The Connecticut Agricultural Experiment Station, New Haven

Pesticides in Ground Water in Connecticut

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Ethylene dibromide (EDB) was discovered in wells in the upper Connecticut River Valley in the fall of 1983. By March 31, 1986, 1556 private wells were sampled and 267 found to contain EDB in excess of the 0.1 part per billion (ppb) standard established by the Department of Health Services (DOHS). In addition, sampling of 265 public wells revealed 54 community supplies exceeded the tolerance level.

EDB was applied to the soil to control pests, especially the pests of tobacco, following the demonstration in 1946 that a crop could be saved by it (Anderson and Swanback 1951). EDB is also used in leaded gasoline, but has been found in only about a dozen wells in the vicinity of gasoline spills.

The contamination of wells with EDB evoked concern that ground water in other areas of the state might contain unknown quantities of many other pesticides. The Station investigates soil and water, and has a particular responsibility to farmers and citizens alike for the wise use of agricultural chemicals. Hence, we undertook the present investigation of the major aquifers of Connecticut for the presence of pesticides in cooperation with the Department of Environmental Protection (DEP). Our goal was to relate land use in the recharge areas of the aquifers to the quality of the ground water, following the pattern of earlier studies at the Station of land use and surface water quality (Frink and Norvell 1984). Preliminary reports of our findings were released in the fall of 1985.

About 700 community water utilities provide over 82% of all the water used in Connecticut. Of these 700, 97 supply over 98% of the water withdrawn from reservoirs, streams and wells. Forty-nine of these 97 rely at least in part on ground water (Natural Resources Center, DEP 1983). Thus, the utilization of ground water in Connecticut is:

Ground Water Source	People Served
Major Water Utilities (49)	305,000
Smaller Utilities (600)	135,000
Private Wells (200,000 est.)	544,000

Sampling individual private wells is costly and inefficient when seeking other than a particular contaminant whose use was restricted geographically. Hence, we decided to sample wells used by the 49 major public water utilities in Connecticut. Samples were collected from the well-head by inspectors of the DEP, and were generally obtained in proportion to the total number of wells in use by the utility. Several other water companies were added at the suggestion of the DEP which felt that agricultural land over the aquifer justified additional sampling. Land use was classified by the DEP (Table 1).

Pesticides to be analyzed were chosen on several criteria. We originally planned to analyze for four pesticides using the following rationale: Although agricultural use of EDB was banned in the fall of 1984, we analyzed for it to determine if contamination existed away from tobacco fields, and also to determine if gasoline spills had contributed EDB to ground water. We also analyzed for 1,2-dichloropropane, a chlorinated constituent of

TABLE 1. LAND USE CATEGORIES AND SYMBOLS, 1970 LAND USE MAP, DEP.

Land Use Category	Symbol
Residential (5-acre min.)	
Urban low (2 to 8 families/acre)	H2
Suburban high (1 to 2 families/acre)	H3
Suburban low (1/4 to 1 family/acre)	H4
Undeveloped, unused lands and water areas (10-acre min.)	
Forests lands (non-commercial)	XF
Open lands (inactive agricultural scrub, etc.)	XO
Wetlands (bogs, marshes, swamps)	XW
Resource production and extraction (10-acre min.)	
Active agricultural production	AG
Inactive sand and gravel pits (1-acre min.)	EI
Cultural, entertainment and recreational (10-acre min.)	
Golf courses	RG

Vorlex that was used as a soil fumigant, beginning in the 1960s. The persistence of 1,2-dichloropropane in soil caused its withdrawal from commercial formulations of Vorlex in 1984.

Because insecticides applied to the soil to control pests have a particular potential for leaching to ground water, we chose two of them: Diazinon and Vydate. Diazinon is widely used on home lawns and golf courses as well as in agriculture. Vydate is in a similar category as well as being one of the most water soluble pesticides in common use. A recent report (Waggoner 1986) also emphasizes that a large portion of the most potent pesticides sold in Connecticut are used to manage pests in the soil.

We found that with little additional effort we could include a complete scan for several additional chlorinated and organophosphate pesticides as well as for PCB. The total of 33 compounds and the limit of detection for each compound are shown in Table 2. Gas chromatography (GC) was used to determine the organochlorine and organophosphate compounds (Shell Oil Co. 1967). Oxamyl was determined by GC (Greenberg 1981). EDB and 1,2-dichloropropane were determined by GC and mass spectrometry (MS) purge and trap techniques (Federal Register 1984).

A list of utilities, sources tested, and land use in the recharge area is shown in Table 3. The 25 utilities in 29 towns (Figure 1) that were sampled supply about 12,500 million gals/year. Since the total ground water withdrawn by all 49 major utilities in 1980 was 21,200 million gals/year, we sampled about 60% of the total. DEP collected 95 samples and the Station analyzed for 33 compounds for a total of 3135 analyses. Water from four wells in the Cheshire well field of the South Central Connecticut Regional Water Authority contained 1,2-dichloropropane at concentrations below the DOHS action level. The remaining samples contained no detectable amounts of any of the pesticides tested for, despite the fact that 60 of the 95 samples were collected from wells with active agriculture in their recharge area.

This is surely good news, but we cannot neglect the problem of those wells that are contaminated with EDB or, in a few cases to date, with 1,2-dichloropropane. Thus, we

TABLE 2. PESTICIDES SOUGHT IN WATER OF USERS OF MAJOR AQUIFERS IN CONNECTICUT, 1984-85. METHODS: GAS CHROMATOGRAPHY COMBINED WHERE NECESSARY WITH MASS SPECTROMETRY AS INDICATED WITH AN ASTERISK (*).

Chlorinated Hydrocarbons	Detection limit, ppb
Aldrin	0.40
α-BHC (benzenehexachloride)	0.27
β-BHC (benzenehexachloride)	0.67
Bravo (chlorothalonil)	3.3
Captan	6.7
Chlordane	3.3
Dacthal	0.2
DDD (o,p- and p,p)	0.67
DDE (o,p- and p,p)	0.67
DDT (o,p- and p,p)	0.67
1,2-Dichloropropane (*)	0.05
Dieldrin	0.67
EDB	0.03
EDB (*)	0.05
Endrin	2.7
HCB (hexachlorobenzene)	0.07
Heptachlor	0.2
Heptachlorepoxide	0.47
Kelthane	1.3
Lindane	2.0
Methoxychlor	3.3
PCNB (pentachloronitrobenzene)	0.07
Ronalin	0.47
Thiodan I	0.33
Thiodan II	0.67
Toxaphene	66.7
Organophosphates	
Diazinon	0.67
Dursban	0.67
Malathion	1.3
Methyl Parathion	1.3
Parathion	0.67
Carbamates	
Vydate (oxamyl)	66.7
PCBs	3.3

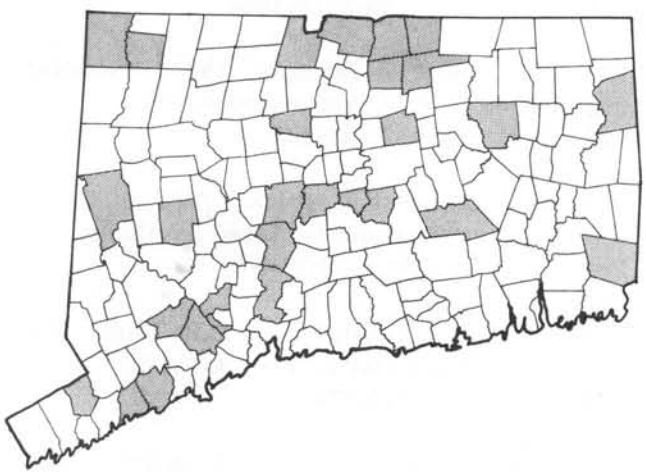

FIGURE 1. SHADED AREAS INDICATE TOWNS WHERE GROUND WATER WAS SAMPLED.

conclude with a summary of research at the Station on the fate of toxic organics in surface and ground water.

We began by determining the transport and distribution of PCBs in the Housatonic River (Frink et al. 1982). We also examined their persistence in soil (Hankin and Sawhney 1984) and reviewed their movement through the food chain (Sawhney and Hankin 1984, 1985). We have analyzed the chemicals leaching from dumps around the state (Sawhney and Kozloski 1984) and investigated their reactions with soils and sediments. The discovery of EDB in wells, however, concentrated our efforts on the fate of these compounds in drinking water.

We have shown that boiling quickly removes EDB and Vorlex from water (Isaacson et al. 1984), and that EDB is taken up but is not concentrated by plants (Isaacson and Frink 1985). These experiments with plants have now been extended to include 1,2-dichloropropane and Vorlex.

In current studies of the biodegradation of EDB we have found that it is readily decomposed in soil from the Windsor Locks well field of The Connecticut Water Co. (Pignatello 1986a). This degradation by microbes occurs in well aerated soils and also in environments lacking in oxygen, which gives us hope that EDB will eventually disappear because it is no longer used.

We have discovered, however, that small amounts of EDB persist in soils collected at Warehouse Point that were last fumigated in 1983. We have also found that EDB persists for at least two years in experimental plots at our Lockwood Farm in Mt. Carmel. In addition, we have a substantial field study underway in Simsbury where EDB has not been used since the 1960s but still persists in many wells. In cooperation with the DEP and the Town of Simsbury, the Station has drilled test wells to delineate the extent of contamination, to determine the direction and rate of movement of the contaminated water, and to learn if clean wells can be drilled. We have also obtained soil samples from below the water table to determine rates of degradation of EDB in that environment (Pignatello 1986b). Our greatest challenge is to determine why low concentrations of EDB persist in nature despite its ready degradation in the laboratory.

Although this bulletin is the final report of our analyses of the major ground water supplies of Connecticut, the research that we have described will continue as we seek to provide clean water for Connecticut.

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TABLE 3. USERS OF MAJOR AQUIFERS, SOURCES TESTED, LAND USE IN RECHARGE AREA.

UTILITY	POP SERVED	MILLION GAL/YR	WELL NAME AND TOWN	LAND USE
Ansonia-Derby Water Company	30800	775	#1, Derby Well Field, Derby	---
			#4, Housatonic Well Field, Seymour	---
			#5, "	---
			#6, "	---
			#7, "	---
Avon Water Co.	5900	209	#2, Avon	XO/AG
			#5, "	---
Berlin Water Control	2250	208	#1, Swede Well, Berlin	AG
			#2, Swede Well, "	AG
Bridgeport Hydraulic --Main System	336200	3570		
			Huntington South Wells, Shelton	AG/RG
			#1, Stepney Well, Monroe	---
			Lakewood Well, Monroe	XW/H3
			#1, Coleytown Well, Westport	H4/XW
			#1, Brookside Well, Fairfield	H3
--Lakeville System, Litchfield Div.	3200	53	#1, Peetee St., Lakeville	---
			B, Salisbury	---
			Eddy Wells, Canaan	AG/XF
			#2, Lakeville	---
			#3, "	---
Camelot Estates	180	6.5	#1, New Milford	---
			#2, "	---
			#2A, "	---
			#3, "	---
			#5, "	---
			#6, "	---
Canaan Water Co.	100	3.6	#2, Canaan	AG/XF/XO
			#3, "	AG/XF/XO
			#4, "	AG/XF/XO
			#5, "	AG/XF/XO
			#6, "	AG/XF/XO
Colchester Water Dept.	3500	114	#2, Cabin Rd., Colchester	---
			#4, Lebanon Ave., "	XO/AG
			#5, Painter Hill Rd., "	---

TABLE 3--Continued

UTILITY	POP SERVED	MILLION GAL/YR	WELL NAME AND TOWN	LAND USE
Conn. Water Company	12400	1360	#2, Mapleton Ave., Suffield	AG
--Somers Sec.,			#1, Fuller Hurd Well, Somers	H2/AG
N Div.			#4, Preston Well, Somers	XW/AG
--West. Sec.,			#2, Broadbrook, E. Windsor	XO/AG
N Div.			#2, Broadbrook, "	XO/AG
			#5, Hunt, E. Windsor	XF/XW/AG
			#6, Hunt, "	XF/XW/AG
			#8, Hunt, "	XF/XW/AG
			#9, Hunt, "	XF/XW/AG
Cromwell Fire Dist.	9000	316	#1, Gardner Well, Cromwell	---
Water Div.				
Crystal Water Co.	9200	180	#2, P.B. Hopkins, Danielson	---
of Danielson			#3, P.B. Hopkins, "	---
Ellington Water Co.			#1, Ellington	H3/AG
Hazardville Water Co.	18100	548	#2, Scitico, Enfield	XF
			#1, Queen St., Enfield	XF/AG
			#2, Queen St., "	XF/AG
			#3, Queen St., "	XF/AG
Kensington Fire Dist.	9000	328	Kensington Well, Kensington	---
Manchester Water	49500	970	#2, Charter Oak Well, Manchester	H2
Dept.			#3, Charter Oak Well, "	H2
			#4, Charter Oak Well, "	H2
			#6, New State Rd., "	XW/AG
			#7, New State Rd., "	XW/AG
			#8, New State Rd., "	XW/AG
New Canaan Water Co.	9200	168	Mayo Well, New Canaan	H4
			Country Day Well, New Canaan	---
			#5, Weed Street Well, New Canaan	H4
Portland Water Works	6500	34	#1, Portland	AG/XF
Salmon Brook Water	270	9.8	#1, Granby	AG
Dist.				
South Central Conn.	125800	1800	#1, Sleeping Giant, Hamden	RG/AG
Reg. Water			#2, Sleeping Giant, "	RG/AG
Authority			#4, Sleeping Giant, "	RG/AG
			South Sleeping Giant, "	---

TABLE 3--Continued

UTILITY	POP SERVED	MILLION GAL/YR	WELL NAME AND TOWN	LAND USE
South Central Conn. Reg. Water Authority (cont.)			#1, Cheshire	EI/AG
			#1, "	EI/AG
			#4, "	EI/AG
			#4	EI/AG
			#1, #4 Blend, Cheshire	EI/AG
			#5, Cheshire	EI/AG
			#5, "	EI/AG
			#13, "	EI/AG
			#13, "	EI/AG
South East Regional Water Authority	828	30	#1, North Stonington	XF/AG
Southington Water Works	30500	996	#7. Southington	AG
			#7, "	AG
			#8, "	AG
			#8, "	AG
University of Conn.	23000	443	A, Fenton River, Mansfield	XO/AG
			B, Fenton River, "	XO/AG
			C, Fenton River, "	XO/AG
			D, Fenton River, "	XO/AG
Watertown Fire Dist.	6600	303	#1, Hart Farm Well, Woodbury	AG
			#2, Hart Farm Well, "	AG
			#3, Hart Farm Well, "	AG
			#4, Hart Farm Well, "	AG
			#6, Hart Farm Well, "	AG
			#7, Hart Farm Well, "	AG
			#8, Hart Farm Well, "	AG
			#9, Hart Farm Well, "	AG
			- stream feeding, " Hart Farm Well	AG
Woodbury Water Co.	1700	60	#1, Washington Rd., Woodbury	AG
			#2, S. Pomperaug Rd., "	---

The Connecticut Agricultural Experiment Station, founded in 1875, is the first experiment station in America. It is chartered by the General Assembly to make scientific inquiries and experiments regarding plants and their pests, insects, soil and water, and to perform analyses for State agencies. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Single copies of bulletins are available free upon request to Publications; Box 1106; New Haven, Connecticut 06504.

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