Elder

Survey of Selected Organic Compounds in Aquifers of New York State, Excluding Long Island

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 81-47

Prepared in cooperation with

NEW YORK STATE DEPARTMENT OF HEALTH

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16. Abstract (Limit: 200 words)

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Analytical sensitivity reported by the laboratory for most compounds was less than 1 microgram per liter, but contamination during collection, shipping, and laboratory processing required that concentrations be about 10 micrograms per liter before the presence of a compound could be confirmed. Only a small percentage of wells sampled was found to be contaminated. Where contamination is present, it probably results from point sources such as landfills or dumps rather than from general sources such as atmospheric deposition or proximity to urban centers. Two sites, Brewster in Putnam County, and Olean in Cattaraugus County, showed clear evidence of contamination. Two other sites, Corning in Steuben County, and Fulton in Oswego County, showed evidence of possible contamination.

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SUBJECT: PUBLICATIONS: "Survey of selected organic compounds in aquifers of New York State, excluding Long Island" WRI 81-47, by Roy A. Schroeder and Deborah S. Snavely

TO:

QW Specialists, WRD, FL

Thru: Subdistrict Chiefs, Hydrologist-in-Charge, JX

The attached report is a good summary of a ground-water reconnaissance of organic-priority pollutants. This should be a handy reference for any staff thinking about this type of endeavor.

Please note that Long Island is excluded, rumor has it that Subdistrict management had difficultly getting anything done during 1978-80.

Tony

G. A. Irwin

Attachment

cc: Robert Kirkland, WRD, QW Ser. Unit, Ocala

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SURVEY OF SELECTED ORGANIC COMPOUNDS IN AQUIFERS OF NEW YORK STATE EXCLUDING LONG ISLAND

By Roy A. Schroeder and Deborah S. Snavely

U.S. GEOLOGICAL SURVEY

Water Resources Investigations 81-47

Prepared in cooperation with the

NEW YORK STATE DEPARTMENT OF HEALTH

Albany, New York

1981

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

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TABLES (continued)

ILLUSTRATION

CONVERSION FACTORS AND ABBREVIATIONS

The following factors may be used to convert inch-pound units of measurement to the International System of Units.

Multiply	by	To obtain
inch (in)	2.540	centimeter (cm)
foot (ft)	3.048×10^{-1}	meter (m)
mile (mi)	1.609	kilometer (km)
degree Fahrenheit (°F)	5/9(°F-32)	degree Celsius (°C)

Abbreviations used in the text of this report include:

mg/L, milligrams per liter
µg/L, micrograms per liter
mL, milliliter
µL, microliter
µg, micrograms

Survey of Selected Compounds in Aquifers of New York State, Excluding Long Island

By

Roy A. Schroeder and Deborah S. Snavely

ABSTRACT

Samples from 56 wells at 49 sites in New York State, excluding Long Island, were analyzed by gas chromatography/mass spectrometry for the presence of organic compounds designated "priority pollutants" by the U.S. Environmental Protection Agency. Most samples were taken from public-supply wells tapping shallow, permeable aquifers, the most susceptible to contamination.

Analytical sensitivity reported by the laboratory for most compounds was less than 1 microgram per liter, but contamination during collection, shipping, or laboratory processing required that concentrations be about 10 micrograms per liter before the presence of a compound could be confirmed. Only a small percentage of wells sampled in this study was found to be contaminated. Where contamination is present, it probably results from point sources such as landfills or dumps rather than from general sources such as atmospheric deposition or proximity to urban centers. Two sites, Brewster in Putnam County and Olean in Cattaraugus County, showed clear evidence of contamination. Two other sites, Corning in Steuben County and Fulton in Oswego County, showed evidence of possible contamination.

INTRODUCTION

Growth of the synthetic chemicals industry during the past three decades has resulted in a wide variety of organic chemicals' being introduced into our environment. Some of these may enter local drinking-water sources and pose a danger to human health. These substances enter aquifers from waste discharges or accidental spills and from point sources such as seepage from holding ponds and landfills; they also enter from nonpoint sources by induced infiltration of contaminated surface waters or from contaminated atmospheric precipitation. Organic contaminants can impair water quality in a variety of ways; for example, some may alter the taste and cause stains or odors, and some may be toxic or carcinogenic. Others are harmless. Serious degradation of ground-water quality can also result in additional expense for water treatment or for development of alternate sources. Because the increasing need for water in New York State places greater dependence on ground-water resources, identification of current or potential contamination is necessary.

Purpose and Scope

This report presents results of a survey conducted in New York from 1978-80 to determine the occurrence and extent of ground-water contamination by organic chemicals and to establish whether airborne contaminants from

industrial and metropolitan centers might be a factor in aquifer contamination. To these ends, 74 samples from 56 wells at 49 sites across New York State excluding Long Island[1] were analyzed for the organic chemicals listed by the U.S. Environmental Protection Agency (EPA) as "priority pollutants." The general location of sites sampled is given in figure 1 (p. 26); information on wells sampled is given in table 8 (p. 27).

Acknowledgments

The New York State Department of Health provided a list documenting industries and sites of possible point-source contamination and, together with several county health departments, furnished information on appropriate sampling sites and well selection. Local water-plant operators, water-department supervisors, supervisors of public works, and municipal clerks provided assistance in the sampling program.

METHOD OF STUDY

Site Selection

Sampling was designed to achieve even distribution across the entire State (except Long Island) and to represent areas of rural (agricultural), urban, and industrial land use. Aquifers near metropolitan areas were considered of potential importance because they may be recharged by precipitation and or surface waters containing elevated concentrations of contaminants.

Wells to be sampled were selected on the basis of water use, aquifer size and characteristics, source of aquifer recharge, and geographic setting. Public-supply wells were given priority because of their importance to communities; nearly all samples were from public-supply wells that are in continuous use.

Relatively shallow wells tapping sand and gravel aquifers were preferred because of susceptibility to contamination, but wells tapping bedrock were selected if the aquifer was unconfined and shallow. Wells tapping aquifers recharged by direct precipitation and by induced infiltration from nonpoint sources such as rivers were also included, as were wells in areas of possible point-source contamination such as petroleum well fields, chemical plants, or landfills. In general, only wells tapping aquifers of significant areal extent were included.

Sampling Procedure

Sets of glass bottles, consisting of two 40-mL glass vials with Teflon[2]-lined septa for volatile analyses and a 1-gallon amber glass pharmaceutical

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[1] Chemical quality of Long Island ground water is assessed regularly by Federal, State, and local agencies and was therefore excluded.

[2] Use of brand and corporation names is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

jug with a Teflon-lined cap for extractable analyses, were prepared and shipped to the Geological Survey in Albany, N.Y. by Monsanto Research Laboratory in Dayton, Ohio (hereafter referred to as MRC). The containers had been cleansed with strong acid (50 percent sulfuric + 50 percent nitric), rinsed in distilled water, and heated at 400°C for at least 30 minutes. Teflon-lined caps were applied after the bottles had cooled to room temperature.

One set of bottles was filled at each site with untreated water from a raw-water tap that had been opened for several minutes before sampling. The vials were filled such that no air space remained after capping. Samples were immediately packed in ice and shipped for overnight delivery to MRC, where they were refrigerated and extractions initiated within 24 hours.

Analytical Methods

Instrumentation

Analyses were conducted according to EPA approved methods (U.S. Environmental Monitoring and Support Laboratory, 1977, and Monsanto Research Corporation, 1978) by Monsanto Research in Dayton, Ohio using a Hewlett Packard 5983 gas chromatograph/mass spectrometer (GC/MS) with a 4934 Data System. Qualitative identification of a compound was based on three criteria:

1. retention time coincident with retention time of a standard,

2. simultaneous elution of three characteristic masses, and

3. ratios of the relative intensities of the characteristic masses.

Concentrations were calculated from response ratios relative to an appropriate internal standard.

Water samples were analyzed for 113 of the 114 organic priority pollutants[1] listed in table 1. Table 1 presents these substances in four groups based on the scheme used for their extraction: direct injectables, base/neutral extractables, acid extractables, and volatiles.

Direct Injectable Compounds.--Only two priority pollutants, acrolein and acrylonitrile, were analyzed by injection of the untreated water sample directly into the GC/MS system. Neither compound was detected above its minimum determinable concentration of 200 µg/L in any sample.

Base/Neutral and Acid Extractable Compounds.--The base/neutral and acid extractable compounds were recovered from water in the 1-gallon jug. Two-liter sample solutions were made alkaline to pH>11 with sodium hydroxide and extracted with three successive volumes of 250 mL, 100 mL, and 100 mL

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[1] 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD) was omitted on the recommendation of EPA-Environmental Monitoring and Support Laboratory because of the extreme toxicity of the compound and the health hazard involved in preparing standard solutions from the pure compound.

Table 1.--List of 114 organic priority pollutants and minimum

[Values are in micrograms per liter.
of study; updated values in

Direct Injectables (2)	A	B
Acrolein	200	--
Acrylonitrile	100	--
Volatiles (29)		
Methyl chloride	0.2	5.0
Dichlorodifluoromethane	.2	2.0
Methyl bromide	.2	5.0
Vinyl chloride	.4	5.0
Chloroethane	.5	5.0
Methylene chloride	.4	0.1
Trichlorofluoromethane	2.0	.3
1,1-Dichloroethylene	2.0	.5
1,1-Dichloroethane	3.0	.4
1,2-trans-Dichlorethylene	2.0	.7
Chloroform	5.0	.3
1,2-Dichloroethane	2.0	--
1,1,1-Trichloroethane	2.0	.3
Carbon tetrachloride	4.0	.4
Dichlorobromomethane	.9	.3
bis(Chloromethyl) ether	1.0	5.0
1,2-Dichloropropane	.7	.8
1,3-Dichloropropene	.4	1.1
Trichloroethylene	.5	.2
Chlorodibromomethane	.3	.4
1,1,2-Trichloroethane	.7	.5
Benzene	.2	--
2-Chloroethyl vinyl ether	1.0	5.0
Bromoform	.6	1.0
Tetrachloroethylene	.9	--
1,1,2,2-Tetrachloroethane	.6	.3
Toluene	.1	--
Chlorobenzene	.2	--
Ethylbenzene	.2	.1

Acid Extractables (11)	A	B
2-Chlorophenol	0.09	--
Phenol	.07	--
2,4-Dichlorophenol	.1	--
2-Nitrophenol	.4	--
p-Chloro-m-cresol	.1	--
2,4,6-Trichlorophenol	.2	--
2,4-Dimethylphenol	.1	--
2,4-Dinitrophenol	2.0	--
4,6-Dinitro-o-cresol	40.0	--
4-Nitrophenol	.9	--
Pentachlorophenol	.4	--
Base/Neutral Extractables (72)		
1,3-Dichlorobenzene	0.02	--
1,4-Dichlorobenzene	.04	--
Hexachloroethane	.1	--
1,2-Dichlorobenzene	.05	--
bis(2-Chloroisopropyl) ether	.06	--
Hexachlorobutadiene	.08	--
1,2,4-Trichlorobenzene	.09	--
Naphthalene	.007	--
bis(2-Chloroethyl) ether	.07	--
Hexachlorocyclopentadiene	.2	--
Nitrobenzene	.08	--
bis(2-Chloroethoxy) methane	.06	--
2-Chloronaphthalene	.02	--
Acenaphthylene	.02	--
Acenaphthene	.04	--
Isophorone	.06	--
Fluorene	.02	--
2,6-Dinitrotoluene	.2	--
1,2-Diphenylhydrazine	.02	--
2,4-Dinitrotoluene	.02	--
N-Nitrosodiphenylamine	.07	--

determinable concentrations[1/] *for laboratory-treated water samples*

Values in column A were determined at the beginning
column B were determined near end of study.]

	Base/Neutral Extractables (continued)				
	A	B		A	B
Hexachlorobenzene	0.05	--	Aldrin	4	10
4-Bromophenyl phenyl ether	.1	--	Dieldrin	4	10
Phenanthrene	.01	--	Chlordane (technical mixture)	*	10
Anthracene	.01	--	4,4'-DDT	2	10
Dioctylphthalate	.89	--	4,4'-DDE (p,p'-DDX)	1.5	10
(TCDD)	*	*	4,4'-DDD (p,p'-TDE)	1.5	10
Dimethyl phthalate	.03	--	α-Endosulfan	1200	10
Diethyl phthalate	.03	--	β-Endosulfan	200	10
Fluoranthene	.02	--	Endosulfan sulfate	12	10
Pyrene	.01	--	Endrin	*	10
Dibutyl phthalate	.02	--	Endrin aldehyde	15	10
Benzidine	.02	--	Heptachlor	7	10
Butylbenzyl phthalate	.03	--	Heptachlor epoxide	2	10
Chrysene	.02	--	α-BHC	5	10
bis(2-Ethylhexyl) phthalate	.04	--	β-BHC	89	10
Benzo (a) anthracene	.02	--	γ-BHC (lindane)	5	10
Benzo (b) fluoranthene	.02	--	δ-BHC	4	10
Benzo (k) fluoranthene	.02	--	PCB (Aroclor 1242)	11	10
Benzo (a) pyrene	.02	--	PCB (Aroclor 1254)	6	10
Indeno (1,2,3-c,d) pyrene	.02	--	PCB (Aroclor 1221)	*	10
Dibenzo (a,h) anthracene	.02	--	PCB (Aroclor 1232)	*	10
Benzo (g,h,i) perylene	.01	--	PCB (Aroclor 1248)	*	10
N-Nitrosodimethylamine	.8	--	PCB (Aroclor 1260)	*	10
N-Nitrosodi-n-propylamine	.2	--	PCB (Aroclor 1016)	*	10
4-Chlorophenyl phenyl ether	.03	--	Toxaphene	*	10
3,3'-Dichlorobenzidine	1.0	--			

1/ Quoted from Monsanto Research, Dayton, Ohio.

* Minimum determinable concentration not established.

-- Indicates no change.

methylene chloride. The extracts were combined, dried on a column of anhydrous sodium sulfate, concentrated to 10 mL in a Kuderna-Danish evaporative concentrator (equipped with a three-chamber Snyder column), and ultimately reduced to 1 mL with a micro-Snyder column. The concentration factor was thus approximately 2,000. Each concentrate was then spiked with 20 µg of d_{10}-anthracene (decadeuteroanthracene) as an internal standard, sealed in septum-capped vials, and stored at 4°C until analyzed.

The aqueous phase remaining from the base/neutral extraction was acidified to pH<2 and extracted by a procedure similar to that used to extract the base/neutrals.

Analyses were performed by injecting a 2-µL sample (containing 0.04 µg of d_{10}-anthracene) onto a 6-foot column packed with SP-2250(OV-17) held at 50°C for 4 minutes. Temperature of the column was programmed to increase 8°C per minute to 260°C and remain isothermal for 20 minutes. Mass spectral scans from 35 to 500 atomic mass units were acquired every 4 seconds.

Volatile Compounds.--Volatile organic compounds were recovered from water in the vials by the purge and trap method described by Bellar and Lichtenberg. A 5-mL volume of the aqueous sample, spiked with an internal standard of 0.25 µg each of bromochloromethane and 1,4-dichlorobutane, was sparged (bubbled) for 12 minutes with a stream of helium flowing 40 mL per minute. The compounds were trapped into a 1/8-inch-diameter collection tube filled with 4 inches of Tenax-GC porous polymer, backed with 2 inches of Davison Type 15 silica gel. The compounds in the tube were then thermally desorbed at 180°C for 4 minutes onto a 6-foot chromatographic column packed with 0.2-percent Carbowax 1500 on a Carbopak-C support. The column was maintained at -40°C to allow the volatile compounds to accumulate at the top of the column. Column temperature was then raised at a programmed rate of 8°C per minute to 170°C. Under these conditions chloromethane elutes in 1.5 minutes and ethylbenzene in 28.5 minutes.

Detection Limits

Concentrations were calculated from response ratios relative to the mass 55 peak of the 1,4-dichlorobutane internal standard for volatile compounds and the mass 188 peak of the d_{10}-anthracene internal standard for extractable compounds. Minimum determinable concentrations of the priority pollutants measured in laboratory-treated clean water samples by MRC, are listed in table 1. The analytical method employed in this work is a screening tool and is only a semi-quantitative procedure; therefore, the fact that these values were revised slightly [compare initial values in column A and revised values in column B of table 1] during the project is not important. No concentration correction was made for recovery efficiency in these samples; however, less than 100 percent recoveries are generally obtained in these types of analyses with spiked distilled water samples. Recoveries can be expected to vary considerably, depending on the chemical characteristics or matrix of a particular sample; for example, extraction efficiency typically decreases in the presence of organic macromolecules and particulate material (written commun., Monsanto Research Center). However, for the samples in this study, recoveries were probably close to the maximum attainable because the dissolved organic and particulate content of ground water is generally low.

Method of Data Presentation

Compound Groups

The 114 organic priority pollutants are often divided into groups of compounds based on the method of analysis and chemical characteristics of the compounds. (See Keith and Telliard, 1979.) Only about one-quarter of the 114 priority pollutants were detected in this study and, for purposes of discussion, they have been divided into the following groups:

Group 1--volatile trihalomethanes (trihaloforms)

Group 2--volatile saturated halogenated hydrocarbons (saturated halocarbons)

Group 3--volatile unsaturated halogenated hydrocarbons (unsaturated halocarbons)

Group 4--volatile benzenes (benzenes)

Group 5--acid extractable phenols (phenols)

Group 6--base/neutral extractable phthalate esters (phthalates)

Group 7--base/neutral extractable polynuclear aromatic hydrocarbons (PAH)

The volatile compounds listed in groups 1 to 4 are produced in large quantities by chemical industries and have important uses as solvents and starting materials for other products. The trihaloforms (group 1) are reaction products of the chlorination of dissolved organic macromolecules. Chloroform, in particular, is formed by this mechanism in chlorinated drinking waters and wastewaters (Rook, 1974). Other saturated organchlorines (group 2), such as methylene chloride, may also be formed as a result of chlorination but in concentrations considerably less than chloroform. Unsaturated organochlorines (group 3) are not formed by the chlorination reaction. Phenols (group 5) are also produced by chemical industries, but substantial quantities of some phenols are also natural products.

Phthalate esters (group 6) and polynuclear aromatic hydrocarbons (group 7), which occur as base/neutral compounds, are ubiquitous. Phthalate esters have widespread use in the plastics industry. Some of the polynuclear aromatics are used in the chemical industry, and some are present in petroleum, but the most probable sources in water and sediment are forest fires and combustion of fossil fuels (Giger and Schaflner, 1977; Hunter and others, 1979).

DISCUSSION OF RESULTS

Results of GC/MS analyses are given in table 2; brief descriptions of each site and dates of sampling are given in table 8 (at end of report).

Table 2.--Results of gas chromatograph/mass spectrometer analysis[1] for

[Well locations are given in table 8;
Dashes indicate value below minimum determinable concentration.

Well site	Group 1 (trihaloforms)				Group 2 (saturated halocarbons)							Group 3 (unsaturated halocarbons)			
	Chloroform	Dichlorobromomethane	Chlorodibromomethane	Bromoform	Methylene chloride	1,1,1-Trichloroethane	Carbon tetrachloride	Trichlorofluoromethane	1,1-Dichloroethane	1,1,2,2-Tetrachloroethane	1,2-Dichloropropane	1,1-Dichloroethylene	1,2-trans-Dichloroethylene	Trichloroethylene	Tetrachloroethylene
1	--	--	--	--	22	--	--	13	--	--	--	--	--	0.6	--
2	--	--	--	--	4.9	--	--	--	--	--	--	--	--	--	--
3A	--	--	--	--	5.6	--	--	--	--	--	--	--	--	3.7	--
3B	--	--	--	--	4.1	--	--	--	--	--	--	--	--	0.6	--
4	--	--	--	--	6.0	--	--	--	--	--	--	--	--	1.8	--
5	--	--	--	--	430	--	--	--	--	2.3	--	--	36	19	200
6	--	--	--	--	9.3	--	--	--	--	--	--	--	--	1.4	1.9
7	--	--	--	--	1100	--	--	3.3	--	--	--	--	--	2.8	--
8	8.7	2.4	--	--	950	--	--	5.4	--	--	--	--	--	3.1	--
9	13	--	--	--	1500	--	--	7.0	--	--	--	--	--	11	0.2
10	--	--	--	--	16	--	--	--	--	--	--	--	--	2.6	--
11	--	--	--	--	9.4	--	--	--	--	--	--	--	--	0.7	--
12A	--	--	--	--	10	--	--	--	--	--	--	--	--	1.2	--
12B	--	--	--	--	11	--	--	--	--	--	--	--	--	1.5	--
13A	--	--	--	--	11	--	--	0.7	--	--	--	--	--	1.4	--
14	--	--	--	--	11	--	--	--	--	--	--	--	--	0.3	--
15	--	--	--	--	9.9	--	--	--	--	--	--	--	--	0.7	--
16	--	--	--	--	11	--	--	--	--	--	--	--	--	0.6	--
11	--	--	--	--	15	--	--	--	--	--	--	--	--	4.9	--
5	--	--	--	--	15	--	--	--	--	--	--	--	3.0	7.0	37
6	--	--	--	--	8.1	--	--	--	--	--	--	--	--	7.1	--
8	2.3	--	--	--	15	--	--	--	--	--	--	--	--	1.4	--
7	--	--	--	--	20	--	--	--	--	--	--	--	--	4.1	--
9	--	--	--	--	20	--	--	--	--	--	--	--	--	4.1	--
13E	--	--	--	--	27	--	--	3.0	--	--	--	--	--	0.1	--
13D	--	--	--	--	26	--	--	3.9	--	--	--	--	--	--	--
13C	--	--	--	--	28	--	--	8.5	--	--	--	--	--	0.2	--
13B	--	--	--	--	24	--	--	--	--	--	--	--	--	--	--
13A	2.4	--	--	--	2.7	--	--	--	--	--	--	--	--	--	--
17	--	--	--	--	1.8	4.8	--	--	--	--	--	--	--	--	--
18	--	--	--	--	9.9	--	--	--	--	--	--	--	--	--	--
19	--	--	--	--	17	--	--	--	--	--	--	--	--	--	--
20	--	--	--	--	2.7	--	--	--	--	--	--	--	--	--	--
21	--	--	--	--	6.4	--	--	--	--	--	--	--	--	--	--
22	--	--	--	--	2.6	--	--	1.1	--	--	--	--	--	--	--
23	--	--	--	--	10	--	--	--	--	--	--	--	--	--	--
24	--	--	--	--	2.1	--	1.7	--	--	--	--	--	--	--	--
25	--	--	--	--	11	--	--	2.2	--	--	--	--	--	--	--
26	--	--	--	--	4.4	--	--	--	--	--	--	--	--	--	--
27A	--	--	--	--	5.4	--	--	--	--	--	--	--	--	--	--

1 Analyses by Monsanto, Research, Dayton, Ohio.

priority pollutants in New York State ground-water samples, 1978-79

Values are in micrograms per liter.
Compounds not detected are omitted from list.]

Well site	Group 4 (benzenes)			Group 5 (phenols)		Group 6 (phthalates)						Group 7 (PAH)			
	Benzene	Toluene	Ethylbenzene	Phenol	2,4,6-Trichlorophenol	Dimethyl phthalate	Diethyl phthalate	Dibutyl phthalate	Dioctyl phthalate	Butylbenzyl phthalate	bis(2-Ethylhexyl) phthalate	Anthracene/phenanthrene	Pyrene	Fluorene	Fluoranthene
1	--	5.7	--	--	--	--	--	--	--	--	2	--	--	--	--
2	--	0.4	--	--	--	--	--	--	--	--	10	--	--	--	--
3A	--	0.7	--	--	--	--	--	--	--	--	2.7	--	--	--	--
3B	--	0.5	--	--	--	--	--	--	--	--	45	--	--	--	--
4	--	0.7	--	--	--	--	--	--	--	--	10	--	--	--	--
5	0.7	1.3	3.1	--	--	--	--	0.6	--	--	28	--	--	--	--
6	--	0.8	1.3	1.9	0.9	--	0.2	0.9	--	--	1.9	--	--	--	--
7	--	4.9	1.1	0.6	--	--	--	--	--	--	2.2	--	--	--	--
8	--	8.2	0.8	--	--	--	--	--	--	--	3.3	--	--	--	--
9	--	5.4	0.6	0.2	--	--	--	--	--	--	13	--	--	--	--
10	--	0.7	0.2	0.6	--	--	--	--	--	--	--	--	--	--	--
11	--	0.4	0.2	--	--	--	--	4.2	--	--	14	--	--	--	--
12A	--	0.5	0.2	--	--	--	--	--	--	--	--	--	--	--	--
12B	--	0.5	--	0.6	--	--	--	3.0	--	--	35	--	--	--	--
13A	0.5	0.5	--	--	--	--	--	5.3	--	--	24	--	--	--	--
14	1.1	1.0	32	--	--	--	0.7	1.5	--	--	2.4	0.4	--	--	--
15	--	--	40	--	--	--	0.8	1.6	--	--	120	0.7	--	--	--
16	--	0.6	29	--	--	--	0.6	2.2	--	--	23	0.04	--	--	--
11	--	0.6	0.05	--	--	--	0.8	0.7	--	--	9.7	0.4	--	--	--
5	0.03	0.3	--	--	--	--	--	2.4	--	--	17	0.3	0.1	0.02	0.1
6	--	--	0.5	--	--	--	--	--	--	--	23	0.2	--	--	--
8	--	3.9	0.3	--	--	--	--	--	--	--	13	0.3	--	0.06	--
7	--	1.1	0.2	--	--	--	0.3	--	--	0.05	9.8	0.2	--	--	--
9	--	0.7	0.3	--	--	--	4.6	2.1	--	--	69	10	--	--	--
13E	9.6	1.1	0.2	--	--	--	--	0.9	--	--	0.6	--	--	--	--
13D	3.6	0.6	0.1	--	--	--	--	0.4	--	--	0.2	--	--	--	--
13C	4.0	0.8	0.1	--	--	--	--	0.6	--	--	0.6	--	--	--	--
13B	3.3	0.2	--	--	--	--	--	0.5	--	--	0.2	--	--	--	--
13A	1.4	0.7	0.2	--	--	--	--	0.3	--	--	0.3	--	--	--	--
17	--	0.8	2.8	--	--	--	--	--	--	--	1.6	--	--	--	--
18	--	--	--	1.5	--	--	--	--	--	--	5.2	--	--	--	--
19	--	--	--	--	--	--	--	--	--	--	0.9	--	--	--	--
20	--	--	1.0	--	--	--	--	--	--	--	32	--	--	--	--
21	--	0.4	0.5	0.5	--	--	--	--	--	--	2.4	--	--	--	--
22	--	--	--	--	--	--	--	0.4	--	--	1.2	--	--	--	--
23	--	0.6	--	0.2	--	--	--	--	--	--	3.1	--	--	--	--
24	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--
25	--	4.7	--	--	--	--	2.0	2.3	--	--	1.0	--	--	--	--
26	--	2.8	--	--	--	--	0.2	0.3	0.2	0.3	10	0.1	--	--	--
27A	--	5.0	1.2	--	--	--	1.6	0.3	--	--	6.1	0.7	--	--	--

-- Indicates compound not present above minimum determinable concentration listed in table 1.

Table 2.--Results of gas chromatograph/mass spectrometer analysis for

Well site	Group 1 (trihaloforms)				Group 2 (saturated halocarbons)							Group 3 (unsaturated halocarbons)			
	Chloroform	Dichlorobromomethane	Chlorodibromomethane	Bromoform	Methylene chloride	1,1,1-Trichloroethane	Carbon tetrachloride	Trichlorofluoromethane	1,1-Dichloroethane	1,1,2,2-Tetrachloroethane	1,2-Dichloropropane	1,1-Dichloroethylene	1,2-trans-Dichloroethylene	Trichloroethylene	Tetrachloroethylene
27B	--	--	--	--	2.3	--	--	--	--	--	--	--	--	2.1	--
28	--	--	--	--	4.0	--	--	1.5	3.9	--	--	--	--	--	--
28	--	--	--	--	13	--	--	--	9.5	--	--	--	--	--	--
29	--	--	--	--	5.2	--	--	--	--	--	--	--	--	--	--
30	--	--	--	--	8.8	--	--	--	--	--	--	--	--	--	--
31	--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--
32	--	--	--	--	5.1	--	--	0.4	--	--	--	--	--	--	--
33	--	--	--	--	1.8	--	--	--	--	--	--	--	--	--	--
34	--	--	--	--	27	--	--	5.1	--	--	--	--	--	--	--
35	--	--	--	--	16	14	0.9	--	4.5	--	--	--	8.7	11	--
36	--	--	--	--	27	1.3	--	--	--	--	--	--	--	--	--
37	--	--	--	--	34	1.0	--	4.4	--	--	--	--	1.6	--	--
38	--	--	--	--	29	--	--	3.8	--	--	--	--	--	--	--
39	--	--	--	--	12	--	--	2.8	--	--	--	--	--	--	--
40	--	--	--	--	31	--	1.0	1.7	--	--	--	--	--	--	--
41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
41	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--
42	--	--	--	--	1.7	--	--	--	--	--	--	--	--	--	--
43	--	--	--	--	1.8	--	--	--	--	--	--	--	--	--	--
44	--	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--
45	--	--	--	--	2.5	--	--	4.2	--	--	--	--	--	--	--
46	--	--	--	--	12	--	--	0.4	--	--	--	--	--	--	--
46	--	--	--	--	24	--	--	4.1	--	--	--	--	--	--	--
47	5.5	3.5	--	--	0.5	--	--	--	--	--	--	--	--	--	--
48	0.5	--	--	--	--	0.1	--	1.2	--	--	0.4	--	--	--	--
32	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
32	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
34	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
40	--	--	--	--	2	--	--	--	--	--	--	--	--	--	0.6
37	0.8	0.9	--	--	--	0.6	--	--	--	--	--	--	--	--	--
35	12	7.8	13	2.9	53	18	3.6	--	--	--	--	--	--	16	3.0
13C	1.7	--	--	--	320	--	--	--	--	--	--	--	--	2.1	1.0
13E	1.5	--	--	--	210	--	--	--	--	--	--	--	--	0.7	0.2
49	18	--	--	--	29	--	--	--	--	--	--	1.3	--	13	--

* Indicates volatile fraction not analyzed.

priority pollutants in New York State ground-water samples, 1978-79 (continued)

Well site	Group 4 (benzenes)			Group 5 (phenols)		Group 6 (phthalates)						Group 7 (PAH)			
	Benzene	Toluene	Ethylbenzene	Phenol	2,4,6-Trichlorophenol	Dimethyl phthalate	Diethyl phthalate	Dibutyl phthalate	Dioctyl phthalate	Butylbenzyl phthalate	bis(2-Ethylhexyl) phthalate	Anthracene/phenanthrene	Pyrene	Fluorene	Fluoranthene
27B	--	10	--	--	--	--	--	0.3	--	--	3.4	0.3	--	--	--
28	0.7	6.6	4.4	--	--	--	--	0.2	--	0.1	2.8	0.1	--	--	--
28	--	5.0	--	--	--	--	--	0.2	--	--	12	0.1	--	--	--
29	--	4.4	--	--	--	--	0.3	0.4	--	2.6	56	0.1	--	--	--
30	--	7.2	--	--	--	--	1.2	--	--	0.9	6.7	0.1	--	--	--
31	--	7.2	--	--	--	--	0.7	0.8	--	--	5.3	0.2	--	--	--
32	--	2.8	--	--	--	--	1.2	0.9	8.0	38	170	0.1	--	--	--
33	--	10	--	--	--	--	0.9	14	0.2	--	3.0	0.1	--	--	--
34	--	3.5	--	--	--	--	1.4	470	1600	15000	--	21	--	--	--
35	--	15	--	0.2	--	4.1	--	4.2	--	--	1.9	2.3	0.1	--	0.3
36	--	0.6	--	--	--	1.1	--	0.8	1.7	1.5	20	0.4	--	--	--
37	--	0.8	--	--	--	1.1	--	1.6	0.4	--	4.6	0.4	--	--	--
38	--	0.6	--	0.2	--	0.8	--	1.0	0.2	--	9.1	0.3	--	--	--
39	--	1.2	--	--	--	1.2	--	1.0	--	0.3	2.0	0.4	--	--	--
40	--	0.3	--	0.05	--	0.4	--	1.0	--	--	3.5	0.2	--	--	--
41	--	0.8	--	--	--	--	--	1.2	--	--	0.7	--	--	--	--
41	0.2	0.6	--	--	--	--	--	0.4	--	--	1.4	--	--	--	--
42	--	0.8	0.1	--	--	--	--	2.3	--	--	0.8	--	--	--	--
43	0.5	0.6	--	--	--	--	--	--	--	--	2.0	--	--	--	--
44	--	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--
45	0.1	0.6	0.04	--	--	--	0.3	1.9	--	--	--	--	--	--	--
46	3.9	2.8	--	--	--	--	--	0.98	--	1.5	0.64	--	--	--	--
46	1.5	7.3	0.1	--	--	--	--	0.5	--	--	5.1	--	--	--	--
47	--	1.6	--	0.05	--	--	--	1.2	--	4.5	7.2	0.2	--	--	--
48	--	--	--	--	--	--	--	0.2	--	--	5.5	--	--	--	--
32	*	*	*	--	--	--	1.2	2.3	--	0.2	4.3	1.4	--	--	--
32	*	*	*	--	--	--	2.0	1.5	--	0.2	3.1	1.1	--	--	--
34	*	*	*	--	--	--	1.9	2.4	--	0.4	3.2	0.2	--	--	--
40	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**
37	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**
35	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**
13C	1.5	7.4	0.7	**	**	**	**	**	**	**	**	**	**	**	**
13E	0.6	3.1	--	**	**	**	**	**	**	**	**	**	**	**	**
49	2.6	6.6	0.3	--	--	--	0.2	0.1	--	0.1	5.9	0.2	--	--	--

** Indicates extractable fraction not analyzed.

Quality Control

The following quality-control checks were made in the field, office, and laboratory during this study:

1. periodic analysis of 10 MRC water blanks,

2. repeat sampling of 14 wells,

3. reanalysis of aliquots of samples from 3 wells,

4. comparison of results of this study with those from other published studies, and

5. changes in the frequency with which some compounds were reported from beginning to the end of this study.

Evidence gathered from these quality-control checks indicate that contamination at the laboratory may affect results at levels near the stated minimum determinable concentrations. Thus, a given compound can be regarded as actually present only when the reported concentration exceeds the stated minimum determinable concentration by a substantial margin, in this case, by about 10 µg/L.

Results of MRC blank-sample analyses obtained at various times throughout the study are given in table 3. Blanks consisted of treated municipal water from the city of Dayton that had been distilled and filtered through activated charcoal. As many as 14 compounds were detected in the blanks, but it was not possible to distinguish whether the compounds had been in the treated water orginally or were acquired from the laboratory atmosphere and(or) glassware. Contamination by methylene chloride probably occurred in the laboratory because it was used in large quantities for extraction of the acid and base/neutral nonvolatile compounds. Similarly, contamination from phthalates may be attributed to their presence in plastics used in the laboratory. The presence of phthalates in indoor atmospheres is well documented (Weschler, 1980). The source of toluene contamination in the blank samples is not certain, although leaching from the charcoal filter used in preparing the blank is a possibility. However, the presence of toluene in many of the groundwater samples suggests that contamination may have resulted from the analytical equipment.

Results of aliquots split in the laboratory from samples at three sites are given in table 4; results of a resampling done at 14 sites are given in table 5. Although quantitative statements of reproducibility cannot be made from these results, some general observations are possible. As a rough guide, reproducibility is probably no better than an order of magnitude in the submicrogram per liter range and a factor of 2 to 3 in the microgram per liter range. A few samples were grossly contaminated during collection, shipment, or analysis; for example, samples collected June 27, 1978 at sites 6, 8, 9, and 10 were contaminated (probably in the laboratory) by methylene chloride,

and samples collected November 16, 1978 at sites 32 and 34 were contaminated by phthalate esters and some aromatic derivatives. Resampling at several of the sites (see table 5) did not confirm the initial reported high values for these compounds. In addition to the priority pollutants, acetone was occasionally detected in high concentration but was probably an artifact of laboratory contamination.

Evidence of laboratory contamination at concentrations near values listed in table 1 is indicated further by a comparison of the percent frequency with which a compound was found in this study with its percent frequency of occurrence in more than 2,000 industrial wastewaters as reported by Keith and Telliard (1979). Selected results of this comparison are summarized in table 6. Although the occurrence of priority pollutants should have a higher frequency in industrial wastewater than in comparatively clean ground waters, several compounds were reported more frequently in ground water than in industrial wastewaters. It is concluded that data obtained by this study represent analytical contamination to some extent.

Detailed investigations of the occurrence of trichlorofluoromethane (Freon-11) have been conducted. Thompson and Hayes (1979) report that surface waters in equilibrium with current atmospheric contamination levels have a Freon-11 concentration of about 0.0005 µg/L, with concentrations as much as 2 orders of magnitude greater than this in water in the Edwards aquifer, near San Antonio, Texas, even though no point source is known. Nevertheless, even these high values are well below the levels detected at many sites in this study. Trichlorofluoromethane detected in about one-third of the samples in this study, in the absence of other indicators of contamination, probably results from analytical contamination.

Although it is not possible to directly translate the results of intensive study on trichchlorofluoromethane to other halocarbons, the fact that worldwide release rates of the 10 most abundant halocarbons to the atmosphere (Dilling, 1977; Helz and Hsu, 1978) are comparable to that of trichlorofluoromethane (within a factor of 2) suggests their equilibrium surface-water concentrations should also range well below detection limits of this study.

Additional evidence that analytical contamination affected results obtained in this study is the apparent change in frequency with which trichloroethylene and ethylbenzene were reported. Results in table 2 (presented in chronological order of sample collection and laboratory processing) indicate that these two compounds were detected with much greater frequency in the earlier samples, although there is no indication that sites sampled earlier were more likely to be contaminated than those sampled later.

In summary, the evidence suggests that certain priority pollutants (methylene chloride, toluene, phthalates, anthracene/phenanthrene, trichloroethylene, ethylbenzene, and trichlorofluoromethane) could not be quantified at stated minimum determinable concentrations because samples were subject to contamination at some stage of collection or processing. This observation also implies that other compounds could not be quantified at the concentration limits given in table 1.

Table 3.--Results of analysis of treated water blanks.

[Concentrations in micrograms per liter.]

Blank no.	Chloroethane	Methylene chlorice	1,1-Dichloroethylene	Trichloroethylene	Tetrachloroethylene	Benzene	Toluene	Ethylbenzene	(acetone)	Diethyl phthalate	Dibutyl phthalate	Butylbenzyl phthalate	bis(2-Ethylhexyl) phthalate	Anthracene/phenanthrene
1	21	17	1.3	0.3	0.1	10	8	0.5	5000	--	--	--	--	--
2	--	4.7	--	--	--	--	0.8	--	--	--	--	--	1.6	0.1
3	--	20	--	--	--	--	--	--	--	0.2	0.4	--	1.0	0.1
4	--	12	--	--	--	--	4.6	--	--	0.8	0.9	0.2	4.9	0.6
5	--	10	--	--	--	--	2.9	--	--	--	0.1	0.2	7.7	0.2
6	--	8.5	--	--	--	--	4.0	--	--	--	0.1	--	0.2	--
7	--	8.6	--	--	13	--	1.8	4.9	--	8.6	5.6	--	5.4	0.2
8	--	9.4	--	--	--	--	1.2	--	--	--	10	--	7.4	--
9	--	4.2	--	--	--	--	0.6	--	--	--	1.5	--	4.5	--
10	--	5.9	--	1.3	--	1.3	2.6	--	1.1	0.3	0.4	0.1	0.8	--

-- Indicates compound not present above minimum determinable concentration listed in table 1.

Table 4.--Results of analysis of three ground-water aliquots split in the laboratory.

[Concentrations in micrograms per liter.]

Well site	Methylene chloride	Trichlorofluoromethane	Benzene	Toluene	Ethylbenzene	Diethyl phthalate	Dibutyl phthalate	Dioctyl phthalate	Butylbenzyl phthalate	bis (2-Ethylhexyl) phthalate	Anthracene/phenanthrene
41	--	--	--	0.8	--	--	1.2	--	--	0.7	--
	0.7	--	0.2	0.6	--	--	0.4	--	--	1.4	--
46	12	0.4	3.9	2.8	--	--	0.98	--	1.5	0.64	--
	24	4.1	1.5	7.3	0.1	--	0.5	--	--	5.1	--
32	*	*	*	*	*	1.2	2.3	--	0.2	4.3	1.4
	*	*	*	*	*	2.0	1.5	--	0.2	3.1	1.1

-- Indicates compound not present above minimum determinable concentration listed in table 1.
* Indicates volatile fraction not analyzed.

Table 5.--Results of analysis for 14 wells resampled

[Concentrations are in micrograms per liter.]

Well site	Group 1 (trihaloforms)				Group 2 (saturated halocarbons)						Group 3 (unsaturated halocarbons)		
	Chloroform	Dichlorobromomethane	Chlorodibromomethane	Bromoform	Methylene chloride	1,1,1-Trichloroethane	Carbon tetrachloride	Trichlorofluoromethane	1,1-Dichloroethane	1,1,2,2-Tetrachloroethane	1,2-trans-Dichloroethylene	Trichloroethylene	Tetrachloroethylene
5	--	--	--	--	430	--	--	--	--	2.3	36	19	200
5	--	--	--	--	15	--	--	--	--	--	3.0	7.0	37
6	--	--	--	--	9.3	--	--	--	--	--	--	1.4	1.9
6	--	--	--	--	8.1	--	--	--	--	--	--	7.1	--
7	--	--	--	--	1100	--	--	3.3	--	--	--	2.8	--
7	--	--	--	--	20	--	--	--	--	--	--	4.1	--
8	8.7	2.4	--	--	950	--	--	5.4	--	--	--	3.1	--
8	2.3	--	--	--	15	--	--	--	--	--	--	1.4	--
9	13	--	--	--	1500	--	--	7.0	--	--	--	11	0.2
9	--	--	--	--	20	--	--	--	--	--	--	4.1	--
11	--	--	--	--	9.4	--	--	--	--	--	--	0.7	--
11	--	--	--	--	15	--	--	--	--	--	--	4.9	--
13A	--	--	--	--	11	--	--	0.7	--	--	--	1.4	--
13A	2.4	--	--	--	2.7	--	--	--	--	--	--	--	--
13C	--	--	--	--	28	--	--	8.5	--	--	--	0.2	--
13C	1.7	--	--	--	320	--	--	--	--	--	--	2.1	1.0
13E	--	--	--	--	27	--	--	3.0	--	--	--	0.1	--
13E	1.5	--	--	--	210	--	--	--	--	--	--	0.7	0.2
28	--	--	--	--	4.0	--	--	1.5	3.9	--	--	--	--
28+	--	--	--	--	13	--	--	--	9.5	--	--	--	--
34	--	--	--	--	27	--	--	5.1	--	--	--	--	--
34	*	*	*	*	*	*	*	*	*	*	*	*	*
35	--	--	--	--	16	14	0.9	--	4.5	--	8.7	11	--
35	12	7.8	13	2.9	53	18	3.6	--	--	--	--	16	3.0
37	--	--	--	--	34	1.0	--	4.4	--	--	1.6	--	--
37	0.8	0.9	--	--	--	0.6	--	--	--	--	--	--	--
40	--	--	--	--	31	--	1.0	1.7	--	--	--	--	--
40	--	--	--	--	2	--	--	--	--	--	--	--	0.6

-- Indicates compound not present above minimum determinable concentration listed in table 1.
* Indicates volatile fraction not analyzed.

Table 5.--Results of analysis for 14 wells resampled (continued)

Well site	Group 4 (benzenes)			Group 5 (phenols)		Group 6 (phthalates)						Group 7 (PAH)			
	Benzene	Toluene	Ethylbenzene	Phenol	2,4,6-Trichlorophenol	Dimethyl phthalate	Diethyl phthalate	Dibutyl phthalate	Dioctyl phthalate	Butylbenzyl phthalate	bis(2-Ethylhexyl) phthalate	Anthracene/phenanthrene	Pyrene	Fluorene	Fluoranthene
5	0.7	1.3	3.1	--	--	--	--	0.6	--	--	28	--	--	--	--
5	0.03	0.3	--	--	--	--	--	2.4	--	--	17	0.3	0.1	0.02	0.1
6	--	0.8	1.3	1.9	0.9	--	0.2	0.9	--	--	1.9	--	--	--	--
6	--	--	0.5	--	--	--	--	--	--	--	23	0.2	--	--	--
7	--	4.9	1.1	0.6	--	--	--	--	--	--	2.2	--	--	--	--
7	--	1.1	0.2	--	--	--	0.3	--	--	0.05	9.8	0.2	--	--	--
8	--	8.2	0.8	--	--	--	--	--	--	--	3.3	--	--	--	--
8	--	3.9	0.3	--	--	--	--	--	--	--	13	0.3	--	0.06	--
9	--	5.4	0.6	0.2	--	--	--	--	--	--	13	--	--	--	--
9	--	0.7	0.3	--	--	--	4.6	2.1	--	--	69	10	--	--	--
11	--	0.4	0.2	--	--	--	--	4.2	--	--	14	--	--	--	--
11	--	0.6	0.05	--	--	--	0.8	0.7	--	--	9.7	0.4	--	--	--
13A	0.5	0.5	--	--	--	--	--	5.3	--	--	24	--	--	--	--
13A	1.4	0.7	0.2	--	--	--	--	0.3	--	--	0.3	--	--	--	--
13C	4.0	0.8	0.1	--	--	--	--	0.6	--	--	0.6	--	--	--	--
13C	1.5	7.4	0.7	**	**	**	**	**	**	**	**	**	**	**	**
13E	9.6	1.1	0.2	--	--	--	--	0.9	--	--	0.6	--	--	--	--
13E	0.6	3.1	--	**	**	**	**	**	**	**	**	**	**	**	**
28	0.7	6.6	4.4	--	--	--	--	0.2	--	0.1	2.8	0.1	--	--	--
28	--	5.0	--	--	--	--	--	0.2	--	--	12	0.1	--	--	--
34	--	3.5	--	--	--	--	1.4	470	1600	15000	--	21	--	--	--
34	*	*	*	--	--	--	1.9	2.4	--	0.4	3.2	0.2	--	--	--
35	--	15	--	0.2	--	4.1	--	4.2	--	--	1.9	2.3	0.1	--	0.3
35	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**
7	--	0.8	--	--	--	1.1	--	1.6	0.4	--	4.6	0.4	--	--	--
7	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**
)	--	0.3	--	0.05	--	0.4	--	1.0	--	--	3.5	0.2	--	--	--
)	--	--	--	**	**	**	**	**	**	**	**	**	**	**	**

** Indicates extractable fraction not analyzed.
+ Resampling was done on same day as original sampling.

Table 6.--Frequency of occurrence of selected priority pollutants in analyses from this study and in industrial wastewaters.

[Values are in percent. Results for industrial wastewaters are from Keith and Telliard (1979).]

Compound	This study	Industrial wastewater
	GROUP 1 (trihaloforms)	
Chloroform	17%	40%
Dichlorobromomethane	7	4
Bromoform	2	2
Chlorodibromomethane	2	2
	GROUP 2 (saturated halocarbons)	
Methylene chloride	98%	34%
Trichlorofluoromethane	38	7
1,1,1-Trichloroethane	9	10
Carbon tetrachloride	5	8
1,1-Dichloroethane	4	1
1,1,2,2-Tetrachloroethane	2	4
1,2-Dichloropropane	2	2
	GROUP 3 (unsaturated halocarbons)	
Trichloroethylene	39%	10%
Tetrachloroethylene	12	10
1,2-trans-Dichloroethylene	5	8
1,1-Dichloroethylene	2	8
	GROUP 4 (benzenes)	
Toluene	89%	29%
Ethylbenzene	42	17
Benzene	25	29
	GROUP 5 (phenols)	
Phenol	21%	26%
2,4,6-Trichlorophenol	2	5
	GROUP 6 (phthalates)	
bis(2-Ethylhexyl) phthalate	98%	42%
Dibutyl phthalate	72	19
Diethyl phthalate	35	8
Butylbenzyl phthalate	26	8
Dioctyl phthalate	12	6
Dimethyl phthalate	11	6
	GROUP 7 (PAH)	
Anthracene/phenanthrene	51%	11%
Pyrene	4	8
Fluoranthene	4	7
Fluorene	4	6

Evaluation of Results

Similar Studies

Few large-scale reconnaissance studies of priority pollutants in groundwaters have been conducted. A survey somewhat comparable to this report, but limited to volatile halocarbons, indicated that most wells in New Jersey (Burke and Tucker, 1978) were not significantly contaminated. The most frequently reported contaminants were 1,1,1-trichlorethane; carbon tetrachloride; 1,1,2-trichloroethylene; and 1,1,2,2-tetrachloroethylene. In the initial report, results were reported to 0.1 µg/L, but in a second report (Tucker and Burke, 1978), the minimum reportable concentration was increased substantially to values comparable to or even greater, as in the case of methylene chloride at 90 µg/L, than those listed in table 1 of this report. The revised detection limits may reflect recognition that laboratory contamination is a serious problem at the submicrogram per liter level.

Natural Background Levels

A study of ground water in East Texas (Glaze and Rawley, 1979) suggests the current background level of chloroform is 1 to 2 µg/L. On the basis of other studies cited earlier in this report, the value seems a little too high for theoretical "baseline." Possible explanations are laboratory contamination or that some of the East Texas aquifers may be receiving recharge by chlorinated surface waters. Further indication of natural background levels is provided by analyses of rainwater and surface seawater. Chloroform, carbon tetrachloride, trichloroethylene, tetrachloroethylene, and trichloroethane concentrations were reported to be 0.1 to 0.3 µg/L in rainwater in Great Britain (Pearson and McConnell, 1975) and 0.01 µg/L or less in Northeast Atlantic surface waters (Murray and Riley, 1973).

Clearly the analytical sensitivity in this study was not sufficient to determine background levels for any of the priority pollutants. The discussion on laboratory contamination raises the question of what measured concentration indicates that a well is contaminated. Only a semiquantitative answer to this question can be given. With the exception of methylene chloride and phthalates, concentrations greater than approximately 10 µg/L are generally indicative of contamination. Also, because contamination by a single compound is unlikely, concentrations of several related compounds should be used to establish whether contamination exists.

Contaminated Sites

By the various criteria established, ground water at Brewster (Putnam County, site 5) and Olean (Cattaraugus County, sites 27 and 28) is contaminated. Contamination at Brewster was independently confirmed by the New York State Department of Health (Kim and Stone, 1979), who reported a tetrachloroethylene concentration of 200 µg/L. This Geological Survey study found the same concentration in a sample collected June 27, 1978. A second sampling by the Geological Survey on August 16, 1978, yielded a lower value (see table 5 for comparison), but it is likely that a part of the volatile compounds was lost from the latter sample because the cap on the vial was found loosened upon arrival at MRC.

The reported contamination at Olean was not unexpected (Randall, 1976 and 1978) because the wells tested are on an industrial site. Although they are upgradient from public-supply wells, they are used only as an industrial-water supply. The wells are on a site formerly occupied by a petroleum refinery and later by a nitrogen-fertilizer manufacturing plant. The presence of xylenes, alkyl benzenes, and alkyl styrenes (see table 7), which are not on the priority pollutant list, is consistent with petroleum contamination.

The aquifer at Corning (Steuben County, site 35) may be slightly contaminated. The site was sampled twice and, although the two sets of values differ substantially (table 5), the volatile compounds (groups 1-4) found suggest possible contamination from organochlorine solvents and the chlorination reaction.

Wells in the Fulton area (Oswego County, site 13) may be contaminated by benzene and toluene. Unfortunately, their presence, especially toluene, in blank samples (table 3) complicates the interpretation. The probable source of contamination in the Fulton area is industrial wastes from landfills and dumps, but further sampling would be needed to establish the magnitude of contamination at both Fulton and Corning.

Within the analytical uncertainties of these results, no other clearly contaminated sites can be identified. From results of this survey, it can be generalized that nonpoint contamination of shallow ground water is unlikely and that most contamination is caused by a point source. The only exception to this conclusion may be aquifers beneath large, densely populated areas, such as Long Island (Kim and Stone, 1979), where contamination may result from a large number of widely dispersed point sources.

Other Organic Compounds

Some chromatographic peaks that could not be identified as priority pollutants were observed during the routine GC/MS scan. Certain compounds causing these peaks could be identified with little additional effort. Scans from about a dozen samples were studied in detail in an attempt to identify the unknown compounds. Selected results are summarized in table 7. The presence of xylenes at the Olean purge well supports the historical evidence for petroleum contamination at this site. Most of the other compounds identified could be attributed to analytical artifacts such as column bleed and tuning distortion.

Table 7.--Occurrence and source of organic compounds other than priority pollutants detected in New York State ground-water samples.

Compound	Possible Source	Site Where Observed
Acetone	Incomplete drying of glassware rinsed with acetone	Approximately 10 percent of samples
Organo-silicones and Triphenyl phosphine oxide	Gas chromatograph septum and column bleed	Nearly all samples
Minor aliphatic patterns	Tuning distortion in mass spectrometer	Several samples
Xylenes	Petroleum contamination	28
C_2 -->C_5 alkyl benzenes	Petroleum contamination	27B
C_2 -->C_5 alkyl styrenes	Petroleum contamination	27B
Methyl napthalenes	Petroleum contamination	27B
Numerous aromatic derivatives	Identified in initial sampling and believed to result from severe laboratory contamination or mixing of samples at log-in. Resampling yielded only aliphatic series; this probably resulted from tuning distortion of mass spectrometer	34

SUMMARY AND CONCLUSIONS

This reconnaissance survey evaluated contamination of water in surficial aquifers by synthetic organic chemicals. Analyses were made on 74 samples from 56 wells at 49 sites in New York State, excluding Long Island. Because this survey made no attempt to directly sample public wells known to be contaminated, the observed low frequency of contamination suggests that contamination of aquifers by synthetic organic chemicals above the 10-µg/L level is not widespread. The few instances of contamination probably result from isolated point discharges rather than from large-scale nonpoint sources such as atmospheric transport of contaminants from industrial areas. Detection limits several orders of magnitude lower than currently available would be needed to confirm atmospheric transport as a measurable nonpoint source of contamination.

The limited evidence obtained in this study, coupled with published results from previous studies, indicates that contamination by volatile organic compounds is more likely than contamination by nonvolatile organic compounds, partly because greater quantities of volatile compounds are produced (Helz and Hsu, 1978), but also because nonvolatile compounds are more readily adsorbed by soils (Chou, Peters, and Freed, 1980).

Results of the analysis of samples from public-supply wells at Brewster in Putnam County, and industrial-supply wells on an industrial location at Olean in Cattaraugus County, indicated severe contamination. The pattern and concentration of compounds observed at Corning in Steuben County, and Fulton in Oswego County, indicate possible slight contamination, but further study is needed for confirmation.

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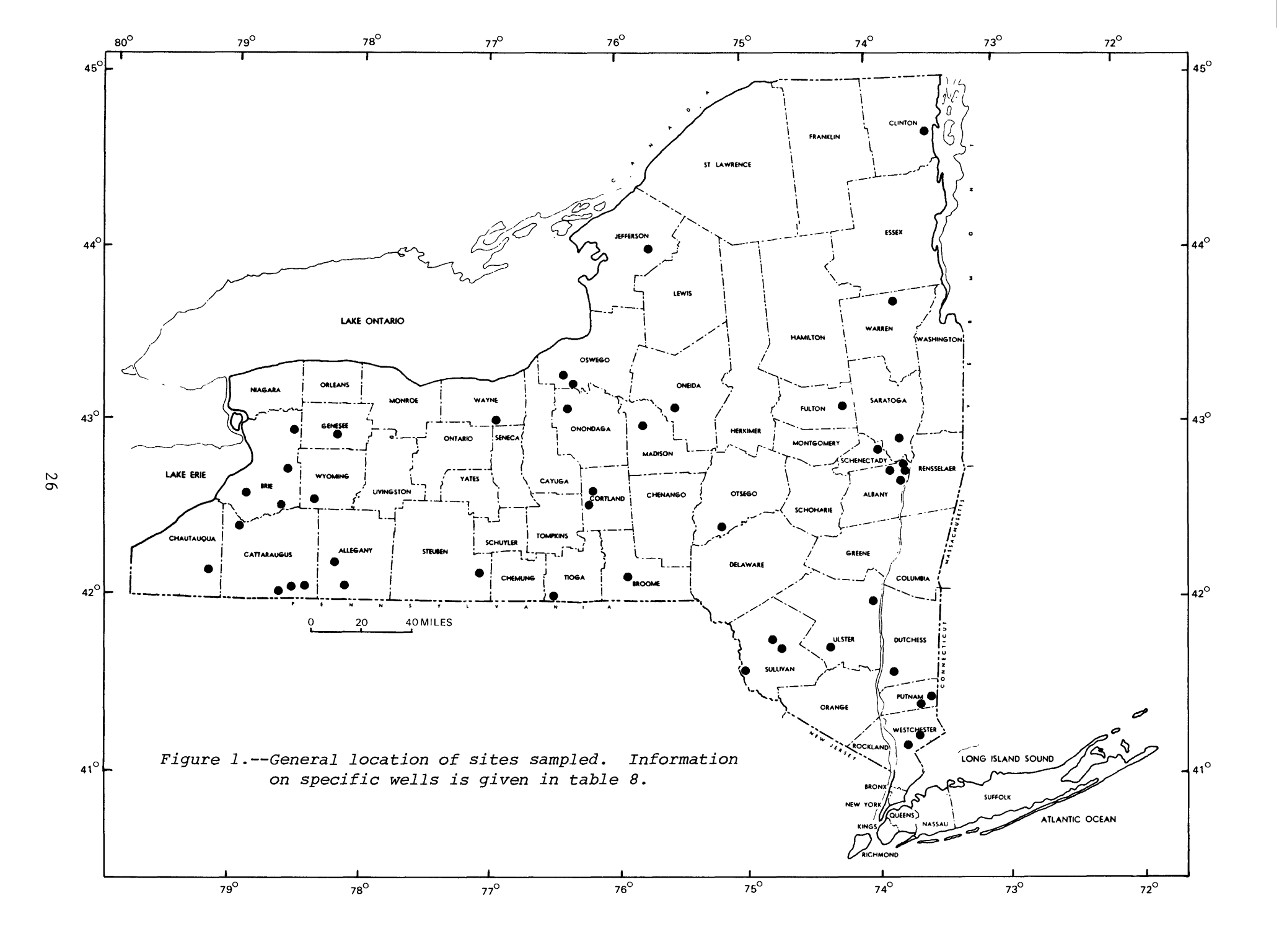

Figure 1.--General location of sites sampled. Information on specific wells is given in table 8.

Table 8.--Description of site locations.

[General locations are shown on map opposite]

This section gives pertinent information about wells sampled, including construction data, selection criteria, and date of sampling. References giving geohydrologic characteristics in the area of sampled wells are cited. Maps showing surficial geology and location of wells at each site can be obtained from the U.S. Geological Survey, P.O. Box 744, Albany, New York 12201.

Site 1

Well owner: Shenendehowa Central School, Clifton Park, Saratoga County

Date sampled: June 19, 1978

Owner's well identification: Main well

Well location: 42°52'00" N lat.; 73°48'33" W long.

Quadrangle: Niskayuna, N.Y.

Well data:
Construction: drilled in 1952
Depth: 49.5 ft
Casing: 10-in. diameter to a depth of 40.3 ft
Finish: 8.6-in. diameter screen from 40.3 ft to 49.5 ft in sand and gravel

Site-selection criteria:
To compare quality of water from a surficial aquifer to that of a bedrock aquifer (site 4) in an unindustrialized area.

Remarks: School owns three other wells tapping the same aquifer.

Reference: Heath and others (1963).

Site 2

Well owner: Town of Guilderland, Albany County

Date sampled: June 19, 1978

Owner's well number: 3

Well location: 42°41'11" N lat.; 73°54'01" W long.

Quadrangle: Voorheesville, N.Y.

Table 8.--Description of site locations (Continued)

Site 2 (cont.)

Well data:
Construction: drilled in 1967
Depth: 117 ft
Casing: 14-in. diameter to a depth of 87 ft
Finish: 12-in. diameter screen in sand and gravel

Site-selection criteria:
To compare water quality of this aquifer with that of sand aquifer at site 49 in the same general area.

Remarks: Town owns two other wells in the same aquifer.

Reference: Arnow (1949).

Site 3A

Well owner: City of Schenectady, Schenectady County

Date sampled: June 19, 1978

Owner's well number: 1

U.S. Geological Survey numbers: 249-359-75 (from Simpson, 1952); Sn 129 (from Winslow and others, 1965)

Well location: 42°49'13" N lat.; 73°59'17" W long. about 1,000 ft west of the Mohawk River

Quadrangle: Schenectady, N.Y.

Well data:
Construction: drilled in 1940
Depth: 67 ft
Casing: 47 ft
Finish: screened in sand and gravel

Site-selection criteria:
To determine the quality of the water infiltrated from the Mohawk River.

Remarks: Aquifer is in hydraulic contact with the Mohawk River. The City of Schenectady owns 11 other wells in the same aquifer.

References: Simpson (1952) and Winslow and others (1965).

Table 8.--Description of site locations (Continued)

Site 3B

Well owner: City of Schenectady, Schenectady County

Date sampled: June 19, 1978

Owner's well number: 7A

Well location: 42°49'09" N lat.; 73°59'16" W long., about 1,500 ft southwest of the Mohawk River

Quadrangle: Schenectady, N.Y.

Well data:
Construction: drilled in 1959
Depth: about 50 ft
Finish: screened in sand and gravel

Site-selection criteria:
To determine the quality of the water infiltrated from the Mohawk River.

Remarks: Well field is in hydraulic contact with the Mohawk River. The City owns 11 other wells in the same aquifer.

References: Simpson (1952) and Winslow and others (1965).

Site 4

Well owner: Town of Colonie, Latham Water District, Albany County

Date sampled: June 19, 1978

U.S. Geological Survey number: Sa 542

Well location: 42°47'33" N lat.; 73°46'34" W long., about 50 ft north of the Mohawk River, Saratoga County

Quadrangle: Niskayuna, N.Y.

Well data:
Construction: drilled in 1946
Depth: 150 ft
Casing: 12-, 8-, and 6-in. diameter casing
Finish: finished in shale

Site-selection criteria:
To compare the quality of water from a bedrock aquifer to that of a surficial aquifer (site 1) in an unindustrialized area.

Remarks: Town owns another well in the same aquifer.

Reference: Heath and others (1963).

Table 8.--Description of site locations (Continued)

Site 5

Well owner: Village of Brewster, Putnam County

Date sampled: June 27, 1978

Date resampled: August 16, 1978

Owner's well identifications: Well fields 1 and 2

U.S. Geological Survey number: Well field 1-P825-P833

Well location:

Well field 1: 41°24'01" N lat.; 73°36'13" W long., about 1,100 ft north of the East Branch Croton River

Well field 2: 41°24'02" N lat.; 73°36'07" W long., about 500 ft north of the East Branch Croton River

Quadrangle: Brewster, N.Y. - Conn.

Well data:
Construction: Well field 1 - constructed about 1953.
Well field 2 - drilled about 1966.
Depth: about 25 ft
Finish: finished with 10-15 ft of screen in sand and gravel

Site-selection criteria:
To determine the quality of water from a surficial aquifer relative to that from a bedrock aquifer (site 6) in the same general area.

Remarks: Water sample is a mixed-composite from all 18 wells that the Village owns in the same aquifer. The wells are in hydraulic contact with the East Branch Croton River.

Reference: Grossman (1957).

Site 6

Well owner: Town of Carmel, Putnam County

Date sampled: June 27, 1978

Date resampled: August 16, 1978

Well location: 41°22'08" N lat.; 73°43'27" W long.

Quadrangle: Lake Carmel, N.Y.

Table 8.--Description of site locations (Continued)

Site 6 (cont.)

Well data:
Construction: drilled in 1975
Depth: 339 ft
Finish: finished in granite

Site-selection criteria:
To compare the quality of water from a bedrock aquifer to that from a surficial aquifer (site 5) in the same general area.

Reference: Grossman (1957).

Site 7

Well owner: Town of Ulster, Ulster County

Date sampled: June 27, 1978

Date resampled: August 16, 1978

Owner's well number: 1

U.S. Geological Survey number: 158-400-4

Well location: 41°58'47" N lat.; 74°00'25" W long., about 100 ft east of Esopus Creek

Quadrangle: Kingston West, N.Y.

Well data:
Construction: drilled
Depth: 79 ft
Casing: 12-in. diameter to a depth of 67 ft
Finish: screened in sand and gravel

Site-selection criteria:
To compare the quality of water infiltrated from a stream to that receiving direct recharge (site 9) in the same general area.

Remarks: Aquifer is in hydraulic contact with Esopus Creek. The Town owns two other wells in the same general area.

Reference: Frimpter (1970, 1972).

Table 8.--Description of site locations (Continued)

Site 8

Well owner: Village of Ellenville, Ulster County

Date sampled: June 27, 1978

Date resampled: August 16, 1978

Owner's well number: 1

U.S. Geological Survey number: 142-423-1

Well location: 41°42'23" N lat.; 74°23'28" W long., about 150 ft east of Sandburg Creek

Quadrangle: Ellenville, N.Y.

Well data:
Construction: dug
Depth: 39 ft
Casing: 105-in. diameter to a depth of 37 ft
Finish: screened in sand and gravel

Site-selection criteria:
To determine the water quality of an aquifer from a previously unsampled geographic area.

Remarks: Aquifer is in hydraulic contact with Sandburg Creek. The Village has two other wells in the same aquifer.

Reference: Frimpter (1970, 1972).

Site 9

Well owner: Kingsvale Water Company, Kingston, Ulster County

Date sampled: June 27, 1978

Date resampled: August 16, 1978

Owner's well numbers: 1-6

Pump house location: 41°59'38" N lat.; 73°57'51" W long.

Quadrangle: Kingston East, N.Y.

Well data:
Construction: drilled
Depth: 30 - 48 ft
Casing: 6-in. diameter to the depth of the wells
Finish: all finished open end

Table 8.--Description of site locations (Continued)

Site 9 (cont.)

Site-selection criteria:
To determine the quality of water from a surficial aquifer with direct recharge down-wind of the New York City metropolitan area.

Remarks: Sample is a 6-well mixed composite. All wells are within 100 yd of the pump house and are in the same aquifer.

Reference: Frimpter (1970, 1972).

Site 10

Well owner: Town of Rotterdam, Schenectady County

Date sampled: July 11, 1978

Owner's well number: 1

U.S. Geological Survey numbers: 249-359-91 (from Simpson, 1952); Sn 334 (from Winslow and others, 1965)

Well location: 42°49'20" N lat.; 73°59'14" W long., about 250 ft east of the old Erie Canal about 400 ft west of the Mohawk River

Quadrangle: Schenectady, N.Y.

Well data:
Construction: drilled in 1949
Depth: 82 ft
Casing: 16-in. and 12-in. diameter to a depth of 63 ft
Finish: screened in gravel

Site-selection criteria:
To determine the quality of water infiltrated from the Mohawk River relative to the City of Schenectady wells (site 3).

Remarks: Aquifer is in hydraulic contact with the Mohawk River. The Town of Rotterdam has two other wells in the same aquifer.

References: Simpson (1952) and Winslow and others (1965).

Site 11

Well owner: Town of Green Island, Albany County

Date sampled: July 11, 1978

Date resampled: August 15, 1978

Table 8.--Description of site locations (Continued)

Site 11 (cont.)

Well location: 42°44'20" N lat.; 73°41'35" W long., about 60 ft west of the Hudson River

Quadrangle: Troy South, N.Y.

Well data:
Construction: dug
Depth: about 35 ft
Casing: concrete

Site-selection criteria:
To determine the quality of water infiltrated from the Hudson River.

Remarks: Aquifer is in hydraulic contact with the Hudson River.

Reference: Arnow (1949).

Site 12A

Well owner: U.S. Army, Fort Drum, Jefferson County

Date sampled: July 12, 1978

Owner's well number: 10

Well location: 44°04'47" N lat.; 75°42'51" W long.

Quadrangle: Deferiet, N.Y.

Well data:
Construction: drilled
Depth: about 80 ft
Finish: finished in limestone

Site-selection criteria:
To determine the quality of water from the limestone aquifer compared to that from the sandstone aquifer (well 1) in an unindustralized, urbanized area.

Remarks: The Fort has one other well in the same aquifer.

Reference: Waller (1969).

Site 12B

Well owner: U.S. Army, Fort Drum, Jefferson County

Date sampled: July 12, 1978

Table 8.--Description of site locations (Continued)

Site 12B (cont.)

Owner's well number: 1

Well location: 44°02'44" N lat.; 75°42'47" W long.

Quadrangle: Deferiet, N.Y.

Well data:
Construction: drilled
Depth: 173 ft
Casing: cased to a depth of 173 ft
Finish: finished open end in sandstone

Site-selection criteria:
To determine the quality of water from the sandstone aquifer compared to that from the limestone aquifer (well 10) in an unindustralized, unurbanized area.

Remarks: Fort Drum has five other wells in the same aquifer.

Reference: Waller (1969).

Site 13A

Well owner: City of Fulton, Oswego County

Date sampled: July 12, 1978

Date resampled: September 18, 1978

Owner's well number: 1

Well location: 43°18'12" N lat., 76°23'33" W long. about 250 ft east of the Oswego River

Quadrangle: Fulton, N.Y.

Well data:
Construction: drilled
Depth: 42 ft
Casing: 3-in. diameter casing
Finish: screened in sand and gravel

Site-selection criteria:
To determine the quality of water from well 1 relative to the water from the other City of Fulton wells.

Remarks: Aquifer is in hydraulic contact with the Oswego River. The City owns eight other wells in the same aquifer.

Reference: Kantrowitz (1970).

Table 8.--Description of site locations (Continued)

Site 13B

Well owner: City of Fulton, Oswego County

Date sampled: September 18, 1978

Owner's well number: 3

Well location: 43°17'57" N lat.; 76°23'19" W long., about 200 ft east of the Oswego River

Quadrangle: Fulton, N.Y.

Well data:
Construction: drilled
Depth: 48 ft
Casing: 6-in. diameter
Finish: finished in sand and gravel

Site-selection criteria:
To determine the quality of water from well 3 relative to the water from the other City of Fulton wells.

Remarks: Aquifer is in hydraulic contact with the Oswego River. The City owns eight other wells in the same aquifer.

Reference: Kantrowitz (1970).

Site 13C

Well owner: City of Fulton, Oswego County

Date sampled: September 18, 1978

Date resampled: May 2, 1979

Owner's well number: 6

Well location: 43°17'33" N lat.; 76°23'04" W long., about 400 ft east of the Oswego River

Quadrangle: Fulton, N.Y.

Well data:
Construction: drilled in 1953
Depth: 45 ft
Finish: 10 ft of 12-in. diameter screen in sand and gravel

Site-selection criteria:
To determine the quality of water from well 6 relative to the water from the other City of Fulton wells.

Table 8.--Description of site locations (Continued)

Site 13C (cont.)

Remarks: Aquifer is in hydraulic contact with the Oswego River. The City owns eight other wells in the same aquifer.

Reference: Kantrowitz (1970).

Site 13D

Well owner: City of Fulton, Oswego County

Date sampled: September 18, 1978

Owner's well number: 7

Well location: 43°17'32" N lat.; 76°23'01" W long., about 500 ft east of the Oswego River

Quadrangle: Fulton, N.Y.

Well data:
Construction: drilled
Depth: 43 ft
Casing: 8-in. diameter
Finish: finished in sand and gravel

Site-selection criteria:
To determine the quality of water from well 7 relative to the water from the other City of Fulton wells.

Remarks: Aquifer is in hydraulic contact with the Oswego River. The City owns eight other wells in the same aquifer.

Reference: Kantrowitz (1970).

Site 13E

Well owner: City of Fulton, Oswego County

Date sampled: September 18, 1978 (Wells GB1, GB2, GB3, and GB4)

Date sampled: May 2, 1979

Owner's well number: Great Bear Farm wells

Table 8.--Description of site locations (Continued)

Site 13E (cont.)

Well location:

Well 1: 43°15'48" N lat.; 76°21'13" W long., 2,400 ft northeast of Oswego River

Well 2: 43°15'39" N lat.; 76°21'05" W long., 2,100 ft northeast of Oswego River

Well 3: 43°15'38" N lat.; 76°21'15" W long., 1,200 ft northeast of Oswego River

Well 4: 43°15'46" N lat.; 76°21'24" W long., 1,700 ft northeast of Oswego River

Quadrangle: Pennellville, N.Y.

Well data: The wells are spring fed.

Well 1:
Construction: constructed in 1967
Depth: 105 ft
Casing: 12-in. diameter
Finish: 15 ft of 12-in. diameter screen

Well 2:
Construction: constructed in 1967
Depth: 118 ft
Casing: 12-in. diameter
Finish: 15 ft of 12-in. diameter screen

Well 3:
Construction: constructed in 1968
Depth: 91 ft
Casing: 12-in. diameter
Finish: 10 ft of 12-in. diameter screen

Well 4:
Construction: constructed in 1967
Depth: 124 ft
Casing: 18-in. diameter casing
Finish: 20 ft of 18-in. diameter screen

Site-selection criteria:
To compare the water from these springs to the water infiltrated from the Oswego River (sites 13A - 13D).

Remarks: The four spring-fed wells are connected to the same pipeline in the pumphouse. The samples are composites of water taken from the specified wells pumping at the time the sample was taken. The aquifer is sand beneath less permeable material.

Reference: Kantrowitz (1970).

Table 8.--Description of site locations (Continued)

Site 14

Well owner: City of Cortland, Cortland County

Date sampled: July 19, 1978

Owner's well number: 4

U.S. Geological Survey number: 4235420761154 (from Randall, 1972)

Well location: 42°35'42" N lat.; 76°11'54" W long., about 300 ft south of Otter Creek

Quadrangle: Cortland, N.Y.

Well data:
Construction: drilled in 1957
Depth: 77 ft
Casing: 26-in. diameter concrete casing to a depth of 16 ft
Finish: slotted from 16 to 68 ft in gravel

Site-selection criteria:
To determine the quality of water from an unindustrialized, urbanized area in central New York State.

Remarks: Aquifer is in hydraulic contact with Otter Creek. The City owns three other wells tapping the same aquifer.

References: Randall (1972) and Buller (1978).

Site 15

Well owner: Village of Homer, Newton Water Works, Cortland County

Date sampled: July 19, 1978

Owner's well number: 2

U.S. Geological Survey number: 4238340761123 (from Randall, 1972)

Well location: 42°38'34" N lat.; 76°11'23" W long., about 100 ft south of Factory Brook

Quadrangle: Homer, N.Y.

Well data:
Construction: constructed in 1903
Depth: 65 ft
Casing: 6-in. diameter
Finish: finished in gravel

Table 8.--Description of site locations (Continued)

Site 15 (cont.)

Site-selection criteria:
To compare the quality of this water with that of sites 14 and 16.

Remarks: Aquifer is in hydraulic contact with Factory Brook. The Village owns four other wells in the same aquifer.

References: Randall (1972) and Buller (1978).

Site 16

Well owner: Town of Cortlandville, Cortland County

Date sampled: July 19, 1978

Owner's well number: 3

U.S. Geological Survey number: 4234520761242 (from Randall, 1972)

Well location: 42°34'52" N lat.; 76°12'42" W long.

Quadrangle: Cortland, N.Y.

Well data:
Construction: drilled in 1959
Depth: 76 ft
Casing: 8-in. diameter to a depth of 57 ft
Finish: screened in gravel from 57 to 72 ft

Site-selection criteria:
To compare the quality of water from sites 14 and 15 which is infiltrated from streams, with the quality of water from this site, which receives direct recharge from precipitation.

References: Randall (1972) and Buller (1978).

Site 17

Well owner: Town of Plattsburgh, Salmon River Water District, Clinton County

Date sampled: October 31, 1978

U.S. Geological Survey number: 443826N0732940.1

Well location: 44°38'26" N lat.; 73°29'40" W long., about 150 ft east of Salmon River

Quadrangle: Plattsburgh, N.Y. - Vt.

Table 8.--Description of site locations (Continued)

Site 17 (cont.)

Well data:
Construction: drilled in 1964
Depth: 105 ft
Casing: 6-in. diameter to a depth of 105 ft
Finish: finished open end is sand and gravel

Site-selection criteria:
To determine the organic content of water from a remote, unindustralized area.

Remarks: Aquifer is in hydraulic contact with the Salmon River.

Reference: Giese and Hobba (1970).

Site 18

Well owner: Town of Liberty, White Sulfur Springs Water District, Sullivan County

Date sampled: November 1, 1978

Owner's well number: 2

U.S. Geological Survey number: Sv 127

Well location: 41°47'36" N lat.; 74°49'37" W long., about 200 ft west of one unnamed tributary to Swan Lake and about 350 ft east of another

Quadrangle: Liberty West, N.Y.

Well data:
Construction: drilled in 1949
Depth: 51 ft
Casing: 12-in. diameter
Finish: 10 ft of screen in sand and gravel

Site-selection criteria:
To compare the organic content of water infiltrated from these streams to that of water infiltrated from a nearby lake (site 19).

Remarks: Aquifer is in hydraulic contact with the streams. The Town owns another well in the same aquifer.

Reference: Soren (1961).

Table 8.--Description of site locations (Continued)

Site 19

Well owner: Town of Liberty, Stevensville Water District, Sullivan County

Date sampled: November 1, 1978

Owner's well number: 1

Well location: 41°45'16" N lat.; 74°46'49" W long., about 700 ft east of Swan Lake

Quadrangle: Liberty West, N.Y.

Well data:
Construction: drilled
Depth: 50 ft
Finish: screened in sand and gravel

Site-selection criteria:
To compare the quality of water infiltrated from Swan Lake to that of water infiltrated from nearby streams (site 18).

Remarks: Aquifer is in hydraulic contact with Swan Lake. The Town owns three other drilled wells in the same aquifer.

Reference: Soren (1961).

Site 20

Well owner: Town of Tusten, Narrowsburg Water Department, Narrowsburg, Sullivan County

Date sampled: November 1, 1978

Owner's well number: 2

U.S. Geological Survey number: Sv 58

Well location: 41°36'25" N lat.; 75°04'16" W long., about 950 ft east of the Delaware River

Quadrangle: Narrowsburg, Pa. - N.Y.

Well data:
Construction: drilled in 1956
Depth: 41 ft
Casing: 16-in. diameter to a depth of 29 ft
Finish: screened in sand and gravel from 29 to 41 ft

Table 8.--Description of site locations (Continued)

Site 20 (cont.)

Site-selection criteria:
To determine the quality of water infiltrated from the Delaware River.

Remarks: Aquifer is in hydraulic contact with the Delaware River. The Town owns another well in the same aquifer.

Reference: Soren (1961).

Site 21

Well owner: Village of Otego, Otsego County

Date sampled: November 1, 1978

Owner's well number: "New Well"

Well location: 42°23'11" N lat.; 75°11'05" W long., about 200 ft north of the Susquehanna River

Quadrangle: Otego, N.Y.

Well data:
Construction: drilled
Depth: about 70 ft
Casing: 12-in. diameter inner casing and 18-in. diameter outer casing
Finish: screened in sand and gravel

Site-selection criteria:
To determine the quality of water infiltrated from the Susquehanna River.

Remarks: Aquifer is in hydraulic contact with the Susquehanna River.

References: Hollyday (1969) and Randall (1972).

Site 22

Well owner: Village of Cazenovia, Madison County

Date sampled: November 6, 1978

Owner's well number: 1

Well location: 42°55'33" N lat.; 75°51'07" W long.

Quadrangle: Cazenovia, N.Y.

Table 8.--Description of site locations (Continued)

Site 22 (cont.)

Well data:
Construction: drilled in 1958
Depth: about 85 ft
Casing: 6-in. diameter
Finish: screened for 10 ft and gravel packed in sand and gravel

Site-selection criteria:
To determine the organic content of an extensive aquifer in a previously unsampled part of the State.

Remarks: Village owns another drilled well in the same aquifer.

Reference: Kantrowitz (1970).

Site 23

Well owner: Village of Baldwinsville, Onondaga County

Date sampled: November 6, 1978

Owner's well number: Doan Well Number 2

U.S. Geological Survey number: 309-624-1

Well location: 43°09'55" N lat.; 76°24'42" W long., about 100 ft north of the Seneca River

Quadrangle: Lysander, N.Y.

Well data:
Construction: drilled in 1961
Depth: 91 ft
Casing: 81 ft of 8-in. diameter casing
Finish: open end in sand and gravel

Site-selection criteria:
To determine the quality of water infiltrated from the Seneca River.

Remarks: Aquifer is in hydraulic contact with the Seneca River. The Village owns another well in the same aquifer.

Reference: Kantrowitz (1970).

Table 8.--Description of site locations (Continued)

Site 24

Well owner: Village of Phoenix, Oswego County

Date sampled: November 6, 1978

Owner's well number: 1 (formerly well 3)

Well location: 43°14'40" N lat.; 76°14'42" W lon

Quadrangle: Brewerton, N.Y.

Well data:
Construction: drilled
Depth: about 50 ft
Casing: about 30 ft
Finish: screened in sand and gravel

Site-selection criteria:
To compare the quality of water in this area receiving direct recharge from precipitation to the water infiltrated from the Oswego River (sites 13A - 13D).

Remarks: Village owns another drilled well in the same aquifer.

Reference: Kantrowitz (1970).

Site 25

Well owner: City of Batavia, Genesee County

Date sampled: November 14, 1978

Owner's well number: 11 (Well A)

U.S. Geological Survey number: 259-809-6

Well location: 42°59'07" N lat.; 78°09'30" W long.

Quadrangle: Batavia South, N.Y.

Well data:
Construction: drilled in 1963
Depth: 60 ft (reference reports 75 ft depth)
Casing: 16-in. diameter casing
Finish: 16-in. diameter screen in sand and gravel

Site-selection criteria:
To establish the organic content of an extensive aquifer in a previously unsampled geographic area.

Table 8.--Description of site locations (Continued)

Site 25 (cont.)

Remarks: City owns another drilled well in the same aquifer.

Reference: La Sala (1968).

Site 26

Well owner: Village of Alden, Erie County

Date sampled: November 14, 1978

Owner's well number: 3

U.S. Geological Survey number: 254-829-1

Well location: 42°54'27" N lat.; 78°29'52" W long., about 1,000 ft southwest of Ellicott Creek

Quadrangle: Corfu, N.Y.

Well data:
Construction: drilled in 1957
Depth: 35.7 ft
Casing: 16-in. and 8-in. diameter casing
Finish: 8-in. diameter, 125-slot screen from 29-34 ft; gravel packed from 24-34 ft in sand and gravel

Site-selection criteria:
To determine the quality of water from an aquifer bordering the Buffalo metropolitan area.

Remarks: Village owns three other wells in the same aquifer.

Reference: La Sala (1968).

Site 27A

Well owner: Felmont Oil Company, Olean, Cattaraugus County

Date sampled: November 15, 1978

Owner's well number: 3

U.S. Geological Survey number: 420534N0782630.1 (Frimpter, 1974)

Well location: 42°05'34" N lat.; 78°26'30" W long.

Quadrangle: Olean, N.Y.

Table 8.--Description of site locations (Continued)

Site 27A (cont.)

Well data:
Depth: 72 ft
Casing: 18-in. diameter casing to a depth of 52 ft
Finish: screened in sand and gravel from 52 ft to 72 ft

Site-selection criteria:
To determine the quality of water from a well in the vicinity of a nitrogen-fertilizer production plant.

Remarks: Felmont Oil owns six other wells in the same aquifer.

References: Frimpter (1974) and Randall (1976).

Site 27B

Well owner: Felmont Oil Company, Olean, Cattaraugus County

Date sampled: November 15, 1978

Owner's well number: 1

U.S. Geological Survey number: 420526N0782636.1 (Frimter, 1974)

Well location: 42°05'26" N lat.; 78°26'36" W long.

Quadrangle: Olean, N.Y.

Well data:
Depth: 82 ft
Casing: 18-in. diameter casing to a depth of 62 ft
Finish: screened in sand and gravel from 62 ft to 82 ft

Site-selection criteria:
To determine the quality of water from a well in the vicinity of a nitrogen-fertilizer production plant.

Remarks: Felmont Oil owns six other wells in the same aquifer.

References: Frimpter (1974) and Randall (1976).

Site 28

Well owner: C. F. Industries, Olean, Cattaraugus County

Date sampled: November 15, 1978 (two samples)

Owner's well identification: purge well

Table 8.--Description of site locations (Continued)

Site 28 (cont.)

Well location: 42°05'16" N lat.; 78°26'46" W long.

Quadrangle: Olean, N.Y.

Well data:
Construction: drilled in March, 1978
Depth: 73.5 ft
Casing: 14-in. diameter casing
Finish: 40-slot screen from 57.5 to 59.5 ft, 110-slot screen from 59.5 to 71.5 ft, 100-slot screen from 71.5 to 73.5 ft; screened in sand and gravel

Site-selection criteria:
To determine the quality of water from a well in the vicinity of a nitrogen-fertilizer production plant.

References: Frimpter (1974) and Randall (1976).

Site 29

Well owner: Village of Bolivar, Allegany County

Date sampled: November 15, 1978

Owner's well number: 4

Well location: 42°04'45" N lat.; 78°09'48" W long., about 100 ft southeast of the Little Genesee Creek

Quadrangle: Bolivar, N.Y.

Well data:
Depth: about 100 ft
Finish: screened in sand and gravel

Site-selection criteria:
To compare the organic content of this water to that from wells in the fertilizer processing plant area (sites 27 and 28).

Remarks: Aquifer is in hydraulic contact with Little Genesee Creek. The Village owns three other drilled wells in the same aquifer.

Reference: Frimpter (1974).

Table 8.--Description of site locations (Continued)

Site 30

Well owner: Village of Cuba, Allegany County

Date sampled: November 15, 1978

Owner's well identification: Bicentennial Well (new well)

Well location: 42°12'55" N lat.; 78°16'22" W long.

Quadarangle: Cuba, N.Y.

Well data:
Construction: drilled in 1978
Depth: about 70 ft
Finish: screened in sand and gravel

Site-selection criteria:
To compare the organic content of this water to that from the wells in the fertilizer processing plant area (sites 27 and 28).

Remarks: Village owns two other drilled wells in sand and gravel.

Reference: Frimpter (1974).

Site 31

Well owner: Village of Arcade, Wyoming County

Date sampled: November 16, 1978

Owner's well identification: Church Street Well

U.S. Geological Survey number: 232-825-1

Well location: 42°32'06" N lat.; 78°25'30" W long., about 150 ft south of Cattaraugus Creek

Quadrangle: Arcade, N.Y.

Well data:
Construction: drilled in 1953
Depth: 53 ft
Casing: 12-in., 10-in., and 8-in. diameter casing to a depth of 44 ft
Finish: 10-in. diameter, 100-slot screen from 44 to 49 ft and packed in sand and gravel

Site-selection criteria:
To determine the quality of water infiltrated from Cattaraugus Creek.

Table 8.--Description of site locations (Continued)

Site 31 (cont.)

Remarks: Aquifer is in hydraulic contact with Cattaraugus Creek. The Village owns three other wells in the same aquifer.

Reference: La Sala (1968).

Site 32

Well owner: Village of Springville, Erie County

Date sampled: November 16, 1978

Date resampled: March 9, 1979 (nonvolatiles only)

Owner's well number: 2

U.S. Geological Survey number: 230-840-3

Well location: 42°30'54" N lat.; 78°40'14" W long., about 100 ft north of unnamed stream

Quadrangle: Springville, N.Y.

Well data:
Construciton: drilled in 1942
Depth: 159 ft
Casing: 18-in. and 10-in. in diameter
Finish: screened with 10-in. diameter, 100-slot from 144 to 149 ft, 80-slot from 149 to 159 ft and packed in sand and gravel

Site-selection criteria:
To compare the organic content of this water with water from a site to the greater Buffalo area (site 33) and a site further away from Buffalo (site 31).

Remarks: Aquifer is in hydraulic contact with the stream. Village owns another well in the same aquifer.

Reference: La Sala (1968).

Site 33

Well owner: Village of North Collins, Erie County

Date sampled: November 16, 1978

Owner's well number: 4

Table 8.--Description of site locations (Continued)

Site 33 (cont.)

U.S. Geological Survey number: 234-856-5

Well location: 42°34'27" N lat.; 78°56'42" W long.

Quadrangle: North Collins, N.Y.

Well data:
Construction: drilled in 1962
Depth: about 35 ft
Finish: screened and gravel packed in sand and gravel

Site-selection criteria:
To determine the water quality of an aquifer outside the Buffalo metropolitan area.

Remarks: Village owns three other wells in the same aquifer.

Reference: La Sala (1968).

Site 34

Well owner: Village of East Aurora, Erie County

Date sampled: November 16, 1978

Date resampled: March 9, 1979 (nonvolatiles only)

Owner's well number: 6

Well location: 42°46'49" N lat.; 78°36'47" W long.

Quadrangle: East Aurora, N.Y.

Well data:
Construction: drilled in 1967
Depth: about 120 ft
Finish: screened in sand and gravel

Site-selection criteria:
To determine the quality of water directly outside the Buffalo metropolitan area.

Remarks: Village owns three other wells in the same aquifer.

Reference: La Sala (1968).

Table 8.--Description of site locations (Continued)

Site 35

Well owner: City of Corning, Steuben County

Date sampled: December 7, 1978

Date resampled: March 21, 1979 (volatiles only)

Owner's well number: 2

U.S. Geological Survey number: 4209110770421 (from Hollyday, 1969)

Well location: 42°09'11" N lat.; 77°04'21" W long., about 400 ft north of the Chemung River

Quadrangle: Corning, N.Y.

Well data:
Construction: constructed in 1942
Depth: 63 ft
Casing: 43 ft of 18-in. diameter casing
Finish: screened and gravel packed in gravel

Site-selection criteria:
To determine the quality of water infiltrated from the Chemung River.

Remarks: Aquifer is in hydraulic contact with the Chemung River. City owns eight other wells in the same aquifer.

References: Hollyday (1969) and Randall (1972).

Site 36

Well owner: Village of Waverly, Tioga County

Date sampled: December 7, 1978

Owner's well number: 1

Well location: 42°00'40" N lat.; 76°32'05" W long., about 2,100 ft west of Cayuta Creek

Quadrangle: Waverly, N.Y. - Pa.

Well data:
Depth: about 40 ft
Finish: screened in gravel

Site-selection criteria:
To determine the quality of water from an aquifer in a remote, unindustrialized area.

Table 8.--Description of site locations (Continued)

Site 36 (cont.)

Remarks: Village owns two other wells in the same aquifer.

References: Hollyday (1969) and Randall (1972).

Site 37

Well owner: Johnson City, Broome County

Date sampled: December 8, 1978

Date resampled: March 21, 1979

Owner's well number: 2

U.S. Geological Survey number: 4206460755842 (from Hollyday, 1969)

Well location: 42°06'46" N lat.; 75°58'42" W long., about 50 ft north of the Susquehanna River

Quadrangle: Binghamton West, N.Y.

Well data:
Construction: drilled in 1931
Depth: 101 ft
Casing: 25-in. diameter casing to a depth of 66 ft
Finish: slotted from 66 to 101 ft in gravel

Site-selection criteria:
To determine the quality of water infiltrated from the Susquehanna River.

Remarks: Aquifer is in hydraulic contact with the Susquehanna River. City owns six other wells in the same aquifer.

References: Hollyday (1969) and Randall (1972).

Site 38

Well owner: Village of Mayfield, Mayfield Water Works, Fulton County

Date sampled: December 13, 1978

U.S. Geological Survey number: 430558N0741616.1

Well location: 43°05'58" N lat.; 74°16'16" W long., about 50 ft north of the Great Sacandaga Lake

Quadrangle: Gloversville, N.Y.

Table 8.--Description of site locations (Continued)

Site 38 (cont.)

Well data:
Construction: dug
Depth: 26 ft
Finish: finished in gravel

Site-selection criteria:
To determine the quality of water in a remote unindustrialized, unurbanized area.

Remarks: Aquifer is in hydraulic contact with the Great Sacandaga Lake.

Reference: Giese and Hobba (1970).

Site 39

Well owner: Village of Verona, Verona Water District, Oneida County

Datae sampled: December 15, 1978

Owner's well number: 1

U.S. Geological Survey number: 308-534-1

Well location: 43°08'52" N lat.; 75°34'17" W long.

Quadrangle: Verona, N.Y.

Well data:
Construction: drilled in 1957
Depth: 23 ft
Casing: 18 ft of 10-in. diameter casing
Finish: finished in sand and gravel

Site-selection criteria:
To determine the organic content of an extensive aquifer in a previously unsampled portion of the State.

Remarks: Village owns another well in the same aquifer.

Reference: Kantrowitz (1970).

Site 40

Well owner: Town of Chestertown, Chestertown Water District, Warren County

Date sampled: December 18, 1978

Date resampled: February 23, 1979 (volatiles only)

Table 8.--Description of site locations (Continued)

Site 40 (cont.)

U.S. Geological Survey number: 433856N0734759.1

Well location: 43°38'56" N lat.; 73°47'59" W long., about 200 ft north of Chester Creek

Quadrangle: Chestertown, N.Y.

Well data:
Construction: drilled in 1960
Depth: 88 ft
Casing: 8-in. diameter casing
Finish: screened in sand and gravel

Site-selection criteria:
To establish the water quality of an aquifer in a remote unindustrialized, unurbanized area.

Remarks: Aquifer is in hydraulic contact with Chester Creek.

Reference: Giese and Hobba (1970).

Site 41

Well owner: City of Jamestown, Chautauqua County

Date sampled: January 30, 1979

Owner's well number: 4

U.S. Geological Survey number: 208-912-4

Well location: 42°08'10" N lat.; 79°12'11" W long., about 100 ft south of Cassadaga Creek

Quadrangle: Gerry, N.Y.

Well data:
Construction: drilled in 1947
Depth: 147 ft
Casing: 12-in. and 18-in. diameter
Finish: finished in sand and gravel

Site-selection criteria:
To establish the quality of water from an aquifer in extreme western New York State.

Remarks: Aquifer is in hydraulic contact with Cassadaga Creek. City owns four other wells in the same aquifer.

Reference: Crain (1966).

Table 8.--Description of site locations (Continued)

Site 42

Well owner: Village of Allegany, Cattaraugus County

Date sampled: January 30, 1979

Owner's well number: 3

U.S. Geological Survey number: 420459N0782907.1

Well location: 42°04'59" N lat.; 78°29'07" W long., about 1,800 ft northeast of the Allegany River

Quadrangle: Olean, N.Y.

Well data:
Depth: 90 ft
Casing: 8-in. diameter to a depth of 90 ft
Finish: open end in sand and gravel

Site-selection criteria:
To compare the water quality of this aquifer to the water from wells in the area of an oil-processing plant (sites 27 and 28).

Remarks: Aquifer is in hydraulic contact with the Alleghany River. Village owns two other wells in the same aquifer.

Reference: Frimpter (1974).

Site 43

Well owner: Village of Gowanda, Cattaraugus County

Date sampled: January 31, 1979

Owner's well number: 2

Well location: 42°27'22" N lat.; 78°56'21" W long., about 100 ft east of Thatcher Brook and 2,500 ft southwest of Cattaraugus Creek

Quadrangle: Gowanda, N.Y.

Well data:
Construction: drilled in 1971
Depth: 380 ft
Casing: 16-in diameter to a depth of 21 ft and 10-in. diameter from land surface to a depth of 318 ft
Finish: Lead packer at 304 ft.; screen from 318 ft: 10 slot from 360 to 362 ft, 20 slot from 362 to 365 ft, 30 slot from 365 to 370 ft, 40 slot from 370 to 380 ft; screened in sand and gravel.

Table 8.--Description of site locations (Continued)

Site 43 (cont.)

Site-selection criteria:
To examine the organic content of water from a deep well finished in sand and gravel.

Remarks: Aquifer is in hydraulic contact with Thatcher Brook and Cattaraugus Creek. Village owns another well in the same aquifer.

Reference: Frimpter (1974) and La Sala (1968).

Site 44

Well owner: William Trowbridge, Allegany, Cattaraugus County

Date sampled: January 31, 1979

Well location: 42°04'10" N lat.; 78°35'11" W long., about 300 ft east of Chipmunk Creek

Quadrangle: Knapp Creek, N.Y.

Well data:
Construction: drilled in 1978
Depth: 82 ft
Finish: finished in sand and gravel

Site-selection criteria:
To establish the quality of water from a well in an oil field.

Remarks: Aquifer is in hydraulic contact with Chipmunk Creek.

Reference: Frimpter (1974).

Site 45

Well owner: Village of Lyons, Wayne County

Date sampled: February 1, 1979

Owner's well number: 3

U.S. Geological Survey number: 430349N0765858.1

Well location: 43°03'49" N lat.; 76°58'58" W long., about 1,200 ft north of the Erie Canal

Quadrangle: Lyons, N.Y.

Table 8.--Description of site locations (Continued)

Site 45 (cont.)

Well data:
Construction: drilled in 1962
Depth: 62 ft
Casing: 10-in. diameter to a depth of 57 ft
Finish: finished in gravel

Site-selection criteria:
To establish a sampling site in a previously unsampled part of the State.

Remarks: Aquifer is in hydraulic contact with the Erie Canal.

Reference: Crain (1974).

Site 46

Well owner: Village of Wappingers Falls, Dutchess County

Date sampled: February 13, 1979

Owner's well number: 1

U.S. Geological Survey number: Du 84

Well location: 41°36'26" N lat.; 73°55'06" W long., about 200 ft west of Wappinger Lake

Quadrangle: Wappingers Falls, N.Y.

Well data:
Construction: drilled
Depth: 80 ft
Casing: 16-in. and 8-in. diameter
Finish: finished in sand and gravel

Site-selection criteria:
To establish the water quality of an aquifer in a previously unsampled geographic area.

Remarks: Aquifer is in hydraulic contact with Wappinger Lake. Village owns three other wells in the same aquifer.

Reference: Simmons and others (1961).

Site 47

Well owner: Village of Mount Kisco, Westchester County

Date sampled: February 14, 1979

Table 8.--Description of site locations (Continued)

Site 47 (cont.)

U.S. Geological Survey number: We 505

Well location: 41°13'34" N lat.; 73°43'04" W long., about 100 ft east of an unnamed tributary to Chappaque Brook

Quadrangle: Mount Kisco, N.Y.

Well data:
Construction: drilled
Depth: 166 ft
Casing: 6-in. diameter
Finish: 30 ft of 8-in. screen in sand

Site-selection criteria:
To establish the water quality of an aquifer in proximity to the New York City metropolitan area.

Remarks: Aquifer is in hydraulic contact with the stream.

Reference: Asselstine and Grossman (1955).

Site 48

Well owner: Village of Thornwood, Thornwood Water District, Weschester County

Date sampled: February 14, 1979

Owner's well number: two-well mixed composite

U.S. Geological Survey number: We 567

Well location: 41°07'36" N lat.; 73°46'59" W long., about 200 ft west of Nanny Hagen Brook

Quadrangle: Ossining, N.Y.

Well data:
Construction: drilled
Depth: 60 ft
Casing: 8-in. diameter
Finish: 8-in. diameter screen for about 20 ft in gravel

Site-selection criteria:
To establish the water quality of an aquifer in proximity to the New York City metropolitan area.

Table 8.--Description of site locations (Continued)

Site 48 (cont.)

Remarks: Aquifer is in hydraulic contact with Nanny Hagen Brook. Village owns two wells in the same aquifer and the water sample is a mixed composite of water from both wells.

Reference: Asselstine and Grossman (1955).

Site 49

Well owner: U.S. Geological Survey/City of Albany, Albany County

Date sampled: July 12, 1979

Owner's well number: 4

Well location: 42°42'50" N lat.; 73°51'57" W long.

Quadrangle: Albany, N.Y.

Well data:
Construction: drilled June 28, 1979 by the air rotary method
Depth: 60 ft
Casing: 6-in. diameter casing to a depth of 55 ft
Finish: 6-in. diameter screen from a depth of 55 to 60 ft; screened in sand

Site-selection criteria:
To establish the organic content of an extensive aquifer in the Albany-Schenectady metropolitan area.

Remarks: Well was drilled for observation of water levels and determination of aquifer characteristics. It is located in a geographic area known as the Pine Bush.

Reference: Dineen (1975).