.80 g/mol [1]
K_{oc}	22 - 310 [3]
Log K_{ow}	3.13 [4]
Water Solubility	530 mg/L at 20 °C [5]
Vapor Pressure	3.14×10^{-5} mm Hg at 25 °C [5]
Henry's Law Constant	9.0×10^{-9} atm-m^3/mole at 20 °C [6] 3.7×10^{-7} (dimensionless), predicted [7]
Freundlich Isotherm Constant (K)	98,200 (µg/g)(L/µg)$^{1/n}$ [8]

[1] *Budavari, 1996 (as cited in HSDB, 2004)*

[2] *Tomlin, 1997 (as cited in HSDB, 2004)*

[3] *HSDB, 2004*

[4] *Hansch et al., 1995 (as cited in HSDB, 2004)*

[5] *Wauchope et al., 1992 (as cited in HSDB, 2004)*

[6] *Chesters et al., 1989 (as cited in HSDB, 2004)*

[7] *Speth et al., 2001*

[8] *Speth and Miltner, 1990 (as cited in Speth et al., 2001)*

13.1.2 Environmental Fate and Behavior

Due to the relatively low soil/water partitioning of metolachlor, the compound is expected to be moderately to highly mobile in soil. Substantial leaching of metolachlor from soil by run-off is expected to occur (USEPA, 1995). The mobility of metolachlor in soil varies depending on the characteristics of the soil where it is applied: high organic content may increase sorption (USEPA, 1995).

Based on its relatively low Henry's Law constant and vapor pressure, metolachlor is expected to be essentially nonvolatile from soil and water under most environmental conditions (Lyman *et al*., 1990 as cited in HSDB, 2004). In soil, microbial activity appears to be the primary method of degradation of chloroacetanilide herbicides such as metolachlor (Zimdahl and Clark, 1982; Potter and Carpenter, 1995 both as cited in Rheineck and Postle, 2000). Ahrens

(1994 as cited in HSDB, 2004) reports half-lives of 67-122 days from field experiments. Half-lives under aerobic and anaerobic conditions in a sandy loam soil are reported as 67 days and 81 days, respectively (USEPA, 1995).

Volatilization and photolysis of metolachlor are not expected to be significant removal mechanisms from water (Lyman *et al*., 1990 and Chesters *et al*., 1989 both as cited in HSDB, 2004). Hessler and Frimmel (1992 as cited in HSDB, 2004) found that photolysis is hindered by the presence of humic substances in water. Other studies have demonstrated an aqueous photolysis half-life of 70 days and a soil photolysis half-life of 8 days following exposure to natural sunlight (USEPA, 1995). Metolachlor is relatively resistant to hydrolysis at pH values of 5, 7, and 9, with no significant degradation observed after 30 days (USEPA, 1995). Gustafson (1989 as cited in HSDB, 2004) reports an estimated hydrolysis half-life in water of 210 days. Half-lives under aerobic and anaerobic conditions in water are reported as 47 days and 78 days, respectively (USEPA, 1995). Empirically, the half-life of metolachlor in lake water under summer conditions was reported to be 11 days (Kochany and Maguire, 1994 as cited in HSDB, 2004).

Metolachlor undergoes biodegradation in soil; five degradates have been identified (Chesters *et al.*, 1989 as cited in HSDB, 2004). The two primary degradates are metolachlor ESA (ethane sulfonic acid) and metolachlor OA (oxanilic acid). The transformation by soil microorganisms of metolachlor to its primary degradates has been suggested to occur as a result of displacement of the chlorine atom of the parent compound by glutathione, followed by the formation of the ESA and OA degradates by different enzymatic pathways (Barbash *et al.*, 1999). The ESA and OA degradates of metolachlor can be persistent in soil; Phillips *et al.* (1999a) found that the degradates persisted in agricultural soils for more than four years after application. The metabolites are also relatively mobile; Thurman *et al.* (1996 as cited in Rheineck and Postle, 2000) have attributed their mobility to their greater solubility relative to the parent compound. Due to their mobility, the metabolites may be transported into ground water and surface water, and may be detected more frequently and often at higher concentrations than the parent compounds (Kalkhoff *et al*., 1998; Rheineck and Postle, 2000; Trent and Paulsen, 2002; Phillips, *et al*., 1999a; Phillips, *et al*., 1999b; Eckhardt, *et al*., 1999). Once in ground water, the degradation products are likely to persist for long periods of time because microbial degradation in ground water appears to be limited (Potter and Carpenter, 1995 as cited in Rheineck and Postle, 2000).

13.2 Health Effects

The Agency established a reference dose (RfD) for metolachlor of 0.1 mg/kg/day based on a "no-observed-adverse-effect level" (NOAEL) of 9.7 mg/kg/day and an uncertainty factor (UF) of 100 (USEPA, 1995). The Agency derived the NOAEL from a one-year chronic feeding study in beagle dogs where the critical effect was decreased body weight gain. Metolachlor shows some evidence of causing developmental toxicity effects in rats but none in rabbits. The doses associated with the developmental effect in rats are greater than the NOAEL and therefore the NOAEL would be protective against developmental toxicity.

Metolachlor has been evaluated for carcinogenic activity in both rats and mice. No treatment-related cancer effects were observed in 2 studies using mice. In studies using rats,

metolachlor caused a significant increase in liver nodules and carcinomas in high dose females. Negative results from mutagenicity studies suggest that tumors may result from a nonmutagenic mode of action. In 1991, a peer review committee recommended that metolachlor be classified as a possible human carcinogen based on increases in liver tumors in the female rat. However, a peer review conducted in July 1994 recommended that the evidence for cancer was suggestive and should not be quantified. This recommendation was supported by negative mutagenicity data and recent metabolism data indicating that the formation of the metabolite presumed to be the ultimate carcinogen is very low (USEPA, 1995).

13.3 Occurrence and Exposure

13.3.1 Use and Environmental Release

Metolachlor, a broad spectrum herbicide, was first registered in 1976 for general weed control in noncrop areas. Registration has since been extended to include use on corn, cotton, peanuts, pod crops, potatoes, safflowers, sorghum, soybeans, stonefruits, tree nuts, non-bearing citrus, non-bearing grapes, cabbage, certain peppers, buffalograss, guymon bermudagrass for seed production, nurseries, hedgerows/fencerows, and landscape plantings. Syngenta (formerly Ciba-Geigy) is the sole producer and primary registrant of metolachlor (USEPA, 1995). Syngenta currently markets the S-isomer, under the name S-metolachlor, as the active ingredient in the product Pennant Magnum (Syngenta, 2000).

National estimates of agricultural use for metolachlor are available from several sources. Using data from the U.S. Department of Agriculture and Resources for the Future and its own proprietary data, EPA has estimated that approximately 58.7 million pounds of metolachlor active ingredient (a.i.) were applied annually between 1987 and 1993 on registered agricultural sites (USEPA, 1995).

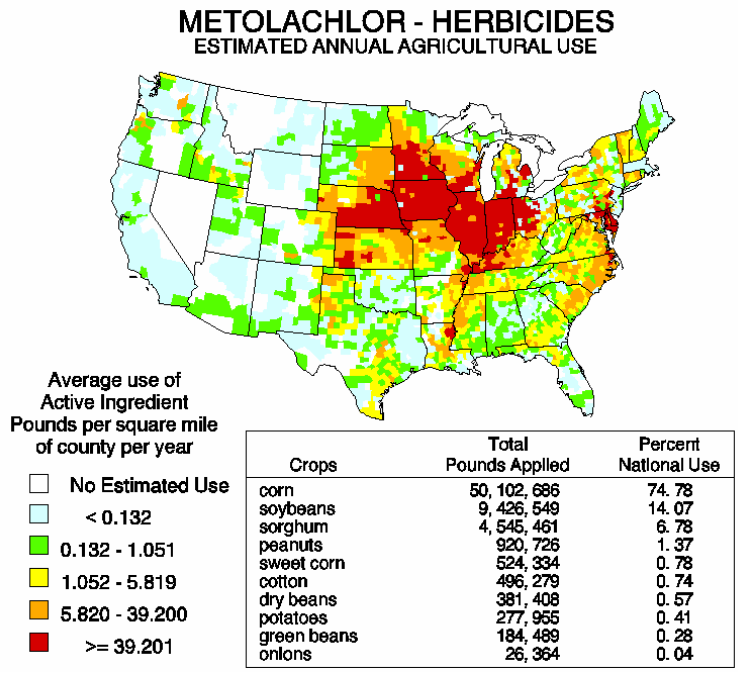
According to the National Center for Food and Agricultural Policy (NCFAP), around 1992 approximately 59.4 million pounds of metolachlor a.i. were applied annually to 16 types of crops on 32.4 million acres, and around 1997 approximately 67.3 million pounds of metolachlor a.i. were applied annually to 21 types of crops on 36.7 million acres. NCFAP estimates are based on State-level commercial agriculture usage estimates for the periods 1990-1993 and 1995-1998, and State-level estimates of crop acreage for 1992 and 1997 (NCFAP, 2004). For more information on NCFAP pesticide use estimates, see Chapter 2.

The United States Geological Survey (USGS) combined data collected by NCFAP with data from the Census of Agriculture to estimate that 57.9 million pounds of metolachlor a.i. were used annually in the early 1990s (Thelin and Gianessi, 2000). While USGS has not published national estimates for 1997, an estimate of approximately 67.0 million pounds a.i. can be inferred from the “total pounds applied” and “percent national use” data in the 1997 geographical distribution map (see below).

Exhibit 13-2 shows the estimated geographic distribution and intensity of typical annual metolachlor use in the United States in the late 1990s. A breakdown of use by crop is also included. The map was created by the USGS using State-level data sets on pesticide use rates from 1995-1998 compiled by the National Center for Food and Agricultural Policy (NCFAP),

and from county-level data on harvested crop acreage obtained from the 1997 Census of Agriculture (USGS, 2004). Due to the nature of the data sources, non-agricultural uses are not reflected here and variations in use at the county-level are also not well represented (Thelin and Gianessi, 2000). For background on the USGS pesticide use maps, see Chapter 2. The map indicates that metolachlor use is heaviest in the Midwest, but common throughout the country.

Exhibit 13-2: Estimated Annual Agricultural Use of Metolachlor, c. 1997



Crops	Total Pounds Applied	Percent National Use
corn	50, 102, 686	74. 78
soybeans	9, 426, 549	14. 07
sorghum	4, 545, 461	6. 78
peanuts	920, 726	1. 37
sweet corn	524, 334	0. 78
cotton	496, 279	0. 74
dry beans	381, 408	0. 57
potatoes	277, 955	0. 41
green beans	184, 489	0. 28
onions	26, 364	0. 04

Source: USGS, 2004

13.3.2 Ambient Water Occurrence

Ambient lakes, rivers, and aquifers are the source of most drinking water. Data on the occurrence of metolachlor in ambient surface and ground water are available from the National Water Quality Assessment (NAWQA) program of the USGS. For details on this program, see the discussion in Chapter 2. NAWQA data have been analyzed independently by USGS and EPA.

NAWQA National Pesticide Synthesis

Under the NAWQA program, USGS monitored metolachlor between 1992 and 2001 in representative watersheds and aquifers across the country. Reporting limits varied but did not exceed 0.013 µg/L.

In surface water (Exhibit 13-3), metolachlor was detected at frequencies ranging from 29.11% of samples in undeveloped areas to 49.74% of samples in urban settings, 71.37% of samples in mixed land use settings, and 82.74% of samples in agricultural areas. The 95th percentile concentrations ranged from non-detects in undeveloped areas to 1.38 µg/L in

agricultural areas. The highest maximum concentration, estimated at 77.6 µg/L, occurred in an agricultural land use setting (Martin *et al.*, 2003).

Exhibit 13-3: USGS National Synthesis Summary of NAWQA Monitoring of Metolachlor in Ambient Surface Water, 1992-2001

Land Use Type	No. of Samples (No. of Sites)	Detection Frequency	50th Percentile (Median) Concentration	95th Percentile Concentration	Maximum Concentration
Agricultural	1,887 (78)	82.74%	0.029 µg/L	1.38 µg/L	77.6 µg/L (E)
Mixed	1,023 (47)	71.37%	0.010 µg/L	0.335 µg/L	9.10 µg/L
Undeveloped	60 (4)	29.11%	<RL	<RL	0.027 µg/L
Urban	885 (32)	49.74%	0.003 µg/L	0.056 µg/L	2.42 µg/L

Notes:
RL = Reporting limit. Reporting limits for metolachlor varied, but did not exceed 0.013 µg/L.

E = Estimated (outside normal calibration limits)

The USGS National Pesticide Synthesis used one year of data, generally the year with the most sampling results, to represent each site in this analysis. The sampling results were time-weighted, to eliminate bias from more frequent sampling at certain times of year. Detection Frequencies and Percentile Concentrations can be interpreted as representing annual occurrence. For instance, the detection frequency can be thought of as the percent of the year in which detections are found at a typical site in this land use category, and the 95th percentile concentration can be thought of as a concentration that is not exceeded for 95% of the year at a typical site in this land use category.

Source: Martin et al., 2003

In ground water (Exhibit 13-4), metolachlor detection frequencies ranged from 1.49% of samples in undeveloped settings to 5.04% in mixed land use settings, 8.98% in urban settings and 17.0% in agricultural settings. The 95th percentile concentrations were 0.022 µg/L in agricultural settings, and non-detects in other settings. The highest concentration, estimated at 32.8 µg/L, was found in an agricultural setting (Kolpin and Martin, 2003).

Exhibit 13-4: USGS National Synthesis Summary of NAWQA Monitoring of Metolachlor in Ambient Ground Water, 1992-2001

Land Use Type	Number of Wells	Detection Frequency	50th Percentile (Median) Concentration	95th Percentile Concentration	Maximum Concentration
Agricultural	1,443	17.0%	<RL	0.022 µg/L	32.8 µg/L (E)
Mixed (Major Aquifer)	2,717	5.04%	<RL	<RL	2.62 µg/L
Undeveloped	67	1.49%	<RL	<RL	0.005 µg/L
Urban	835	8.98%	<RL	<RL	2.09 µg/L

Notes:

RL = Reporting limit. Reporting limits for metolachlor varied, but did not exceed 0.013 µg/L.

The USGS Pesticide National Synthesis considered each well a distinct site in this analysis. Each well was represented by one sample: normally the first one taken, but possibly a later sample if the first sample was not analyzed for the full range of analytes.

Percentile Concentrations were drawn from the range of detects and non-detects. The method for calculating Percentile Concentrations varied depending on how much of the data was censored at particular levels by the laboratory.

Source: Kolpin and Martin, 2003

EPA Summary Analysis of NAWQA Data

Whereas the NAWQA program often uses the most representative data for a site to calculate summary statistics, EPA, with the cooperation of USGS, has performed a summary analysis of all Cycle 1 water monitoring data from all study units (1991-2001) for many of the Second Contaminant Candidate List (CCL 2) contaminants being considered for regulatory determination, including metolachlor. Detection frequencies were simply computed as the percentage of samples and sites with detections (i.e., with at least one result equal to or greater than the reporting limit). Note that reporting limits were not uniform. Sample detections can be biased by frequent sampling in areas with high (or low) occurrence. Calculating the percentage of sites with detections can reduce this bias. For more details on the data set and the EPA analysis, see Chapter 2.

The results of the EPA analysis are presented in Exhibit 13-5. Overall, metolachlor was detected in 53.0% of samples and at 25.4% of sites. Metolachlor was detected more frequently and at higher concentrations (maximum of 77.6 µg/L) in surface water.

Exhibit 13-5: EPA Summary Analysis of Metolachlor Data from NAWQA Study Units, 1992-2001

	Detection Frequency (detections are results ≥ RL[1])				Concentration Values (of detections, in µg/L)				
	Number of Samples	% Samples with Detections	Number of Sites	% Sites with Detections	Minimum	Median	95th Percen-tile	99th Percen-tile	Maximum
surface water	15,634	68.9%	1,948	62.6%	0.0004	0.028	1.64	7	77.6
ground water	6,108	12.3%	5,217	11.4%	0.0002	0.007	0.364	2.43	32.8
all sites	21,742	53.0%	7,165	25.4%	0.0002	0.025	1.51	6.71	77.6

[1] RLs (Reporting Limits) for metolachlor varied but did not exceed 0.013 µg/L. For more information, see Chapter 2. Note that because this EPA analysis involves more data points than the USGS analyses presented above, a direct comparison is not possible.

13.3.3 Drinking Water Occurrence

Nationally representative data on metolachlor occurrence in drinking water were collected by large and small public water systems in Round 2 (1993-1999) of EPA's Unregulated Contaminant Monitoring (UCM) program.

UCM Program, Round 2

Round 2 of the UCM lasted from 1993 to 1999. A geographical cross-section of States with the most complete and reliable data was chosen to provide a roughly representative picture of national occurrence in each round. Note that one of the Round 2 cross-section States with high data quality overall, Massachusetts, had data quality problems specific to metolachlor and other SOCs, and thus was not included in the cross-section analysis for metolachlor. For a complete description of the UCM program, see Chapter 2.

Exhibit 13-6 shows the results from the Round 2 cross-section (excluding Massachusetts). Results from all States, including those with incomplete and less reliable data, are also presented for the sake of comparison. Results are analyzed at the level of simple detections (at or above the minimum reporting level, or ≥ MRL--MRLs varied). Results are also analyzed at the level of a health reference level (HRL) of 70 µg/L, and at the level of ½ the HRL, or 35 µg/L.[1]

In Round 2 cross-section States, metolachlor was detected at 0.83% of public water systems (PWSs), affecting 11.58% of the population served, equivalent to approximately 24.7 million people nationally. While detections of metolachlor where primarily found in surface water systems, no detected concentration of metolachlor exceeded the HRL or ½ the HRL at any of the PWSs in the Round 2 cross-section of States.

1 The HRL is derived from the RfD by applying a risk management factor of 10 to account for suggestive evidence of carcinogenicity, and a 20-percent relative source contribution.

When all Round 2 results are included in the analysis, including results from States with incomplete or less reliable data, metolachlor occurrence findings appear to be slightly greater than those observed for the cross-section data. Detections affect 1.20% of PWSs and 14.41% of the population served. Again, no detected concentration of metolachlor exceeded the HRL or ½ the HRL.

Exhibit 13-6: Summary UCM Occurrence Statistics for Metolachlor (Round 2)

Frequency Factors	19 State Cross-Section[1]		All Reporting States[2]		National System & Population Numbers[3]	
Total Number of Samples	33,930		42,798		--	
Percent of Samples with Detections	0.57%		0.86%		--	
99th Percentile Concentration (all samples)	< MRL		< MRL		--	
Health Reference Level (HRL)	70 µg/L		70 µg/L		--	
Minimum Reporting Level (MRL) - Range	0.01 - 52 µg/L		0.01 - 52 µg/L		--	
- (modal value)[4]	0.2 µg/L		0.1 µg/L			
Maximum Concentration of Detections	13.8 µg/L		13.8 µg/L		--	
99th Percentile Concentration of Detections	7.1 µg/L		6 µg/L		--	
Median Concentration of Detections	0.61 µg/L		1.0 µg/L		--	
Total Number of PWSs	12,953		14,878		65,030	
Number of GW PWSs	11,503		13,062		59,440	
Number of SW PWSs	1,450		1,816		5,590	
Total Population	47,098,573		59,101,488		213,008,182	
Population of GW PWSs	14,279,627		15,749,200		85,681,696	
Population of SW PWSs	32,818,946		43,352,288		127,326,486	
Occurrence by System	**Number**	**Percentage**	**Number**	**Percentage**	**National Extrapolation[5]**	
					Cross-Section	**All States**
PWSs with detections (≥ MRL)	108	0.83%	178	1.20%	542	778
Range across States	0 - 40	0 - 20.00%	0 - 60	0 - 20.0%	N/A	N/A
GW PWSs with detections	13	0.11%	47	0.36%	67	214
SW PWSs with detections	95	6.55%	131	7.21%	366	403
PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
Range across States	0	0 - 0.00%	0	0 - 0.00%	N/A	N/A
GW PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
SW PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
PWSs > HRL	0	0.00%	0	0.00%	0	0
Range across States	0	0 - 0.00%	0	0 - 0.00%	N/A	N/A
GW PWSs > HRL	0	0.00%	0	0.00%	0	0
SW PWSs > HRL	0	0.00%	0	0.00%	0	0
Occurrence by Population Served						
Population served by PWSs with detections	5,452,616	11.58%	8,516,409	14.41%	24,660,000	30,694,000
Range across States	0 - 4,575,644	0 - 44.41%	0 - 4,575,644	0 - 48.02%	N/A	N/A
Pop. Served by GW PWSs with detections	99,372	0.70%	172,839	1.10%	596,000	940,000
Pop. Served by SW PWSs with detections	5,353,244	16.31%	8,343,570	19.25%	20,769,000	24,505,000
Population served by PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
Range across States	0	0 - 0.00%	0	0 - 0.00%	N/A	N/A
Pop. Served by GW PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
Pop. Served by SW PWSs > 1/2 HRL	0	0.00%	0	0.00%	0	0
Population served by PWSs > HRL	0	0.00%	0	0.00%	0	0
Range across States	0	0 - 0.00%	0	0 - 0.00%	N/A	N/A
Pop. Served by GW PWSs > HRL	0	0.00%	0	0.00%	0	0
Pop. Served by SW PWSs > HRL	0	0.00%	0	0.00%	0	0

1. Summary Results based on 19-State Cross-Section, UCM Round 2 data.
2. Summary Results based on All Reporting States, UCM Round 2 data.
3. Total PWS and population numbers are from EPA March 2000 Water Industry Baseline Handbook, 2nd Edition.
4. Because several different analytical methods were used, MRLs were not uniform. The modal value is the most common MRL.
5. National extrapolations are generated by multiplying the system/population percentages and the national Baseline Handbook system/population numbers.

Abbreviations:
PWS = Public Water Systems; GW = Ground Water; SW = Surface Water; N/A = Not Applicable; Total Number of Samples = total number of samples on record for the contaminant; 99th Percentile Concentration = the concentration in the 99th percentile sample (out of either all samples or just samples with detections); Median Concentration of Detections = the concentration in the median sample (out of samples with detections); Total Number of PWSs = the total number of PWSs for which sampling results are available; Total Population Served = the total population served by PWSs for which sampling results are available; PWSs with Detections, PWSs > ½ HRL, or PWSs > HRL = PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively; Population Served by PWSs with Detections, by PWSs > ½ HRL, or by PWSs > HRL = population served by PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively.

Notes:
-Only results at or above the MRL were reported as detections. Concentrations below the MRL are considered non-detects.
-Due to differences between the ratios of GW and SW systems with monitoring results and the national ratio, extrapolated GW and SW figures might not add up to extrapolated totals.
-The HRL used in this analysis is a draft value for working review only.

Each of the following maps focuses on a somewhat different aspect of the geographical distribution of metolachlor occurrence. Exhibit 13-7 identifies all States with at least one PWS with a detection of metolachlor in Round 2. All States are included in this analysis, including both cross-section States with reliable data and non-cross-section States with less reliable data, in order to provide the broadest assessment of possible metolachlor occurrence.

Exhibit 13-8 illustrates the geographic distribution of States with different detection frequencies (percentage of PWSs with at least one detection). Only cross-section States, which have the most complete and reliable occurrence data, are included in this analysis. Massachusetts, normally a Round 2 cross-section State, is excluded from the analysis due to problems with its metolachlor data.

In each map, States not analyzed are represented in white if they were not included in the relevant Round or cross-section, or the lightest category of shading if the State was included in the Round or cross-section but no data are available for metolachlor. The darker shades are used to differentiate States that have and do not have detections.

These maps reveal no clear geographic pattern of metolachlor occurrence. States with PWSs with detections are distributed from the east to the west coast, and from the Canadian to the Mexican borders.

Exhibit 13-7: Geographic Distribution of Metolachlor Detections in Both Cross-Section and Non-Cross-Section States (UCM Round 2)

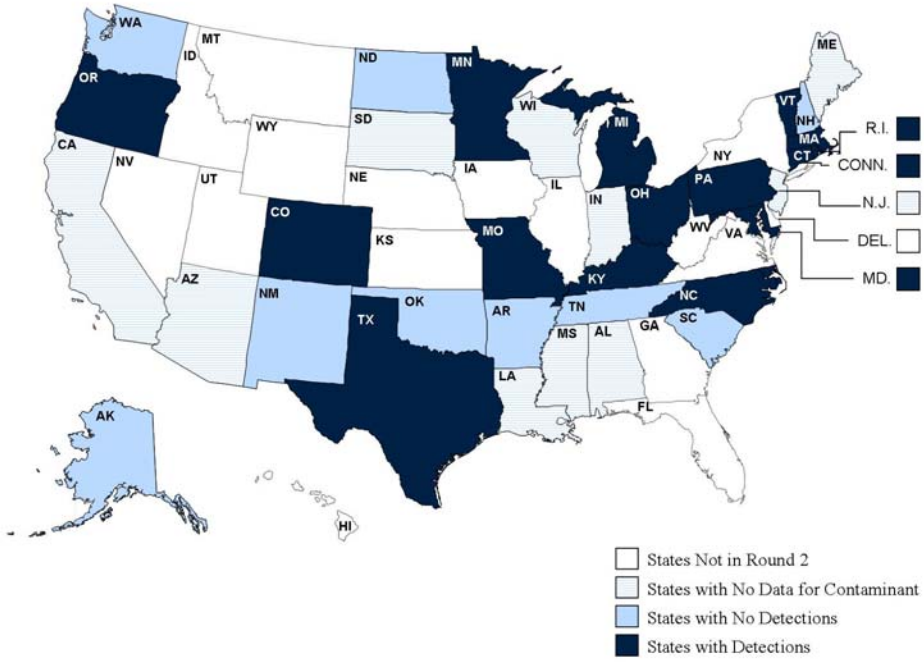
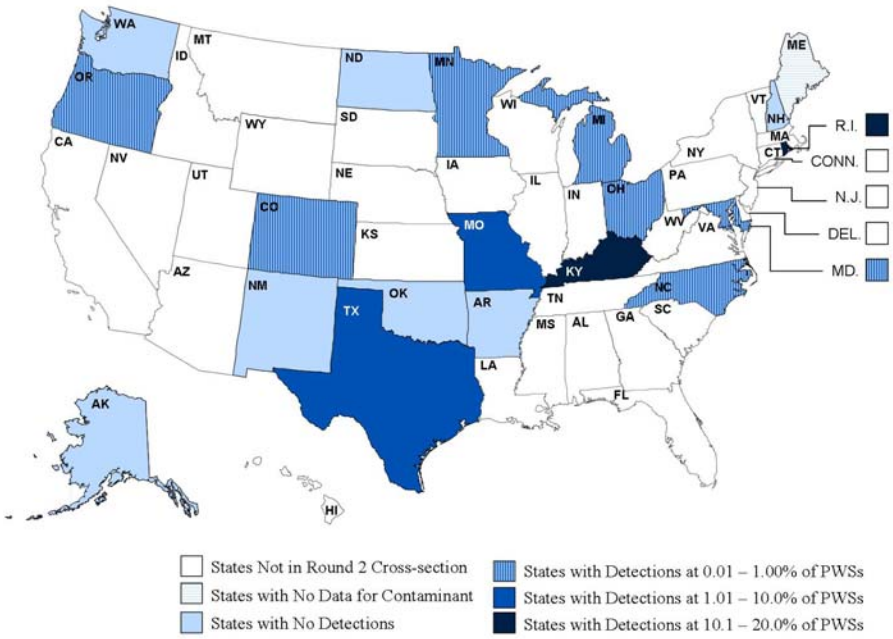
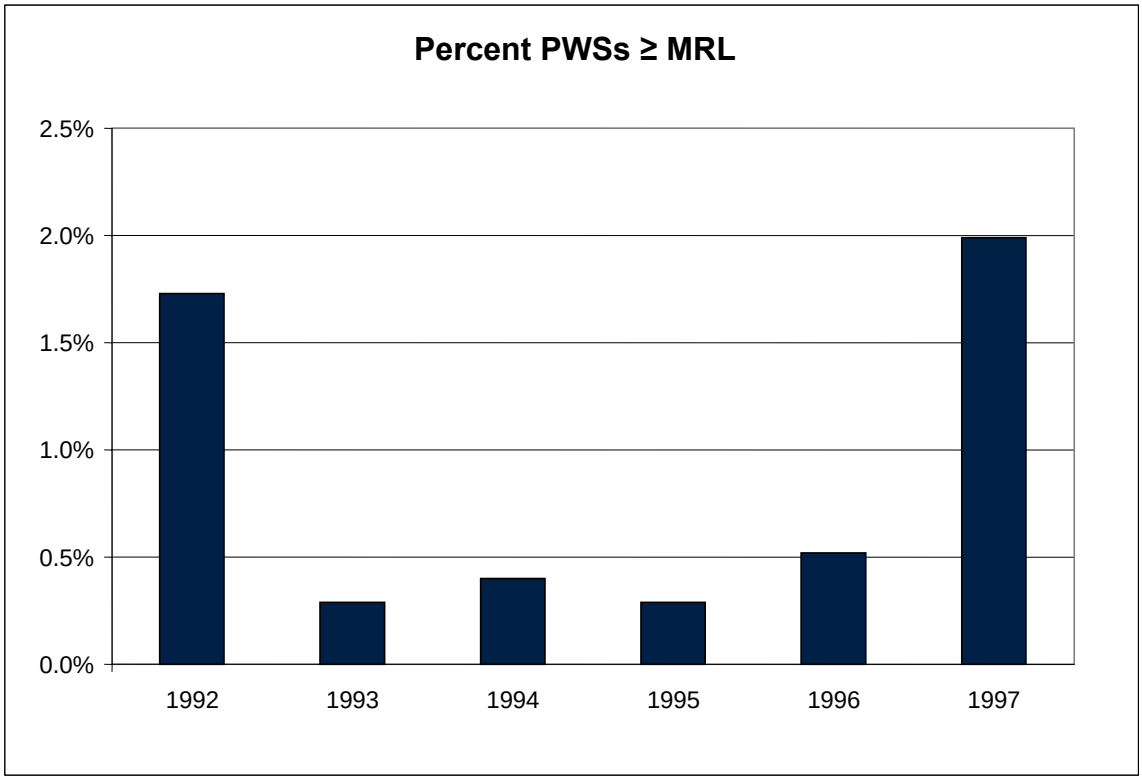


Exhibit 13-8: Geographic Distribution of Metolachlor Detection Frequencies in Cross-Section States (UCM Round 2)



The nineteen States included in Round 2 enable a preliminary temporal assessment of metolachlor occurrence from 1992 to 1997, presented in Exhibit 13-9. The years with the greatest number of PWSs with detections were 1992 and 1997, at the beginning and the end of the monitoring period. A much smaller percentage of PWSs had detections from 1993 through 1996.

Exhibit 13-9: Annual Frequency of Metolachlor Detections, 1992-1997, in Cross-Section States



Pesticides in Ground Water Database (PGWDB)

The Pesticides in Ground Water Database (PGWDB) is a compilation of data from ground water studies conducted by federal, State, and local governments, the pesticide industry, and other institutions between 1971 and 1991 (USEPA, 1992). Most of the data are from drinking water wells. Since PGWDB data come from multiple sources, they should be interpreted with caution. Results might be biased high, because areas with suspected contamination are likely to have been sampled more frequently than pristine areas. For further information on the PGWDB, see Chapter 2.

According to the data compiled in the PGWDB, metolachlor was detected in 213 (0.96 percent) of 22,255 wells. Metolachlor was found in 20 out of 29 States where monitoring was conducted. The following table shows the range of concentrations by state (USEPA, 1992).

Exhibit 13-10: PGWDB Detections of Metolachlor, 1971-1991

State	No. of Wells with Metolachlor Detections	Range of Detected Concentrations µg/L
Arizona	1	6.9
California	0	-
Connecticut	5	0.2 – 26.0
Delaware	9	0.1 – 12.0
Florida	4	0.150 – 0.520
Georgia	0	-
Iowa	28	0.040 – 22.0
Illinois	7	0.087 – 12.0
Indiana	3	0.3-7.9
Kansas	0	-
Louisiana	0	-
Massachusetts	1	0.24
Minnesota	15	0.10 – 2.4
Maryland	1	120.0
Mississippi	0	-
North Dakota	0	-
Nebraska	6	trace – 2.32
New Jersey	3	0.4 – 1.1
New York	7	0.13 – 112
Ohio	71	0.001 – 6.031
Oklahoma	0	-
Oregon	0	-
Pennsylvania	15	trace – 48
South Dakota	4	0.09 – 0.12
Texas	2	5.3 – 5.7
Virginia	11	0.02 – 2.86
Vermont	6	1.10 – 7.20
Washington	0	-
Wisconsin	14	0.08 – 157.0

National Pesticide Survey (NPS)

EPA collected samples from approximately 1,300 community water system (CWS) wells and rural drinking water wells between 1988 and 1990 for the National Pesticide Survey (NPS). The survey was designed to provide a statistically reliable estimate of pesticide occurrence in the nation's drinking water wells. For details about NPS, see Chapter 2.

With a minimum reporting limit of 0.75 µg/L, metolachlor was not detected in the survey (USEPA, 1990).

Community Water System Survey

The 2000 Community Water System Survey (CWSS) (USEPA, 2002a; 2002b) gathered data on the financial and operating characteristics of a random sample of CWSs nationwide. In addition, the Survey asked all "very large" community water systems, those that serve more than 500,000 people (a total of 83 systems), to provide monitoring results for five regulated compounds (arsenic, atrazine, 2,4-D, simazine, and glyphosate) and four unregulated compounds (radon, methyl tertiary-butyl ether [MTBE], metolachlor, and boron), including results from raw water at each intake and from finished water at each treatment plant. EPA received completed questionnaires from 58 systems. However, not all systems answered every question. Note that because reported results are incomplete, they are more illustrative than statistically representative.

Results of raw water monitoring are aggregated by type of intake. In raw ground water, 4 observations of metolachlor occurrence were reported. Among detects, the median concentration was 1 µg/L and the 90th percentile concentration was 210 µg/L. Non-detects were reported at 44.9 percent of ground water intakes. In raw surface water, 15 observations of metolachlor occurrence were reported. Among detects, the median concentration was 1 µg/L and the 90th percentile concentration was 5 µg/L. Non-detects were reported at 36.7 percent of surface water intakes (USEPA, 2002b).

Results of finished water monitoring are aggregated by system type. At systems primarily served by ground water, 2 observations of metolachlor occurrence were reported. Among detects, the median concentration was 205 µg/L and the 90th percentile concentration was 210 µg/L. Non-detects were reported at 9.1 percent of treatment plants. At systems primarily served by surface water, 20 observations of metolachlor occurrence were reported. Among detects, the median concentration was approximately 0 µg/L (presumably a trace amount) and the 90th percentile concentration was 4 µg/L. Non-detects were reported at 49.5 percent of treatment plants. At systems primarily served by purchased water, there were no reported observations of metolachlor. Non-detects were reported at 67.3 percent of treatment plants (USEPA, 2002b).

Additional Metolachlor Drinking Water Data from the Corn Belt

National metolachlor occurrence data can be augmented by reviewing metolachlor occurrence data collected in the "Corn Belt" States, where metolachlor use is highest. Data from Iowa, Illinois, Indiana, and Ohio are available (Hallberg *et al.,* 1996; USEPA, 1999; Kross *et al.*, 1990; Kolpin *et al*., 1997).

In Iowa, Safe Drinking Water Act (SDWA) compliance monitoring data from surface water and ground water PWSs for the years 1988-1995 reveal that approximately 16 percent of samples analyzed for metolachlor had detections of the compound, with a maximum concentration of 9.4 µg/L. The 99th percentile concentration of all samples was 2.4 µg/L (Hallberg *et al.,* 1996). In a comparison of compliance monitoring data from Illinois, Indiana, and Ohio, mostly collected between 1993 and 1997, the percentage of samples with detections ranged between 0.5 percent for Ohio and 5.2 percent for Illinois. Illinois also had the highest percentage (7.3 percent) of PWSs with detections (USEPA, 1999).

The Iowa State-Wide Rural Well-Water Survey, conducted in 1988-1989 to assess pesticide occurrence in rural private wells, established a statistically significant correlation between increasing well depth and decreasing pesticide contamination, as evidenced by the lower detection frequency of metolachlor in drinking water wells 50 or more feet deep (Kross *et al.*, 1990). This finding is corroborated by the analysis of Illinois compliance monitoring data described above. Although only 7.3 percent of all PWSs in Illinois had metolachlor detections, the rate was approximately 65 percent for surface water PWSs (USEPA, 1999). Nevertheless, data compiled by the Iowa Groundwater Monitoring Program indicate a significant increase in median metolachlor concentration in Iowa ground water from 1982 to 1995. The increase in ground water detections appears to follow the trend of increasing Statewide metolachlor use (Kolpin *et al*., 1997).

13.3.4 Occurrence of Metolachlor Degradates

No national data are available on the occurrence of metolachlor degradates in ambient or drinking water. However, a number of studies have been performed at the local and State level. These can give an indication of the likely occurrence of degradates in areas where metolachlor is used.

In a study by the Wisconsin Department of Agriculture, Trade and Consumer Protection, Wisconsin ground water was sampled from October 1999 to May 2000 for alachlor, acetochlor, metolachlor and their ESA and OA metabolites (Rheineck and Postle, 2000). The 27 monitoring wells, 22 private drinking water wells, and 23 municipal wells sampled for the study were chosen based on past detections of pesticides or proximity to agricultural fields to increase the probability of detecting the pesticides. (These are not, therefore, representative of average occurrence, but are wells of known high occurrence.) Results for metolachlor and its degradates are presented in Exhibit 13-11.

Exhibit 13-11: Wisconsin Ground Water Detections of Metolachlor and Degradates

	Detections	Average Detect (µg/L)	Highest Detect (µg/L)
Metolachlor			
Monitoring Wells	15%	1.7	2.1
Private Drinking Water Wells	36%	1.4	5.9
Municipal Wells	0%	N/A	N/A
Metolachlor ESA			
Monitoring Wells	78%	14	42
Private Drinking Water Wells	91%	4.9	18
Municipal Wells	39%	1.3	4.6
Metolachlor OA			
Monitoring Wells	63%	9.2	32
Private Drinking Water Wells	86%	3.7	23
Municipal Wells	35%	0.57	2.7

Source: Rheineck and Postle, 2000.

In general, the monitoring wells and private drinking water wells showed higher detection frequencies and concentrations than the deeper municipal water wells. Also, the metabolites were detected more frequently and in greater concentrations than the parent compound (Rheineck and Postle, 2000).

A study conducted by Phillips *et al.* (1999a) also found that acetanilide herbicide degradates are detected in higher concentrations than parent compounds. In this study, water samples were collected from April to November 1997 in central New York from tile drains under agriculture fields. Metolachlor ESA was found in a higher range of concentrations than metolachlor OA and the parent compound (3.27-23.4 µg/L versus 1.14-13.5 µg/L and 0.01-0.1 µg/L, respectively).

In 1998, USGS, the New York State Department of Environmental Conservation, and Suffolk County Department of Health Services sampled wells in Suffolk County with known or suspected pesticide residues. Samples were collected from 50 wells that tap the surficial sand-and-gravel water-table aquifer in Suffolk County between May and August. In agricultural areas, at a common reporting level of 0.05 µg/L, metolachlor was detected in more than 35 percent of samples and metolachlor ESA and OA were detected in about 70 percent. In residential and mixed land use areas all three compounds were detected in approximately 10 percent of samples (Phillips *et al.*, 1999b).

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