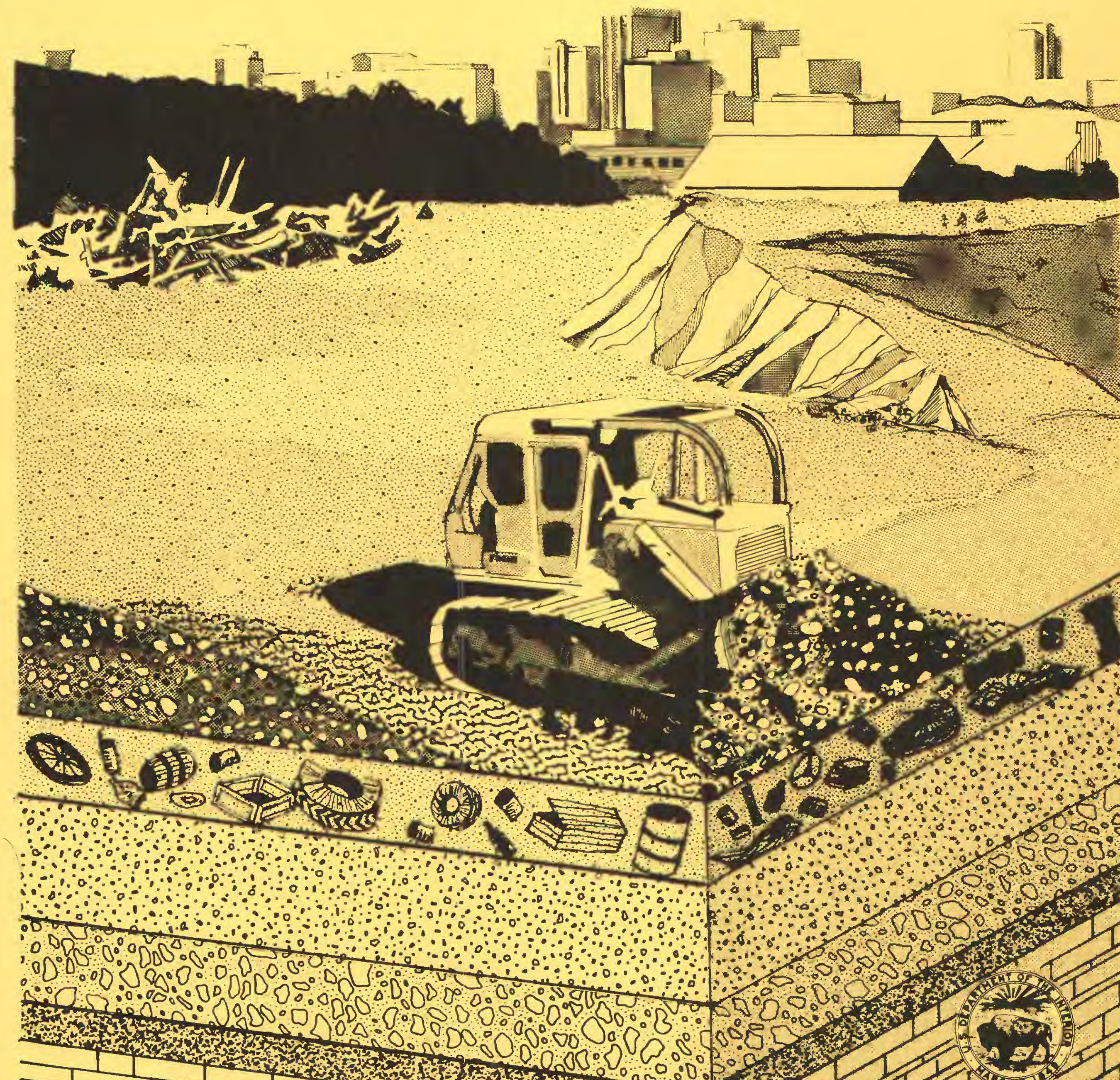
GROUND-WATER QUALITY IN THE VICINITY OF LANDFILL SITES SOUTHERN FRANKLIN COUNTY, OHIO

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Open-file report 81-919

Prepared in cooperation with the CITY OF COLUMBUS, OHIO



UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
Water Resources Division

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UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

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CONVERSION FACTORS

Factors for converting inch-pound units to the International System (SI) units are given below:

To convert from	To	Multiply by
inch (in)	millimeter (mm)	25.4
foot (ft)	meter (m)	0.3048
acre	square meter (m^2)	4,047
mile (mi)	kilometer (km)	1.609
square mile (mi^2)	square kilometer (km^2)	2.590
cubic yard (yd^3)	cubic meter (m^3)	0.7646
micromho per centimeter (umho/cm)	microsiemens per centimeter (uS)	1.00

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ABSTRACT

The hydrogeology and ground-water quality in the vicinity of five landfills in southern Franklin County, Ohio, were investigated by use of data obtained from 46 existing wells, 1 seep, 1 surface-water site, and 1 leachate-collection site. Interpretation was based on data from the wells, a potentiometric-surface map, and chemical analyses. Four of the five landfills are in abandoned sand and gravel pits. Pumping of water from a quarry near the landfills has modified the local ground-water flow pattern, increased the hydraulic gradient, and lowered the water table.

Ground water unaffected by the landfills is a hard, calcium bicarbonate type with concentrations of dissolved iron and dissolved sulfate as great as 3.0 milligrams per liter and 200 milligrams per liter, respectively. Water sampled from wells downgradient from two landfills shows an increase in sodium, chloride, and other constituents. The change in water quality cannot be traced directly to the landfills, however, because of well location and the presence of other potential sources of contamination. Chemical analysis of leachate from a collection unit at one landfill shows significant amounts of zinc, chromium, copper, and nickel, in addition to high total organic carbon, biochemical oxygen demand, and organic nitrogen. Concentrations of chloride, iron, lead, manganese and phenolic compounds exceed Ohio Environmental Protection Agency Water Quality Standards for drinking water. Water from unaffected wells within the study area have relatively small amounts of these constituents.

INTRODUCTION

The purpose of this study, made in 1979 by the U.S. Geological Survey in cooperation with the city of Columbus, Division of Water, was to evaluate the chemical quality of ground water in the vicinity of landfills in southern Franklin County, Ohio. The study was needed because Columbus is developing a water supply by inducing infiltration from glacial outwash deposits near the Scioto River 3 miles downstream from the landfill sites. The plan of investigation was to use existing wells as a source of data. Primary objectives were to inventory wells, define the potentiometric surface, and describe water-quality conditions in the vicinity of the landfills. Unfortunately, few wells could be found directly downgradient from the landfills. Therefore, an exact definition of water quality and water movement was difficult. Nevertheless, the data base will be useful as a reference in monitoring changes in the potentiometric surface and water quality. The inventory also identifies areas where data are unavailable.

Changes in ground-water quality caused by leachate from landfills has occurred at many major urban centers, and is often not recognized until urban or industrial expansion creates demand for new sources of water. As the use of ground water increases greater attention is being focused on the effects of landfills on ground water.

Leachate is formed in landfills by percolation of precipitation or runoff through solid waste. Chemical processes occur, such as biological decay, dissolution of inorganic components, sorption, and ion exchange. The mixing of leachate with water from adjacent aquifers is controlled primarily by hydrologic conditions in the vicinity of the landfill.

Suitable hydrologic conditions for minimizing migration of leachate include the presence of materials of low permeability, such as clay and till, and a thick unsaturated zone that separates the refuse from local aquifers. In central Ohio, the mining of glacial sand and gravel has left many abandoned pits which have been utilized as landfill sites. Most pits were excavated into the saturated zone before mining was stopped.

Physical Setting and Climate

The five landfills (fig. 1) are in 6-mi^2 area within a mile of the Scioto River. Single-family residences are south and west of the landfills and business and manufacturing establishments are along the north and east boundaries. A large rendering plant that produces tallow and bone meal is south of landfill 3 and sewage-treatment facilities for Columbus are immediately north of landfill 4.

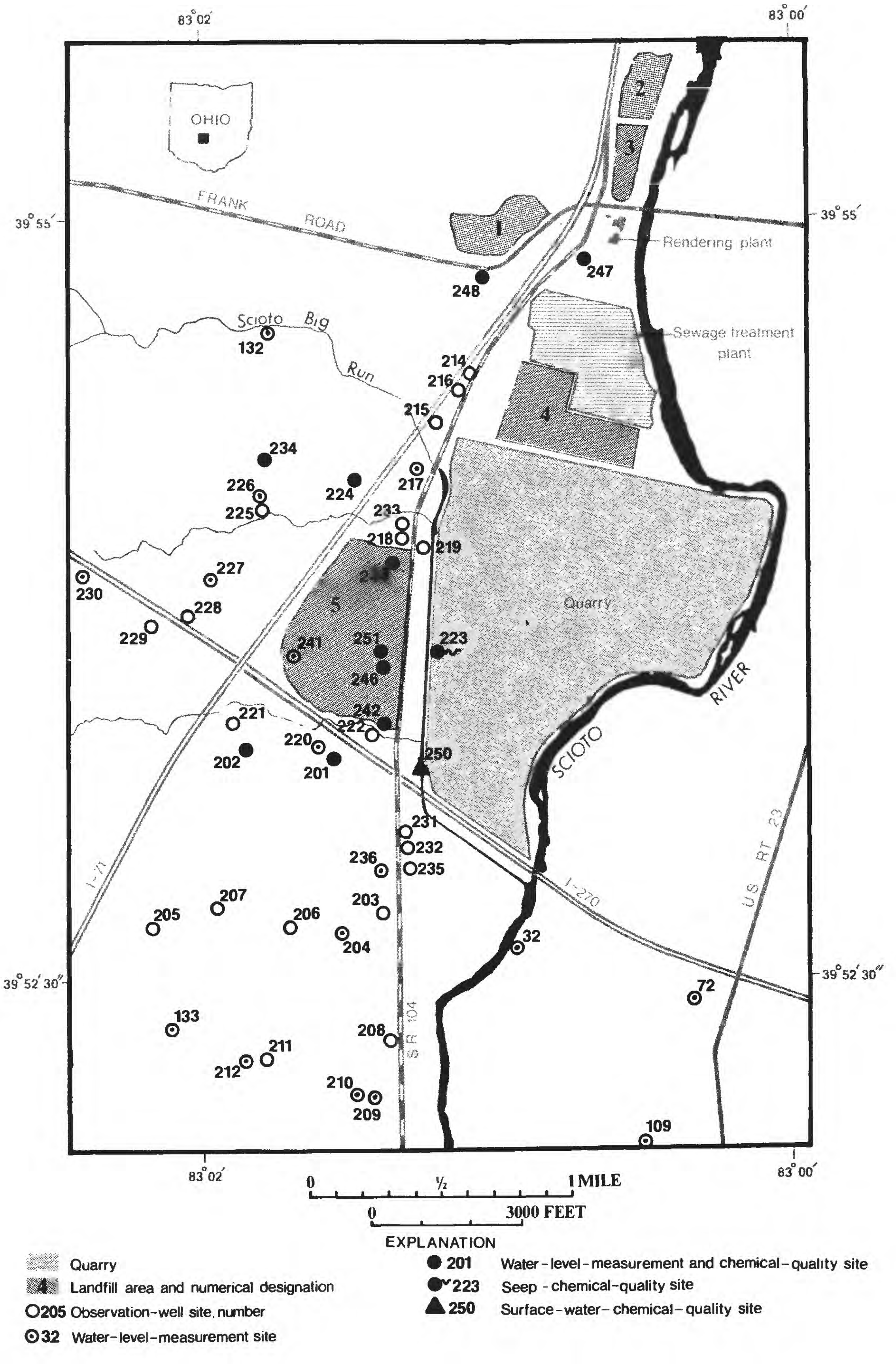

Figure 1.--Location of study area, landfills, quarry and observation wells. (The county code prefix, FR-, has been deleted from well numbers.)

The land slopes 50 to 70 ft/mi from west to east toward the Scioto River. Surface drainage is by Scioto Big Run and several smaller streams. All runoff eventually enters the Scioto River.

The climate of Franklin County is characterized by warm, humid summers and cold winters. Average annual temperature is 50°F, and average annual precipitation is 36.9 inches based on the 1941-71 period (U.S. National Oceanic and Atmospheric Administration, 1978).

Hydrogeology

Glacial deposits overlying gently eastward dipping limestone and shale of Devonian age occur in southern Franklin County. Near the landfills the glacial deposits consist primarily of ground moraine (till) and valley train (outwash). The flood plain is further covered by alluvial sediments deposited by the modern stream.

The major aquifers are the glacial sand and gravel and the Columbus Limestone. The sand and gravel aquifer varies over a wide range in extent and thickness (3 to 75 feet) and is interbedded with deposits of clayey till. Tests of the sand and gravel aquifer by drillers and others indicate yields to individual wells of 300 to 1,000 gal/min.

The Columbus Limestone yields up to 175 gal/min to individual wells (Schmidt and Goldthwait, 1958, p. 23). Overlying the Columbus Limestone is the Delaware Limestone, a thinly bedded brown limestone with shale partings and chert that forms the base for the glacial deposits. The Delaware Limestone does not yield significant amounts of water.

Previous Studies and Acknowledgments

No previous reports on the effects of landfills on ground-water quality in Franklin County have been published, but several site-specific investigations have been made. The Ohio Environmental Protection Agency (Ohio EPA) made a preliminary investigation at landfill 5 before it was enlarged. Chemical-quality analyses of samples taken by the Ohio EPA did not indicate any chemical constituent above recommended levels. Emcon Associates (1975), a waste-management consulting firm, also made a study on the proposed addition to landfill 5.

The authors thank officials of the city of Columbus, the Franklin County Sanitary Engineers Department, the Ohio Environmental Protection Agency, and Waste Management, Inc., for providing information, and property owners for permitting access to their wells.

POTENTIAL GROUND-WATER CONTAMINATION SITES

Changes in ground-water quality may occur from sources other than landfills, therefore an evaluation of other possible sources was necessary. The location and wastes produced by manufacturing and sewage treatment facilities within the area were evaluated. Based upon this evaluation five landfills in the area were selected for further study.

Criteria for site selection were type and amount of waste present and accessibility to the ground water-surface water system. The five landfills were all constructed in abandoned sand and gravel pits. Landfills 2, 3, and 4 are in close proximity to the Scioto River, and site 3 is flooded because of the high water table in the area. Landfills 1 and 5 are adjacent to or have access to drainage that ultimately enters the Scioto River.

Landfill 1

Landfill 1, currently operating, consists of 41 acres north of Frank Road, west of Interstate 71 (fig. 1). Topography is generally flat with surface drainage provided by roadway ditches and a small stream. Several abandoned and flooded gravel pits are located north of the landfill.

During the 1950's sand and gravel mining created a pit 30 feet deep which became partly flooded in the 1960's. Landfilling started in 1968 with debris from razed buildings (demolition waste). Occasionally domestic and industrial wastes were dumped also. Early disposal at the landfill was directly into the water-filled part with no cover material used. During the time of the study, daily additions of waste were bulldozed flat and covered with a layer of fill dirt. The present volume of waste is estimated at 1.4 million yd^3. The site is expected to close about 1984.

Landfill 2

Landfill 2, an abandoned 22.5-acre sand and gravel pit, is east of Interstate 71 and 0.5 mile north of Frank Road (fig. 1). Topography is generally flat, though a man made levee separates the landfill from the Scioto River, which is approximately 500 feet to the east. During the 1960's, the sand and gravel deposits were excavated to 25 feet. The pits were abandoned and later filled with water.

The landfill, which opened in 1975, has no apparent operational scheme. Municipal, domestic, and industrial wastes have been dumped directly into the water, where the wastes are in direct contact with the sand and gravel deposits. Currently, in the northern part of the landfill, waste is bulldozed flat and occasionally layered with fill dirt or foundry sand. Dumping of wastes into the water will probably continue for the next year or two, when the total volume of waste will be about 0.9 million yd^3.

Landfill 3

Landfill 3 is east of Interstate 71 and south of landfill 2 (fig. 1). It occupies an abandoned sand and gravel pit, and topography and surface drainage conditions are similar to those at landfill 2. The 16.5-acre site was excavated to 15 to 30 feet in the early 1970's and was used for waste disposal beginning in 1973.

Initially, demolition wastes and old tires were dumped into water in the pit and covered with fill dirt and foundry sand. Currently, the site is used only for disposal of demolition materials that are layered with fill dirt taken from the site. Use of landfill 3 is restricted to the private owner, with no public dumping allowed. The landfill is expected to close in 1990 and will contain approximately 0.6 million yd^3 of waste.

Landfill 4

Landfill 4 is on State Route 104, 0.85 mile south of Frank Road (fig. 1). The site is bounded on the north by a waste-water treatment plant, on the south by several large ponds belonging to a sand and gravel mining operation, and on the east by the Scioto River.

The 38-acre landfill was opened in 1969 as a trench operation in the soil and Holocene river alluvium. Some of the excavations reached the underlying glacial aquifer, which is between 2 and 20 feet below land surface, and in some areas extends as deep as 90 feet. Some domestic wastes were deposited below the water table. Noyes (1975, p. 1) reported that ground-water levels around the landfill fluctuated with changes in the stage of the Scioto River, indicating a good connection between the ground-water and surface-water systems.

In the early 1970's, the operation was converted to an area-fill method, and a 2-year experiment was started to evaluate the effectiveness of shredded refuse in reducing leachate production. The site closed in 1976 and the final cover, completed in 1978, resulted in an unvegetated mound rising 20 to 25 feet above the surrounding land. The site is currently used for the spreading of sewage sludge. The total volume of waste is estimated at 1.0 million yd^3.

Landfill 5

Landfill 5 is on State Route 104, north of Interstate 270 and east of Interstate 71 (fig. 1). The land is gently sloping from west to east with surface drainage by roadway ditches, a small stream on the southern edge of the landfill, and Scioto Big Run on the east. The 174-acre site is underlain by glacial sand and gravel interbedded with clay and till.

The landfill was started in an abandoned gravel pit in the mid-1960's as an open dump. In 1967, the site was purchased by Franklin County and operation of the southern section (88 acres) was converted to an area-fill method. The northern part of the site (86 acres) is insulated from underlying aquifers by natural clay layers and constructed-clay liners with estimated hydraulic conductivities of 3.0×10^{-3} to 3.0×10^{-6} ft/d (Emcon Associates, 1975, p. VII-1). Disposal methods provided for a 10-foot minimum separation between the refuse and the historic water table. A system for monitoring leachate production and gas generation has been installed. This system also allows for leachate removal and gas venting.

The southern part of the landfill is nearly filled and has been partly seeded. The landfill is expected to be completed in 1982 and will contain about 29 million yd^3 of refuse.

Municipal and Industrial Sites

Directly north of well FR-247 and east of State Route 104 is a rendering plant, which began operation in 1847, producing tallow and bonemeal. Most waste products from the plant are piped directly into the sewage-treatment plant, immediately to the south and adjacent to the Scioto River.

The sewage-treatment plant began operation in the early 1900's. The original plant was abandoned and a new plant constructed in 1939, with additional improvements added in 1950. The plant processed an average of 82 million gallons of raw sewage per day in 1979.

Landfill 4 has been used for spreading sludge produced by the sewage-treatment plant, and is almost covered. Tentative plans call for the sludge to be buried or hauled away and burned. Several large settling ponds for the sludge border landfill 4 on the east and northeast.

DATA COLLECTION NETWORK

The observation well-network (fig. 1, table 1) provides data on ground-water conditions in areas affected by the landfills and a means for monitoring changes in ground-water quality.

TABLE 1.--RECORDS OF SELECTED WELLS, SEEP, AND SURFACE WATER SITES IN FRANKLIN COUNTY, OHIO, 1979

Altitude of land surface: Interpolated from U.S. Geological Survey 7½ minute topographic maps, contour interval 10 feet National Geodetic Vertical Datum of 1929.

Aquifer: S&G - sand and gravel; Ls - limestone.

Depth of well: Taken from drillers' logs and measured (M).

Water use: C - commercial, D - domestic, I - industrial, N - not used, P - public supply.

Well No.	Owner or user	Location		Altitude of land surface (feet)	Well drilled (year)	Aquifer	Depth of well (feet)	Altitude of water (feet)	Date of water level measurement	Water use	Water quality - field		
		Latitude	Longitude								pH	Specific conductance (umho at 25°C)	Temperature (°C)
FR-32	City of Columbus	395234	0830113	680	1968	S&G	80	663	7-79	N	---	----	----
FR-72	do.	395217	0830023	715	1950	S&G	48	686	7-79	N	---	----	----
FR-109	do.	395157	0830035	702	1975	S&G	92	687	7-79	N	---	----	----
FR-132	Franklin County	395437	0830213	730	1977	S&G	34	699	10-79	N	---	----	----
FR-133	do.	395218	0830239	765	1977	S&G	82	715	10-79	N	---	----	----
FR-201	Mason-Dixon Truck Lines	395314	0830156	731	1968	S&G	84	664	6-79	C	7.2	900	13.5
FR-202	Daniel W. Himes	395314	0830219	752	1977	Ls	220	685	6-79	D	7.2	960	14.0
FR-203	Ohio Auto Auction	395240	0830141	717	1977	S&G	76	---	----	C	7.3	960	----
FR-204	Clifford Evans	395238	0830155	740	1969	S&G	92	672	6-79	D	7.3	880	----
FR-205	Ramada Inn	395240	0830245	775	1972	Ls	175	---	----	C	7.5	800	----
FR-206	M. Smalling	395239	0830208	750	----	--	--	---	----	D	7.4	895	----
FR-207	Joe Rose	395242	0830228	766	----	S&G	--	---	----	D	7.4	950	----
FR-208	Ernie Ehlers	395217	0830140	710	----	S&G	--	---	----	D	7.4	950	----
FR-209	Martin Davis	395206	0830145	700	----	S&GS	--	686	6-79	D	7.6	825	----
FR-210	------------	395206	0830149	707	----	S&G	--	686	6-79	D	7.4	910	----
FR-211	Walter Willing	395213	0830214	744	----	S&G	--	---	----	D	7.4	1100	----
FR-212	John Seidenschmidt	395213	0830221	752	1978	S&G	--	689	6-79	D	---	---	----
FR-214	A-Z Packaging Co	395429	0830120	705	1964	S&G	52	---	----	C	7.6	720	----
FR-215	Waller & Lund	395419	0830128	705	1962	S&G	60	---	----	C	7.6	745	----
FR-216	Mitchell Motor Parts	395426	0830124	705	1968	S&G	35	---	----	C	7.2	1200	----
FR-217	John Strawser	395409	0830132	712	1976	S&G	90	676	7-79	D	7.4	820	----
FR-218	Herman Ward	395355	0831037	720	----	S&G	--	---	----	D	7.4	860	----
FR-219	Span Deck	395355	0830131	700	----	S&G	--	---	----	I	7.4	960	----

FR-220	Tom Cannon Co	395315	0830200	731	----	S&G	81	665	7-79	C	7.1	940	----
FR-221	Calvin Griggs	395319	0830222	753	1974	Ls	162	---	----	D	7.4	960	----
FR-222	Gene Carter	395318	0830145	710	1969	S&G	75	---	----	P	7.3	900	----
FR-223[1]	American Aggregates Corp	395334	0830128	705	----	Ls	--	590	7-79	N	7.8	775	12.5
FR-224	Herman Barnes	395409	0830150	721	1979	S&G	78	676	7-79	D	7.3	620	----
FR-225	French D. Wood	395402	0830214	715	1976	S&G	58	---	----	D	7.1	880	----
FR-226	William Fleming	395405	0830214	735	1978	S&G	75	676	7-79	D	7.3	860	----
FR-227	Jerry Johnson	395348	0830227	748	1978	Ls	260	686	7-79	D	7.2	915	16.0
FR-228	James Blanton	395341	0830232	755	1962	S&G	81	---	----	D	7.1	790	----
FR-229	William Bartram	395339	0830242	770	----	Ls	--	---	----	D	7.3	780	----
FR-230	James Kendrick	395350	0830300	760	----	S&G	--	690	7-79	D	7.2	790	17.5
FR-231	Mary Mehrle	395259	0830139	710	1960	S&G	64	---	----	D	7.6	970	----
FR-232	Neil Benedict	395256	0830137	708	----	S&G	--	---	----	D	7.4	950	16.5
FR-233	Ernest Harbor	395357	0830136	720	----	S&G	--	---	----	D	7.3	810	16.5
FR-234	Harold Koontz	395413	0830213	733	1977	Ls	108	677	7-79	D	7.2	760	11.0
FR-235	Richard Poenisch	395252	0830137	700	----	S&G	--	---	----	D	7.4	870	----
FR-236	Mary Casto	395250	0830141	718	1975	S&G	95	664	7-79	D	7.2	1100	----
FR-241	Model Landfill Inc	395333	0830207	740	1979	S&G	80 M	677	7-79	N	---	---	----
FR-242	do.	395319	0830128	705	1979	--	70 M	640	8-79	N	7.1	940	----
FR-244	do.	395351	0830137	700	1979	S&G	75 M	654	8-79	N	7.2	877	13.5
FR-246	do.	395331	0830139	722	1972	Ls	142	618	10-79	N	6.7	1110	15.0
FR-247	Inland Products	395451	0830050	695	1964	S&G	83	683	8-79	I	7.0	2520	14.0
FR-248	Agg-Rok Inc	395458	0830116	698	1966	S&G	68	674	8-79	C	7.0	1150	13.0
FR-250[2]	--------------	395316	0830133	690	----	--	--	---	----	N	8.6	424	24.0
FR-251[3]	Model Landfill Inc	395302	0830138	710	----	--	--	---	----	N	6.7	4340	24.5

[1] Seep.
[2] Surface water (Scioto Big Run).
[3] Leachate-collection system.

Monitoring ground-water quality downgradient from the landfills was hampered because observation wells could not be found. Domestic, commercial, and industrial wells were selected for monitoring on the basis of accessibility, good connection with the aquifer, and owner cooperation. These and additional wells were also chosen for a one-time water-level measurement to define the potentiometric surface and direction of flow in areas adjacent to the sites.

At landfills 4 and 5, no wells could be found downgradient to define the chemical quality of the ground water. At landfills 2 and 3, well FR-247 (fig. 1) is not directly downgradient but intercepts some subsurface flow from these landfills. However, well FR-247 may also intercept water flowing from the rendering facility immediately to the north.

GROUND-WATER MOVEMENT

The configuration of the water table must be known to determine the rate and direction of movement of any contaminant that might be introduced into the aquifer system. The rate of migration of a contaminant depends in part on the hydraulic conductivity of the aquifer, effective porosity, and the head distribution (or hydraulic gradient) within the aquifer. The direction of ground-water movement may be determined from potentiometric surface maps. The water moves from areas of high head to areas of low head along paths roughly at right angles to the potentiometric contour lines.

A potentiometric surface map (fig. 2) was constructed from water-level measurements made mostly between June and September 1979. The glacial outwash and underlying limestone are presumed to react as a unit when stress is applied to the aquifer system. This presumption is based on analysis of water-level measurements, drillers' logs, and geologic borings. Ground-water levels and flow directions have been modified substantially since 1967 by dewatering of a quarry just east of landfill 5.

Ground-water levels at the time dewatering started were at an altitude of 680 feet in the vicinity of landfill 5 (Emcon Associates, p. IV-3). The primary direction of flow was from west to east with equipotential lines roughly parallel with the Scicto River. Present flow is toward the quarry, as shown by the shape and extent of the cone of depression (fig. 2). In addition to the changed direction of flow, the gradient of the potentiometric surface was increased, thus increasing the velocity of flow.

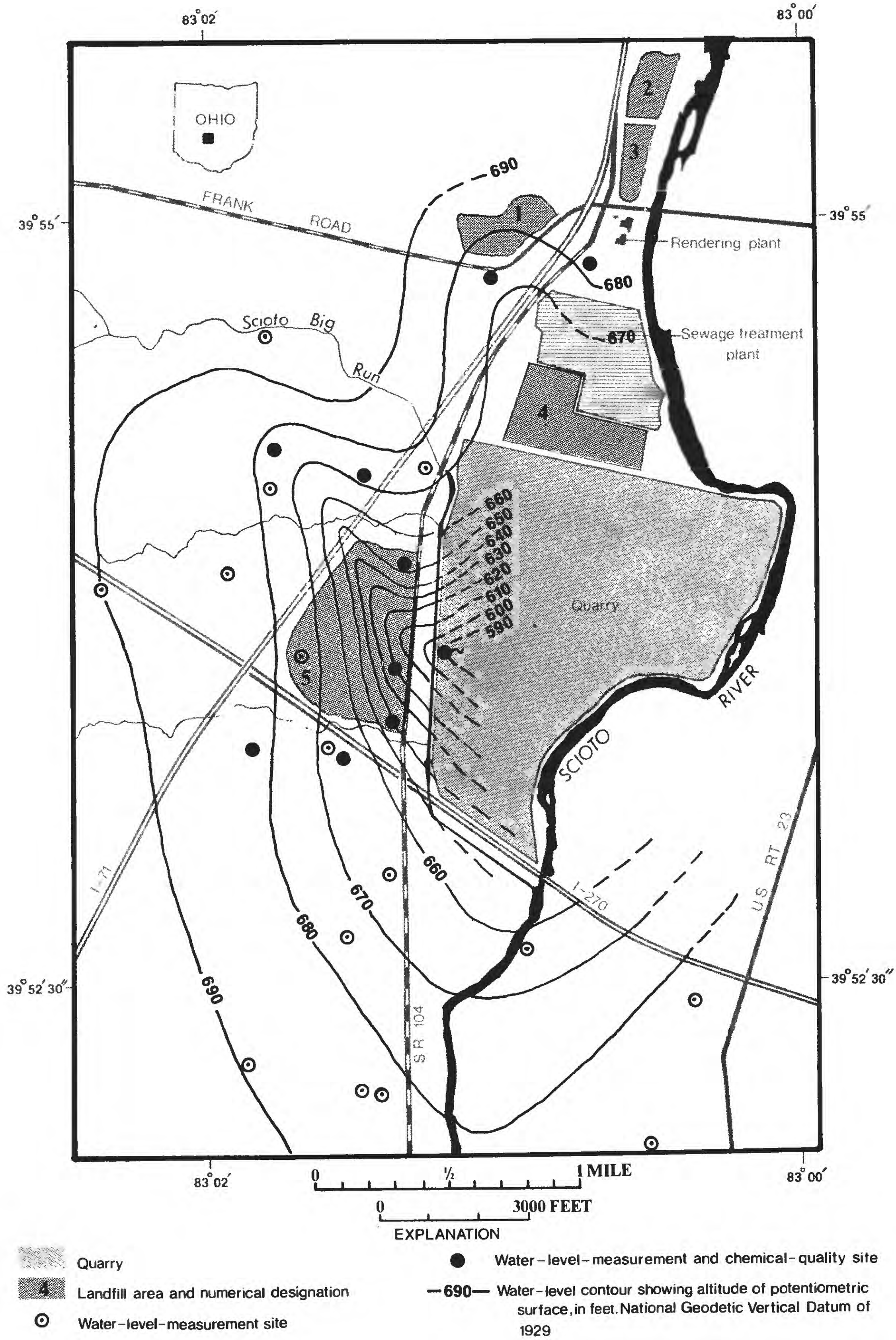

Figure 2.--Potentiometric surface in the study area, June-August, 1979.

The velocity of ground-water flow may be calculated from a form of Darcy's law:

$$V = \frac{KI}{n}$$

where

V is average velocity of flow, in feet per day

K is hydraulic conductivity, in feet per day

I is hydraulic gradient (dimensionless)

n is effective porosity, in percent.

Average hydraulic conductivity of the sand and gravel aquifer was estimated from test borings and drillers' well logs to be 200 ft/d. Using an effective porosity of 25 percent for sand and gravel and a hydraulic gradient of 2.7×10^{-2} in the vicinity of landfill 5, the estimated velocity of ground-water flow is 22 ft/d. Estimated ground-water velocities at landfill 1 and landfill 4 are 0.8 ft/d and 10.4 ft/d, respectively. No attempt was made to estimate the velocity of ground-water flow in the vicinity of landfills 2 and 3 because data were insufficient.

WATER QUALITY

Water samples were collected from nine wells, one seep, one leachate-collection system, and one surface-water sampling point near the landfills in August 1979 (table 2). Selection of sampling sites was based on preliminary field water-quality data (table 1) and direction of ground-water flow (fig. 2). Collection points were also chosen to identify possible areas of contamination from landfill leachate.

The character of the glacial deposits and underlying limestone largely determines the general water-quality characteristics in areas unaffected by the landfills. Chemical characteristics of water from wells FR-201, FR-202, FR-224, and FR-234 reflect the ambient water quality in the study area. This water has a dissolved-solids concentration of 448 to 619 mg/L. Calcium (83 to 110 mg/L) and magnesium (25 to 40 mg/L) are the most abundant cations, and the most abundant anions are bicarbonate (300 to 445 mg/L) and sulfate (85 to 200 mg/L). Chloride is present in concentrations ranging from 2.7 to 85 mg/L. Concentrations of silica range from 10 to 15 mg/L, and nitrogen species are present in amounts less than 1.0 mg/L.

Table 2.--Chemical analyses of water from selected sites near landfills in Franklin County, Ohio, 1979.

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (UNITS)	TEMPER-ATURE (DEG C)	OXYGEN DEMAND, CHEM-ICAL (HIGH LEVEL) (MG/L)	OXYGEN DEMAND, BIO-CHEM-ICAL, 5 DAY (MG/L)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
FR-201	79-08-16	933	7.2	13.5	0	0.0	440	74	110	40
FR-202	79-08-20	975	7.2	14.0	13	.0	460	100	110	44
FR-223	79-08-15	814	7.2	12.0	0	.3	410	100	110	33
FR-224	79-08-20	750	7.3	12.5	37	.4	310	64	83	25
FR-234	79-08-21	740	7.2	11.0	14	.2	370	80	86	37
FR-242	79-08-15	1000	7.1	--	44	.9	270	1	72	21
FR-244	79-08-16	960	7.2	13.5	9	.0	370	75	110	23
FR-246	79-08-20	1100	6.7	15.0	5	.3	530	92	140	43
FR-247	79-08-21	2200	7.0	14.0	28	.1	680	200	170	61
FR-248	79-08-21	1050	7.0	13.0	17	.1	490	100	130	40
FR-250	79-08-16	482	8.6	24.0	60	2.5	160	42	41	13
FR-251	79-08-30	4850	6.7	24.5	1600	22	1900	1900	480	180
Ohio EPA Water Quality Standards, 1978		800-1200	--	--	--	--	--	--	--	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	BICAR-BONATE FET-FLD (MG/L AS HCO3)	CAR-BONATE FET-FLD (MG/L AS CO3)	ALKA-LINITY FIELD (MG/L AS CACO3)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	SULFATE DIS-SOLVED (MG/L AS SO4)
FR-201	79-08-16	25	11	0.5	2.3	445	0	365	45	200
FR-202	79-08-20	28	12	.6	2.3	430	0	353	43	200
FR-223	79-08-15	16	8	.3	2.1	377	0	309	38	100
FR-224	79-08-20	42	23	1.0	3.6	300	0	246	24	85
FR-234	79-08-21	16	9	.4	1.9	350	0	287	35	93
FR-242	79-08-15	97	44	2.6	4.7	324	0	266	41	110
FR-244	79-08-16	27	14	.6	3.4	360	0	295	36	71
FR-246	79-08-20	35	13	.7	3.6	530	0	435	169	190
FR-247	79-08-21	280	47	4.7	7.6	580	0	476	93	200
FR-248	79-08-21	52	19	1.0	3.0	470	0	385	75	68
FR-250	79-08-16	25	25	.9	3.0	123	8	114	.6	45
FR-251	79-08-30	320	23	3.2	280	--	--	--	--	32
Ohio EPA Water Quality Standards, 1978		--	--	--	--	--	--	--	--	250

LOCAL IDENT-I-FIER	DATE OF SAMPLE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS NH4)	NITRO-GEN, ORGANIC DIS-SOLVED (MG/L AS N)	NITRO-GEN, DISSOLV (MG/L AS N)
FR-201	79-08-16	2.8	1.6	15	619	0.15	.560	0.72	0.02	0.73
FR-202	79-08-20	2.7	1.7	15	619	<.10	.530	.68	.03	.56
FR-223	79-08-15	41	.3	11	502	.40	.070	.09	.01	.48
FR-224	79-08-20	85	.2	11	484	<.10	.060	.08	.10	.16
FR-234	79-08-21	30	.7	10	448	.02	.280	.36	.09	.39
FR-242	79-08-15	92	.4	7.8	565	<.10	.180	.23	.48	.66
Ohio EPA Water Quality Standards, 1978		250	1.8	--	500-750	10	--	--	--	--

Table 2.--Chemical analyses of water from selected sites near landfills in Franklin County, Ohio, 1979.--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS NH4)	NITRO-GEN, ORGANIC DIS-SOLVED (MG/L AS N)	NITRO-GEN, DISSOLV (MG/L AS N)
FR-244	79-08-16	93	.2	8.9	515	.09	.090	.12	.06	.24
FR-246	79-08-20	33	1.0	14	724	<.10	1.40	1.8	.20	1.6
FR-247	79-08-21	460	.3	12	1490	<.10	3.60	4.6	.10	3.7
FR-248	79-08-21	130	.5	14	672	.01	.080	.10	.39	.48
FR-250	79-08-16	39	.2	3.1	239	.19	.080	.10	.31	.58
FR-251	79-08-30	420	.1	83	1850	.39	.030	.04	130	130
Ohio EPA Water Quality Standards, 1978		250	1.8	--	500-750	10	--	--	--	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	NITRO-GEN, AM-MONIA + ORGANIC DIS. (MG/L AS N)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
FR-201	79-08-16	0.58	0.010	--	--	--	--	2200	--	40
FR-202	79-08-20	.56	.010	--	--	--	--	3000	--	30
FR-223	79-08-15	.08	.230	--	--	--	--	500	--	60
FR-224	79-08-20	.16	<.010	1	ND	<20	ND	1100	ND	80
FR-234	79-08-21	.37	.030	--	--	--	--	920	--	60
FR-242	79-08-15	.66	.060	--	--	--	--	30	--	100
FR-244	79-08-16	.15	.010	2	<2	<20	ND	130	2	120
FR-246	79-08-20	1.6	.020	1	<2	<20	2	3200	<2	160
FR-247	79-08-21	3.7	<.010	1	ND	20	2	8300	3	790
FR-248	79-08-21	.47	.020	<1	ND	<20	ND	3000	ND	120
FR-250	79-08-16	.39	.010	--	--	--	--	<10	--	20
FR-251	79-08-30	130	.030	8	<2	50	400	47000	<200	2100
Ohio EPA Water Quality Standards, 1978		--	--	50	10	50	1000	300	50	50

LOCAL IDENT-I-FIER	DATE OF SAMPLE	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ZINC, DIS-SOLVED (UG/L AS ZN)	CARBON, ORGANIC TOTAL (MG/L AS C)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)	CARBON, ORGANIC SUS-PENDED TOTAL (MG/L AS C)	PHENOLS (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
FR-201	79-08-16	--	--	--	1.7	1.6	0.1	0	--
FR-202	79-08-20	--	--	--	3.4	3.3	.1	0	--
FR-223	79-08-15	--	--	--	1.0	1.0	.0	0	--
FR-224	79-08-20	<.5	<2	320	2.9	2.8	.1	0	.00
FR-234	79-08-21	--	--	--	8.1	8.0	.1	0	--
FR-242	79-08-15	--	--	--	9.4	7.7	1.7	0	--
FR-244	79-08-16	<.5	<2	<20	2.3	1.3	1.0	0	.00
FR-246	79-08-20	<.5	3	20	3.7	3.6	.1	0	.00
FR-247	79-08-21	<.5	5	20	5.0	4.8	.2	0	.10
FR-248	79-08-21	<.5	<2	3	6.7	6.6	.1	0	.00
FR-250	79-08-16	--	--	--	5.2	4.1	1.1	0	--
FR-251	79-08-30	<.5	75	4600	263	--	--	1100	.80
Ohio EPA Water Quality Standards, 1978		20	--	5000	--	--	--	10	--

Concentrations of iron (920 to 3,000 ug/L) and manganese (30 to 80 ug/L) commonly exceed Ohio EPA Drinking Water Standards (1978) of 300 ug/L and 500 ug/L, respectively. Lead, zinc, mercury, chromium, cadmium, and arsenic are present in trace amounts.

Chemical analyses of water from wells FR-201 and FR-202 showed higher concentrations of most major cations, anions, and metals than water from wells FR-224 and FR-234. By utilizing the potentiometric map (fig. 2) and constructing flow lines perpendicular to water-level contours, the trend for increased mineralization of water in wells FR-201 and FR-202 can be extended to include wells FR-222, FR-242, and FR-246. Comparison of historical chemical analyses for these three wells with current analyses from background wells FR-201 and FR-202, indicates similar chemical characteristics, most notably high sulfate and low chloride concentrations. The variation in the ambient chemical quality, as shown by increased mineralization in the southern wells, might be due to mineralogic differences within the aquifer (Hem, 1960, p. 65; Hem, 1970, p. 175).

Chloride concentrations in wells FR-224 and FR-234 are 10 to 30 times higher than in wells FR-201 and FR-202. The chloride concentration of 30 mg/L in well FR-234 is probably representative of the ambient water, whereas the concentration of 85 mg/L in water from FR-234 suggests contamination. Chemical analysis of water from well FR-234 indicates low biological oxygen demand (BOD), low total organic carbon (TOC), sulfate, and nitrogen species, but high sodium and chloride. The location of FR-224 in a low area 400 feet west of Interstate 270 suggests road deicing salts as a possible source of the sodium and chloride.

Well FR-248, just south of landfill 1 is located at the scale house of a sand and gravel company, and water from it is used for washing down trucks. Although the well is not directly downgradient from landfill 2, it probably intercepts a part of the ground-water flow from the landfill. Chemical analysis of water from the well indicates that sodium, chloride, and TOC concentrations differ appreciably from the chemical quality of the ambient water. Because of the relatively low amounts of other constituents reported, the contamination cannot be traced to landfill 2 and most likely is from a source nearer the well.

Chemical analysis of water from well FR-247 shows high concentrations of calcium, sodium, magnesium, sulfate, chloride, iron, and manganese. Some subsurface flow from beneath landfills 2 and 3 might reach the well, but, because of poor definition of the potentiometric surface (fig. 2), this is not certain. The contamination is most likely from industrial sources immediately north of the well.

FR-244 is located in the northern part of landfill 5, which has only recently been used for disposal. Accordingly, the chemical quality of the water closely parallels that of the ambient water, except for higher concentrations of chloride and manganese. FR-244 is also located in a low area near the highway, which suggests that the high concentration of chloride might be due to road salts.

Chemical analysis of water from well FR-246 shows constituent levels that closely approximate those of water from wells FR-201 and FR-202. The water is slightly more mineralized; however, there is no evidence of organic contamination. The chemical quality of the seep (FR-223) also closely resembles the ambient water quality but is less mineralized. Chemical analysis of a sample from surface-water sampling point FR-250 shows low concentrations of the major anions, cations, and metals and a BOD of 2.5 mg/L.

FR-242, the southernmost well at landfill 5 contains high concentrations of sodium, chloride, and manganese. The well is in the older part of the landfill, where disposal was into an abandoned pit, having no protective liners or clay layers. Concentrations of BOD, TOC, and chemical oxygen demand (COD) in water from FR-242 although relatively low, are higher than those in water from any other of the observation wells and might indicate contamination by landfill 5.

Analysis of a sample from the leachate-collection system, FR-251, shows high concentrations of heavy metals, including dissolved chromium (50 ug/L), copper (400 ug/L), iron (47,000 ug/L), lead (100 ug/L), manganese (2,100 ug/L), nickel (75 ug/L), and zinc (4,600 ug/L). Also present were high concentrations of COD (1,600 mg/L), potassium (280 mg/L), silica (83 mg/L), organic nitrogen (130 mg/L), TOC (263 mg/L), phenols (1,100 ug/L), and MBAS (methylene blue active substances) (0.80 mg/L).

The only specific departures from the ambient chemical quality of the ground water that might indicate contamination by landfills were observed in water from wells FR-242 and FR-247 and leachate-collection system FR-251. The water-analysis diagram (fig. 3) shows these differences from the ambient chemical quality. Although chloride concentration in several other wells is high, other constituents were relatively low, and these wells may have been affected by other types of infiltrates such as road salt. At landfill 5 ground-water contamination caused by waste disposal may be occurring, as indicated by analysis of water from well FR-242. A possibility of contamination exists in other areas but was not detected because of the dependence on the location and depth of pre-existing wells used as a source of data. The contamination in water from well FR-247 cannot be traced directly to landfills 2 and 3 and could originate at the rendering plant, which is directly upgradient.

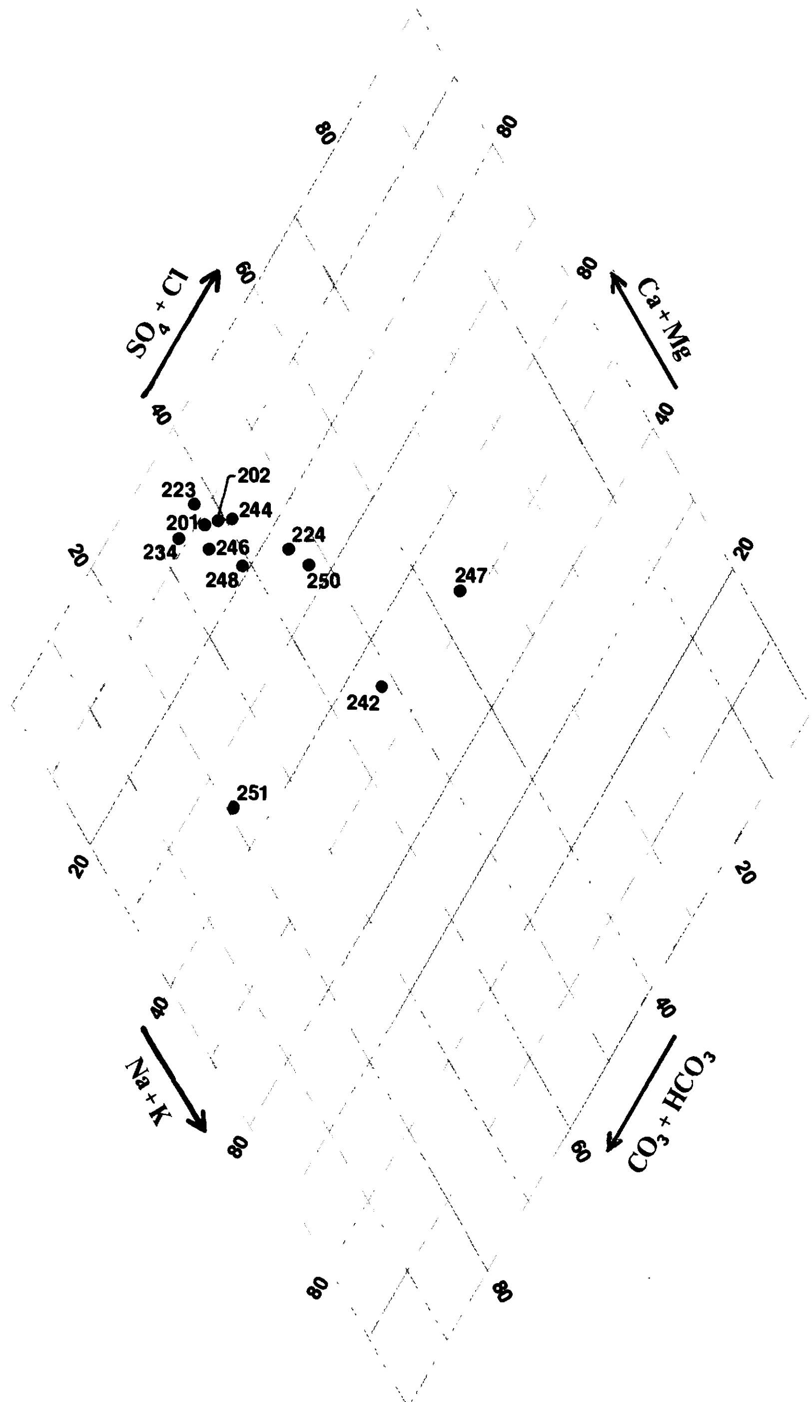

Figure 3.--Water-analysis diagram showing the distribution of constituents in water near landfills in southern Franklin County. (The bicarbonate value for FR-251 has been estimated.)

SUMMARY AND CONCLUSIONS

The hydrologic environment and ground-water quality at five landfills in southern Franklin County were studied using data from 46 wells, 1 seep, 1 surface-water site, and 1 leachate-collection site. The study consisted of an inventory of available wells (table 1), preparation of a potentiometric-surface map (fig. 2), collection of field water-quality data (table 1), and collection and interpretation of water-quality data at 12 selected sites near the landfills.

A potentiometric-surface map based on data from 27 wells measured in June-October 1979 (fig. 2) shows a depression centered around a heavily pumped quarry. Although the full effect of this ground-water removal on the landfills is unknown, the increase in thickness of the unsaturated zone provides increased opportunity for filtration and decomposition of any contaminant before it reaches the water surface. The high gradient of the water surface will cause any contaminate to move away from the landfills.

Chemical analyses indicate that a moderately mineralized calcium bicarbonate type ground water, variable in concentrations of sulfate and chloride, is typical of the study area. Relatively high concentrations of chloride in water from several wells cannot be attributed directly to landfills and may be due to other sources. The only area being contaminated by a landfill was in the vicinity of well FR-242.

A chemical analysis of the leachate from landfill 5 (FR-251) shows high concentrations of heavy metals and organic substaces. However, chemical analyses of water from nearby wells suggest that the heavy metals and organic substances are not migrating away from the landfill in significant quantities.

Ground-water conditions near the landfills could be more fully described if the water were monitored at additional specific areas. Only two wells are downgradient from landfills 1, 2, and 3, and no wells are downgradient from landfills 4 and 5. Wells are not finished at a complete range of depths in the sand and gravel outwash, and some wells may have been subjected to contamination from other sources. For these reasons, significant contamination, if it exists, might not have been detected. If additional wells, were installed at various depths near landfills 1, 2, 3, and 4, and near the Scioto River water-level data from these wells could be used to better define the potentiometric surface, determine more fully the effects of local pumping, and the rate and direction of ground-water movement. Water-quality data from additional wells could be used to describe more accurately the chemical quality of the ground water and the sources and extent of contamination.

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