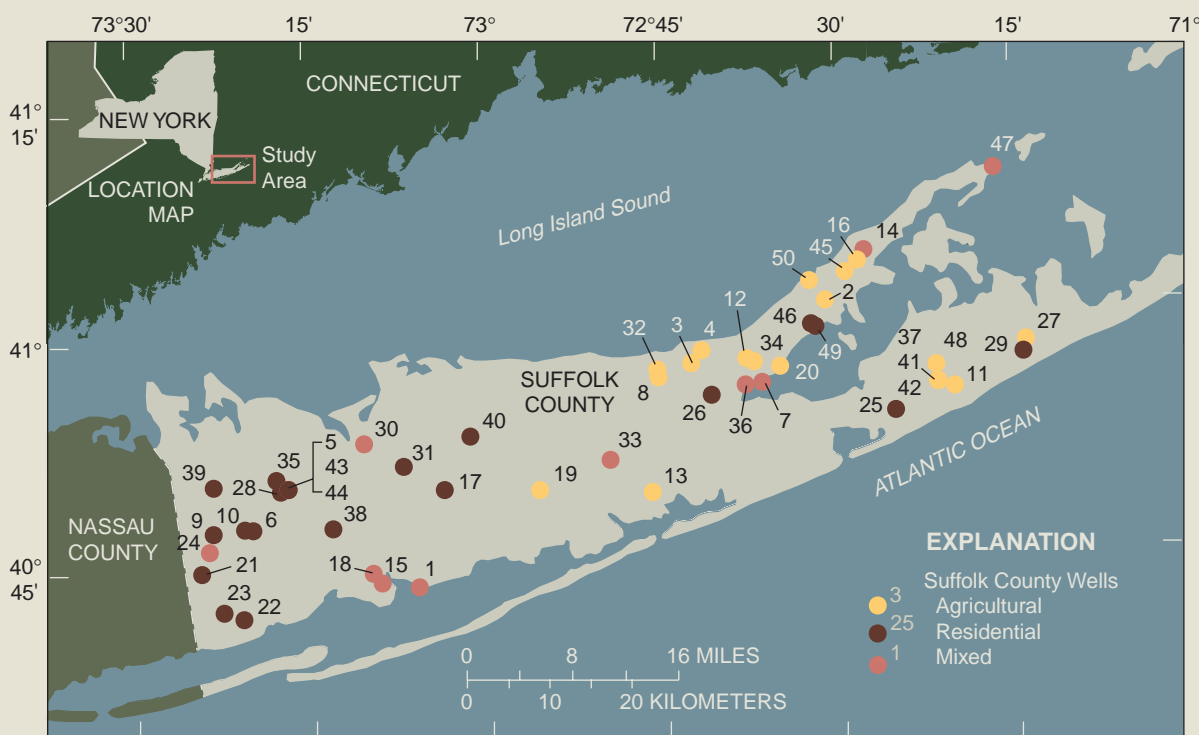




# Pesticides and their Metabolites in Wells of Suffolk County, New York, 1998



Base from U.S. Census TIGER/line files (1990)  
Albers equal-area conic projection  
1:100,000 scale

**Figure 1.** Map of Suffolk County showing location of sites sampled.

## ABSTRACT

Five insecticide residues and 20 herbicide residues were detected in water samples collected from 50 shallow wells screened in the surficial sand and gravel aquifer in Suffolk County, Long Island in areas with known

or suspected residues. Laboratory analytical methods with extremely low detection limits - from 0.001 to 0.2 µg/L (micrograms per liter) - were used to analyze the samples for 60 pesticide residues. Forty-four of the samples contained at least one pesticide

residue, and some samples contained as many as 11 different pesticides or pesticide metabolites. Only four water-quality standards were exceeded in the samples collected in this study. Dieldrin exceeded the New York State Class GA standard

(0.004 µg/L) in samples from eight wells. The Federal and New York State Maximum Contaminant Level for simazine (4 µg/L) was exceeded in samples from two wells, and the State Class GA standard for simazine (0.5 µg/L) was exceeded in samples from six wells. Federal water-quality standards have not been established for many of the compounds detected in this study, including herbicide metabolites.

Maximum concentrations of four herbicide metabolites - metolachlor ESA (ethanesulfonic acid), metolachlor OA (oxanilic acid), and the alachlor metabolites alachlor ESA and alachlor OA - exceeded 20 µg/L. The maximum concentration of one herbicide (tebuthiuron) exceeded 10 µg/L, and the maximum concentration of three herbicides (simazine, metolachlor, and atrazine) and one herbicide metabolite (deisopropylatrazine) ranged from 1 to 10 µg/L. The herbicide metolachlor, which is used on potato fields in Suffolk County, and its metabolites (metolachlor ESA and metolachlor OA) were most frequently detected in samples from agricultural areas. The herbicides simazine and tebuthiuron, which were used in utility rights-of-way, and the simazine metabolite deisopropylatrazine were detected at concentrations greater than 0.05 µg/L most frequently in samples from residential and mixed land-use areas. The results of this investigation are not necessarily representative of conditions throughout the remainder of Long Island, because these samples were collected in areas of known or suspected residues.

## INTRODUCTION

The permeable soils in Suffolk County make the surficial sand-and-gravel aquifer highly susceptible to contamination from activities on the land surface. This highly permeable aquifer is a source of water for domestic and public supply systems in the County, and is hydraulically connected to underlying aquifers that are also used for public supply. Because of the vulnerability and importance of the surficial sand-and-gravel aquifer, and in response to documented contamination of the surficial aquifer by aldicarb in the early 1980's (Zaki and others, 1982; Baier and Robbins, 1982; Soren and Stelz, 1984; Eckhardt and Stackelberg, 1995), the Suffolk County Department of Health Services (SCDH) established a ground-water monitoring program for pesticides and other chemicals of concern. The SCDH program has consistently demonstrated the presence of older, persistent residues from pesticides like aldicarb, which are no longer used on Long Island. More recent monitoring by the SCDH has shown that the herbicides metolachlor and simazine are commonly detected in the shallow ground water of Suffolk County (Baier and Trent, 1998). Metolachlor has been used on potato crops, and simazine has recently been used for weed control at utility substations.

In 1997, the New York State Department of Environmental Conservation (NYSDEC) in cooperation with the U.S. Geological Survey (USGS) began

a statewide monitoring program to assess pesticide occurrence in ground water and surface water of Long Island and the State of New York. This report describes the results of a joint study conducted by the NYSDEC, USGS, and SCDH to sample wells in Suffolk County (including water supply wells) with known or suspected pesticide residues. The primary purpose of this study was to supplement the SCDH pesticide-monitoring program. Because all of these samples are from raw, untreated water from the surficial aquifer, the results reported here are not representative of chemical characteristics of drinking water.

The pesticide residues monitored in this study include many not monitored by SCDH. For example, the samples collected in this study were analyzed for the herbicide tebuthiuron, which is commonly used in association with simazine, and the metolachlor metabolites metolachlor ethanesulfonic acid (metolachlor ESA), metolachlor oxanilic acid (metolachlor OA), and the simazine metabolite deisopropylatrazine. Other pesticides monitored in this study include many of the most commonly used pesticides in the country. The laboratory methods used to analyze the samples collected in this study have lower detection limits for many pesticides than do the methods used by SCDH.

Because this study was intended to complement the SCDH program, however, many pesticides that are commonly detected by the SCDH (including aldicarb and its degradates) were not investigated in this study.

Thus, the results of this study will not represent a complete description of all pesticide residues in ground water in Suffolk County.

This report presents data on the concentration and frequency of detection of the 60 pesticide residues monitored in this study and discusses the concentrations in relation to Federal and State water-quality standards. This report also relates the detection of selected herbicide residues to the predominant land use around the 50 wells sampled, and discusses the concentrations of these residues in relation to one another.

## STUDY METHODS

Samples were collected from 50 wells that tap the surficial sand-and-gravel (upper glacial) water-table aquifer in Suffolk County by personnel from the SCDH and USGS between May and August 1998 (fig. 1, table 1). Most (41) of these wells were installed by the SCDH, and are part of their water-quality monitoring network. Well depths range from 9 to 202 feet below land surface. The depth of the midpoint of the screened interval ranges from 8 to 200 feet, and the depth of the median midpoint of the screened interval was less than 60 feet. Depth to water ranged from less than 10 feet to 130 feet, and the median depth to water was less than 50 feet.

The wells selected for sampling are in areas known or suspected to contain pesticide residues from simazine used on

## WHAT ARE METABOLITES?

Metabolites are formed when a parent compound degrades. Metabolites commonly are present at higher concentrations than the parent compound. Some metabolites can form from the degradation of more than one compound. For example, deisopropylatrazine can form from the degradation of either atrazine or simazine (Thurman and others, 1994). Other metabolites are specific to only one parent compound. For example, metolachlor ESA and metolachlor OA are derived solely from the parent compound metolachlor.

Sampling for herbicide metabolites in this study was motivated in part by findings in the midwestern United States that have shown that metolachlor ESA, metolachlor OA, and deisopropylatrazine commonly are present in ground water in agricultural areas (Kolpin and others, 1997; Kolpin and others, 1998). Concentrations of these metabolites often equaled or exceeded those of the parent compound. Few, if any, federal water-quality standards have been established for these metabolites.

utility rights-of-way, or metolachlor, aldicarb, or other pesticides used in agricultural fields. These residues were not caused by small-scale spillage of pesticides, but rather are the result of larger scale, nonpoint, pesticide use.

Samples were analyzed by the USGS for 60 pesticides or pesticide metabolites using methods described by Zaugg and others (1995), Meyer and others (1993), and Ferrer and others (1997) (table 2). The detection limits of the methods used to analyze the samples ranged from 0.001 to 0.2 µg/L. The analytical method devised by Zaugg and others was developed in cooperation with the U.S.

Environmental Protection Agency and includes some of the most commonly used pesticides in the nation.

Each well sampled was classified according to the land use - agricultural, residential, or mixed — within a quarter-mile radius of the well. Land-use data are based on mapping-data imagery generated from satellite data collected in 1994 (U. S. Geological Survey, 1997). Agricultural wells include those with more than 35 percent agricultural land use (row crop and pasture and hay), but less than 30 percent residential land within a quarter-mile radius of the well. Residential wells include those with more than 55 percent of the

**Table 1.** Data on Wells sampled in Suffolk County, Long Island, New York, April-August 1998

[Depths are in feet below land surface. A dash (-) denotes missing data. Well Numbers for water supply wells are listed in bold]

Number on fig. 1	Well Number	USGS Station no.	Sampling date (mo/d/yr)	Community	Depth to water	Depth of screened interval	Land use*
1	S112740.1	404319073055101	6/23/98	W. Sayville	10	10 - 15	MI
2	S 71280.1	410106072293701	5/27/98	Cutchogue	20	42.0 - 44.5	AG
3	S 51566.1	405716072413301	6/10/98	Riverhead	55	76 - 86	AG
4	S 51571.1	405805072403701	6/10/98	Riverhead	76	96 - 106	AG
5	S112499.1	404953073170501	6/18/98	Commack	95	130 - 140	RE
6	S112248.1	404717073201301	5/28/98	Dix Hills	35	48 - 58	RE
7	S112422.1	405554072352201	7/1/98	Jamesport	6	15 - 20	MI
8	S112679.1	405626072442701	5/14/98	Baiting Hollow	76	100 - 110	AG
9	S112870.1	404719073205701	6/3/98	Dix Hills	46	51 - 61	RE
10	S112328.1	404707073234201	5/19/98	Melville	55	68 - 78	RE
11	S112741.1	405516072183401	7/2/98	Mecox	10	16 - 26	AG
12	S112742.1	405730072364101	6/25/98	Aquebogue	35	39 - 49	AG
13	S112307.1	404900072451701	6/29/98	E. Moriches	24	30 - 40	AG
14	<b>S 24850.1</b>	410415072260701	5/21/98	Southold	45	53 - 78	MI
15	S112739.1	404339073090601	6/23/98	Great River	7	10 - 15	MI
16	<b>S 33775.1</b>	410337072264401	5/21/98	Southold	40	63 - 83	AG
17	S109995.1	404936073032601	6/30/98	Holtsville	87	91 - 96	RE
18	S 63825.1	404418073095001	6/23/98	Great River	17	22 - 27	MI
19	S112574.1	404922072550701	6/29/98	Yapank	20	20 - 30	AG
20	S 71569.1	405655072334702	5/13/98	Jamesport	16.5	30 - 32	AG
21	S 75033.1	404433073244905	6/11/98	E. Farmingdale	28	48.5 - 52.5	RE
22	S 64556.1	404131073211301	6/11/98	Lindenhurst	5	7-9	RE
23	S 43813.1	404158073225802	6/11/98	Lindenhurst	6.5	61 - 71	RE
24	S112871.1	404555073240501	7/6/98	Half Hollow Hills	19.5	30 - 40	MI
25	S 48441.1	405349072234801	6/4/98	Tuckahoe	40	48 - 58	RE
26	S 52449.1	405512072395202	6/24/98	Riverhead	14	29 - 39	RE
27	S 48429.1	405807072121001	6/4/98	Freetown	41	54 - 64	AG
28	S 45210.1	404945073174501	6/3/98	Commack	75	99 - 109	RE
29	<b>S 83707. 4</b>	405720072122704	7/2/98	Bridgehampton	20	73 - 123	RE
30	S112681.1	405243073102301	6/25/98	St. James	130	131 - 141	MI
31	S 47675.1	405111073065801	6/17/98	Lake Grove	55	65 - 75	RE
32	S112678.1	405656072443201	5/14/98	Baiting Hollow	73	87 - 92	AG
33	S112252.1	405111072485401	6/24/98	Manorville	16	19 - 29	MI
34	S112255.1	405715072360201	5/27/98	Aquebogue	27	30 - 40	AG
35	S 65602.1	405030073180601	5/19/98	Commack	73	91 - 96	RE
36	S111891.1	405547072365001	7/1/98	Aquebogue	5	10 - 20	MI
37	S112329. 3	405535072200004	6/10/98	Bridgehampton	4.5	10 - 20	AG
38	S 45720. 2	404716073131602	6/16/98	Islip	39	67 - 77	RE
39	S 45208.1	405005073233701	6/16/98	S. Huntington	113	123 - 133	RE
40	S 48958.1	405259073010301	6/17/98	Coram	45	65 - 75	RE
41	S112329. 2	405535072200003	6/9/98	Bridgehampton	4.5	50 - 60	AG
42	S112329.1	405535072200002	6/9/98	Bridgehampton	4.5	112 - 122	AG
43	S112498.1	404953073170502	6/18/98	Commack	95	108 - 118	RE
44	S112497.1	404953073170503	6/18/98	Commack	95	192 - 202	RE
45	<b>S100380.1</b>	410252072275001	8/13/98	Peconic	-	-	AG
46	<b>S106745.1</b>	405935072305601	8/13/98	Mattituck	-	-	RE
47	<b>S 81306.1</b>	410918072143001	8/24/98	Orient	-	-	MI
48	<b>S 97916.1</b>	405640072200501	8/24/98	South Hampton	-	-	AG
49	<b>S65092.1</b>	405924072303401	8/25/98	Mattituck	55	-	RE
50	<b>S112317.1</b>	410222072310001	8/25/98	Cutchogue	-	-	AG

\* AG = Agricultural, RE = Residential, MI = Mixed

land use classified as residential, commercial, or industrial land, and less than 15 percent as agricultural land use within a quarter-mile radius. Mixed land use wells includes wells not categorized as either residential or agricultural. Some wells also were located near utility substations or rights-of-way, or in areas with golf courses, vineyards, or plant nurseries.

Nine of the wells sampled supply raw water used for water supply: three wells (wells 14, 16, and 29) provide water for public supply, and six (45, 46, 47, 48, 49, 50) provide domestic supply. All of these samples represent water quality in the surficial aquifer before treatment. The water described in this report is not representative of treated (finished) water that is provided to consumers. Owners of all of the water-supply wells sampled are aware of the presence of pesticides in the untreated water, as all of these wells have been sampled by SCDH prior to this study. Treatment systems that remove pesticides from the water have been installed at all of the public-supply wells and at most of the private wells sampled in this study.

## PESTICIDES AND PESTICIDE METABOLITES IN SUFFOLK COUNTY WELLS

Of the 60 pesticide residues monitored, 25 were detected (fig. 2<sup>1</sup>). Five of these were

insecticides or insecticide metabolites, and 20 were herbicides or herbicide metabolites. At least one pesticide or metabolite was detected in 44 of the 50 samples. Some samples contained as many as 11 different pesticides or pesticide metabolites. Many of these compounds had not been previously monitored. The data collected in this study indicate that some pesticides that are commonly monitored by the SCDH are present at trace levels, well below the level of detection provided by the laboratory analytical methods used by SCDH.

The maximum concentrations of 9 pesticide residues monitored in this study were greater than 1 µg/L. The highest maximum concentrations were generally those for herbicide metabolites. Maximum concentrations of one or more pesticide residues were greater than 1 µg/L in 24 of the 50 wells sampled. Concentrations of at least one herbicide or herbicide metabolite were greater than 1 µg/L in all of the water supply wells. Other results include:

- Maximum concentrations of four metabolites of herbicide metabolites (metolachlor ESA, metolachlor OA, alachlor ESA and alachlor OA) were greater than 20 µg/L. The concentration of metolachlor ESA or metolachlor OA was greater than 1 µg/L in 16 of the 50 samples collected in the study.
- The maximum concentration of one herbicide (tebuthiuron) was greater than 10 µg/L, and

maximum concentrations of three herbicides (simazine, metolachlor, and atrazine) and one herbicide metabolite (deisopropylatrazine) ranged from 1 to 10 µg/L. The concentration of simazine was greater than 1 µg/L in 5 of the 50 samples collected in the study.

- Maximum concentrations of four herbicides (alachlor, EPTC, metribuzin, and prometon) and two insecticides (carbofuran and dieldrin) and one herbicide metabolite (hydroxyatrazine) ranged from 0.1 to 1 µg/L.
- Maximum concentrations of the 10 remaining pesticides detected in this study ranged from 0.003 to 0.07 µg/L.

## COMPARISON OF RESULTS WITH WATER-QUALITY STANDARDS

The concentrations of only a few compounds detected in the samples collected in this study exceeded applicable State or Federal water quality standards (figure 2). No Federal drinking water standards have been established for many of the pesticides and pesticides metabolites that were detected, however. (A description of the water-quality standards used is given on page 6).

The following Federal or State Standards were exceeded:

- The concentration of dieldrin, an insecticide, exceeded the New York State Class GA standard (0.004 µg/L) in eight samples (wells 8, 20, 23, 35, 39, 43, 44, and 46, see fig. 1). Three of these samples were from wells in agricultural areas, three were

<sup>1</sup> The samples in this study were intentionally collected in areas with known or suspected pesticide use. Accordingly, these data are not representative of water-quality conditions throughout the sand-and-gravel aquifer in Suffolk County.

from wells in residential areas, and two were from wells in mixed land use areas. One of these samples (well 45) was from a water supply well, but because the sample was from raw, untreated water, these data do not represent drinking water quality. The presence of dieldrin in these samples is consistent with the results of Eckhardt and Stackelberg (1995) and reflects the historical use of dieldrin as an insecticide. (The use of Dieldrin

was banned in the 1970's).

- The concentration of simazine exceeded the Federal and New York State Maximum Contaminant Levels (4 µg/L) (U. S. Environmental Protection Agency, 1996; New York State, 1998) in samples from only two wells (wells 5 and 18). Both of these wells are in mixed land use areas. Neither of these wells are used for water supply.
- The New York State Class GA standard for simazine (0.5 µg/L)

(New York State, 1998) was exceeded in samples collected from six wells (wells 5, 18, 29, 43, 44, and 47). Four of these are in mixed land use area, and two in a residential area. Two of these samples (wells 29 and 47) are from wells used for water supply, but these data are for raw, untreated water, and do not represent drinking water quality.

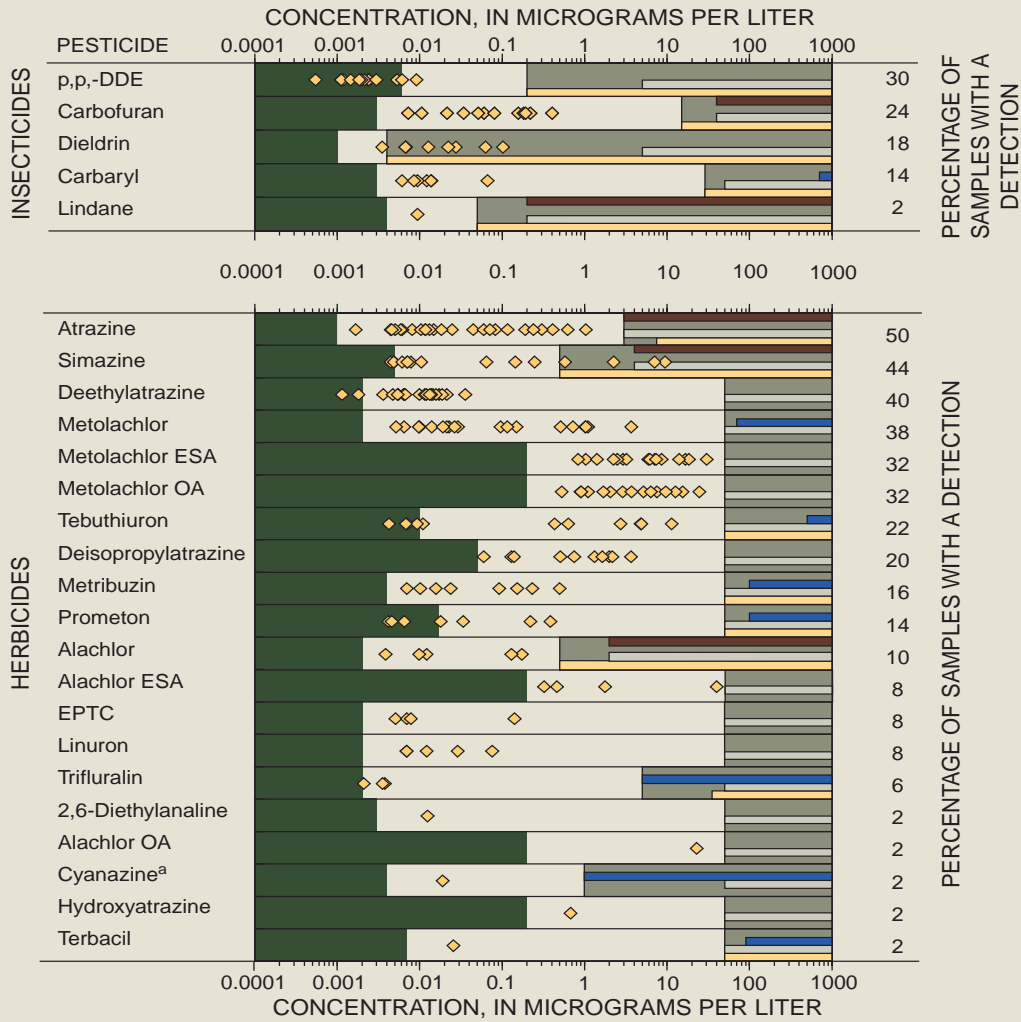
- No other pesticide concentrations exceeded available State or Federal water quality standards.

## FEDERAL AND NEW YORK STATE WATER QUALITY STANDARDS USED IN THIS STUDY

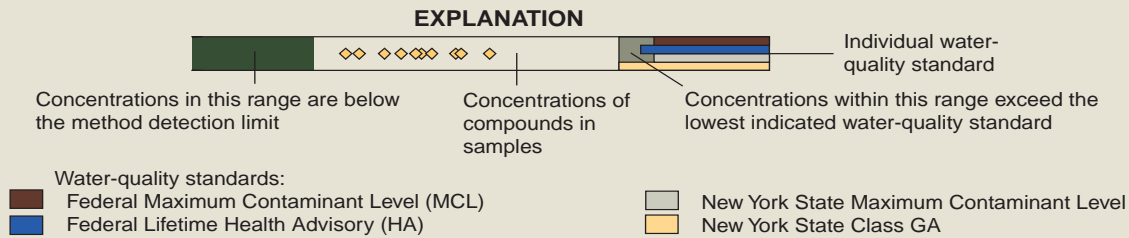
The concentrations of pesticide residues detected in this study are compared with four different State and Federal standards. The standards are based on concentrations of individual pesticides and do not account for mixtures of pesticide residues. Web sites with additional information on the Federal standards are given below.

- Federal Maximum Contaminant Levels (MCLs) are the maximum permissible level of a contaminant in water that is delivered to any user of a public water system under provisions of the Federal Safe Drinking Water Act. MCLs are set as close as feasible to the concentration at which no known or anticipated adverse effects on health are expected to occur. Federal MCLs are based on a one-year average concentration of more than one sample. <http://www.epa.gov/safewater/glossary.html>
- Federal Health Advisory values (HA) are established by U.S. Environmental Protection Agency under the Safe Drinking Water Act where adequate scientific information is available but an MCL has not yet been officially set. <http://www.epa.gov/OST/Tools/dwstds.html>
- New York State Maximum Contaminant Levels are established under the New York State Department of Health Public Water Systems Regulations (New York State Department of Health, 1998). State MCLs are similar to Federal MCLs but they include a standard of 50 µg/L for some organic contaminants and a standard for Principal Organic Contaminants of 5 µg/L.
- New York State Class GA Standards are set by NYSDEC, on the basis of health-based or aesthetic-based procedures established in New York State regulations (New York State Department of Environmental Conservation, 1998) to protect ambient ground waters that are a potential source of drinking water. Class GA Standards are used for protection of the resource, rather than as a maximum allowable limit for water consumption and use. Accordingly, these risk-based values are typically more stringent than drinking-water MCLs.

SUFFOLK COUNTY - MAY-AUGUST 1998



The results of this study are not likely to be representative of conditions throughout the surficial sand-and-gravel aquifer on Long Island because this study targeted areas with known or suspected pesticide residues.



NOTE: Percentage values and constituent range include quantifiable detections below method detection limits. Percentage values may not be comparable among pesticides because (1) detection limits differ and (2) the number of quantifiable detections below the method detection limit differ. New York State regulations include general standards of 50 µg/L for Unspecified Organic Contaminants and 5 µg/L for Principal Organic Contaminants. New York State water-quality standards are based on New York State Department of Environmental Conservation (1998) and New York State Department of Health (1998). Federal water-quality standards are based on U.S. Environmental Protection Agency (1996). Federal MCL standards are based on a one-year average concentration of more than one sample.

Footnote:  
<sup>a</sup> Draft Federal Lifetime Health Advisory (HA)

Figure 2. Concentrations of 25 pesticide residues detected in Suffolk County well samples collected in May-August 1998, and percentage of samples in which each pesticide was detected.

**Table 2.** Detection limits for the 60 pesticide and pesticide degradates for which shallow ground-water samples from Suffolk County, New York, were analyzed, May-August 1998

[ESA, ethanesulfonic acid. OA, oxanilic acid. Detection-limit concentrations shown in parentheses are in micrograms per liter (µg/L).]

Pesticide	Detection limit (µg/L)	Pesticide	Detection limit (µg/L)	Pesticide	Detection limit (µg/L)	Pesticide	Detection limit (µg/L)
<b>A. Gas Chromatography/Mass Spectrometry - US Geological Survey National Water Quality Laboratory, Denver, Colorado</b>							
Acetochlor	(0.002)	Deethylatrazine*	(0.002)	Metolachlor	(0.002)	Pronamide	(0.003)
Alachlor	(0.002)	Diazinon	(0.002)	Metribuzin	(0.004)	Propachlor	(0.007)
alpha-HCH	(0.002)	Dieldrin	(0.001)	Molinate	(0.004)	Propanil	(0.004)
Atrazine	(0.001)	Disulfoton	(0.017)	Napropamide	(0.003)	Propargite	(0.013)
Benfluralin	(0.002)	EPTC	(0.002)	<i>p,p'</i> -DDE*	(0.006)	Simazine	(0.005)
Butylate	(0.002)	Ethalfuralin	(0.004)	Parathion	(0.004)	Tebuthiuron	(0.010)
Carbaryl	(0.003)	Ethopropos	(0.003)	Parathion-methyl	(0.006)	Terbacil	(0.007)
Carbofuran	(0.003)	Fonofos	(0.003)	Pebulate	(0.004)	Terbufos	(0.013)
Chlorpyrifos	(0.004)	Lindane	(0.004)	Pendimethalin	(0.004)	Thiobencarb	(0.002)
Cyanazine	(0.004)	Linuron	(0.002)	<i>cis</i> -Permethrin	(0.005)	Tri-allate	(0.001)
DCPA	(0.002)	Malathion	(0.005)	Phorate	(0.002)	Trifluralin	(0.002)
2,6-Diethylaniline *	(0.003)	Methyl azinphos	(0.001)	Prometon	(0.017)		
<b>B. High Performance Liquid Chromatography - USGS Organic Research Laboratory, Lawrence, Kansas</b>							
Acetachlor ESA*	(0.2)	Alachlor ESA*	(0.2)	Hydroxyatrazine*	(0.2)	Metolachlor OA*	(0.2)
Acetachlor OA*	(0.2)	Alachlor OA*	(0.2)	Metolachlor ESA*	(0.2)		
<b>C. Gas Chromatography/Mass Spectrometry - USGS Organic Research Laboratory, Lawrence, Kansas</b>							
Ametryn	(0.05)	Deisopropylatrazine*	(0.05)	Propazine	(0.05)		
Cyanazine Amide*	(0.05)	Prometryn	(0.05)	Terbutryn	(0.05)		

\* degradation product

The Suffolk County Department of Health recommends against the drinking of water that exceeds State or Federal MCLs or HALs.

## HERBICIDES AND LAND USE

Comparison of the presence of seven frequently detected herbicides or herbicide metabolites with land use around the wells indicates that the occurrence of these pesticides is related to land use. Comparison

of pesticide residue detection patterns with land use can be complicated by several factors, including (1) the distance and direction in which ground water has traveled since pesticide residues reached the water table, (2) changes in land-use patterns since ground water was recharged, (3) effects of ground-water pumping on ground-water flow paths, and (4) degradation of pesticides. Nevertheless, the results of such comparisons can provide a useful initial assessment of the sources of pesticide residues detected in ground water.

The frequency of detection of seven herbicides or herbicide metabolites —metolachlor, metolachlor ESA, metolachlor OA, simazine, deisopropylatrazine, tebuthiuron, and atrazine — are compared to predominant land use around each well in this section. These seven herbicide or herbicide metabolites are among the most frequently detected compounds (all were detected in at least 20 percent of the samples) and had some of the highest concentrations of any of the pesticides found in this study. Concentrations of some of these herbicide residues also are closely



## USE OF LOW DETECTION LIMITS

The use of analytical methods with low detection limits for the analysis of many pesticide residues in this study resulted in a higher frequency of detection of these compounds than would be reported from less sensitive methods. This effect is particularly important for insecticides, because many of these compounds were detected at extremely low concentrations. The use of analytical methods with such low detection limits not only aids in the identification of trace amounts of pesticide residues in water, but also allows researchers to discern relations between pesticide exposure and human health. These low detection limits also increase the likelihood that pesticide residues not detected in the analysis are truly absent from the waters sampled.

Five insecticide residues, including p,p'-DDE, carbofuran, dieldrin, carbaryl, and lindane were detected in one or more samples. The maximum concentrations of all but carbofuran were below 0.2 µg/L, the detection limit commonly used in routine pesticide monitoring in Suffolk County. Although p,p'-DDE was detected in nearly one-third of the samples, the maximum concentration did not exceed 0.01 µg/L (fig. 2). Similarly, only two of the nine detections of dieldrin exceeded 0.05 µg/L, and only one of the detections of carbaryl exceeded 0.05 µg/L. Carbofuran was detected in four wells used for water supply (wells 14, 16, 46, and 50). Dieldrin (site 46), carbaryl (site 48) and p,p'-DDE (site 46) were each detected in one water supply well.

These results indicate that some pesticides may be present at trace levels (concentrations between 0.001 and 0.05 µg/L) in near-surface ground water of Suffolk County. With the exception of dieldrin, these concentrations are well below all established Federal and State water quality standards. These pesticides will often remain undetected in routine monitoring programs, however, because they are well below detection limits provided by most analytical methods.

related with one other; thus, samples with high concentrations of one herbicide residue typically had high concentrations of other pesticides.

A detection level of 0.05 µg/L is used in the following sections to compare detection frequency among samples from differing land-use settings. This detection level probably underestimates the presence of the herbicide metabolites, however, because the laboratory analytical methods used for many of those compounds have a detection limit of 0.2 µg/L.

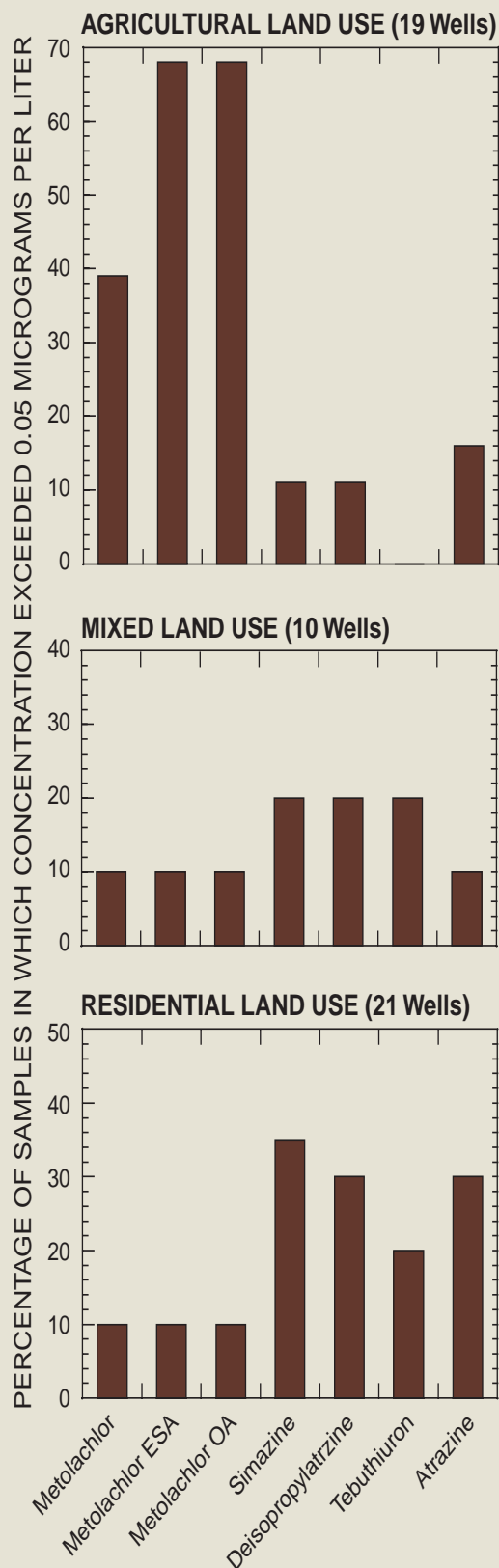
### Metolachlor and its Metabolites

Metolachlor and its metabolites — metolachlor ESA

and metolachlor OA — were most commonly detected at concentrations above 0.05 µg/L in samples from agricultural areas (fig. 3). Metolachlor was detected in more than 35 percent of the agricultural-well samples, and metolachlor ESA and metolachlor OA were detected about 70 percent of the agricultural wells. In contrast, these compounds were detected in only 10 percent of the samples from wells in residential and mixed-land-use areas. These findings are consistent with known herbicide use patterns: metolachlor has been used on potato fields on Long Island for weed control for several years (Baier and Trent, 1998). Concentrations of metolachlor ESA and metolachlor OA were greater than 0.05 µg/L

in six of the nine samples from water supply wells (wells 14, 16, 46, 48, 49, and 50), and concentrations of metolachlor were above 0.05 µg/L in all but one of these samples (well 48).

A combination of processes could account for the presence of metolachlor and its metabolites in residential areas. At some locations, current land use does not reflect land use in the past, because former agricultural areas have been converted to residential areas. Also, ground-water flow carrying pesticides from agricultural fields to adjacent, nonagricultural areas could account for the presence of metolachlor in samples from non-agricultural settings. Overall, however, the metolachlor and metolachlor metabolites in



**Figure 3.** Graph showing percent of samples with detections above 0.05 µg/L for the most frequently detected pesticides, by land use type.

residential or mixed land use areas probably originated from agricultural applications.

Concentrations of metolachlor ESA are closely related to the concentrations of metolachlor OA and metolachlor. Most samples with concentrations of metolachlor ESA above 6 µg/L had metolachlor concentrations greater than 0.2 µg/L, and all samples with metolachlor ESA concentrations greater than 6 µg/L had metolachlor OA concentrations above 5 µg/L. When detected, concentrations of metolachlor ESA and metolachlor OA always exceeded those of metolachlor, in part because these metabolites are highly soluble and are more mobile in ground water than the parent compound metolachlor.

### Simazine, Deisopropylatrazine, Tebuthiuron

The herbicide simazine, its metabolite deisopropylatrazine and the herbicide tebuthiuron were most frequently detected at concentrations greater than 0.05 µg/L in samples from residential and mixed-land use areas (fig. 3). Simazine and deisopropylatrazine were detected at concentrations above 0.05 µg/L in samples from about 30 percent of the wells in residential areas, and tebuthiuron was detected in 20 percent of the residential wells. All three compounds — simazine, deisopropylatrazine, and tebuthiuron — were detected in samples from 20 percent of the wells in mixed-land-use areas. Simazine and deisopropylatrazine were detected in about 10 percent of the wells in agricultural areas, and no tebuthiuron was detected in any samples of this category. Samples from two of the nine water supply wells (wells 29 and 47) had concentrations of simazine, tebuthiuron, and deisopropylatrazine above 0.05 µg/L. The sample from one other water supply well (well 16) had a simazine concentration greater than 0.05 µg/L, and one other sample from a water supply well (well 45) had a deisopropylatrazine concentration greater than 0.05 µg/L.

These patterns of detections are consistent with known patterns of simazine and tebuthiuron use in Suffolk County. Previous sampling by SCDH documented that simazine use at utility substations and along utility rights-of-way has resulted in the movement of simazine into the surficial aquifer downgradient of utility rights-of-way. Many of the detections of simazine, deisopropylatrazine, and tebuthiuron in the present study were in samples from wells near utility rights-of-way. Ground-water flow and associated pesticide transport from utility rights-of-way to surrounding areas could account for the presence of

simazine in areas near, but not at the utility rights-of-way. Some of the detections could be due to simazine use on non-utility rights-of way.

Simazine concentrations were closely related to those of its metabolite (deisopropylatrazine) and tebuthiuron. All samples with concentrations of simazine greater than 0.5 µg/L also had concentrations of both deisopropylatrazine and tebuthiuron greater than 0.4 µg/L. This relation probably reflects the use of these compounds (or their parent compounds) in utility settings. In general, samples with elevated concentrations of simazine did not have elevated concentrations of metolachlor. This probably reflects the use of simazine mainly in utility right-of-way areas, and the use of metolachlor mainly in agricultural areas.

## Atrazine

Patterns of atrazine detection at concentrations above 0.05 µg/L were not as clearly related to land use as the other frequently detected herbicides or herbicide metabolites. Atrazine was detected at concentrations above 0.05 µg/L in 30 percent of the wells in residential areas, in about 15 percent of the wells in agricultural areas, and in 10 percent of the wells in mixed land-use areas (fig. 3). Concentrations of atrazine were above 0.05 µg/L in samples from four of the nine water supply wells (wells 29, 45, 47, and 48). These results indicate that, unlike metolachlor, elevated concentrations of atrazine are

not strongly related to agricultural land use and are more likely attributable to the use of atrazine in a wider variety of settings than metolachlor.

The reason for the high proportion of atrazine detections above 0.05 µg/L in residential areas is unknown. Atrazine generally is more heavily used in agricultural areas than in residential or utility settings. One possible explanation for the detection of atrazine in residential areas is that it was used in agricultural areas that have been converted to residential land.

## SUMMARY

In 1998, water samples were collected from 50 wells completed in the surficial sand-and-gravel aquifer in areas of known or suspected pesticide use in Suffolk County. Of the 60 pesticide residues monitored, 25 were detected. The seven pesticide residues detected at the highest frequency and highest concentrations were the herbicides atrazine, metolachlor, simazine, tebuthiuron; the metolachlor degradation products metolachlor ESA and metolachlor OA; and the simazine degradation product deisopropylatrazine. The insecticide residues dieldrin, p,p'-DDE, and carbofuran were detected in more than 20 percent of the samples collected, and concentrations of insecticide residues generally were below 0.05 µg/L. Except for dieldrin and simazine, concentrations of the pesticide residues detected in the samples were below established State and Federal standards. The

State and Federal Maximum Contaminant Levels for simazine were exceeded in 2 samples. New York State Class GA standards for dieldrin were exceeded in 8 of the samples and for simazine in 6 of the samples. All of the samples in this study represent water quality conditions of raw water from the surficial aquifer, so that these results are not indicative of the quality of treated water provided for water supply.

Maximum concentrations of the seven herbicides or herbicide metabolites that were most frequently detected and that were found at the highest concentrations (atrazine, simazine, tebuthiuron, deisopropylatrazine, metolachlor, metolachlor ESA, and metolachlor OA) ranged from 1 to 30 µg/L. Concentrations of metolachlor and its metabolites were generally highest in samples from agricultural areas, where metolachlor has been applied in the past. In contrast, concentrations of simazine, deisopropylatrazine (a simazine metabolite), and tebuthiuron were highest in residential and mixed land use areas, and were particularly high in areas near utility rights-of-way. This pattern is consistent with previously known areas of simazine residues.

Elevated concentrations of metolachlor and simazine were not often found in the same samples because these pesticides are used in different settings. Concentrations of metolachlor were closely related with those of its metabolites. Concentrations of metolachlor metabolites, when detected, were higher than those of

metolachlor. Concentrations of simazine were closely related to its metabolite, deisopropylatrazine, and to the herbicide tebuthiuron.

Since the purpose of this study was to investigate the pesticide residue occurrence in parts of Suffolk County with known or suspected pesticide use, these results are not necessarily representative of ground-water quality elsewhere in the surficial sand-and-gravel aquifer in Suffolk County.

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## REFERENCES CITED

- Baier, J.H. and Robbins, S.F., 1982, Report on the occurrence and movement of agricultural chemicals in ground water, North Fork of Suffolk County: Suffolk County Department of Health Services, 71 p.
- Baier, J. H. and Trent, Martin, 1998, Water quality monitoring program to detect pesticide contamination in groundwaters of Nassau and Suffolk Counties, New York: Suffolk County Department of Health Services, 15 p.
- Ferrer, Imma, Thurman, E. M., Barcelo, Damia, 1997, Identification of ionic chloroacetanilide herbicide metabolites in surface and groundwater by HPLC/MS using negative ionspray: Analytical Chemistry, v. 69, p. 4547-4553.
- Kolpin, D.W., Kahlhoff, S.J., Goolsby, D.A., Sneek-Fahrer, D.A., and Thurman, E.M., 1997, Occurrence of selected herbicides and herbicide degradation products in Iowa's ground water, 1995: Ground Water, v. 35, p. 679-687.
- Kolpin, D.W., Thurman, E.M., and Linhart, S.M., 1998, The Environmental occurrence of herbicides—The importance of degradedates in ground water: Archives of Environmental Contamination and Archives of Environmental Contamination and Toxicology, v. 35, p. 385-390.
- Meyer, M.T., Mills, M.S., and Thurman, E.M., 1993, Automated solid-phase extraction of herbicides from water for gas chromatographic-mass spectrometric analysis: Journal of Chromatography, v. 629, p. 55-59.
- New York State Department of Environmental Conservation, 1998, Water quality regulations for surface and groundwaters, Title 6 chapter X (parts 703.5, table 1), 10 NYCRR Subpart 5-1.
- New York State Department of Health, 1998, : New York State Health Department Public Water Systems Regulations effective March 12, 1998.
- Soren, Julian, and Stelz, W. G., 1984, Aldicarb pesticide contamination of ground water in eastern Suffolk County, Long Island, New York: U.S. Geological Survey Water-Resources Investigations Report 84-4251, 34 p.
- Thurman, E. M., Meyer, M. T., Mills, M. S., Zimmerman, L. R., and Perry, C. A., 1994, Formation and transport of deethylatrazine and deisopropylatrazine in surface water: Environmental Science and Technology, v. 28, p. 2267-2277.
- U. S. Geological Survey, 1997, Digital map file of land cover for the U.S. Environmental Protection Agency Region II, version 1: Sioux Falls, S. D., EROS Data Center, 1:100,000-scale, 1 sheet.
- U.S. Environmental Protection Agency, 1996, Drinking water regulations and health advisories: Washington D.C., U.S. Environmental Protection Agency Office of Water, EPA 822-B-96-002, Oct., 1996, 11 p.
- Zaki, M. H., Moran, Dennis, and Harris, David, 1982, Pesticides in ground water - the aldicarb story in Suffolk County, New York: American Journal of Public Health, v. 72, p. 1391-1395.
- Zaugg, S. D., Sandstrom, M. W., Smith, S. G., and Fehlberg, K. M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography with selective-ion monitoring: U.S. Geological Survey Open-File Report 95-181, 49 p.

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