HISTORY OF GROUND-WATER CONTAMINATION AND SUMMARY OF GROUND-WATER INVESTIGATIONS THROUGH 1985 AT FOUR INDUSTRIAL SITES, LOGAN TOWNSHIP, NEW JERSEY

By Jean C. Lewis and Joseph J. Hochreiter, Jr.

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CONVERSION FACTORS

Multiply inch-pound unit	By	To obtain metric unit
acre	4,037	square meter (m^2)
foot (ft)	0.3048	meter (m)
gallon (gal)	3.785	liter (L)
mile (mi)	1.609	kilometer (km)

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ABSTRACT

Various federal and state regulatory agencies and private consultants have studied and reported on potential sources of ground-water contamination at four industrial sites in Logan Township, New Jersey. These reports document ground-water contamination at all four sites and at properties adjoining two of the sites. The four sites directly overlie the Potomac-Raritan-Magothy aquifer system, the Township's sole source of potable water.

Bridgeport Rental and Oil Services, Inc., was a waste-oil processing and storage business. The major source of ground-water contamination at the site is a lagoon containing waste oil. Ground water within 1,000 feet of the lagoon is contaminated.

Chemical Leaman Tank Lines, Inc., maintains, dispatches, and cleans chemical-transportation tanks. Potential sources of ground-water contamination at the site include former wastewater lagoons, leaking storage drums, and leaking tank trucks. Ground water at and immediately north of the property is contaminated.

Monsanto Company manufactures organic compounds. Potential sources of ground-water contamination at the site include landfilled industrial wastes. Ground water underlying the property is contaminated, but there is no evidence of off-site ground-water contamination from this source.

Rollins Environmental Services treats and disposes of hazardous wastes. The major source of ground-water contamination at the site is landfilled residue from waste-treatment processes. Ground water underlying the property is contaminated, but there is no evidence of off-site ground-water contamination from this source.

INTRODUCTION

During the past 30 years, Logan Township has evolved from a mostly rural and agricultural community to one that includes an increasing number of industrial sites. In 1982, the New Jersey Department of Environmental Protection (NJDEP) expressed concern that operations at four industrial sites posed a threat of contamination to the area's ground-water resources (Miller and others, 1982, p. 1). The sites are Bridgeport Rental and Oil Services, Inc. (BROS)[1]; Chemical Leaman Tank Lines, Inc. (CLTL); Monsanto Company; and Rollins Environmental Services, Inc. (RES) (fig. 1). At least three domestic wells in the vicinity of BROS and CLTL have been closed by the NJDEP due to contamination from organic chemicals (Miller and others, 1982, p. 35). BROS and CLTL are included on the U.S. Environmental Protection Agency (USEPA) National Priorities ("Superfund") List (U.S. Environmental Protection Agency, 1984).

Logan Township is underlain by the Potomac-Raritan-Magothy aquifer system; all four of the industrial sites discussed in this report are located in the outcrop area of that aquifer system (Zapecza, 1984, pl. 6). No other aquifers underlie the Township (Zapecza, 1984, pl. 6), and there are no nearby sources of potable surface water. Because the Township depends on the Potomac-Raritan-Magothy aquifer system as its sole source of potable water, assessment of the effect of industrial sites on the aquifer system is essential.

During 1983 and 1984, the U.S. Geological Survey (USGS), in cooperation with Logan Township, Gloucester County, New Jersey, investigated the quality of ground water and surface water at the four sites listed above as part of a comprehensive study of the Township's water resources. Although additional potential sources of ground-water contamination may exist within the Township, well-documented histories of hazardous-waste disposal and ground-water contamination are available only for these four sites.

Prior to beginning on-site water-quality investigations, the USGS conducted a review of existing literature and data on previous ground-water investigations at the four industrial sites. The purpose of the literature review was to determine the scope of previous work so that the subsequent investigation by the USGS could be designed to complement the previous investigations conducted by consultants hired by the industries, some consultants hired by the USEPA, and County and State regulatory agencies.

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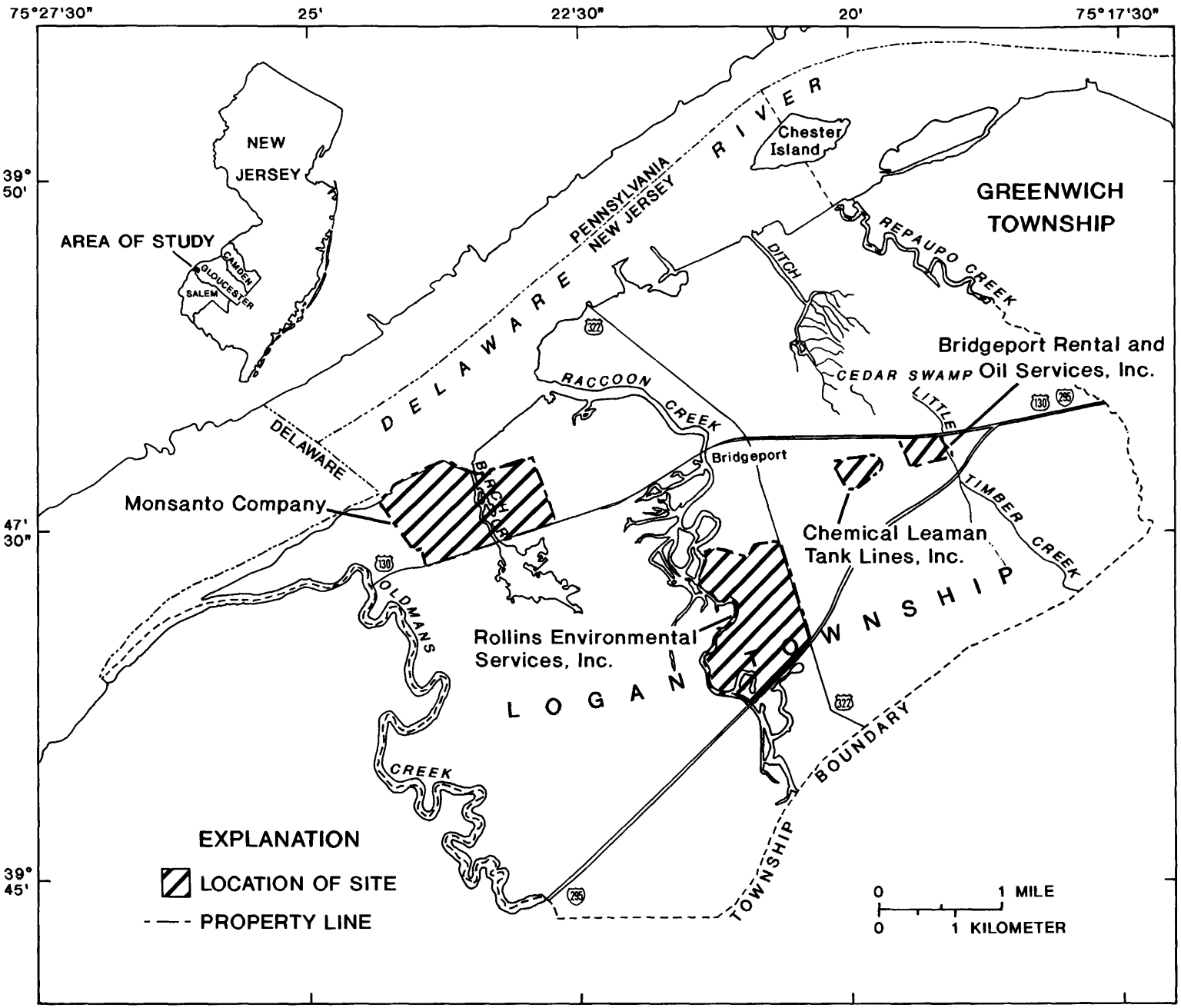
[1] Use of company, brand, and trade names in this report is for identification only, and does not impute responsibility for any potential effects on the natural resources.



Base from U.S. Geological Survey 1:24,000 quadrangles
Bridgeport, 1967; Marcus Hook, 1967

Figure 1.--Logan Township, New Jersey, and sites investigated.

Purpose and Scope

This report compiles literature and data pertaining to the history of ground-water contamination and ground-water investigations through 1985 at four industrial sites in Logan Township, New Jersey.

Literature on ground-water quality at the four sites includes more than 50 reports by Federal and State regulatory agencies and by private consultants as well as numerous data sets, letters, memoranda, and other documents. A single document that compiles all of this information is needed by current and future water-quality investigators.

Because of the wide variety of water-quality-data source material that was reviewed as part of this study, information such as types of data presented, units of concentration, and levels of analytical accuracy were not standardized in any way in the source material. In many cases, only detected constituents were reported; whether samples were analyzed for additional constituents is unknown. In some cases, water-quality data were not linked explicitly to specific wells, and in other cases, precise well locations were not reported. For the purpose of this report, no attempt was made to standardize, verify, or augment reported water-quality data or to determine well locations precisely. Consequently, well locations are not plotted on figures, but general well locations are discussed. In addition, no attempt is made in this report to interpret the data presented; however, interpretations described in the literature are summarized.

Because the ground-water-quality data in the literature for each of the four sites are extensive and, in many cases, repetitive, all of the available data are not presented in this report. For those sites for which several similar data sets are available, the most recent data set is summarized. For one site for which the types of data available vary significantly from reference to reference, two complementary data sets are summarized in this report.

Acknowledgments

The authors thank Richard Littlepage of Chemical Leaman Tank Lines, Inc., Edward Jamro of Monsanto Company, and Gerald Jordan of Rollins Environmental Services, Inc., for providing access to reports and other related documents. Special thanks are extended to Kathy Locane of the New Jersey Department of Environmental Protection (NJDEP) and Haig Kasabach of the New Jersey Geological Survey for providing both access to files and copies of the documents contained in those files.

BRIDGEPORT RENTAL AND OIL SERVICES, INC.

History of Ground-Water Contamination

The Bridgeport Rental and Oil Services, Inc., site (fig. 2) consists of an 11.8-acre waste-oil lagoon and tank farm containing about 90 above-ground storage vessels including tanks, process vessels, drums, and tank trucks. The site is located on the south side of Cedar Swamp Road and Route 130 west of

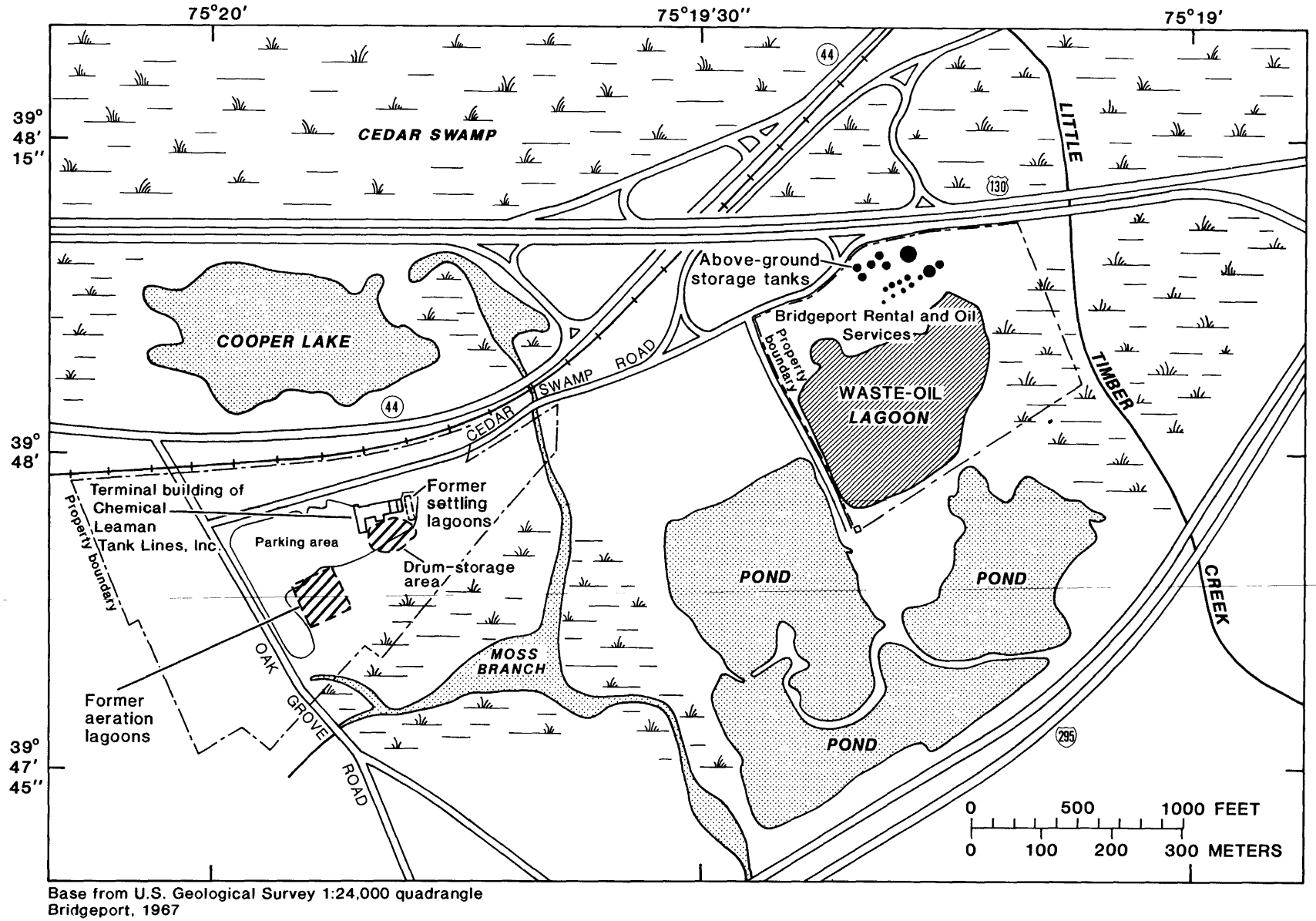
Little Timber Creek. Little Timber Creek flows north into Cedar Swamp, which is connected to the Delaware River by a ditch that was dredged in 1975 (fig. 1) (E.C. Weissmann, Roy F. Weston, Inc., written commun., 1981).

The lagoon occupies a depression formed by excavation for sand and gravel from the late 1930's through the late 1960's (Camp Dresser and McKee, Inc., 1983). Aerial photographs reveal that unknown materials were dumped in the lagoon as far back as 1940 (NUS Corporation, 1984a, p. 3-4). Construction of the tank farm began in the late 1950's (A.H. Gevirtz, U.S. Environmental Protection Agency, written commun., 1980). Waste-oil storage and recovery operations at the site reportedly date back to at least the early 1960's (R.E. Dixon, Gloucester County Planning Department, written commun., 1980). In 1969, BROS was established as a waste-oil storage and recovery facility and a tank-leasing business (R.E. Dixon, Gloucester County Planning Department, written commun., 1980). While the plant was owned by BROS, the lagoon was used for oil storage (R.E. Dixon, Gloucester County Planning Department, written commun., 1980). No information is available concerning the composition of the stored oil. The site has not been used commercially since BROS discontinued operations 1979.

Operations conducted by BROS were described by the company's operating supervisor as follows (A.H. Gevirtz, U.S. Environmental Protection Agency, written commun., 1980). Waste oil was obtained from gas stations, government installations, and trucking firms. Crankcase oil and numbers 2, 4, and 5 fuel oils were among the types of waste oils that were accepted, but no polychlorinated biphenyls (PCB's) or transformer oils reportedly were accepted. The waste oils were blended in underground tanks from which they were pumped into a steam-heated tank and diluted. Solids were removed and clean oil was collected. Approximately one drum of solids per week was derived from the oil-cleaning process and was removed by a waste handler. The filtered oil was transferred to storage tanks and sold as industrial fuel. Excess unprocessed oil also was stored in tanks. No records exist to document the nature of the materials that were accepted or the disposition of any shipment. In addition to using underground tanks as part of the oil-processing procedure, BROS also leased above-ground storage tanks to several firms. The contents of many of the leased tanks reportedly were unknown to the site owner (A.H. Gevirtz, U.S. Environmental Protection Agency, written commun., 1980).

In the early 1970's, the NJDEP ordered BROS to treat the oil phase of the lagoon contents using an on-site oil-treatment system. This action was discontinued by order of the NJDEP in 1975 because the treatment system was inadequate, and wastewater of unacceptable quality was being discharged into Little Timber Creek (Camp Dresser and McKee, Inc., 1983).

A major concern regarding the BROS site has been the rising level of liquid in the lagoon. Since the oil-processing operation began, the liquid level in the lagoon has been as much as 10 feet higher than the local water table (NUS Corporation, 1984b, p. 3-6). The contents of the lagoon currently are separated into three phases: an upper oil layer with floating debris, a middle contaminated aqueous layer, and a lower oily sediment-sludge layer (NUS Corporation, 1984b, p. 3-6). The rising liquid level probably is the result of a combination of two factors: (1) the oil layer on top of the lagoon permits precipitation to enter the lagoon but prevents evaporation of water



Base from U.S. Geological Survey 1:24,000 quadrangle
Bridgeport, 1967

Figure 2.--Bridgeport Rental and Oil Services, Inc., and Chemical Leaman Tank Lines, Inc. sites, Logan Township, New Jersey.

out of the lagoon (Camp Dresser and McKee, Inc., 1983) and (2) the lagoon is lined by sludge that retards the seepage of liquids from its sides and bottom (NUS Corporation, 1984b, p. 3-10).

Although dikes have been in place around the lagoon for several years, they were breached on at least one occasion in the early 1970's when oil and water spilled out and flowed east from the lagoon toward Little Timber Creek (NUS Corporation, 1984a, p. 3-5). In addition, oil may have seeped out of the lagoon through the dikes, as suggested by the detection of a slight sheen on the surface of the pond southwest of the oil lagoon (fig. 2).

Another concern associated with the high liquid level in the lagoon is the possibility of radial flow of contaminated water outward from the sides of the lagoon (NUS Corporation, 1984a, p. 3-6), an inevitable result of the high hydraulic head unless the sides are completely sealed by sludge.

The rising liquid level in the lagoon has been addressed both by upgrading the dike and by pumping water from the lagoon. The dike was upgraded and enlarged in the spring of 1981 by the U.S. Coast Guard under the Federal Clean Water Act (NUS Corporation, 1984a, p. 3-5). In the spring of 1982, the USEPA pumped water from the lagoon, lowering its level by 2 feet. This operation was repeated in the spring of 1983, when heavy rain again raised the liquid level. The pumped water was treated with activated carbon and discharged into Little Timber Creek (NUS Corporation, 1984a, p. 3-5).

The aqueous layer of the lagoon was pumped again by the USEPA from November 1983 through July 1984 until the level was within 5 feet of the surrounding water table. Water pumped during that operation was treated by gravity separation, air stripping, flocculation, clarification, and granular activated-carbon adsorption before being discharged into Little Timber Creek (NUS Corporation, 1984a, p. 3-6).

Storage tanks on the property also may have threatened the quality of ground water and surface water. A.H. Gevirtz (U.S. Environmental Protection Agency, written commun., 1980) noted evidence of leaking tanks, the absence of containment dikes around most tanks, and the generally poor physical condition of the tanks.

Summary of Ground-Water Investigations

In 1983, NUS Corporation conducted an investigation to define the location and extent of ground-water contamination at the BROS site. Magnetic and electromagnetic-conductivity surveys were conducted and samples were collected from the oil lagoon and nearby wells.

The magnetometer survey, conducted in areas bordering the lagoon on the east, west, and northwest, indicated that buried material may exist in areas east and northwest of the lagoon (NUS Corporation, 1984b, p. 3-3). The electromagnetic-conductivity surveys indicated the presence of three discrete plumes of contaminated ground-water extending from the lagoon toward the east-northeast, south, and west-northwest. All three plumes were estimated to have traveled less than 500 feet from the lagoon (NUS Corporation, 1984b, p. 3-4).

All three phases of the lagoon (top-oil, middle-aqueous, and bottom-sludge) were sampled in August 1983; the oil and sludge phases were sampled again in January 1984. The top oil layer, with an estimated volume of 2 to 3 million gallons, contained PCB's in concentrations ranging from 100 to 1,380 ppm (parts per million) and averaging 667 ppm (NUS Corporation, 1984b, p. 3-6). Other hazardous substances in the oil layer included ethylbenzene in concentrations ranging from 11.5 to 50.9 ppm and toluene in concentrations ranging from 35 to 74 ppm (NUS Corporation, 1984b, p. 3-7). Metals detected in the oil layer included lead (160 to 1,525 ppm), nickel (1.0 to 6.0 ppm), barium (40 to 180 ppm), chromium (2.0 to 29 ppm), and mercury (<0.15 to 0.25 ppm) (NUS Corporation, 1984b, p. 3-7).

Organic and inorganic substances found in the aqueous layer of the lagoon are listed in table 1 along with NJDEP and USEPA drinking-water standards. Of the 37 organic constituents listed in table 1, 19 were detected in the aqueous phase of the lagoon. NJDEP drinking-water standards for benzene and xylene were exceeded in nearly all of the samples (NUS Corporation, 1984c)[2]. Inorganic constituents detected in the aqueous layer of the lagoon at concentrations exceeding USEPA drinking-water standards were cadmium, chromium, copper, lead, mercury, selenium, and zinc. No information is available to indicate whether analyses were made for any constituents not listed in table 1. No PCB's were detected in the aqueous layer of the lagoon by NUS Corporation in 1983 or 1984, probably because of the low solubility of PCB's in water (NUS Corporation, 1984b, p. 3-8).

The sludge layer of the lagoon contained PCB's in concentrations ranging from 190 to 1,400 ppm. Sludge samples were not analyzed for volatile organic compounds. Metals detected in the sludge layer included lead (368 to 760 ppm), chromium (12 to 25 ppm), nickel (9.2 to 31 ppm), and arsenic (0.53 to 7.6 ppm) (NUS Corporation, 1984b, p. 3-8). Sludge samples also were analyzed for pesticides and herbicides; no concentrations of these substances in excess of USEPA toxicity criteria were detected (NUS Corporation, 1984b, p. 3-7).

In 1983 and 1984, NUS Corporation collected 37 water samples from 18 observation wells located at distances ranging from 65 to 980 feet from the oil lagoon. Analytical results for those samples are summarized in table 1. Although no information regarding depths of specific wells was reported, observation wells at the site range in depth from 14 to 115 feet (NUS Corporation, 1984a, p. A3-A4).

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[2] Throughout the text of this report, generalizations regarding violations of drinking-water standards are made to summarize the detailed information presented in tables 1-5. Some of the drinking-water standards listed in tables 1-5 were established by the NJDEP; others were established by the USEPA. Consequently, the term "drinking-water standards" in the text may refer to standards set by the NJDEP, primary drinking-water regulations or secondary drinking-water recommended limits set by the USEPA, or a combination of these depending on the chemical constituent discussed. Refer to tables 1-5 for detailed information regarding the drinking-water standards of each regulatory agency.

Table 1--Chemical compounds and constituents and range of reported concentrations detected in the waste-oil lagoon and in wells at and near Bridgeport Rental and Oil Services, Inc., 1983-84

[Data from NUS Corporation (1984b); and Camp, Dresser, McKee (1983); all concentrations in parts per billion; ND, none detected; NR, that no data were reported for this constituent]

Chemical constituent	Drinking water standard	Sampling location and number of samples or wells: Aqueous layer of lagoon (5 samples)	Observation wells east and northeast of lagoon (5 wells)	Observation wells south of the lagoon (5 wells)	Observation wells north and northwest of lagoon (6 wells)	Observation wells west of lagoon (2 wells)	Domestic wells within 1,000 feet west, northwest, and north of lagoon (10 wells)
ORGANIC: Pesticides							
Aldrin	(a)	NR	NR	0.19 - 0.23	0.15	NR	NR
Dieldrin	(a)		NR	0.52 - 1.15		.46 - .61	ND - 1.12
	0.39		NR				
Endosulfan	(a)	NR	ND - .32	.23	ND - 0.47	.27	NR
Endrin	[b]0.2	NR	NR	.52	NR	NR	NR
Heptachlor	(a)	NR	ND - .60	NR	ND - .53	.42	NR
OTHER ORGANIC							
1,1,1-trichloro ethane	[c]26	ND - 19	ND - 840	12	NR	NR	ND - 4.5
1,1,2,2-Tetrachloroethane	(a)	NR	ND - 430	NR	NR	NR	NR
1,2-Dichloropropane	(a)	ND - 16	NR	NR	NR	NR	ND - 27
1,2-Trans-dichloroethane	(a)	140 - 280	ND - 520	NR	ND - 5	ND - 8	30 - 62
2-Butanone	(a)	NR	ND - 4,900	NR	ND - 34	NR	NR
2-Methylnaphthalene	(a)	28 - 44	NR	NR	NR	NR	NR
2-Methylphenol	(a)	ND - 112	ND - 380	NR	NR	NR	NR
2,4-Dimethylphenol	(a)	ND - 64	ND - 180	NR	NR	NR	NR
4-Methyl-2-pentanone	(a)	NR	ND - 9,600	NR	ND - 1,500	NR	NR
4-Methylphenol	(a)	ND - 190	ND - 510	NR	NR	NR	NR
Acetone	(a)	510 - 1,200	ND - 73,000	NR	ND - 21	NR	NR
Benzene,	[c]1	34 - 86	ND - 800	NR	ND - 360	NR	ND - 6.4
Benzoic acid	(a)	NR	ND - 5,600	NR	NR	NR	NR
Benzyl alcohol	(a)	ND - 90	ND - 5,200	NR	ND - 600	NR	NR
Bis (2-chloroethyl) ether	(a)	NR	86 - 990	NR	ND - 72	NR	NR
Bis (2-ethylhexyl) phthalate	(a)	ND - 24	ND - 110	43	NR	ND - 12	NR
Butyl benzyl phthalate	(a)	ND - 50	NR	NR	NR	NR	NR

Table 1--Chemical compounds and constituents and range of reported concentrations detected in the waste-oil lagoon and in wells at and near Bridgeport Rental and Oil Services, Inc., 1983-84--Continued

Chemical constituent	Drinking water standard	Aqueous layer of lagoon (5 samples)	Observation wells east and northeast of lagoon (5 wells)	Observation wells south of the lagoon (5 wells)	Observation wells north and northwest of lagoon (6 wells)	Observation wells west of lagoon (2 wells)	Domestic wells within 1,000 feet west, northwest, and north of lagoon (10 wells)
		Sampling location and number of samples or wells					
OTHER ORGANIC--Continued							
Chlorobenzene	[c]4	NR	ND - 130	NR	NR	NR	NR
Ethylbenzene	(a)	ND - 100	4 - 490	NR	NR	NR	NR
Hexachloroethane	(a)	NR	NR	NR	ND - 80,000	NR	NR
Isophorone	(a)	NR	ND - 2,800	NR	ND - 26	NR	NR
Methylene chloride	[c]2	NR	44 - 6,900	10 - 11,000	9 - 10,000	12 - 3,600	NR
Naphthalene	(a)	ND - 70	NR	NR	NR	NR	NR
PCB's	[c]0.5	ND	NR	NR	NR	NR	NR
Phenanthrene	(a)	ND - 24	NR	NR	NR	NR	NR
Phenol	(a)	ND - 270	NR	NR	NR	NR	NR
O-xylene	[c]44	43 - 130	NR	NR	NR	NR	NR
Tetrachloroethane	[c]1	NR	NR	NR	NR	NR	ND - 20
Toluene	(a)	30 - 450	28 - 3,100	NR	ND - 1,000	ND - 74	ND - 4.7
Trichloroethene	[c]1	ND - 11	10 - 9,000	110	NR	ND - 8	ND - 290
Undifferentiated petroleum hydrocarbons	(a)	NR	NR	6,200 - 15,500	NR	NR	NR
Vinyl chloride	[a]2	NR	NR	NR	NR	NR	ND - 11
INORGANIC							
Cadmium	[b]10	<100 - 110	NR	NR	NR	NR	NR
Chromium	[b]50	240 - 2,800	NR	NR	NR	NR	NR
Copper	[d]1,000	<10 - 3,020	NR	NR	NR	NR	NR
Iron	[d]300	NR	53,700 - 639,000	5,150 - 14,600	6,300 - 118,000	3,100 - 15,000	NR
Lead	[b]50	400 - 656,600		20 - 120	5 - 45	10 - 80	10 - 100 NR
Manganese	[d]50	NR	1,830 - 6,230	315 - 1,740	45 - 10,500	180 - 915	NR
Mercury	[b]2	12 - 60	NR	NR	NR	NR	NR
Nickel	(a)	NR	ND - 400	NR	NR	ND - 40	NR
Selenium	[b]10	<10 - 168	NR	NR	NR	NR	NR
Vanadium	(a)	NR	ND - 4,200	NR	NR	NR	NR
Zinc	[d]5,000	460 - 52,800	7,490 - 310,000	12,700 - 43,000	570 - 116,000	240 - 29,800	NR

a No drinking-water standard has been established for this constituent.

b USEPA Primary Drinking-Water Regulation. Constituents covered by these criteria have been determined to be harmful to public health (U.S. Environmental Protection Agency, 1986).

c Proposed maximum concentration allowed by the New Jersey Department of Environmental Protection in drinking water in New Jersey. Constituents covered by these criteria have been determined to be harmful to public health (New Jersey Register, 1987).

d USEPA Secondary Drinking-Water Recommended Limit. These standards are for esthetic qualities of water such as taste and odor (U.S. Environmental Protection Agency, 1979).

Of the 37 organic constituents listed in table 1, all except PCB's were detected in at least one of the water samples. The NJDEP drinking-water standard for at least one of the organic constituents listed in table 1 was exceeded in at least one sample from each of the 18 observation wells. Inorganic constituents detected in concentrations exceeding drinking-water standards were iron, lead, manganese, and zinc.

On the basis of the results of water-quality sampling and surface-geophysical surveys, NUS Corporation (1984b, p. 3-15) concluded that (1) discrete contaminant plumes emanating from the lagoon were flowing to the south, northwest, and east-northeast; (2) the plume to the south was least contaminated and the plume to the east-northeast was most contaminated; (3) the plume to the east-northeast was flowing into Little Timber Creek; and (4) the plumes to the south and northwest of the lagoon had not traveled far from the lagoon, as evidenced by substantial improvement in water quality at a distance of 400 to 600 feet from the lagoon. Because no observation wells are located greater than 200 feet east of the lagoon, no conclusions were made concerning plume migration to the east.

Domestic wells near the BROS site are located in four general areas: (1) an area 3,000 to 4,000 feet southwest of the site, (2) an area 2,500 to 4,000 feet west of the site, (3) an area 3,000 to 4,000 feet northeast of the site, and (4) an area adjacent to the site extending about 1,000 feet to the north, northwest, and west. Water-quality data for the domestic wells provided by the USEPA to NUS Corporation was summarized by NUS Corporation (1984b, p. 3-16 - 3-19). These data indicate that no contamination was detected in water samples from the five domestic wells located 3,000 to 4,000 feet southwest of the site (NUS Corporation, 1984b, p. 3-19). Organic contamination was detected in samples from the nine wells located 2,500 to 4,000 feet west of the site and the four wells located 3,000 to 4,000 feet northeast of the site. However, on the basis of the types of chemicals detected in the wells and on assumed ground-water-flow directions, NUS Corporation (1984b, p. 3-18) concluded that the contamination in those wells was not derived from the BROS site. For example, 1,2-dichloroethane (up to 93 ppb (parts per billion)) and vinyl chloride (up to 170 ppb) were detected in the the most contaminated residential well in the area west of the site but neither chemical was detected in any BROS observation well. In addition, two ground-water discharge zones (Cedar Swamp and Cooper Lake) are located between the BROS site and the domestic wells west of the site. Another discharge zone (Little Timber Creek) is located between the BROS site and the domestic wells northeast of the site.

Organic contamination also was detected in water samples from five of the 10 domestic wells located less than 1,000 feet north, northwest, and west of the site. NUS Corporation (1984b, p. 3-16) concluded that the BROS site is the source of contamination in these wells. A summary of ground-water-quality data for these wells is listed in table 1.

To summarize, NUS Corporation (1984b) concluded that leakage from the oil lagoon caused contamination of ground water in areas within 1,000 feet of the oil lagoon and that contamination found at distances greater than 1,000 feet from the oil lagoon was derived from another source.

CHEMICAL LEAMAN TANK LINES, INC.

History of Ground-Water Contamination

The Chemical Leaman Tank Lines, Inc., facility in Bridgeport, New Jersey, is located on the south side of Cedar Swamp Road at the intersection with Oak Grove Road (fig. 2). The facility, which has been in operation since 1960, includes a tank-truck terminal where chemical-transportation tanks are maintained, dispatched, and cleaned. Substances used to clean the tanks include caustic solutions and hot kerosene (A.S. Andres, New Jersey Department of Environmental Protection, written commun., 1980) as well as hot and cold water, detergents, and steam (Environmental Resources Management, 1981, p. 1-4).

Between late 1960 and August 1975, effluent from the cleaning process was discharged into a series of three settling lagoons east of the main building for solid-liquid separation, then sprayed into a series of aeration lagoons south of the main building for additional evaporation and settling. From there, the effluent drained by gravity into the swamp at the southern edge of the property (Environmental Resources Management, 1981, p. 1-6). In 1975, CLTL ceased discharging its effluent to the lagoons and the swamp (NUS Corporation, 1985, p. 2-13). Since then, wastewater from the cleaning operation as well as oil, grease, and other materials from the truck-maintenance operations have been shipped off-site for disposal. In 1977, the former settling lagoons were drained, dredged, and filled with imported materials and former lagoon-dike material (NUS Corporation, 1985, p. 2-9). The aeration lagoons also were backfilled after evaporation of the remaining contents (Environmental Resources Management, 1981, p. 1-6).

Other potential sources of ground-water contamination at the site have included leaking tank trucks parked in unpaved areas and drums containing waste sludge stored without secondary containment (J.K. Hamilton, New Jersey Department of Environmental Protection, written commun., 1981). In about 1970 or 1971, a full tank of nitric acid leaked from a tank truck at the northeastern edge of the property (W.R. Hutchinson, New Jersey Department of Environmental Protection, written commun., 1977).

Summary of Ground-Water Investigations

The first documented indication of ground-water contamination at the site occurred in 1977, when NJDEP personnel noted dead vegetation in the swamp northeast of the facility (W.R. Hutchinson, New Jersey Department of Environmental Protection, written commun., 1977). The NJDEP subsequently sampled the well used by CLTL for its potable supply and found it to contain 981 ppb total volatile organic compounds (Environmental Resources Management, 1981). The proposed maximum concentration of volatile organic compounds allowed by the NJDEP in drinking water is 50 ppb (New Jersey Register, 1987). Use of that well for potable-water supply subsequently ceased. In 1981, the NJDEP sampled four domestic wells north of the CLTL property; those wells also were found to contain organic contaminants (G.L. Kachroo, New Jersey Department of Environmental Protection, written commun., 1981). As a result of these analyses, NJDEP officials concluded that CLTL was responsible for contaminating its own water supply as well as that of homes to the north of the terminal (Environmental Resources Management, 1981, p. 5-1), and

recommended that the company conduct a hydrologic investigation to determine the extent of the contamination (New Jersey Department of Environmental Protection, 1981). In 1980, CLTL engaged the services of Environmental Resources Management (ERM) for that purpose.

In 1981, ERM installed 18 shallow wells (6 to 13 feet deep), five intermediate depth wells (30 to 68 feet deep), and two deep wells (97 and 102 feet deep). The wells are concentrated in five areas: the area in and around the site of the former settling lagoons east of the terminal building, the drum-storage area southeast of the terminal building, the area in and around the former aeration lagoons south of the terminal building, an area northwest of the terminal building, and an area north of the terminal building in the direction of the contaminated domestic wells. All of the wells are located within 650 feet of the terminal building.

Between March and June 1981, water samples were collected from all the wells installed by ERM. All of the analyses were done by Betz-Converse-Murdoch, Inc., for ERM. Table 2 summarizes the results of the analyses reported by ERM (1981). All of the samples were analyzed for several organic compounds (see table 2). All of the samples were analyzed for calcium, chloride, magnesium, potassium, sodium, sulfate, zinc, alkalinity, dissolved solids, oil and gas, pH, phenols, and specific conductance. Samples from some of the wells also were analyzed for arsenic, barium, cadmium, hexavalent chromium, copper, lead, mercury, and selenium.

East of the terminal building, in and around the former settling lagoons, eight shallow wells, two intermediate depth wells, and one deep well were installed and sampled. Contaminant concentrations in these samples generally decreased with depth and with distance from the former lagoons. Of the 60 organic constituents listed in table 2, 39 were reported in one or more of the water samples from the shallow wells, and NJDEP drinking-water standards were exceeded for 13 organic constituents. In some wells, barium, cadmium, chloride, copper, lead, sulfate, and dissolved solids were detected in concentrations exceeding USEPA drinking-water standards.

Samples from the intermediate depth wells east of the terminal building contained 20 of the organic constituents listed in table 2. NJDEP drinking-water standards for nine of the organic constituents and the USEPA standard for sulfate were exceeded in samples from the intermediate depth wells. The sample from the deep well east of the terminal building contained 15 of the organic constituents listed in table 2. NJDEP drinking-water standards for seven of the organic constituents and USEPA standards for chloride, sulfate, and dissolved solids also were exceeded in the sample from the deep well.

In the area southeast of the terminal building, in and around the drum-storage area, four shallow wells were installed and sampled. No intermediate depth or deep wells were installed in this area. Of the 60 organic constituents listed in table 2, 22 were reported in samples from these wells. Generally, samples from these wells contained the same contaminants as did the samples from the shallow wells east of the terminal building. However, concentrations generally were lower in samples from these wells than in samples from the shallow wells east of the terminal building.

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Drinking water standard	Location and number of wells: East of main building — Shallow observation wells (8 wells)	East of main building — Intermediate observation wells (2 wells)	East of main building — Deep observation well (1 well)	Southeast of main building — Shallow observation wells (4 wells)	South of main building — Shallow observation wells (5 wells)	South of main building — Intermediate observation well (1 well)
ORGANIC							
1,1,1-trichloroethane	[a]26	ND - 89,000	ND	19.3	ND	ND	ND
1,1,2,2-tetrachloroethane	(b)	ND	ND -0.33	54.9	ND - 66	ND - 24	ND - 7.5
1,1,2,2-tetrachloroethane and/or tetrachloroethene	(b)	[c]730,000	2.0 - 31.3	54.9	NR	NR	NR
1,1,2-trichloroethane	(b)	ND[c]	ND[c]	NR	ND	ND	ND
1,2-dichlorobenzene	[a]600	[c]ND - 5,600	ND	ND	ND - 217	[c]ND - 65	100
1,1-dichloroethene	[a]2	ND - 56	ND - 287	165	ND - 1.7	ND	3
1,2-dichloroethene	(b)	NR	NR	NR	NR	NR	NR
1,1-dichloroethane	(b)	ND	ND - 316	ND	ND	ND	ND
1,2-dichloroethane	[a]2	ND - 640,000	ND - 510	92.9	ND - 547	ND - 2,880	49
1,2-dichlorpropane	(b)	ND - 16,000	ND	0.4	ND - 11	ND - 640	2.4
1,2-trans-dichloroethane	[a]10	ND - 850,000	ND - 3,600	2,000	ND - 3,100	1 - 3,880	700
1,3-Cis-dichloropropane	(b)	ND[c]	ND[c]	NR	ND	ND	ND
1,3-dichlorobenzene	[a]600	ND[c]	ND	ND	NR	NR	NR
1,3-trans-dichloropropene	(b)	ND[c]	ND - 43.4	ND	NR	NR	NR
1,4-dichlorobenzene	[a]6	ND[c]	ND	ND	NR	NR	NR
2-Chloroethylvinyl ether	(b)	ND[c]	ND[c]	NR	ND	ND	ND
Acetone	(b)	[c]ND - 4,800	NR	NR	ND - 7,500c	ND*	NR
Acrolein	(b)	ND[c]	ND[c]	NR	ND	ND	ND
Acrylonitrile	(b)	ND[c]	ND[c]	NR	ND	ND	ND
Aniline	(b)	[c]ND - 2,000	NR	NR	NR	ND*	NR
Benzaldehyde	(b)	[c]ND - 156	ND[c]	NR	NR	NR	ND
Benzene	[a]1	ND - 1,600,000	ND - 136	70.5	ND - 76	ND - 67	121
Bromobenzene	(b)	[c]ND - 170	NR	NR	NR	ND[c]	NR

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Location and number of wells				
	Northwest of main building	North of main building			
	Intermediate observation well (1 well)	Shallow observation well (1 well)	Intermediate observation well (1 well)	Deep observation well (1 well)	Domestic (4 wells)
	ORGANIC				
1,1,1-trichloroethane	ND	D	ND	ND	NR
1,1,2,2-tetrachloroethane	ND	ND	ND - 164	2.2	NR
1,1,2,2-tetrachloroethane and/or tetrachloroethene	NR	NR	83.8	2.2	NR
1,1,2-trichloroethane	ND	ND	ND	NR	NR
1,2-dichlorobenzene	ND	ND	ND	ND	NR
1,1-dichloroethene	ND	ND	0.8 - 36.7	0.5	[c]5.3 - 6.8
1,2-dichloroethene	NR	NR	NR	NR	[c]19.6 - 336
1,1-dichloroethane	ND	ND	ND - 1.6	ND	NR
1,2-dichloroethane	ND	ND	9 - 322	30.9	[c]148 - 216
1,2-dichlorpropane	ND	ND	ND	ND	NR
1,2-trans-dichloroethane	ND	10	479 - 4,500	1,600	NR
1,3-Cis-dichloropropane	ND	ND	ND	NR	NR
1,3-diclorobenzene	NR	NR	ND	ND	NR
1,3-trans-dichloropropene	NR	NR	ND	ND	NR
1,4-dichlorobenzene	NR	NR	ND	ND	NR
2-Chloroethylvinyl ether	ND	ND	ND	NR	NR
Acetone	NR	NR	NR	NR	NR
Acrolein	ND	ND	ND	NR	NR
Acrylonitrile	ND	ND	ND	NR	NR
Aniline	NR	NR	NR	NR	NR
Benzaldehyde	ND	NR	ND	NR	NR
Benzene	ND	ND	1.5 - 6.5	ND	3.7 - 10.0
Bromobenzene	NR	NR	NR	NR	NR

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Drinking water standard	Location and number of wells: East of main building — Shallow observation wells (8 wells)	East of main building — Intermediate observation wells (2 wells)	East of main building — Deep observation well (1 well)	Southeast of main building — Shallow observation wells (4 wells)	South of main building — Shallow observation wells (5 wells)	South of main building — Intermediate observation well (1 well)
ORGANIC--Continued							
Bromochloromethane and/or 1,2-trichloroethane and/or cis-1,3-dichloropropane	(b)	ND[c]	ND	ND	NR	NR	NR
Bromodichloromethane	[d]100	ND	ND	ND	ND	ND	ND
Bromoform	[d]100	ND	ND	ND	ND	ND	ND
Bromomethane	(b)	ND	ND - 2,500	74.2	ND	ND	ND
Butyl alcohol	(b)	[c]ND - 270	NR	NR	ND*	[c]ND-40	NR
Carbon tetrachloride	[a]2	ND	ND	ND	ND	ND	ND
Chlorobenzene	[a]4	[c]ND - 7,800,000	ND - 84	12.7	ND - 87	ND - 52	10.6
Chlorodifluoromethane and/or vinyl chloride	(b)	ND[c]	38.5 - 102	24.8	NR	NR	NR
Chloroethane	(b)	ND	ND	ND	ND	ND	ND
Chloroform	[d]100	ND - 15,000	ND - 450	44.1	ND	ND - 3	ND
Chloromethane	(b)	ND	ND	ND	ND	ND	ND
Cresol	(b)	[c]ND - 600	NR	NR	NR	ND[c]	NR
Dibromochloromethane	[d]100	ND[c]	ND[c]	NR	ND	ND	ND
Dichlorofluoromethane	(b)	[c]ND - 28	NR	NR	NR	ND[c]	NR
Diethyl ether	(b)	[c]ND - 217	ND[c]	NR	ND - 41	ND - 8	20
Dimethyl hexane	(b)	[c]5 - 220	NR	NR	ND[c]	NR	NR
Dimethyl sulfide	(b)	ND[c]	ND[c]	NR	ND - P[c]	NR	10
Dimethylcyclohexane	(b)	[c]ND - 400	NR	NR	NR	ND[c]	NR
Ethylbenzene	(b)	ND - 2,400,000	ND - 14	ND	ND - 76	ND - 5	18
Hexane	(b)	[c]ND - 15	NR	NR	ND[c]	NR	NR
Isopropyl alcohol	(b)	[c]ND - 133	NR	NR	[c]ND - 560	NR	NR

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Location and number of wells				
	Northwest of main building	North of main building			
	Intermediate observation well (1 well)	Shallow observation well (1 well)	Intermediate observation well (1 well)	Deep observation well (1 well)	Domestic (4 wells)
	ORGANIC--Continued				
Bromochloromethane and/or 1,2-trichloroethane and/or cis-1,3-dichloropropane	NR	NR	ND	ND	NR
Bromodichloromethane	ND	ND	ND	ND	NR
Bromoform	ND	ND	ND	ND	NR
Bromomethane	ND	ND	ND - 1,220	5.9	NR
Butyl alcohol	NR	26	NR	NR	NR
Carbron tetrachloride	ND	ND	ND	ND	NR
Chlorobenzene	ND	ND	ND - 12.4	ND	10.1 - 34.8
Chlorodifluoromethane and/or vinyl chloride	ND	ND	54.4	0.5	NR
Chloroethane	ND	ND	ND	ND	NR
Chloroform	ND	ND	ND	ND	[c]7.5 - 8.5
Chloromethane	ND	ND	ND	ND	NR
Cresol	NR	NR	NR	NR	NR
Dibromochloromethane	ND	ND	ND	NR	NR
Dichlorofluoromethane	NR	NR	NR	NR	NR
Diethyl ether	ND	ND	ND	NR	NR
Dimethyl hexane	NR	NR	NR	NR	NR
Dimethyl sulfide	ND	NR	ND	NR	NR
Dimethylcyclohexane	NR	NR	NR	NR	NR
Ethylbenzene	ND	ND	ND - 8.5	ND	NR
Hexane	NR	NR	NR	NR	NR
Isopropyl alcohol	NR	NR	NR	NR	NR

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Drinking water standard	Location and number of wells: East of main building — Shallow observation wells (8 wells)	East of main building — Intermediate observation wells (2 wells)	East of main building — Deep observation well (1 well)	Southeast of main building — Shallow observation wells (4 wells)	South of main building — Shallow observation wells (5 wells)	South of main building — Intermediate observation well (1 well)
ORGANIC--Continued							
Isopropylbenzene	(b)	ND - 712	ND - [c]3	NR[c]	[c]ND - 222	[c]ND - 4	5
Methylene chloride	[a]2	ND - 650,000	2.8 - 259	59.2	ND - 569	ND - 120	16
Methylisobutylketone	(b)	[c]ND - 2,600	ND - [c]80	NR	ND - 318	ND[c]	40
Methylmethacrylate	(b)	[c]ND - 72	NR	NR	NR	ND[c]	NR
Nitrobenzene	(b)	[c]ND - 400	NR	NR	NR	ND[c]	NR
Phenol	(b)	[c]ND - 2,000	ND[c]	NR	ND - 13	ND - 61	ND
Styrene	(b)	[c]ND - 3,170	NR	NR	NR	ND[c]	NR
Tetrachloroethene	[a]1	ND - 225	[c]23	NR	ND - 60	ND - 24	1.5
Tetrahydrofuran	(b)	[c]ND - 1,250	ND[c]	NR	120 - 152	65 - 450	70
Toluene	(b)	ND - 5,100,000	ND - 54	53.0	ND - 146	ND - 15	23
Trichloroethene	[a]1	ND - 1,400,000	2.3 - 3,700	620	1.5 - 2,500	4 - 3,600	606
Trichlorofluoromethane	(b)	ND - 820,000	ND	ND	ND	ND	ND
Trifluorodichloroethane	(b)	ND - 35	NR	NR	NR	NR	NR
Trimethylcyclohexane	(b)	[c]ND - 16	NR	NR	NR	ND[c]	NR
Vinyl chloride	[a]5	ND - 28	ND[c]	NR	ND	ND	ND
Xylene	[a]44	[c]ND - 2,500	ND - [c]10	NR	ND - 322	ND - 71	100
INORGANIC							
Arsenic	[e]50	[c]25	22 - 37	8	NR	NR	NR
Barium	[e]1,000	[c]18,500	35 - 146	40	NR	NR	NR
Cadmium	[e]10	[c]143	.5 - 7	.4	NR	NR	NR
Calcium (mg/L)	(b)	.195 - 144	3.58 - 16.4	23.7	0.636 - 12.5	ND - 108.6	1.05
Chromium, hexavalent	[e]50	[c]<2 - 48	<2 - <20	<20	[c]<2 - 55	<2 - 8	NR
Chloride (mg/L)	[f]250	16.1 - 309	39.4 - 56.8	284	43.6 - 114.0	28.4 - 340	25.4

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Location and number of wells: Northwest of main building — Intermediate observation well (1 well)	North of main building — Shallow observation well (1 well)	North of main building — Intermediate observation well (1 well)	North of main building — Deep observation well (1 well)	North of main building — Domestic (4 wells)
ORGANIC--Continued					
Isopropylbenzene	ND	NR	ND*	NR*	NR
Methylene chloride	ND	ND	1.3 - 58	ND - 1.7	[c]12.7 - 17
Methylisobutylketone	ND	ND	ND	NR	NR
Methylmethacrylate	NR	NR	NR	NR	NR
Nitrobenzene	NR	NR	NR	NR	NR
Phenol	ND	ND	ND	NR	NR
Styrene	NR	NR	NR	NR	NR
Tetrachloroethene	ND	ND	164	NR	[c]4.6 - 185
Tetrahydrofuran	ND	ND	ND	NR	NR
Toluene	ND	ND	2.7 - 23.2	ND	NR
Trichloroethene	ND	ND	245 - 556	22.2	61 - 104
Trichlorofluoromethane	ND	ND	ND - 10.3	ND	NR
Trifluorodichloroethane	NR	NR	NR	NR	NR
Trimethylcyclohexane	NR	NR	NR	NR	NR
Vinyl chloride	ND	ND	ND	NR	NR
Xylene	ND	ND	ND	NR	NR
INORGANIC					
Arsenic	NR	NR	9	11	NR
Barium	NR	NR	60	74	NR
Cadmium	NR	NR	4	.4	NR
Calcium (mg/L)	0.311	0.218	4.21 - 5.78	1.63	NR
Chromium, hexavalent	<2	<2	<2 - <20	<20	NR
Chloride (mg/L)	5.0	44	5.29 - 34.5	28.7	NR

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Drinking water standard	Location and number of wells: East of main building — Shallow observation wells (8 wells)	East of main building — Intermediate observation wells (2 wells)	East of main building — Deep observation well (1 well)	Southeast of main building — Shallow observation wells (4 wells)	South of main building — Shallow observation wells (5 wells)	South of main building — Intermediate observation well (1 well)
INORGANIC--Continued							
Copper	(b)	[c]1,140	<30	<30	NR	NR	NR
Lead	[e]50	[c]13,000	7 - 34	<2	NR	NR	NR
Magnesium (mg/L)	(b)	20.8 - 642	9.02 - 19.2	44.3	17.0 - 55.6	8.39 - 73.9	19.7
Mercury	[e]2	<.05*	.4 - 2	.5	NR	NR	NR
Potassium (mg/L)	(b)	3.93 - 25.0	1.57 - 6.26	8.50	1.28 - 6.22	6.87 - 17.4	8.97
Selenium	[e]10	[c]2	<1	<1	NR	NR	NR
Sodium (mg/L)	(b)	17.9 - 324	18.2 - 23.4	53.5	29.7 - 407	34.5 - 145	36.9
Sulfate (mg/L)	[f]250	38.3 - 888	39.5 - 1,291	470	26.5 - 1,475	5.31 - 563	305
Zinc	[f]5,000	111 - 1,370	489 - 4,220	133	19 - 740	9 - 410	542
Other constituents or properties							
Alkalinity (mg/L)	(b)	16 - 2,680	20 - 64	24	28 - 336	22 - 690*	10
Dissolved solids (mg/L)	[e]500	332 - 5,510	222 - 403	930	354 - 2,226	364 - 1,610	492
Oil and gas (mg/L)	(b)	1.7 - 16,000	<1 - 2.4	3	5.9 - 40.1	3.4 - 17.3	5.3
pH (standard units)	[f]6.5 - 8.5	5.2 - 7.9	5.0 - 6.4	5.3	5.7 - 6.3	4.0 - 7.3	5.8
Phenols (mg/L)	(b)	.003 - 329	.03 - 3.8	.21	.02 - 75	.05 - 1.9	.2
Specific conductance (μS/cm at 25 °C)	(b)	309 - 5,080	296 - 450	1,040	416 - 2,600	377 - 2,032	559

a Proposed maximum concentration allowed by the New Jersey Department of Environmental Protection in drinking water in New Jersey. Constituents covered by these criteria have been determined to be harmful to public health (New Jersey Register, 1987).

b No drinking-water standard has been established for this constituent.

c No data were reported for some wells.

d For these constituents, the 100-μg/L standard is the maximum total concentration of all these constituents allowed by the New Jersey Department of Environmental Protection in drinking water in New Jersey. These constituents have been determined to be harmful to public health (New Jersey Register, 1987).

e USEPA Primary Drinking-Water Regulation. Constituents covered by these criteria have been determined to be harmful to public health (U.S. Environmental Protection Agency, 1986).

f USEPA National Secondary Drinking-Water Recommended Limit. These standards are for esthetic qualities of water such as taste and odor (U.S. Environmental Protection Agency, 1979a).

Table 2--Organic chemical compounds and constituents, other constituents and properties, and range of reported concentrations detected in wells at and near Chemical Leaman Tank Lines, Inc., 1980-81--Continued

[Data from Environmental Resources Management, Inc. (1981); all concentrations in micrograms per liter (μg/L) unless noted otherwise; mg/L, milligrams per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; ND, none detected; NR, no data were reported; P, constituent was detected but no concentration was reported]

Compound, constituent, or property	Location and number of wells				
	Northwest of main building	North of main building			
	Intermediate observation well (1 well)	Shallow observation well (1 well)	Intermediate observation well (1 well)	Deep observation well (1 well)	Domestic (4 wells)
INORGANIC--Continued					
Copper	NR	NR	<30	<30	NR
Lead	NR	NR	36	10	NR
Magnesium (mg/L)	2.61	14.1	9.80 - 12.5	7.1	NR
Mercury	NR	NR	.5	.6	NR
Potassium (mg/L)	9.14	12.7	2.89 - 7.08	8.61	NR
Selenium	NR	NR	<1	<1	NR
Sodium (mg/L)	15.4	22.6	63.1 - 136	6.47	NR
Sulfate (mg/L)	288	67	104 - 216	38.1	NR
Zinc	65	380	45 - 274	130	NR
Other constituents or properties					
Alkalinity (mg/L)	96	30	98 - 110	4	NR
Dissolved solids (mg/L)	112	200	335 - 369	71	NR
Oil and gas (mg/L)	4.8	7.0	1 - 4.4	1	NR
pH (standard units)	5.4	6.7	5.2 - 6.8	6.1	NR
Phenols (mg/L)	.04	.06	.06 - 1.5	.09	NR
Specific conductance (μS/cm at 25°C)	115	191	479 - 496	91	NR

South of the terminal building, in and around the site of the old aeration lagoons, five shallow wells and one intermediate depth well were installed and sampled. Nineteen of the organic constituents listed in table 2 were reported in samples from the shallow wells, and 16 of these constituents also were detected in the samples from the intermediate depth well. Some samples from the shallow wells contained concentrations of chromium, chloride, sulfate, and dissolved solids in excess of USEPA drinking-water standards; in the intermediate depth well, only sulfate exceeded USEPA drinking-water standards. Contaminant concentrations generally decreased with depth and with distance from the lagoons.

In the area northwest of the terminal building, only one 30-feet-deep well was installed. No organic compounds were detected in the sample from that well; sulfate was the only inorganic constituent detected at a concentration exceeding USEPA or NJDEP drinking-water standards.

North of the facility one shallow well, one intermediate depth well, and one deep well were installed and sampled. No past or present source of contamination in this area has been documented. In samples from the shallow well, two organic compounds were detected. Samples from the intermediate depth well contained 16 organic compounds, eight of them above NJDEP drinking-water standards. No inorganic or other constituents were detected in concentrations exceeding USEPA drinking-water standards in the intermediate depth well. Generally, the organic compounds detected in samples from this well also were detected in samples from the intermediate depth wells east of the terminal building, but concentrations in water from the north well were lower.

The sample from the deep well north of the main building contained nine of the organic constituents listed in table 2, three of them in concentrations above NJDEP drinking-water standards. No other constituents were detected in concentrations exceeding NJDEP or USEPA drinking-water standards in the sample from this well. Generally, the contaminants detected in samples from the deep well were the same as those detected in samples from the adjacent intermediate depth well, but the concentrations of contaminants generally were lower in the deep well than in the intermediate depth well.

Four domestic wells on Cedar Swamp Road north of the CLTL facility were sampled by the NJDEP during 1980 and 1981. These wells range in depth from 13 to 90 feet (Miller and others, 1982, p. 4; Environmental Resources Management, 1981, p. 5-27). Organic compounds detected in water samples collected from these wells are listed in table 2. These samples were not analyzed for inorganic constituents. Of the organic constituents listed in table 2, nine were detected in samples from the domestic wells, and NJDEP drinking-water standards were exceeded for seven. Eight contaminants that were detected in samples from the domestic wells also were detected in samples from wells on the CLTL property.

To summarize the analytical results for all ground-water samples reported in table 2, ground water underlying the CLTL property is contaminated at the sites of the former lagoons and the drum-storage area. Within the sites of these former contamination sources, samples from shallow, intermediate depth, and deep wells all were contaminated; the highest contaminant concentrations were found in shallow wells, whereas the lowest concentrations were found in

deep wells. North of the facility, where no known source of surface contamination has existed, water from the intermediate depth and deep wells was more highly contaminated than was the water from the shallow well. Water from domestic wells north of the facility contained eight of the same organic constituents that were detected in samples from wells on the CLTL property.

MONSANTO COMPANY

History of Ground-Water Contamination

Monsanto Company owns approximately 450 acres bordered by the Delaware River estuary to the north and Route 130 to the south (fig. 1). Plant operations, landfills, and storage facilities are located on approximately 150 acres in the part of the property west of Birch Creek (fig. 3).

Plant operations, which began in 1961, include the manufacture of phthalic anhydride, phthalate esters, organophosphates, and other industrial organic compounds (Miller and others, 1982, p. 13). Wastewater from manufacturing processes and other plant wastewater is treated and discharged into the Delaware River estuary. The wastewater-treatment system, which was installed in 1975, consists of pH neutralization, clarification by settling, activated-sludge treatment, and secondary clarification (Miller and others, 1982, p. 13).

Landfills are the major potential source of ground-water contamination at the Monsanto plant. Between 1961 and 1978, non-liquid plant wastes were disposed of in three landfills (former disposal areas 1, 2, and 3) in the northwestern part of the property (fig. 3). These three landfills were closed and covered in the 1970's (Miller and others, 1982, p. 13). In 1978, the currently active disposal area was constructed in the northeastern part of the property (fig. 3).

The active disposal area receives manufacturing wastes and dried sludge from the wastewater-treatment system. The wastes include phenol, phthalic acid/anhydride, other aromatic derivatives, maleic acid/anhydride, n-butanol, naphthalene, and triethylamine. The predominant hazardous waste contained in the active disposal area is phthalic anhydride pitch (Geraghty and Miller, 1984b, p. 3). The landfill has a double clay liner separated by a sand layer, which is used to detect leakage from the landfill.

The NJDEP has determined that shallow ground water underlying the Monsanto property most likely would flow into the Delaware River or Birch Creek, and that deep water underlying the property is captured by pumpage for Monsanto's plant operations (Miller and others, 1982, p. 27). Therefore, the NJDEP has determined that any ground-water contamination on the Monsanto property poses no threat to ground-water quality on adjacent property (Miller and others, 1982, p. 27).

Summary of Ground-Water Investigations

In 1981, an NJDEP investigation of the Monsanto site revealed the presence of various materials, including drums containing PCB's, in former disposal area 1. Consequently, Monsanto Company hired Geraghty and Miller,

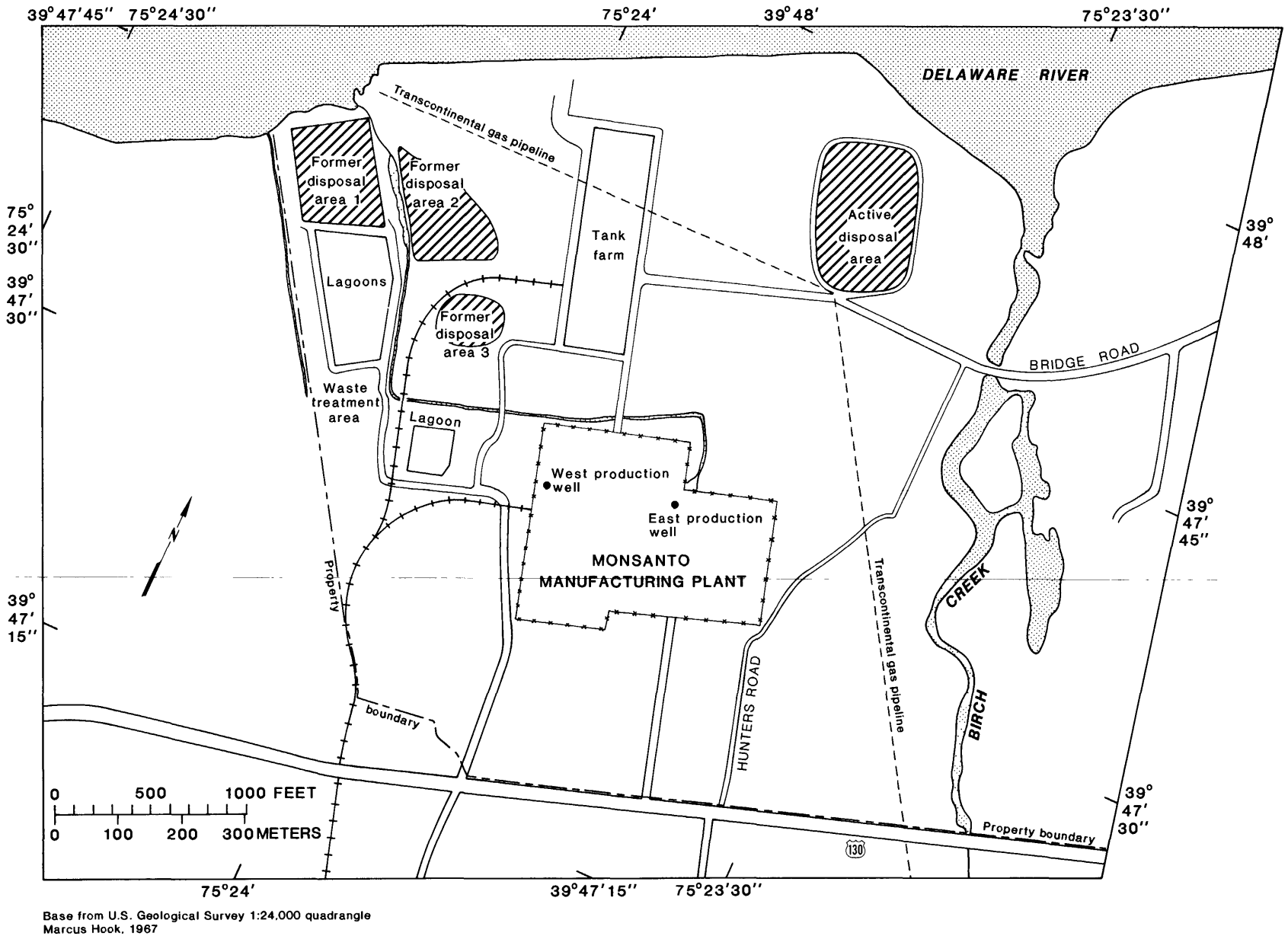

Figure 3.--Monsanto Company site, Logan Township, New Jersey.

Inc., to conduct a hydrogeologic investigation of former disposal area 1 (New Jersey Department of Environmental Protection, 1984, p. 5).

In 1982, Geraghty and Miller, Inc., installed 31 observation wells ranging in depth from 11.5 to 46.5 feet at 14 sites both within the landfill and at distances up to 660 feet from it. In 1983, water samples were collected from these wells and from five previously installed wells in the same area to determine the extent of ground-water contamination associated with the landfill.

Contaminants detected in some of the wells included benzaldehyde, benzyl chloride, benzyl alcohol, and Arochlor 1280 (a mixture of PCB's) (Geraghty and Miller, Inc., 1983a, Appendix B). One well a few feet north of the landfill contained oil as well as water. The highest concentrations of contaminants were found in samples from wells located within the landfill; no contaminants were found in samples from wells more than 100 feet from the landfill (Geraghty and Miller, 1983a, Appendix B). Consequently, the NJDEP determined that the contamination associated with former disposal area 1 had not threatened ground-water quality on adjoining property (New Jersey Department of Environmental Protection, 1984, p. 1). To ensure that no such threat would develop in the future, Monsanto Company constructed a slurry wall around the landfill in 1984 in accordance with a NJDEP recommendation. The wall is about 25 feet deep and 1,800 feet long and consists of bentonite slurry, a relatively impermeable material (New Jersey Department of Environmental Protection, 1984, p. 5).

In 1981, liquid was detected between the two clay liners beneath the active disposal area. Results of an investigation conducted to determine whether the landfill was leaking indicated that the liquid did not contain the same chemicals as the landfill and that the liquid therefore must have come from another source (Geraghty and Miller, 1981c, p. 1).

Observation wells have been installed at a total of 55 sites on the Monsanto property. At most of these sites, both shallow and deep wells were installed. The shallow wells generally are less that 20 feet deep, and the deep wells generally are 30 to 90 feet deep. Many of the wells are located in and near the landfills, some are located near the manufacturing plant, and some are located along the perimeter of the property.

In order to monitor the extent of ground-water contamination over the entire site, Monsanto Company collects water samples quarterly from 21 wells on the property. The samples are analyzed for PCB's, 89 other organic compounds, chloride, and dissolved solids. Table 3 summarizes the ranges of concentrations of the compounds that were detected in the samples collected in May 1984.

In the area south of the manufacturing plant, one shallow well and three deep wells located 800 to 1,500 feet from all plant operations were sampled. No organic constituents were detected in the sample from the shallow well, and one organic constituent, diethyl phthalate, was detected in the sample from one of the deep wells. None of the samples from those wells contained any constituent in concentrations exceeding NJDEP or USEPA drinking-water standards.

Table 3.--Chemical compounds and constituents and properties and range of reported concentrations detected in wells at Monsanto Company, May 1984

[Data from M. A. Kulig, Monsanto Company, written commun. (1984); all concentrations in parts per billion, unless noted otherwise; mg/L, milligrams per liter; ND, none detected]

Compound or constituent	Drinking-water standard	Location and number of wells					
		Southern part of property		Central part of property		Northern part of property	
		Shallow well (1)	Deep wells (2)	Shallow wells (2)	Deep wells (4)	Shallow wells (8)	Deep wells (4)
ORGANIC							
Benzene	[a]1	ND	ND	1.4 - 400	ND	ND - 7.5	ND
Bis-(2-ethylhexyl) phthalate	(b)	ND	ND	ND - 30	ND	ND	ND
Chlorobenzene	[a]4	ND	ND	ND	ND	ND - 2.0	ND
1,1-dichloroethane	(b)	ND	ND	ND	ND	ND - 25.0	ND
1,1-dichloroethylene	[a]2	ND	ND	ND - 26	ND	ND	ND
Diethyl phthalate	(b)	ND	ND - 6	ND - 12.5	ND - 12.6	ND - 45	ND - 12
Ethylbenzene	(b)	ND	ND	1.0 - 7,920	ND	ND	ND
Toluene	(b)	ND	ND	6.8 - 2,800	ND	ND - 53	ND
Tetrachloroethylene	[a]1	ND	ND	ND - 60	ND	ND	ND
1,2-trans-dichloro-ethylene	[a]10	ND	ND	ND - 4,750	ND	ND	ND
Trichloroethylene	[a]1	ND	ND	ND - 6,460	ND	ND	ND
Xylene	[a]44	ND	ND	ND - 1,500	ND	ND - 10.5	ND
PCBs	[a]0.5	ND	ND	ND	ND	ND	ND
Phenol	(b)	ND	ND	ND - 120	ND	ND - 116	ND
INORGANIC							
Chloride (mg/L)	[c]250	10.9	48.6 - 204.5	279.9 - 318.6	120.1-343.1	5.96-727.7	117.1 - 274
Dissolved solids (mg/L)	[c]500	468	338 - 464	134 - 1,100	214-702	140.-3,908	228 - 498

a Proposed maximum concentration allowed by the New Jersey Department of Environmental Protection in drinking water in New Jersey. Constituents covered by these criteria have been determined to be harmful to public health (New Jersey Register, 1987).

b No drinking-water standard has been established for this constituent.

c USEPA Secondary Drinking-Water Recommended Limit. These standards are for esthetic qualities of water such as taste and odor (U.S. Environmental Protection Agency, 1979a).

In the central part of the property, near the manufacturing plant, two shallow wells and four deep wells were sampled (table 3). Samples from the two shallow wells contained detectable concentrations of 11 organic constituents, six of which were found in concentrations greater than NJDEP drinking-water standards. These samples also contained concentrations of chloride and dissolved solids exceeding USEPA drinking-water standards. No surficial source of ground-water contamination in this area has been documented. In the deep wells, one organic constituent, diethyl phthalate, was detected. USEPA drinking-water standards for chloride and dissolved solids were exceeded in samples from three of these wells.

In the northern part of the property, where the landfills are located, eight shallow wells and four deep wells were sampled. At least one of the organic compounds listed in table 3 was detected in seven of the shallow wells, and the NJDEP drinking-water standard for one organic compound, benzene, was exceeded in the sample from one of these wells. USEPA drinking-water standards for chloride and dissolved solids also were exceeded. In water samples from the deep wells, one organic constituent, diethyl phthalate, was detected, and the USEPA drinking-water standard for chloride was exceeded.

The New Jersey Department of Health collected and analyzed water samples from seven wells near the Monsanto property during 1980 and 1981. The wells included two domestic wells about 1,200 feet southwest of the plant, four domestic wells about 1,600 feet south-southeast of the plant, and a municipal well about 5,000 feet southeast of the plant (Miller and others, 1982, p. 2). All of the samples were analyzed for volatile organic compounds. Volatile organic compounds were detected in water samples from two of these wells, but in each case the total concentration of volatile organic compounds was less that 20 ppb (Miller and others, 1982, Appendix, Table 1-21). The maximum allowable concentration of volatile organic compounds in drinking water by the NJDEP is 50 ppb (New Jersey Register, 1987).

To summarize the investigations at Monsanto Company, shallow ground-water underlying the central and northern parts of the Monsanto property contains organic chemicals in concentrations exceeding NJDEP drinking-water standards, but shallow ground water south of the plant is within NJDEP drinking-standards for organic chemicals. Deep ground water underlying all parts of the property also is within NJDEP drinking-water standards for organic chemicals. There is no evidence of movement of contaminated ground-water from the Monsanto property to adjoining properties.

ROLLINS ENVIRONMENTAL SERVICES, INC.

History of Ground-Water Contamination

Rollins Environmental Services, Inc. has operated a hazardous-waste-treatment and -disposal plant in Logan Township since 1970. Land owned by RES encompasses approximately 209 acres bordered by Route 322 to the east, Route 295 to the south, Raccoon Creek to the west, and agricultural land to the north (figs. 1 and 4). Plant operations and waste storage have been confined to approximately 78 acres in the northern part of the property along Raccoon Creek (fig. 4).

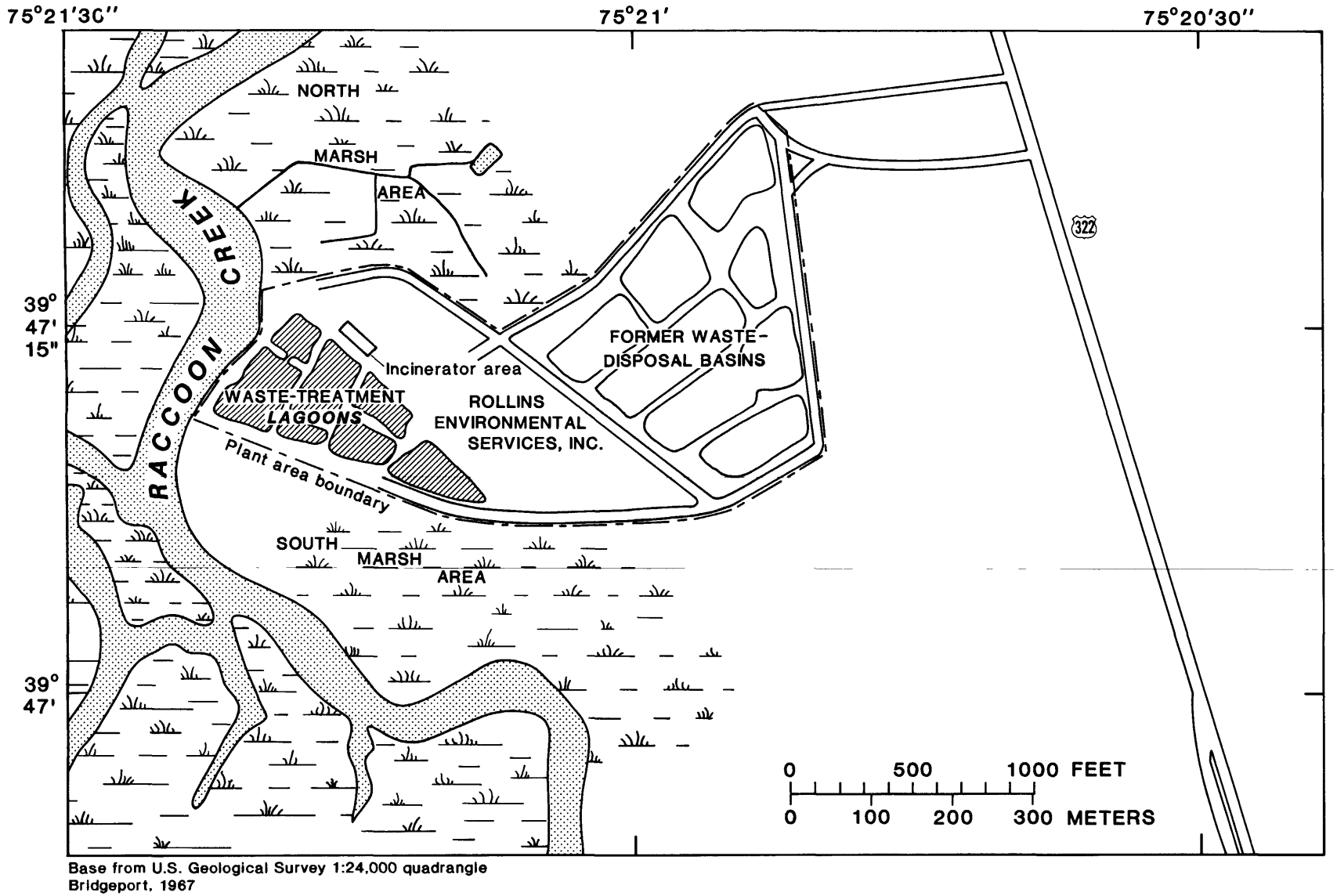

Figure 4.--Rollins Environmental Services, Inc., site, Logan Township, New Jersey.

When RES began operations, the company processed and disposed of a wide variety of industrial wastes (New Jersey Department of Environmental Protection, 1983, p. 1). At that time, six types of wastes were processed at the plant: inorganic wastes (including mixed mineral acids and alkaline solutions), inorganic oxidizers (heavily metal-laden), organic acids, aqueous organic wastes, combustible liquids and sludges, and cyanides (Miller and others, 1982, p. 15). When the plant began operating, four types of waste-treatment systems were used: physical-chemical, oxidation-reduction, biological degradation by activated sludge, and incineration (Miller and others, 1982, p. 15). Solids and sludges from treatment processes were landfilled in waste-disposal basins (fig. 4) in the eastern part of the facility (Miller and others, 1982, p. 15). The number of these basins varied because basins often were added, subdivided, or taken out of service. Wastewater from the waste-treatment processes was treated and was discharged into Raccoon Creek (Miller and others, 1982, p. 15). The wastewater-treatment system consisted of lagoons (fig. 4) for equalization, preaeration, and treatment by activated sludge; a trickling filter; and a clarifier. The incineration system (fig. 4) includes a rotary kiln equipped with an air-pollution scrubber (Battelle Columbus Division, 1983, p. I-1).

Although many potential sources of ground-water contamination have been found at the RES site, some were removed easily because they resulted from isolated incidents or short-term practices such as overflowing lagoons, deposition of untreated liquid waste directly on the ground, or temporary storage of leaking drums in unpaved areas (Geraghty and Miller, Inc., 1972, p. 23).

The waste-disposal basins have been a major source of ground-water contamination. Many of the basins leaked hazardous chemicals into the surrounding aquifers (New Jersey Department of Environmental Protection, 1983, p. 8). Six of the basins were clay-lined, but the others were unlined (New Jersey Department of Environmental Protection, 1983, p. 8). Between 1972 and 1979, unsuccessful attempts were made to stop the leakage by relining the basins. The NJDEP therefore ordered in 1980 that all landfilling in the basins be discontinued and that waste-disposal processes for which the basins were required also be discontinued (New Jersey Department of Environmental Protection, 1983, p. 8). Consequently, RES now is allowed to accept only those wastes that can be treated by incineration. Numerous types of wastes (inorganic wastes, inorganic oxidizers, and cyanides) no longer are accepted (Miller and others, 1982, p. 15).

When landfilling in the basins was discontinued in 1980, there were 14 basins at the site. To prevent further leakage of contaminants from the basins, the contents of two basins were removed and taken off-site, the contents of ten basins were removed and treated, and two basins were capped with impermeable material. The treated material subsequently was placed in three basins that were upgraded for better containment (Battelle Columbus Division, 1983, p. VIII-14). This basin-closure program was completed in 1985.

Summary of Ground-Water Investigations

The first documented evidence of ground-water contamination at the RES site was found in 1971, when high acidity and high concentrations of dissolved

solids, nitrates, and metals were detected in water samples from shallow observation wells (New Jersey Department of Environmental Protection, 1983, p. 31). Consequently, Geraghty and Miller, Inc., was retained in 1972 to determine ground-water-flow directions, delineate the extent of ground-water contamination, and recommend methods of controlling ground-water contamination.

Water-level data collected in 1972 and on many occasions thereafter indicated that shallow (1 to 40 feet deep) ground water at the site generally moves northwest toward Raccoon Creek and the north marsh (Geraghty and Miller, Inc., 1972, p. 15; Geraghty and Miller, Inc., 1976, fig. 4; Geraghty and Miller, Inc., 1980, p. 2; Geraghty and Miller, Inc., 1981b, p. 4; Geraghty and Miller, Inc., 1982b, p. 2; Geraghty and Miller, Inc., 1983b, p. 4; Geraghty and Miller. Inc., 1984a, p. 4).

Because water-level data indicated that shallow ground water moves from the plant area toward the north marsh, the marsh area was investigated in 1981 to determine the presence and extent of any ground-water contamination in that area. At each of nine sites in the marsh, a shallow well (10 to 20 feet deep), an intermediate depth well (21 to 50 feet deep), and a deep well (49 to 70 feet deep) were installed. At two additional sites in the marsh, only intermediate depth and deep wells were installed. In 1981, water samples were collected from these 31 wells. The samples were analyzed for pH, total organic carbon, chloride, specific conductance, cadmium, chromium, calcium, and zinc. Based on these analyses, Geraghty and Miller, Inc. (1981a, p. 6), concluded that contaminated ground water underlay the north marsh up to 600 feet from the plant area. Contaminant concentrations generally were lower in samples from shallow wells than in samples from intermediate and deep wells (Geraghty and Miller, Inc., 1981a, table 2).

To determine whether the shallow and deep zones of the aquifer are hydraulically connected, an aquifer test was conducted in the north marsh in 1981. The test revealed the presence of an indirect connection, at least in the north marsh area (M.F. Wolfert, Geraghty and Miller, Inc., written commun., 1981).

In 1972, RES installed an abatement-well system that was designed to remove contaminated water from the aquifer and to prevent it from moving off-site. Contaminated water pumped by the abatement wells is treated by the on-site wastewater-treatment system and then is discharged into Raccoon Creek. The system initially consisted of six wells located along a line extending generally east-west through the center of the plant. A total of 14,400 gallons per day of contaminated water was pumped (Johe and Stotler, 1981, p. 4). Between 1972 and 1982, the abatement system was redesigned many times by adding wells and increasing total pumpage. By 1982, 16 abatement wells, including 11 in the north marsh, were pumping between 98,000 and 190,000 gallons per day (Geraghty and Miller, Inc., 1982a, table 1).

Beginning in 1972, changes in the distribution of dissolved solids in ground water have been used at RES as an indicator of changes in ground-water quality. In order to delineate the spatial extent of ground-water contamination, a dissolved-solids concentration of 500 ppm has been used to differentiate between contaminated and uncontaminated water.

Ground-water samples were collected from all available observation wells in 1972, 1975, and each year from 1978 through 1984. The number of observation wells at RES has varied over the years because many wells have been added or removed since 1972. Currently, there are approximately 38 observation wells in the north marsh area, 44 in the plant area, and six south of the plant area at distances of up to 600 feet from the plant.

The distribution of dissolved solids in ground-water samples collected in 1972 indicated the presence of contaminated water only beneath the plant area (Geraghty and Miller, Inc., 1972, p. 21). By 1975, dissolved-solids concentrations in the shallow ground water beneath the plant area had increased and contamination had spread into the north marsh (Geraghty and Miller, Inc., 1976, p. 10, 14). By 1978, the contaminated area had not increased in size but the level of contamination had increased significantly, most notably in the north marsh (Geraghty and Miller, Inc., 1978, p. 7). From 1979 through 1984, little additional change was noted in the areal distribution of contaminated ground water, except for continued spreading into the north marsh (Geraghty and Miller, Inc., 1979, p. 5; Geraghty and Miller, Inc., 1980, p. 3-4; Geraghty and Miller, Inc., 1981b, p. 8; Geraghty and Miller, Inc., 1982b, p. 7; Geraghty and Miller, Inc., 1983b, p. 5; Geraghty and Miller, Inc., 1984a, p. 7).

Water samples collected and analyzed for dissolved solids also were analyzed for a variety of additional constituents. Since sampling began in 1972, the suite of chemical constituents analyzed, the methods of analysis, and the number of available observation wells have changed many times. In this report two complementary data sets, one from 1979 and one from 1984, are summarized in tables 4 and 5, respectively. The wells listed in tables 4 and 5 are divided into two groups based on depth. Shallow wells range in depth from 7 to 40 feet; intermediate depth and deep wells range in depth from 21 to 125 feet (Geraghty and Miller, Inc., 1984a, appendix B, tables 1-2). In 1979 and 1984, samples from some shallow wells contained arsenic, cadmium, chromium, copper, lead, zinc, dissolved solids, chloride, iron, manganese, nitrate, and (or) sulfate in concentrations exceeding USEPA drinking-water standards and PCB's in concentrations exceeding the NJDEP the drinking-water standard. Within the shallow zone, samples from the plant area generally contained the highest concentrations of contaminants, whereas samples from the area south of the plant generally contained the lowest concentrations.

In 1979, water samples from deep wells within the plant area contained iron and nitrate in concentrations exceeding USEPA drinking-water standards. At that time, no deep wells existed north or south of the plant area. In 1984, samples from deep wells south of the plant area were not found to contain any constituents in concentrations above drinking-water standards, but samples from intermediate depth and deep wells north of the plant area contained dissolved solids, arsenic, and chromium in concentrations exceeding drinking-water standards.

The 1984 data indicate that the vertical distribution of contamination was different in the north marsh than in the rest of the site. In the north marsh, water samples from the intermediate depth and deep zones generally had higher contaminant concentrations than did samples from the shallow zone. Elsewhere, samples from the shallow zone generally were more contaminated than samples from intermediate depth and deep zones.

Table 4.--Chemical compounds and constituents and properties and range of reported concentrations detected in wells at Rollins Environmental Services, Inc., March-April 1979

[Data from Geraghty and Miller, Inc. (1979); all concentrations are in milligrams per liter, except where noted; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; NR, no data were reported]

Chemical constituent or property	Drinking-water standard	Location and number of wells: North of plant area, Shallow wells (2)	North of plant area, Intermediate and deep wells	Within plant area, Shallow wells (17)	Within plant area, Intermediate and deep wells (2)	South of plant area, Shallow wells (5)	South of plant area, Intermediate and deep wells
ORGANIC							
Nitrobenzene	(a)	<0.1 - 9.5	NR	<0.1 - 7.4	<0.1	[b]<0.01	NR
PCBs (µg/L)	[c]0.5	.26 - 3.47	NR	[b]ND - 72.9	.24 - .44	[b]ND - 2.5	NR
Phenols	(a)	.005 - 61	NR	.004 - 36.4	<.001 - .001	.005 - .22	NR
INORGANIC							
Calcium, as $CaCO_3$	(a)	27.5 - 145	NR	1 - 400	2.8 - 7	[b]12 - 30	NR
Chloride	[d]250	28 - 660	NR	6 - 5,100	17.5 - 200	[b]20 - 200	NR
Chromium, total	[e]0.50	<.1 - .40	NR	<.1 - 1,300	<.1	<.10 - .1	NR
Copper	[d]1	<.05 - .10	NR	<.1 - 1,500	<.05 - .10	<.05 - 2	NR
Dissolved solids	[d]500	166 - 2,417	NR	144 - 36,457	19 - 257	283 - 1,041	NR
Iron	[d]0.3	.40 - 300	NR	<.1 - 280	.50 - 9	[b].25 - 9.5	NR
Magnesium, as $MgCO_3$	(a)	8.8 - 30.5	NR	5 - 2,000	1.6 - 5.2	[b]6.5 - 18	NR
Manganese	[d]0.5	<.01 - 7.5	NR	<.1 - 15	<.05 - .25	[b]<.05 - .20	NR
Nitrate	[e]10	12 - 158	NR	.22 - 1,825	1.11 - 68.7	[b].72 - 201	NR
Nitrite	(a)	.01 - .15	NR	.01 - 1.72	.005 - .008	[b].01 - .103	NR
Phosphate	(a)	1.3 - .81	NR	<.03 - 4.11	<.03 - .30	[b]<.05 - .30	NR
Sulfate	[d]250	85 - 88	NR	20 - 10,000	2.3 - 9.5	[b]128 - 500	NR
Zinc	[d]5	.10 - .25	NR	<.02 - 80	.10 - .12	[b]<.02 - .20	NR
PROPERTIES							
Alkalinity, total	(a)	5 - 480	NR	0 - 4,500	5 - 30	[b]5 - 170	NR
Biological oxygen demand	(a)	1.3 - 5,700	NR	2.9 - 5,700	1.3 - 2.4	[b]2.4 - 46	NR
Chemical oxygen demand	(a)	17.7 - 9,358	NR	15.3 - 25,000	9.6 - 17.7	[b]18.5 - 136	NR
Specific conductance (µS/cm at 25 °C)	(a)	200 - 1,000	NR	120 - 1,800	236 - 500	[b]180 - 500	NR

a No drinking-water standard has been established for this constituent.
b No data were reported for some wells.
c Proposed maximum concentration allowed by the New Jersey Department of Environmental Protection in drinking water in New Jersey. Constituents covered by these criteria have been determined to be harmful to public health (New Jersey Register, 1987).
d USEPA Secondary Drinking-Water Recommended Limit. These standards are for esthetic qualities of water such as taste and odor (U.S. Environmental Protection Agency, 1979a).
e USEPA Primary Drinking-Water Regulation. Constituents covered by these criteria have been determined to be harmful to public health (U.S. Environmental Protection Agency, 1986).

Table 5.--Chemical compounds and constituents and properties and range of reported concentrations detected in wells at Rollins Environmental Services, Inc., July-September 1984

[Data from Geraghty and Miller, Inc. (1984a); concentrations are in milligrams per liter; <, less than]

Chemical constituent or property	Drinking-water standard	Location and number of wells: North of plant area, Shallow wells (12)	North of plant area, Intermediate and deep wells (11)	Within plant area, Shallow wells (21)	Within plant area, Intermediate and deep wells (4)	South of plant area, Shallow wells (4)	South of plant area, Intermediate and deep wells (1)
INORGANIC							
Arsenic	[a]0.05	<0.02 - 0.12	<0.01 - 0.32	<0.01 - 0.11	<0.01	<0.01 - 0.03	<0.01
Cadmium	[a].01	<.01 - .02	<.01	<.01 - .08	<.01	<.01	<.01
Chromium	[a].05	<.05 - 2.50	<.05 - .15	<.05 - .10	<.05	<.05	<.05
Copper	[b]1	<.02 - 2.20	<.02 - .07	<.02 - 1.21	<.02	<.02	<.02
Dissolved solids	[b]500	180 - 1,320	95 - 2,520	90 - 5,050	100 - 190	30 - 1,110	140
Lead	[a].05	<.2	<.2	<.2 - 2.00	<.2	<.2	<.2
Nitrate (as nitrogen)	[a]10	<.2 - 8.2	<.2 - 10.0	<.02 - 6.2	<.2 - 1.3	<.2 - 1.5	6.6
Zinc	[b]1	.03 - .68	<.02 - .15	<.02 - 20.3	<.02 - .10	.03 - 13.8	.08
ORGANIC							
Phenols	(c)	<0.005 - 9.5	<0.005 - 1.56	<0.005 - 0.23	<0.005	<0.006 - 0.42	<0.005
Total organic carbons	(c)	5 - 130	3 - 410	4 - 96	4 - 6	4 - 47	3
Total organic halogens	(c)	<1.0 - 4.9	<1.0	<1.0 - 2.6	<1.0	<.1 - 1.2	<1.0

a USEPA Primary Drinking-Water Regulation. Constituents covered by these criteria have been determined to be harmful to public health (U.S. Environmental Protection Agency, 1986).

b USEPA Secondary Drinking-Water Recommended Limit. These standards are for esthetic qualities of water such as taste and odor (U.S. Environmental Protection Agency, 1979a).

c No drinking-water standard has been established for this constituent.

The NJDEP collected water samples from eight wells located north, east, and south of the RES property in 1980 and 1981 to determine whether ground water on property surrounding the RES plant was contaminated. The eight wells are located at distances ranging from 200 to 3,000 feet from the plant. Depths of six of the wells ranged from 10 to 90 feet; the depths of two wells are unknown. The samples were analyzed by the New Jersey Department of Health. None of the samples contained detectable concentrations of volatile organic compounds, and no inorganic constituents were detected in concentrations exceeding USEPA drinking-water standards (Miller and others, 1982, p. 27).

In 1984, Malcolm Pirnie, Inc., collected water samples from wells near the RES plant to determine whether off-site ground-water quality had been affected. Water from four of the wells previously sampled by the NJDEP was analyzed, and additional observation wells were installed at three sites near the plant. These sites are located approximately 200 feet north of the plant, 400 feet north of the plant, and 2,000 feet southwest of the plant, across Raccoon Creek. Two wells were installed at each site--one about 20 feet deep and one about 75 feet deep (Malcolm Pirnie, Inc., 1985, p. 8-2).

Samples from these wells were analyzed for the 127 priority pollutants established by the USEPA (U.S. Environmental Protection Agency, 1979b). The priority pollutants include 89 organic compounds, 18 pesticides, seven PCB's, and 13 metals (Keith and Telliard, 1979). None of the samples contained concentrations of any priority pollutant in excess of USEPA drinking-water standards, and none contained more than 9 ppb total organic priority pollutants (Malcolm Pirnie, Inc., 1985, table 10-3).

These samples also were analyzed for other organic compounds that cannot be positively identified by using existing laboratory methods. No drinking-water standards have been established for any of these compounds. Between one and six tentatively identified organic compounds were detected in samples from four of the wells. The well where the highest concentration of tentatively identified compounds was found was the shallow well across Raccoon Creek, in which the total estimated concentration of tentatively identified organic compounds was 97.7 ppb (Malcolm Pirnie, Inc., 1985, table 10-4). However, it could not be determined whether the contaminants found in that well originated at the RES site (Malcolm Pirnie, Inc., 1985, p. ES-2). The total concentration of tentatively identified compounds in the three remaining wells in which these compounds were detected was less than 9 ppb (Malcolm Pirnie, Inc., 1985, table 10-4).

In summary, investigations have determined that shallow ground water within 600 feet of the plant contains arsenic, cadmium, chromium, copper, lead, zinc, dissolved solids, chloride, iron, manganese, nitrate, and sulfate in concentrations that exceed USEPA drinking-water standards and PCB's in concentrations that exceed the NJDEP drinking-water standard. Ground water at depths greater than 20 feet below land surface under the north marsh and the plant area also is contaminated, but deep ground water south of the plant area is not contaminated. Off-site investigations have not revealed the presence of any ground-water contamination derived from the RES site.

SUMMARY

The Potomac-Raritan-Magothy aquifer system is the sole source of potable water in Logan Township, New Jersey. Four industrial sites in the Township are located in the outcrop area of that aquifer system. Investigations conducted between 1970 and 1985 indicated the presence of contaminated ground water at each of the four industrial sites and documented the presence of contaminated ground water in areas adjacent to two of the sites.

Bridgeport Rental and Oil Services, Inc. was a waste-oil processing and storage operation from the early 1960's to 1979. The major potential source of ground-water contamination at the site is an 11.8-acre lagoon in which waste oil has been stored. Although dikes surround the lagoon, liquids in the lagoon have spilled onto the surrounding land on at least one occasion.

On the basis of chemical analyses of ground-water samples collected from the BROS oil lagoon and from 46 nearby wells, previous investigators concluded that leakage from the oil lagoon caused contamination of ground water in wells as far as 1,000 feet from the lagoon, including five domestic wells north and northwest of the lagoon, but that ground-water contamination detected at distances greater than 1,000 feet from the oil lagoon was not derived from the BROS site.

Chemical Leaman Tank Lines, Inc., has been operating in Logan Township since 1960. The company consists of a tank-truck terminal where chemical-transportation tanks are maintained, dispatched, and cleaned. Potential sources of ground-water contamination at the CLTL site include lagoons into which wastewater was discharged, an area used for storage of drums containing chemicals, and leaking tank trucks. All of these contamination sources have been removed.

Results of chemical analyses of ground-water samples collected from 25 observation wells on the CLTL property and four domestic wells immediately north of the property indicated that ground-water is contaminated in areas around the former lagoons as well as the drum-storage area, and that ground water in the northern part of the property, where no known surficial source of contamination exists, also is contaminated. Domestic wells directly north of the property are contaminated as well; eight of the nine organic compounds detected in the domestic wells were also detected in wells on the CLTL property.

Monsanto Company has manufactured phthalic anhydride, phthalate esters, organophosphates, and other industrial organic compounds in Logan Township since 1961. The only documented potential sources of ground-water contamination at the Logan Township facility are four landfills that contain industrial wastes. Three of the landfills no longer are used and have been covered. Contaminated ground water has been detected at distances up to 100 feet from one of the closed landfills. A slurry wall was built around that landfill to prevent further migration of contaminants. There is no documented evidence of ground-water contamination emanating from the three other landfills.

Analyses of water samples collected from 21 wells on the Monsanto Company property indicated that shallow ground water underlying the central part of the property, the site of manufacturing operations, and the northern part of the property, where landfills are located, is contaminated by organic chemicals in concentrations exceeding NJDEP drinking-water standards. Shallow ground water south of the plant is within NJDEP and USEPA drinking-water standards, and deep ground water underlying all parts of the property is within NJDEP drinking-water standards for organic chemicals. Ground-water in the Monsanto area either flows toward nearby surface-water bodies or is captured by pumpage for plant operations. There is no documented evidence of off-site ground-water contamination caused by Monsanto Company operations.

Rollins Environmental Services has operated a hazardous-waste-treatment and -disposal facility in Logan Township since 1970. The major source of ground-water contamination at RES is a series of landfills in which solids and sludge from waste-treatment processes were deposited. Because the landfills were found to be leaking, they have not been used since 1980, and steps were taken to prevent further leakage of hazardous liquids from the basins. In 1972 RES installed an abatement-well system to remove contaminated water from the aquifer and to prevent it from moving off-site.

Chemical analyses of ground-water samples collected in 1979 and 1984 indicate that shallow ground water (up to 40 feet deep) within 600 feet of the RES plant area contains concentrations of arsenic, cadmium, chromium, copper, lead, zinc, dissolved solids, chloride, iron, manganese, nitrate, and sulfate in concentrations that exceed USEPA drinking-water standards and PCB's in concentrations exceeding the NJDEP drinking-water standard. Deep ground water (from 21 to 125 feet deep) underlying the north marsh and the plant area also is contaminated, but deep ground water south of the plant area is not contaminated. Changes in the distribution of dissolved solids in ground water between 1972 and 1984 indicate that contamination spread from the plant area into the north marsh during that period. Investigations conducted on property adjacent to RES have not revealed any off-site ground-water contamination caused by RES operations.

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