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leachate damage assessment

case study of the Sayville solid waste disposal site in Islip (Long Island), New York

a current report
on solid waste management

LEACHATE DAMAGE ASSESSMENT

Case Study of the Sayville Solid Waste Disposal Site in Islip (Long Island), New York

This report (SW-509) was written
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FOREWORD

Since its beginning in 1965, one of the concerns of EPA's Office of Solid Waste Management Programs (OSWMP) has been the development and use of environmentally sound methods of solid waste disposal. OSWMP recognizes that land disposal of wastes is an essential element in any present and future solid waste management system, and it is necessary to ensure that these land disposal sites do not adversely impact the environment. To this end, OSWMP currently has four studies in the area of leachate control: (1) leachate characterization, production, and migration, (2) leachate damage assessment, (3) leachate control technology, and (4) leachate administrative controls (land disposal site permitting and enforcement programs). The goal of these projects is to develop landfill standards or guidelines to protect our surface and ground water resources from leachate contamination.

This report is an output of the leachate damage assessment project. It discusses the leachate damages which occurred at a specific land disposal site.

The leachate damage assessment project examines the impacts and magnitude of the leachate contamination problem in the United States on local, regional, and national levels. This includes the identification of the types and locations of sites causing leachate damages, the types and extent of leachate damages, and the comparison of damage costs and risks to control costs. The leachate damage assessment project establishes the need, if any, for leachate control standards or guidelines, and gives insights into what controls are necessary. This project is described further in Leachate Damage Assessment: An Approach.*

—SHELDON MEYERS
Deputy Assistant Administrator
for Solid Waste Management

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*Leachate Damage Assessment: An Approach. Kenneth A. Shuster. Environmental Protection Agency, 1976.

PREFACE

Leachate is contaminated water which is produced when rain or other water passes through wastes in a land disposal site, picking up various mineral, organic, and other contaminants. Depending on the types of wastes received at the disposal site, leachate may contain various decaying organics, bacteria and viruses, and heavy metals and other toxic chemicals. Unless controlled, each of these contaminants will migrate different distances based primarily on the type of operation, the physical and chemical properties of the contaminants, and the hydrogeologic conditions around the site. If allowed to migrate from the site, leachate may contaminate ground or surface water and result in damages such as polluted wells or fishkills. The occurrence of such damages is directly related to the proximity of the resource to the disposal site, the direction of surface or ground water (leachate) flow, and dilution.

Past disposal practices in the United States have typically overlooked the leachate problem, frequently favoring the use of cheaper and more remote "waste lands" such as flood plains, quarries, sand and gravel pits, and marshlands. These marginal sites tend to be more socially and politically acceptable, as well as cheaper when the leachate problem is ignored.

Due to lack of ground-water monitoring around disposal sites in the United States, the seriousness and extent of the leachate problem is unknown. In most situations, only when wells are polluted or fish are killed, does the problem surface and attract attention. A number of studies of leachate production and migration at specific sites, however, has been recently completed. Information on leachate migration from damage cases and specific site studies coupled with general information on disposal site locations and operations in the United States indicate that at least one-fourth and possibly as many as three-fourths of the municipal land disposal sites in the United States have leachate migration problems. Hopefully, as more of the older sites are replaced by new sites which are better located, designed, and operated, these conditions will improve.

This report is the second in a series of case studies documenting damages caused by leachate from municipal land disposal sites. Described are the history and type of operation, damages caused by leachate, remedial actions, and associated costs.

The author acknowledges the special assistance of Grant Kimmel and Olin Braids, United States Geological Survey (U.S.G.S.), and Mr. and Mrs. Joseph Bivona for providing the major information upon which this report is based, and Joyce Corry for editing the report.

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CONCLUSIONS

1. The Islip Sayville disposal site was neither located nor operated according to currently accepted sanitary landfill practices. It was located, in 1933, in a sand and gravel pit, with wastes placed at and possibly below the water table. It evidently was originally an open dump at which compaction and application of daily cover were later initiated.

2. Leachate has migrated at least 5,000 ft from this disposal site to a depth of 170 ft, and contaminated about 0.22 square mile of the surficial aquifer.

3. From 1968 to 1971, three residential wells were placed in the leachate plume near the disposal site. These wells were developed as a result of ignorance on the part of the well developer and homeowners of the contaminated ground water.

4. In addition to the loss of the three wells, damages included ruined laundry, corroded or stained faucets and sinks, and a destroyed water heater.

5. The well owners obtained no financial assistance and little technical advice to solve their problem. The first remedial actions, done upon the misadvice of the well developers, were to install filters on the wells. Temporary (bottled) water was obtained by the homeowners for drinking and cooking. The only long-range solution identified was to get hooked up to the public water system. In doing so, the homeowners had to first donate their private road to the town. Another alternative which was never mentioned would have been to drill a well into the lower (Magothy) aquifer which is not contaminated. It took four years before the homes were finally hooked up to the public water supply. During this period, the town of Islip did nothing to assist the homeowners, but insisted that the private road be given to the town before hookup to the Suffolk County public supply system. The town did not attempt to correct the ground water contamination problem.

6. The impacts on the well owners included: 1) material damages including wells, water fixtures, and water heater; 2) inconveniences of temporary water, torn up street and lawns, and repairing damages; 3) lost time seeking assistance and advice from the town and elsewhere, using temporary water, and making repairs; 4) psychic impact of the inconvenience; lost time; damages; financial impact; anxiety over the possible health effects including those of a newborn; embarrassment caused

by need to borrow water, lack of adequate water, stains, and repair activities; anxiety over placement of the wells in contaminated water, inadequacy of filters, and lack of response from the town; disruptions caused by noise and dirt of construction and scheduling of household repairs; decreased aesthetics caused by damaged fixtures and torn up street and lawn; and 5) economic impacts.

7. The economic impact (out-of-pocket expenditures) was $6,884, or $2,295 per home. This does not include the value of damaged wells (about $3,600), the value of the private road given up, and the expense of water consumption over the expense of electrical consumption of the well system. It also does not include the inconvenience, lost time, or psychic costs, or the value of temporary water which was obtained free of charge.

8. The contamination and discontinued use of the three domestic wells described in this report represent only a very small fraction of the potential economic damage and value of foregone future usage indicated by the extent of the leachate plume and amount of leachate-contaminated ground water.

SUMMARY

History. The town of Islip's Sayville Landfill was started in a sand and gravel pit in 1933, and is still in operation. The waste at this disposal site, which extends from about 20 feet above grade to the water table about 30 feet below grade, covers about 17 acres (Table 1). Incinerators were built on this site in 1939 and 1968. The 1939 incinerator is currently used as a recycling center. Initially, the site was an open dump and received all types of wastes. Presently it receives mostly incinerator residue, and some individually hauled residential wastes. The site is underlain by mostly coarse sand with streaks of gravelly sand. No engineering designs were done on the site.

Damages. The leachate plume at Islip's Sayville Landfill extends more than 5,000 feet downgradient of the site, 170 feet in depth, and up to 1,300 feet in width. The major ground water discharge zone, Great South Bay, is 3.9 miles due south of the disposal site. About 0.22 square mile and one billion gallons of ground water have been contaminated.

Three residential wells which were contaminated and had to be abandoned were located near the disposal site and in the leachate plume. Laundry, sink fixtures, pipes, and a water heater were among the items damaged as a result of the wells' contamination.

Remedial Action. The three wells were abandoned in December 1974 when a public supply line was hooked up to the homes. During the four years between well contamination and hookup to the public supply, bottled water obtained from other homes and buildings was used for drinking, and filters were placed on the wells so they could be used for laundry and other non-consumption uses. No corrective actions were attempted by the town of Islip.

Costs. The total direct cost to the three residences was about $6,884, or $2,295 per home. This cost includes $4,470 for public water supply mainline and hookups, $852 for replacing corroded and stained fixtures and damaged laundry, and $1,562 for well filters and a water pump. Not included are the values of the damaged wells, consumption charges for public water over usage costs for the wells, costs of bottled water, the value of the street donated to the town, and costs of inconvenience and time over the four-year period.

TABLE 1

SUMMARY OF ISLIP'S SAYVILLE LANDFILL LEACHATE DAMAGE CASE

Type of operation	open dump, landfill incinerator residue
Location	sandpit
Years of operation	1933 to present
Size of operation	
Acres	17 (6.8 ha)
Peak annual tonnage	?
Waste thickness (ft)	50 (15 m)
Annual precipitation (in./year)	43 (109 cm)
Extent of contamination	leachate plume extends 5,000 ft (1,500 m) downgradient of the landfill, 170 ft (52 m) in depth, and up to 1,300 ft (400 m) in width. About 0.22 mi^2 (0.57 km^2) have been contaminated. One billion gal (4×10^6 m^3) of ground water are in this plume.
Damages	3 residential wells; home fixtures
Remedial actions	filters on wells; wells abandoned; public water supplied; fixtures replaced
Litigation	none
Costs	
Value of damaged resources (wells)	$3,600
Damage costs (e.g., clothes, fixtures)	$ 852
Corrective costs	$ 0
Avoidance costs	$6,032
Administrative costs	?
Total costs (excluding value of wells)	$6,884
Cost per home affected (excluding value of wells)	$2,295
Status	concluded

Location. The town of Islip is in south central Suffolk County, Long Island, New York (Figure 1). Islip currently has three operating solid waste disposal sites serving a population of 290,000. One of these, in the eastern (Sayville) section of town, contaminated several residential wells.

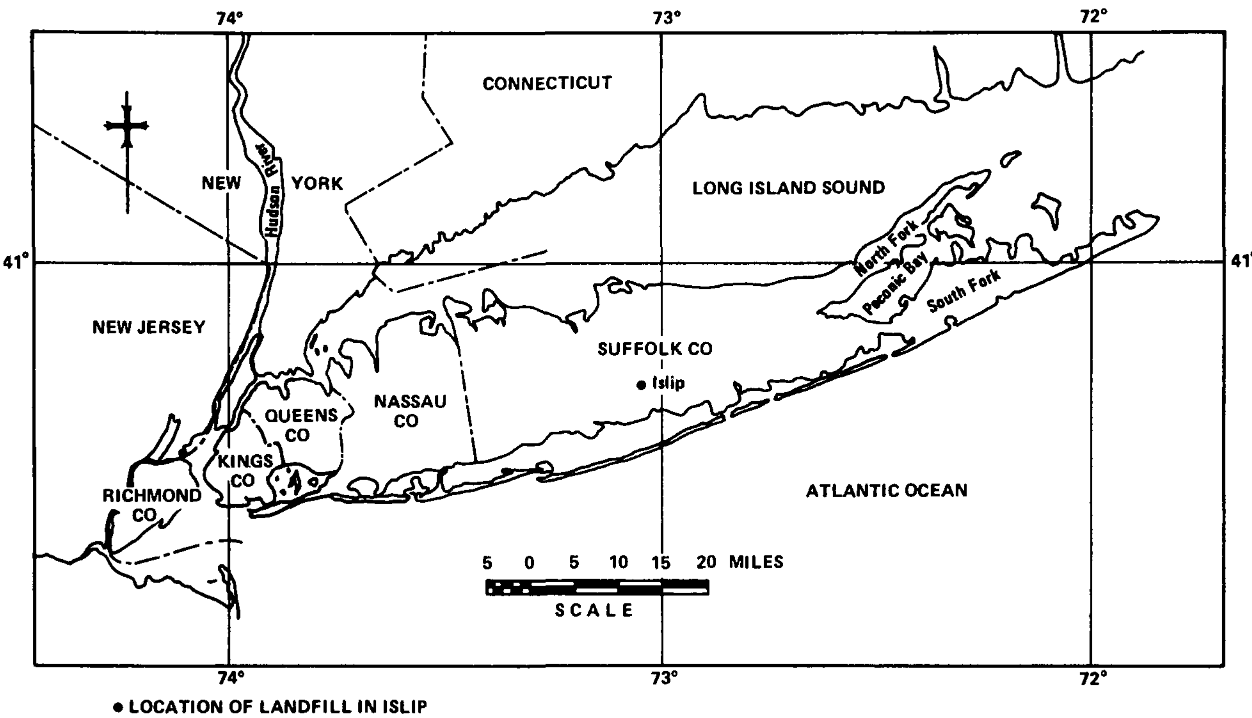

Figure 1. Location of Sayville, Islip Landfill in Suffolk County, Long Island, New York

History and Type of Operation. The town of Islip Sayville Landfill is about 42 years old (Figures 2 to 4). Initially it was an open town dump. In 1939 an incinerator was built on the site. In 1968 a second incinerator with a 300 ton-per-day design capacity was built. This incinerator is currently operating. The older incinerator has been shut down and is currently used as a recycling center. Ferrous salvage from the incinerator residue by a private metal scavenger using a shaker, conveyor, and magnetic separator is soon to start.

On the site was a sand and gravel recovery and washing operation which, except for periodic washings, was shut down about 1970-71. At that time, raw waste was placed in the perimeter of the gravel pit to protect the sides and fence from eroding into the pit.

Figure 2. Incinerator residue at the Islip disposal site (1975).

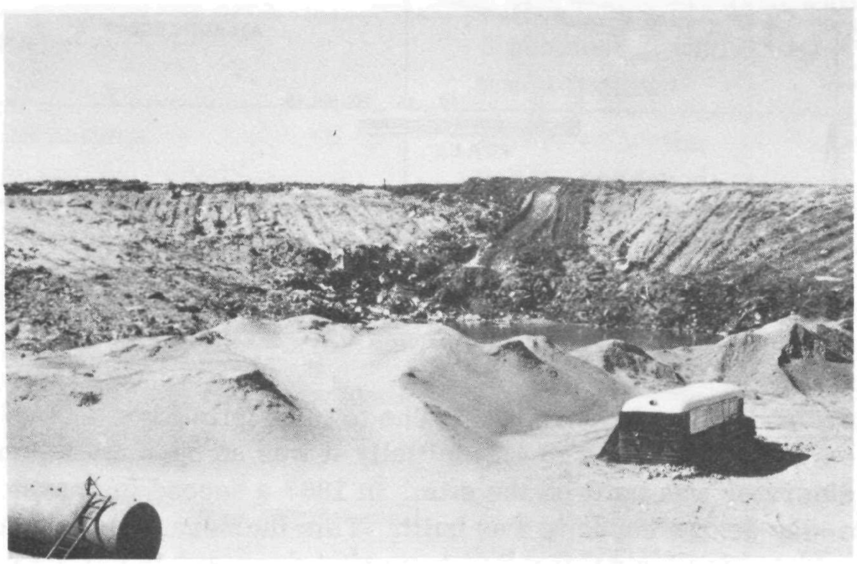

Figure 3. Sandpit adjacent to landfilled waste
at the Islip disposal site (1975).

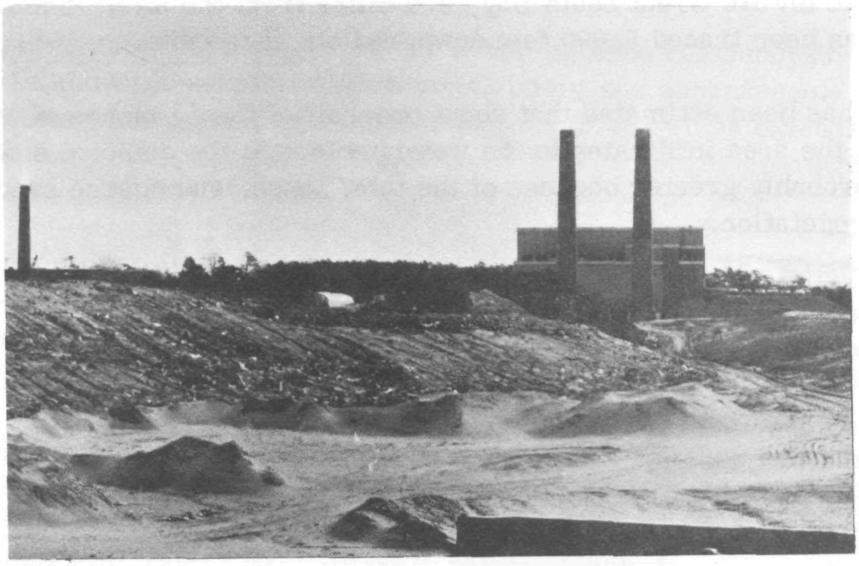

Figure 4. View of incinerator, sandpit, and disposal site (1975).

Types and Amounts of Waste Disposed. Except for a part of the sand borrow pit, most of the Sayville land disposal site has been covered with wastes and incinerator residue. The wastes cover about 17 acres and extend about 30 feet below and 20 feet above grade. From 1970 through 1972, a daily average of 151 tons was incinerated, and a total of 6,200 tons of demolition and noncombustible waste was deposited directly in the disposal site. About 0.8 million cubic yards of waste and residue have been placed in the site since 1933. Initially all types of waste were delivered to the site. From about 1970 to the present, the site has received only residential wastes hauled by individuals, incinerator residue from residential and commercial wastes burned at the incinerator, and some demolition wastes. The site has settled about 10 feet in the past three to four years to about 40 feet in depth.

Site Selection and Engineering Design. No information is available on site selection. There was no engineering design done for the site.

Hydrogeological Description of Site. The upper glacial (water table) aquifer on Long Island consists mainly of medium to coarse sand with streaks of gravel. Under the Islip Landfill, the upper glacial aquifer rests on beds of fine sand and silt which effectively reduce the hydraulic conductivity and form a hydrologic boundary above the Magothy aquifer about 170 feet below the water table. The wastes in the disposal site extend to and possibly below the water table.

The upper aquifer has a hydraulic conductivity of about 270 feet per day. The ground water moves at a velocity of about 0.5 to 2 feet per day due south of the site toward Great South Bay, 3.9 miles from the site. The leachate plume has been traced 5,000 feet downgradient of the site.

It has been estimated that about one-half of the 43 inches of annual precipitation in the area infiltrates to the water table. At the disposal site, the infiltration is probably greater because of the thin, loose, and coarse sand cover and lack of vegetation.

Problem Identification. The tap water in three residences on Ellsworth Street in Islip developed unfavorable taste, odor, and appearance. The three affected wells were drilled in the water table aquifer, which extends to about 190 feet below grade, long after the disposal site had begun operating in 1933 (Table 2).

In the mid- to late-1950s, two wells were drilled at 45- to 60-foot depths for 264 and 258 Ellsworth Street. These wells stopped producing water, possibly due to clogging, so new, deeper wells were drilled in about 1971. In the summer of 1969, the well at 254 Ellsworth picked up a hydrogen sulfide (H_2S) odor and taste, and had iron oxide settling from it upon heating. The new wells at 264 and 258 picked up odor and taste soon after they were drilled. The deeper well at 264 developed an oily scum in it as well as the iron and hydrogen sulfide tastes and coloring. By taste, odor, and appearance criteria, the worst contaminated well was at 264 Ellsworth and the least affected was at 258 Ellsworth. This situation corresponds with the depth of each well: the deeper the well, the worse the contamination. However, there are conflicting reports on the depths of these wells.

TABLE 2

DESCRIPTION OF RESIDENTIAL WELLS CONTAMINATED BY LEACHATE

Location	Date drilled	Approximate depth (ft)
264 Ellsworth	1971	110
258 Ellsworth	1971	65-70
254 Ellsworth	1968	90

Leachate Characterization. The U.S. Geological Survey (U.S.G.S.) collected water samples over a three-year period (1972-74) from different depths at 30 monitoring well locations in order to describe the leachate plume. Using these data, various plots of the leachate plume were made using various leachate characteristics, such as specific conductance (Figures 5 and 6). Ambient water near the bottom of the aquifer has a specific conductance of less than 100 μmhos. The plume of the leachate-contaminated ground water extends about 5,000 feet from the site in the upper glacial aquifer. The worst, unpotable, ground water is near the disposal site. The plume moves as slugs of leachate, tending to sink toward the bottom of the aquifer, which is 170 feet below the water table. At 3,000 feet south of the site, the plume starts about 60 feet below the water table, and extends down to 150 feet below the water table.

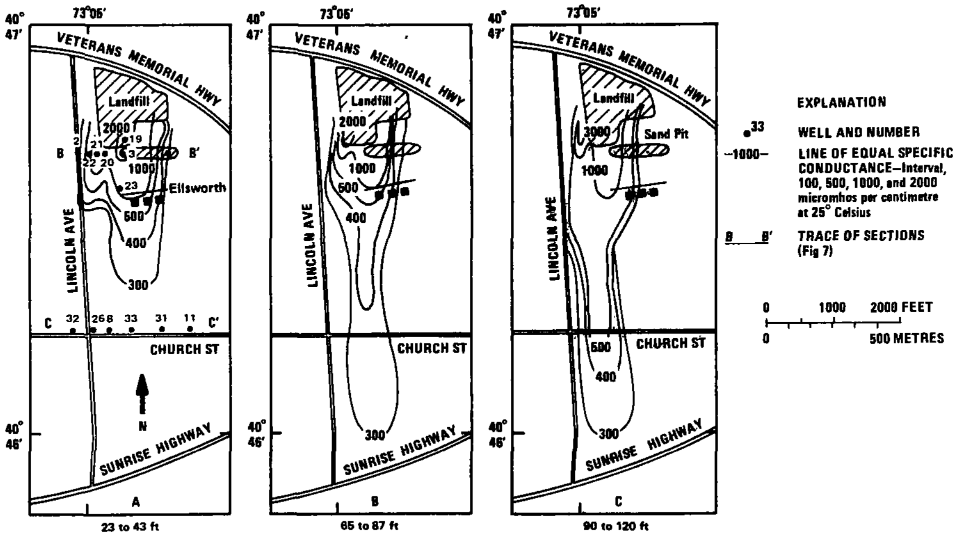

Figure 5. Specific conductance of ground water in the upper glacial aquifer south of the Islip disposal site, in 1973, at the indicated depths below the water table. Source: Kimmel, G. E. and O. C. Braids. Preliminary findings of a leachate study on two landfills in Suffolk County, New York. Journal of Research of the U.S. Geological Survey, 3(3):273-280, May-June 1975.

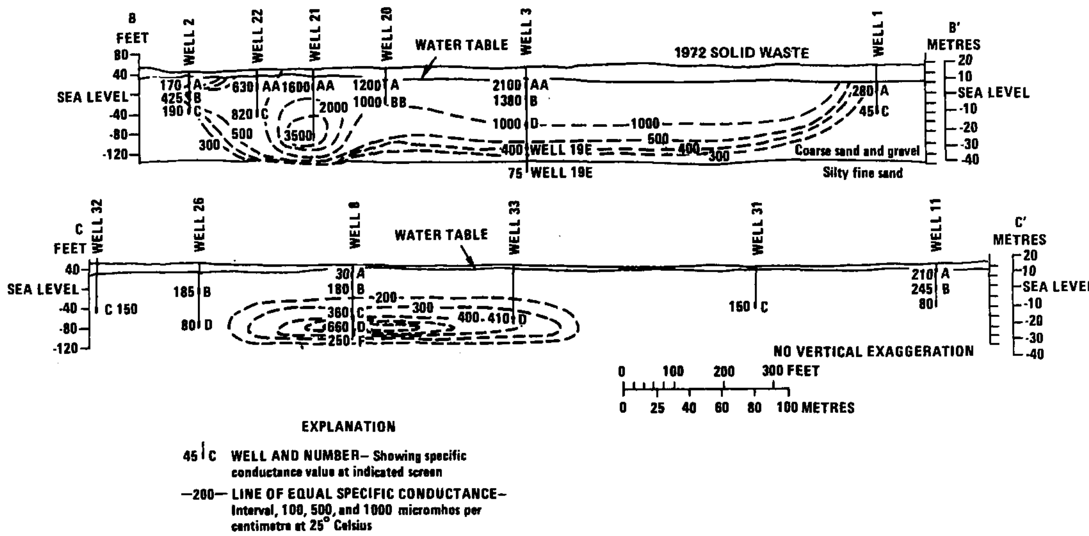

Figure 6. Specific conductance of ground water in the upper glacial aquifer south of the Islip disposal site (cross sections from Figure 5). Conductance for wells 1A, 1C and 3B in 1972; conductance for all wells in 1973. Source: Kimmel, G. E. and O. C. Braids. Preliminary findings of a leachate study on two landfills in Suffolk County, New York. Journal of Research of the U.S. Geological Survey, 3(3):273-280, May-June 1975.

Only two well sample analyses of the contaminated wells were located (Table 3, Appendix). Monitoring well 8 is provided as essentially background to contrast cleaner ground water in the area with that of the affected wells at 264 and 258 Ellsworth. Monitoring well 23, at the end of Ellsworth Street, and monitoring well 3, on the disposal site perimeter and in line with 23, are provided to show additional leachate-contaminated ground water analyses in the vicinity of the individual residential wells (Figure 7).

The levels of consituents in well 8 are significantly lower than in wells near the disposal site, which have constituents that exceed the 1962 PHS and 1972 EPA recommended drinking water standards. Particularly high, and indicative of leachate, are chloride, iron, manganese, sodium, calcium, and dissolved solids. Specific conductance and hardness were other characteristics of leachate that appeared in high concentration in the wells. The wells were not tested for pesticides and herbicides.

Damages. The private wells of three residences downgradient from the Islip Sayville Landfill site were contaminated. In addition to the loss of well water, these residences had ruined laundry, discolored clothes, corroded and stained faucets, sinks, and a water heater, and other damaged water fixtures and devices because of the leachate. The water also resulted in ruined food, such as orange spaghetti and black rice.

Litigation. There were no lawsuits filed in this case.

Remedial Action. The town of Islip did nothing to protect the ground water, to assist the well owners, or to impede the leachate migration. In fact, the Environmental Commissioner said he knew of no wells that had been contaminated by leachate from his landfills. When the residential wells on Ellsworth were mentioned to him as being contaminated, he said he recalled some "bitching" about water quality by some residents down there. The residents had requested assistance from the town, but received none.

A Suffolk County Taxpayers Association representative investigated the problem by interviewing the residents, and he told them that he would seek remedial action. However, he never came back, the telephone number he gave was discontinued, and telephone information had no listing for that Association.

The residents put filters on their wells and used the water temporarily for nondrinking uses. They used bottled water for drinking and cooking. Ultimately, they paid for a public waterline and abandoned their wells. In addition, they replaced and repaired faucets, sinks, shower doors, a hot water heater, etc.

TABLE 3

WATER ANALYSES FROM RESIDENTIAL WELLS AND MONITORING WELLS

Well location Sampling date Sampling depth	8 5-16-73 23-26 ft mg/1	264 Ellsworth 7-23-73 100 ft mg/1	258 Ellsworth 7-23-73 150 ft mg/1	23 6-25-73 22-26 ft mg/1	23 8-12-74 26 ft mg/1	23 6-26-73 38-42 ft mg/1	23 6-25-73 140-144 ft mg/1	3 11-16-73 45 ft mg/1	3 10-19-73 116-120 ft mg/1
Chloride (C1)	6.0	88.0	170.0	17.0	72.0	170.0	400*	180.0	88.0
Iron total (Fe)	0.15	9.4*	7.0*	0.16	170*	52.0*	3.4*	65.0*	7.5*
Manganese total (Mn)	0.1	24.0*	17.0*	2.0*	2.8*	3.7*	0.82*	42.0*	4.6*
Zinc total (Zn)	0	0.73	0.90	0.01	0.06	0.01	0.19	0.14	0.17
Boron dissolved (B)	0.09	0.43	0.53	0.11	0.47	0.83	1.20	1.03	0.99
Magnesium (Mg)	0.9	7.4	4.4	1.9	3.0	9.7	55.0	33.0	30.0
Calcium (Ca)	2.2	13.0	35.0	16.0	120	70.0	180	90.0	52.0
Potassium (K)	0.4	17.0	23.0	3.7	22.0	43.0	75.0	70.0	65.0
Sodium (Na)	3.7	64.0	140.0	11.0	37.0	140.0	260	160.0	150.0
Fluoride (F)	0.6	0.1	0.1	0.1	0.0	0.1	0.2	0.3	0.3
Sulfate (SO_4)	8.0	4.2	80.0	7.3	41.0	92.0	57.0	74.0	0.019
Nitrogen tot. as N	---	60.2	---	3.82	---	22.02	14.13	28.00	35.01
Conductivity†	53	845	1030	151	1260	2230	2665	1920	1620
Diss. solids @180°C	27	445	575*	95	495	718*	1560*	974*	920*
pH (field)	5.4	6.3	6.5	6.4	---	6.6	6.35	6.6	6.7
Alk tot as $CaCO_3$	2	284	126	30	262	318	828	551	513
Hardness total	9	63	106	48	310	215	676	361	253

*Exceed 1962 PHS or 1972 EPA drinking water standards.
†Average of field and lab analyses.

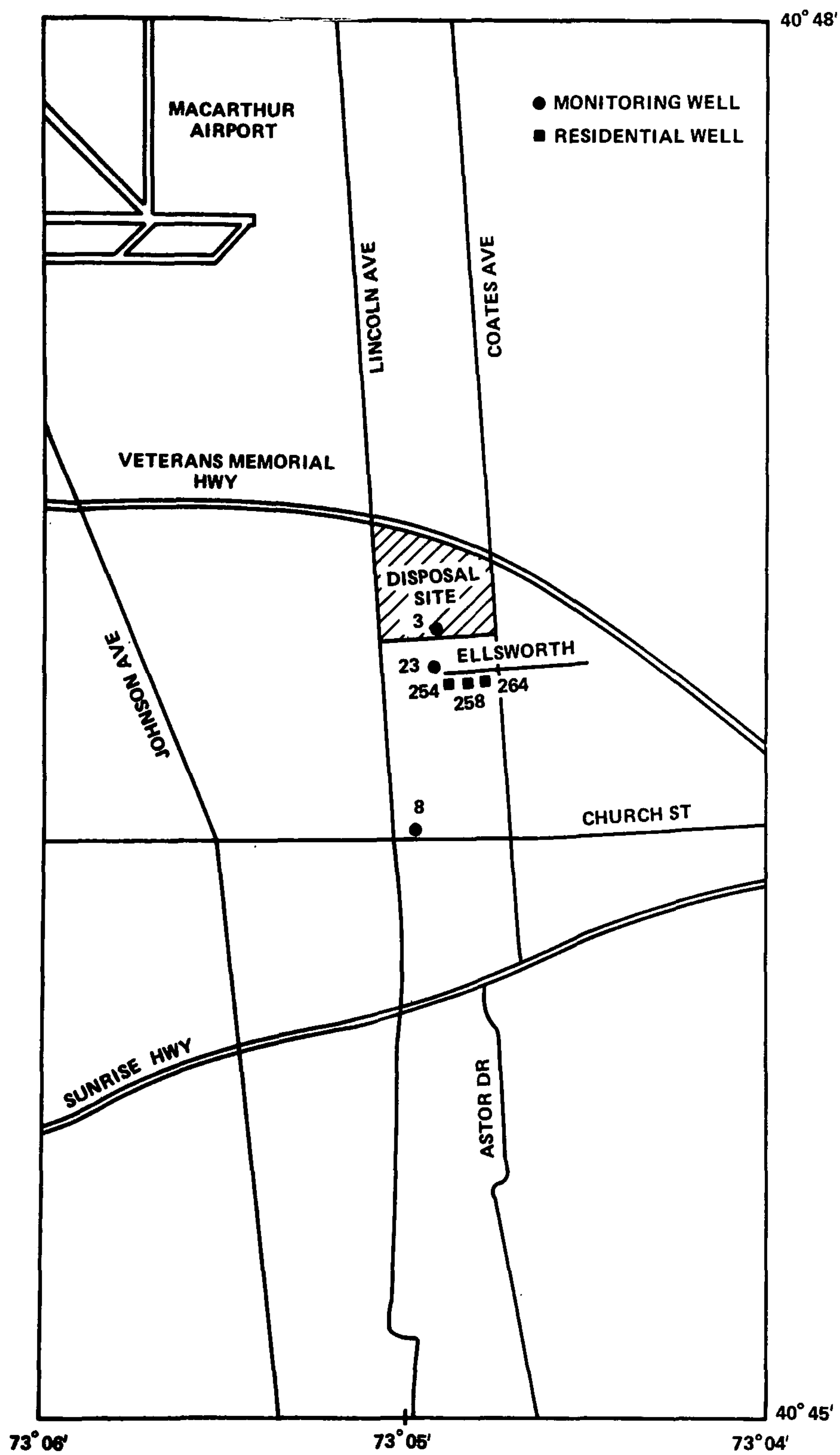

Figure 7. Location of residential wells and monitoring wells.

Tangible Direct Damage Costs. The leachate-contaminated water stained laundry a pinkish-reddish color. Some clothes had to be thrown out and replaced; others were worn despite the discoloring. At first, the resident experiencing this discoloration thought the laundry damage was due to a washing machine malfunction, but found out otherwise when a repairman investigated. The washing machine was still under warranty so there was no charge for the repairman. Food was also ruined (e.g., orange spaghetti). The value of discarded laundry and food is estimated at $51 (Table 4).

Bathroom and other sink fixtures were corroded by the contaminated water. When the public water was hooked up, 264 Ellsworth replaced a bathroom sink, toilet bowl, and kitchen sink, at a cost of about $125. This did not include labor cost since the articles were replaced by the resident himself. Assuming 24 hours of labor, including purchasing, dismantling, and hooking up, at $4 per hour, the labor cost was $96. The sink fixtures in the other homes were also corroded, but they have not been replaced as yet. Shower doors at 264 Ellsworth discolored a reddish-orange, but extensive scrubbing cleansed them sufficiently to avoid replacing them. The water heater-boiler in the newest house (6-year-old 254 Ellsworth) rotted out, so when public water was hooked up, the boiler was replaced at a cost of $580.

Intangible Direct Damage Costs. No attempt was made to estimate the hours spent, or to assign a value to the lost time, inconvenience, or psychic impacts experienced over the four-year period when the three homes were not hooked up to a potable water supply.

Avoidance Costs. The first attempt to avoid the leachate problem was to boil cooking and drinking water. This precipitated out the solids, such as ferrous oxide. Next, bottled water was used, and garages became storage places for water. For 254 Ellsworth, some water was obtained by connecting a hose to the home of a neighbor who was on public water supply. For 258, the resident, a painter, obtained water on the job from the homes or buildings of customers. For 264, some bottled water was purchased, and some water was obtained from 258 and 254.

Next, filters were placed on all the wells to make the water usable for nondrinking purposes. Macromite filters were installed on all three homes, at $70 each, when the rusty water color appeared. In February 1970, two new filters were installed on the 254 Ellsworth well for $750 so that the water could be used for the laundry. To charge these filters, 100-pound bags of salt were purchased. This salt initially cost $4 per bag in 1970, but by 1974, when the public waterline was installed, the cost had risen to $5.50 per bag. About 15 bags were used each year, the bags lasting about three to four weeks each.

The total cost of salt over the 3-1/2 years for 254 Ellsworth was about $277. In June 1974, a new pump had to be put on the 254 Ellsworth well at a cost of $325.

In September 1974, the three residences signed an agreement with the Suffolk County Water Authority (SCWA) to be hooked up to the public water supply. Before this could be done, the residents had to officially transfer their formerly private street to the town of Islip. The paperwork involved in this transfer delayed the agreement with SCWA. In December 1974, the three residences were finally hooked up to the public water supply. Since the first 75 feet of mainline in each home was free, 225 feet of the 460 feet of of 6-inch mainline required did not have to be paid for by the residents. The remaining 235 feet at $12 per foot cost about $2,820, or $940 per residence. The cost of the pipes from the street main to the three houses was about $750, or an average of about $250 for each pipe. The cost of residential taps and water meters was about $900, or $300 each. Thus the total cost of public supply hookup was about $4,470, or $1,490 each.

After being hooked up to the public water supply, the three residences had to begin paying for the water they consumed. Counterbalancing this is a savings of about $20 per month in the electric bill for 254 Ellsworth, since the pump and filters for the well are no longer operating. When in use, the filters had to cleanse themselves for about two hours each night.

Altogether, the direct damage and avoidance costs totaled $6,884, or $2,295 per home (Table 4).

Corrective Costs. The town of Islip did nothing to correct the problem to prevent further ground water contamination, to cleanse the aquifer, or to attempt to reduce leachate migration.

Administrative Costs. There were no administrative costs associated with corrective actions because there were no corrective actions considered. There were no litigations in this case. The only administrative expenses were those stemming from efforts on the part of the homeowners to obtain temporary and permanent water supplies. These efforts included the petitioning by the homeowners to get assistance from, and public supply lines paid for by, the town; the title transfer on the private road to the town before the public supply lines would be laid; and perhaps the brief involvement of the Suffolk County Taxpayers Association.

TABLE 4

LEACHATE DAMAGE COSTS

		Cost
Tangible direct damage costs		
Value of the three damaged wells		$3,600
Replaced damaged laundry and food (est.)		51
Replaced corroded and stained fixtures		221
Parts	$ 125	
Labor (est.)	96	
Water heater replacement		580
Intangible direct damage costs		
Lost time (boiling water, doing laundry out, etc.)		?
Inconvenience (doing laundry out, cooking preparations, temporary water handling and storage, torn-up yard and street)		?
Psychic impacts and costs		?
Avoidance costs		
Temporary and bottled water (for 4 yrs)		?
Loss of use of residential storage space for water		?
Fuel for boiling water		?
Well filters (5)		960
Salt for filters		277
Replaced water pump		325
Public water supply mainline and hookups		4,470
460 ft of 6-in. mainline	2,820	
Pipes from mainline to house	750	
Hookups and water meters	900	
Cost of piped water over well water		?
Administrative costs		
Seeking permanent water supply		?
Loss of private road		?
Increased taxes due to public street		?
Total damage costs (excluding value of wells)		$6,884
Cost per home (excluding value of wells)		2,295

SOURCES

1. Kimmel, G. E. and O. C. Braids. Leachate plumes in a highly permeable aquifer. Ground Water, 12(6):388-392, Nov.-Dec. 1974.

2. Kimmel, G. E. and O. C. Braids. Preliminary findings of a leachate study on two landfills in Suffolk County, New York. Journal of Research of the U.S. Geological Survey, 3(3):273-280, May-June 1975.

3. Personal communications. B. Andres, Environmental Commissioner, and J. Smith, Incinerator Manager, Town of Islip, to K. Shuster, U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Apr. 9, 1975.

4. Personal communications. Mr. and Mrs. J. Bivona, 254 Ellsworth St., (Holbrook) Islip, N. Y., to K. Shuster, U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Apr. 1975.

5. Personal communications. G. E. Kimmel and O. C. Braids, U.S. Geological Survey, Mineola, N. Y., to K. Shuster, U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Jan. and Apr. 1975.

APPENDIX

CHEMICAL ANALYSES OF AFFECTED RESIDENTIAL WELLS*

Constituent	264 Ellsworth 7-23-73 100 ft mg/1	258 Ellsworth 7-23-73 150 ft mg/1
Chloride (Cl)	88.0	170.0
Iron total (Fe)	9.4*	7.0†
Manganese total (Mn)	24.0*	17.0†
Zinc total (Zn)	0.73	0.90
Boron dissolved (B)	0.43	0.53
Magnesium (Mg)	7.4	4.4
Calcium (Ca)	13.0	35.0
Potassium (K)	17.0	23.0
Sodium (Na)	64.0	140.0
Fluoride (F)	0.1	0.1
Sulfate (SO_4)	4.2	80.0
Nitrate diss. as NO_3	.841	---
Nitrate diss. as NO_2	.033	.036
Nitrate diss. as N	.190	---
Nitrite diss. as N	.010	.011
Nitrogen diss. as N	49.00	2.80
Nitrogen org as N	11.00	---
Nitrogen T Kjel N	60.00	2.60
Nitrogen tot as N	60.20	---
Ammonia as NH_4	63.11	3.61
Silica	3.20	4.10
Carbon dioxide (CO_2)	110.0	62.0
Conductivity (field)	820.0	1060.0
Conductivity (lab)	870.0	1000.0
Diss. solids @180°C	445.0	575.0†
pH (field)	6.3	6.5
ph (lab)	6.7	6.6
Carbonate	0	0
Bicarbonate	346.0	154.0
Alk CO_3 as $CaCO_3$	0	0
Alk HCO_3 as $CaCO_3$	284.0	126.0
Alk tot as $CaCO_3$	284.0	126.0
Carbonate equiv.	170.0	76.0
Hardness non-carb	0	0
Hardness total	63.0	106.0
Residue total vol.	59.0	34.0

*SOURCE: Kimmel, G.E. and O.C. Braids. USGS, Mineola, N.Y.

†Exceed 1962 PHS or 1972 EPA drinking water standards.