Field Studies: Hardy Road Landfill and Industrial Excess Landfill, A Superfund Site[1]

JIM L. JACKSON, JAMES R. BAUDER, JAMES HARDY, AND MARK S. KENNEDY, Center for Environmental Studies, The University of Akron, Akron, OH 44325, James Bauder Inc., 3095 Bernewood Dr., NW, Canton, OH 44709, Chemistry Department and Department of Civil Engineering, The University of Akron, Akron, OH 44325

ABSTRACT. The North Central Section of the Geological Society of America met in Akron, April, 1988. Hardy Road Landfill, Akron, Ohio, and Industrial Excess Landfill, Uniontown, Ohio were the foci of a pre-meeting field trip. At Hardy Road, geologic conditions contributed to off-site methane migration in 1984, resulting in destruction by fire of a private dwelling. Gas migration is now controlled by an active gas collection system. Sand and gravels deposited during multiple glacial events are underlain by lacustrine silts and clays. Lacustrine deposits and hydrology of the site are expected to control leachate. The glacial deposits are up to 150 m thick in the buried valley beneath the site.

The major concern at Uniontown is ground water contamination. Water samples were less contaminated than would be expected from waste deposited in a gravel pit. Till at depth may account for the relatively low level of contamination off site. Local ground water recharge and flow patterns may also limit off-site migration of leachate.

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INTRODUCTION

Ohio has a waste problem! Over seven million tons of solid waste are discarded by Ohioans each year. There were 644 licensed landfills operating in Ohio in 1969. By 1986, there were 198, and 50 of those were on-site industrial facilities (Ohio Alliance for the Environment 1986). In 1987 about 7,000 tons of solid waste was brought into Ohio each day. Waste from the New York and New Jersey area, where the charge for disposal of solid waste averages $100 per ton, has been brought to Ohio where the average charge was $13 per ton in 1987. New Jersey has seven operating landfills and three of those are scheduled to close. Ohio now has 163 licensed landfills. The populations of Ohio and New Jersey are nearly the same (Celebrezze 1988). Governor R. Celeste signed HB-592 as amended 24 June 1988 giving the state a new Solid Waste Law with the potential to greatly alter the disposal of waste in Ohio.

Two waste disposal sites, Akron's Hardy Road Landfill (HRL) in Northampton Township and Industrial Excess Landfill (IEL) in Uniontown, Ohio (Fig. 1), were visited as part of the GSA North-Central Regional Meeting held at The University of Akron in April, 1988. The sites were chosen to demonstrate the significance of geologic conditions at waste disposal sites.

The two sites were first used for waste disposal in the 1960's. Therefore, early operations at the sites predate the extensive guidelines and legislation presently governing waste disposal. The field trips to the two sites addressed geological factors that affected the migration of contaminates. Drs. Kennedy and Jackson studied the Hardy Road Landfill with funding from Ohio Water Development Authority and City of Akron. The U.S. Environmental Protection Agency (USEPA) is studying the Uniontown site (Johnson & Associates 1985). Two authors of the present paper, Jackson and Bauder, have been involved in extensive study of Akron area waste disposal sites for nearly twenty years. Bauder studied the Uniontown site for the Stark County Health Department, and Jackson studied the site as part of a regional survey and as a consultant for IEL. Dr. Hardy conducted the chemical analyses of IEL water samples.

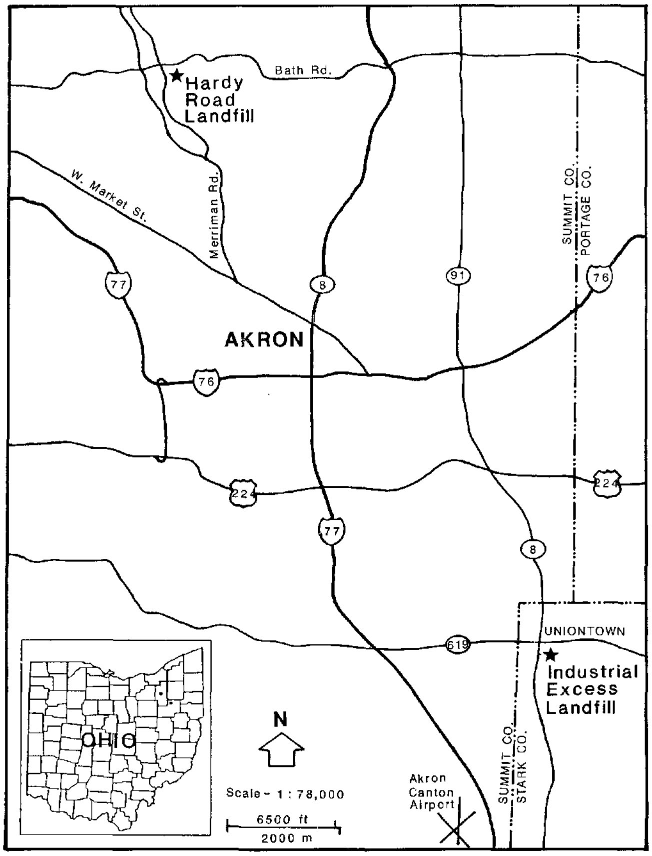

FIGURE 1. Location map of Hardy Road Landfill and Industrial Excess Landfill.

HARDY ROAD LANDFILL

BEDROCK GEOLOGY. There are no bedrock exposures on the landfill site. The nearest surface exposure of bedrock is 275 m east of the eastern boundary and 730 m north of Hardy Road in Woodward Creek at an elevation of about 256 m above mean sea level.

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Sharpsville Sandstone overlies Orangeville Shale in the stream channel. Bedrock beneath the site is Mississippian and Devonian shales that are not important sources of ground water in Northampton Township.

Bedrock in Summit County has been described by Smith and White (1953) and measured sections have been reported by Banks and Feldman (1979). Smith and White (1953) mapped the landfill area and described the bedrock and glacial drift as, "Not a source of ground water. Home owners are forced to rely on cisterns."

Hardy Road Landfill is on the east side of a buried valley (Fig. 2) (Smith and White 1953, Mangum 1980). Depth to bedrock exceeds 45 m at the northeast corner of the site and exceeds 150 m near the middle to the western boundary of the landfill. None of the ground water and gas monitor wells (Fig. 3) reached bedrock. Depths of the ground water monitor wells are: 1-52 m, 2-60 m, 3-26 m, 4-64 m. Gas monitor wells were developed to a depth of 23 meters. Gas monitor wells 1, 2, and 4 were installed in 1981. Gas monitor well 3, north of Hardy Road, was installed in March, 1984. Additional gas monitor wells were installed in 1986. Split-spoon samples, taken every five feet as the gas monitor wells were developed, can be summarized as sand with occasional gravel.

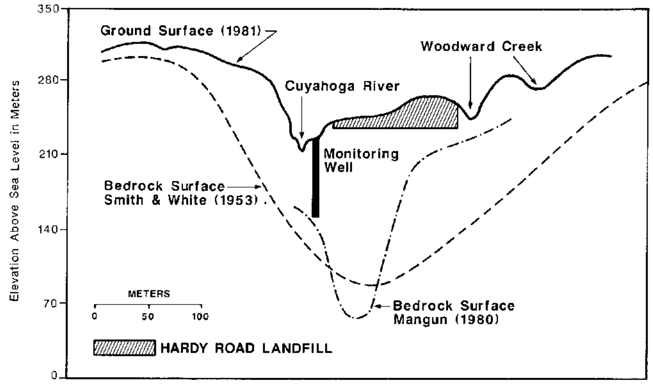

FIGURE 2. Cross-section of Cuyahoga River valley from southwest to northeast beneath the Hardy Road Landfill.

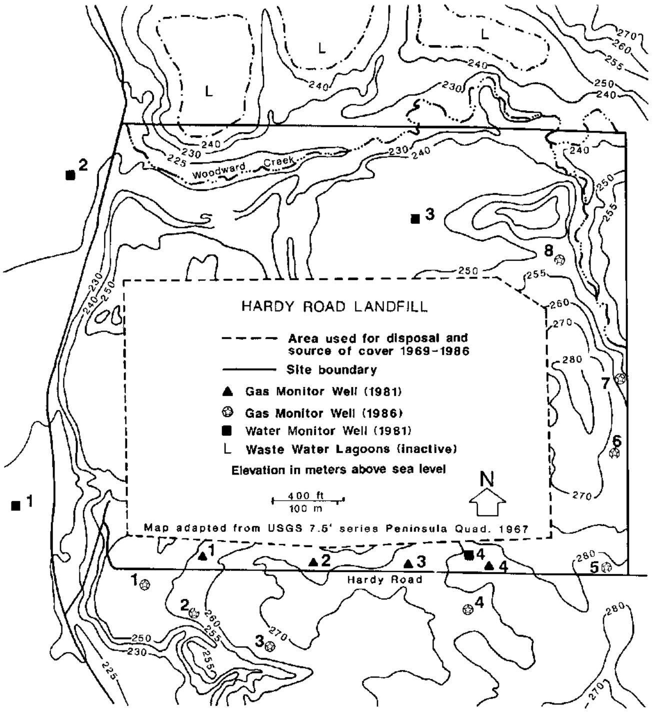

FIGURE 3. Topography and monitor well locations of the Hardy Road Landfill.

SURFICIAL DEPOSITS. Numerous large erratics, local topography, and till indicate the site is part of an end moraine. Test borings, monitor wells, and excavations in borrow pits at the landfill reveal a complex stratigraphy in surficial deposits above 234 m elevation. Below 234 m elevation lacustrine deposits, clayey silts, of a proglacial lake seem to be continuous. Above the lacustrine deposits are sands, some gravel, till and silty sands. Multiple glacial events and changing environments of deposition produced the varied stratigraphy (White 1982, Ryan 1980, Bain 1975). The sequence of beds along Hardy Road (Fig. 3) suggests a kame delta as described by Bain (1975). The beds grade from coarse near the surface to fine with increasing depth. Sediment came from the east, and distributaries carried coarse material farther in the proglacial lake to form the Mud Brook kame delta (Bain 1975).

Lacustrine deposits are more continuous toward the center of the buried valley; most sand and gravel is near the edges of the ancestral Cuyahoga Valley. A smaller delta northeast of the site merged with the kame delta described by Bain to the southeast, and till overlies the deltaic sands along the east boundary of the landfill.

Outwash terrace described by White (1982) was used for sewage sludge lagoons shown on the north side of the landfill (Fig. 3). The lagoons are no longer used for disposal of sewage. Outwash can be seen in a recent excavation 70 m west of gas monitor well 1 (Fig. 3). Numerous large erratics, hummocky topography and till indicate the land to the south and east of the site is end moraine. Split-spoon samples from water monitor wells suggest the lacustrine silts and clays are continuous beneath the site.

GROUND WATER AT HARDY ROAD LANDFILL. Drillers looking for water for the Blossom Music Center several years ago drilled 155 m to bedrock on the Bender farm 3 km north of the site without finding sufficient water and the well was capped. Water monitor well 2 (Fig. 3), drilled near the northwest corner of the site in February, 1981, reached a depth of 75 m in lacustrine silts and clays and was reported as a "dry well" by the driller. The saturated silts and clays are nearly impermeable, and under hydrostatic pressure collapse the hole and/or plug the well screen.

Water monitor well 1 (Fig. 3), drilled near the southwest corner of the site, penetrated 50 m of silts and a few feet of compact till before reaching gravelly sand. Water overflowed the well casing at about 4.4×10^{-4} m^3 per sec.

Ground water under the Hardy Road Landfill originates from the east, southeast, and northeast of the site. The water table drops 18 m in elevation from the east boundary to the west boundary of the site (Kennedy and Jackson 1988). The bulk of the ground water results from areas of high infiltration in the outwash, kames, kame terrace, and kame delta materials to the east, southeast, and northeast.

Relatively impermeable lacustrine silts and clays often exceed 30 m in thickness (over 60 m was observed by Jackson during the drilling of water monitor wells 1 and 2 west of the fill). Lacustrine deposits interfinger with sands to the east. The artesian effect observed at monitor well 1, near the southwest corner of the landfill, was also observed to a lesser degree in monitor well 3 (NE). The hydrostatic head observed in well 1 results from the higher water table to the east. The hydrostatic head in the confined ground water beneath lacustrine material should prevent leachate contamination at depth.

Soils developed on the site and their parent material are described by Ritchie and Steiger (1974). Under current guidelines of the Ohio EPA, the site could not be approved as a landfill if only the soils are considered because the upper several feet of the soil is too permeable. However, surface water infiltration is reduced by using stockpiled till and lacustrine deposits for final cover material. The subsurface conditions of the site are ideal for a sanitary landfill. There are no water wells which penetrate aquifers that are likely to be contaminated within a kilometer of the site. Shale bedrock below the landfill is not a good source of water in Northampton Township and most of northern Summit County. Hydrostatic pressure and low permeability of the lacustrine deposits and shale at depth will prevent bedrock aquifers from being damaged by leachate. Water samples obtained from water monitoring wells installed in 1981, as well as, extensive drilling of ground water monitor wells and water analyses completed from 1986 to 1988 under a grant from the Ohio Water Development Authority and the City of Akron, have not detected leachate. Computer projections suggest chlorides will appear in the northwest area of the site in about 20 years (Kennedy and Jackson 1988). Contamination will be limited to shallow undifferentiated sand, silt, clay and gravel (Fig. 4).

METHANE GAS PROBLEM AT HARDY ROAD. Four gas monitoring wells were to be drilled in 1981. Gas monitoring wells, 1, 2, and 4 were completed along the north side of Hardy Road by winter, 1981. Waste over 30 m thick, anaerobic conditions in the landfill, compacted cover material, and coarse sediments in the upper units of the Mud Brook kame delta led to methane migration to a private home on the south side of Hardy Road on 21 March 1984. The gas was ignited and destroyed the home. Monitoring well 3 was drilled. A nest of three pipes demonstrated that gas was present at depths exceeding 18 m. Subsequently, the area was evacuated, and the property immediately south of Hardy Road from the east to the west boundaries of the landfill was purchased by the City of Akron. Gravel in distributary channels probably enchanced gas migration.

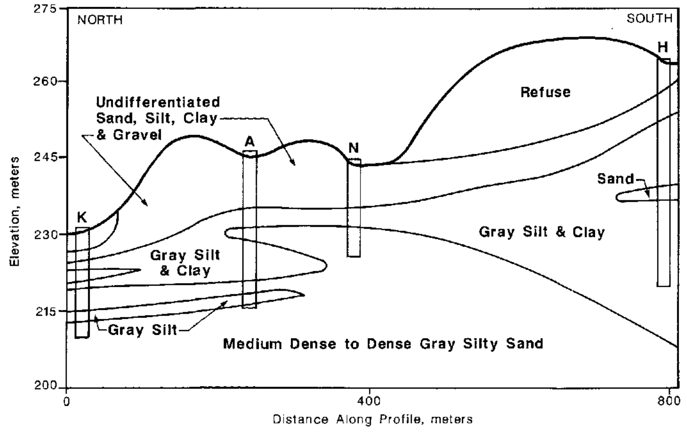

FIGURE 4. North to south cross-section of subsurface deposits beneath the Hardy Road Landfill.

A gas collection system was installed in 1984 as an emergency measure. Table 1 lists methane data from the day of the explosion through July, 1987, when the gas collection system was known to be malfunctioning. The emergency system was completely replaced in June and July of 1987. High methane levels recorded on 19 July occurred because of shutdown of the system for replacement. Gas levels dropped dramatically when the new system began to function.

Presently six hundred thousand cubic feet of landfill gas is collected and flared every day at Hardy Road Landfill. There are 13 gas collection wells along the south boundary of the disposal area. Eleven of the wells were drilled into the refuse. The wells are connected by PVC pipe that carries the gas to the pumps and flare. The "trick" is to not pump too rapidly because oxygen is toxic to the anaerobic bacteria that produce methane. Also the decomposition reactions are exothermic and excess oxygen may lead to fires in the refuse. Gas monitor wells 1-4 and J1-J8 are used to determine the effectiveness of the gas collection system. A thirty-day test conducted by J. Jackson and M. Alvis, the latter, City of Akron engineer, confirmed no gas problem when the gas collection system was operating.

Methane gas migrates farther and faster than CO_2 and other higher molecular weight gases. There is an effect in the soil similar to separation in a gas chromatograph. Jackson suggests a halo effect around landfills, and the CH_4 to CO_2 ratio can be one clue to the extent of CH_4 migration; high ratios, greater than two to one, suggest the gas sample is near the limit of methane migration (Jackson 1984). "The design and operation of a landfill gas recovery system is still as much an art as it is a science" (EMCON Associates 1980).

INDUSTRIAL EXCESS LANDFILL

WATER ANALYSES. In the spring of 1987 water samples were collected and split among C. C. Johnson and Associates, representing USEPA; IT Corporation, representing industrial users of the site; and The University of Akron's Center for Environmental Studies. Dr. James Hardy analyzed the samples for priority pollutants in The University of Akron Environmental Chemistry laboratory. The analysis was conducted in three stages:

1. Determination of metals by Atomic Absorption (AA).
2. Determination of volatile organics by purge and trap with thermal desorption of the trap onto a capillary column gas chromatograph equipped with a flame ionization detector.

TABLE 1

Hardy Road Landfill Gas Analyses Reported in Percents by Volume

Sampling Dates	Monitor well	Methane (CH_4)	Carbon Dioxide (CO_2)	Ratio CH_4/CO_2	Water vapor	Air and other gases
Mar 1984	G81 3	65	34.5	1.89	Some	NA
7 Feb 1986	LF	24	14.5	1.66	NA	NA
2 June 1986	G86 6	ND	ND		Some	Remainder of sample
2 June 1986	LF	25.4	17.2	1.48	Some	Remainder of sample
2 June 1986	G81 3	29.0	18.3	1.58	Some	Remainder of sample
2 June 1986	G86 2	0.5	0.33	1.52	Some	Remainder of sample
18 Dec 1986	G86 1	0	0			
18 Dec 1986	G86 2	1.81	1.36	1.33		
18 Dec 1986	G81 3	1.55	3.35	0.46		
18 Dec 1986	G86 4	2.2	2.9	0.76		
18 Dec 1986	G81 4	1.96	2.90	0.68		
18 Dec 1986	G86 5	0.39	0.36	1.08		
19 July 1987	G86 1	47.7	NA		NA	
19 July 1987	G86 2	65.8	NA		NA	
19 July 1987	G81 3	44.2	NA		NA	
19 July 1987	G81 4	53.1	NA		NA	

3. Extraction under acidic and basic conditions of a portion of the sample into methylene chloride followed by concentration of the extract. The extract was then assayed by capillary column gas chromatography (GC) and mass spectroscopy (MS) detection.

For the assays, Fisher standards were used for the AA work and Supelco standards were used for all other work. For the extraction analysis, napthalene was used as an internal standard.

For the GC-MS determinations, Supelco standards were injected and the instrument programmed to identify each component based on the mass spectra obtained. Identifications were limited to a one minute window. All work was done using a HP5890 gas chromatograph equipped with an autoinjector and a Finnigan Ion Trap Mass Selective Detector.

Water samples were obtained from monitor wells developed by C. C. Johnson and Associates. Monitor well locations 1, 3, 7, 8, 9, 10, 11 and 12 (Fig. 5) are nested, and water samples were obtained from shallow, medium and deep depths. Well depths vary and the deep wells were completed in bedrock. Samples were taken from the nest of three wells per monitor well location at shallow (S), medium (M), and deep (D) levels (Table 2). Nesting of the wells was done in an effort to test ground water quality in the upper and lower parts of the ground water found in surficial deposits and the bedrock at the site.

RESULTS OF GROUND WATER ANALYSIS. The term ND in tables and text represents 'not detectable' and should not be construed as meaning that a species was not present. ND only represents an absence of observed response, based on the limits of each method used. Tests were made for 105 organic priority pollutants, and organic pollutants detected in one or more samples are reported (Table 2).

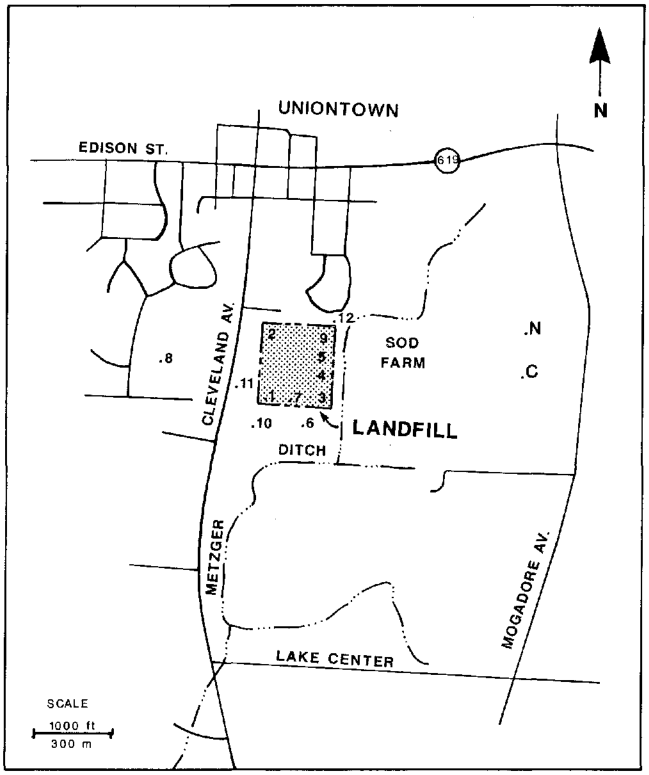

FIGURE 5. IEL ground water monitor well locations. Values in Table 2 were determined from each of these wells, with the numbering and lettering sequence as determined by C. C. Johnson & Assoc.

Measurements indicated a surprisingly low level of contamination for monitor wells within and very near a landfill developed in a sand and gravel deposit (Table 2). Bauder and Jackson believe a combination of till on the site, compaction, type of waste, cover material, and local ground water recharge areas have significantly reduced movement of contaminants off site.

TABLE 2

Ground Water Analytical Results, IEL Site-Uniontown, May, 1987

Parameter	1-S[a]	1-M[b]	1-D[c]	2-D	3-S	3-M	3-D	4-S	5-S	6-S	7-S	7-M	7-D	8-S	8-M
METALS (ppm)															
Antimony Sb	0.84	0.88	ND	ND	ND	0.98	0.75	ND	ND	ND	0.55	0.49	0.54	ND	0.38
Arsenic As	0.13	0.42	0.00149	ND	0.00107	0.54	ND	0.0001	0.0008	ND	ND	0.07	0.19	ND	0.06
Barium Ba	ND	ND	0.055	0.0298	ND	0.57	ND	0.1427	0.1887	ND	ND	ND	1.59	ND	0.07
Cadmium Cd	ND	ND	ND	ND	ND	ND	ND	0.002	0.002	ND	ND	ND	ND	ND	ND
Calcium Ca	209	148	83.3	86.6	183.2	139	54.9	134.2	149	238.7	184	76.4	69.5	123.5	120
Chromium Cr	ND	ND	ND	0.011	ND	ND	ND	0.013	0.009	0.18	ND	ND	ND	ND	ND
Copper Cu	ND	1.14	ND	0.144	0.002	ND	0.02	ND	ND	ND	ND	ND	ND	0.071	ND
Iron Fe	0.53	21.1	1.2	5.07	30.9	5.5	4.41	33	34.7	5.4	111	1.04	0.22	14.2	1.03
Lead Pb	ND	ND	0.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium Mg	131	104	83	17.8	157	112	109	19.1	30.9	84.1	119	103	113	130	100
Mercury Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium K	6.79	3.67	2.8	6.4	62.2	1.53	2.76	15.4	28	13.5	22.5	1.49	1.49	1.9	1.97
Silver Ag	ND	ND	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium Na	21.3	82.8	28.7	13.1	7	102	18.2	12.9	156.1	7	57.4	26.4	14	7	48.1
Zinc Zn	0.025	0.513	ND	ND	0.01	0.016	0.012	ND	ND	0.03	0.102	0.009	0.003	0.61	0.03
ORGANICS (Priority Pollutants)															
PURGABLE (ppm)															
Acetone	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methanol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6	1.6
Ethanol	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	ND	ND	2.2	3.7
Methylene Chloride	ND	ND	1.2	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BASE-NEUTRAL EXTRACTABLE (ppb)															
Acenapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.096	ND	ND	ND	ND	ND
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
di-n-butylphthalate	ND	ND	ND	0.352	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis-2-ethylhexylphthalate	ND	ND	ND	16.2	1.03	ND	ND	ND	ND	ND	ND	ND	ND	0.887	ND
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis-2-chloro-ethoxymethane	ND	ND	ND	10.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.640	ND
n-nitroso-diphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	15.9	ND	ND	ND	ND	ND
n-nitroso-dimethylamine	ND	ND	ND	ND	0.057	ND	ND	ND	ND	0.213	ND	ND	ND	ND	ND

ND = Not Detected

[a] Monitor Well 1—shallow

[b] Monitor Well 1—medium depth

[c] Monitor Well 1—deep

TABLE 2 (Continued)

Ground Water Analytical Results, IEL Site-Uniontown, May, 1987

Parameter	8-D	9-S	9-M	9-D	10-S	10-M	10-D	11-S	11-M	11-D	12-M	12-D	SOD FARMC	SOD FARMN
METALS (ppm)														
Antimony Sb	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic As	ND	0.0004	ND	ND	0.00043	0.00128	0.00171	0.00021	0.0004	ND	0.00014	0.00057	ND	0.0004
Barium Bas	ND	ND	0.0279	0.0167	ND	0.055	0.07	ND	0.1594	0.0194	ND	0.046	0.1068	0.0427
Cadmium Cd	ND	ND	0.001	ND	ND	ND	ND	ND	0.002	ND	ND	ND	0.004	0.001
Calcium Ca	119	151.8	73.2	48.7	232.2	89.8	109.5	238.7	136.7	59.9	168.2	72.6	104.4	95.4
Chromium Cr	ND	ND	0.008	0.002	0.007	ND	ND	ND	0.008	0.005	ND	ND	ND	0.002
Copper Cu	ND	0.006	ND	ND	0.033	ND	ND	ND	0.009	ND	ND	ND	ND	ND
Iron Fe	3.27	0.87	ND	ND	15.5	0.81	1.36	ND	1.72	3.14	5.52	0.68	3.4	4.87
Lead Pb	ND	ND	ND	ND	0.18	0.24	0.23	ND	ND	ND	ND	ND	ND	ND
Magnesium Mg	102	134	16	8.7	140	52	31	180.2	34.6	11.2	154	60	22.5	23.1
Mercury Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium K	1.79	12.3	2.3	3.6	2.8	2.6	3.8	12.2	5.6	13.5	11.1	2.2	2.8	2.7
Silver Ag	ND	ND	ND	ND	ND	0.016	0.011	ND	ND	0.092	ND	0.01	ND	ND
Sodium Na	19	5.5	6.2	8.3	4.3	7.2	21.8	4.6	122.4	10.5	7	13.9	7.4	3.9
Zinc Zn	0.036	0.002	ND	ND	0.61	0.005	0.006	0.009	ND	ND	0.003	ND	ND	ND
ORGANICS (Priority Pollutants)														
PURGABLE (ppm)														
Acetone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methanol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3	ND
Ethanol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND
Methylene Chloride	ND	ND	ND	ND	ND	ND	0.7	ND	ND	1.1	1.4	0.4	1.1	ND
BASE-NEUTRAL EXTRACTABLE (ppb)														
Acenapthalene	ND	ND	0.0047	0.0013	0.0433	ND	0.12	ND	ND	ND	ND	0.0067	ND	ND
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.007	ND
di-n-butylphthalate	ND	ND	ND	ND	38.4	0.047	ND	ND	ND	40.4	ND	ND	ND	ND
bis-2-ethylhexylphthalate	ND	0.39	5.56	ND	346.3	4.36	6.1	ND	ND	ND	ND	7.4	0.91	ND
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005	ND
diethylphthalate	ND	ND	0.167	ND	ND	ND	0.804	ND	ND	1.2	ND	ND	ND	ND
bis-2-chloro-ethoxymethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	Nd	ND	ND	ND	ND	ND	ND
n-nitroso-diphenylamine	ND	41.5	ND	ND	ND	ND	ND	22.8	ND	ND	ND	ND	ND	ND
n-nitroso-dimethylamine	ND	0.111	0.091	0.029	ND	ND	ND	ND	ND	0.54	0.031	0.887	0.078	ND

ND = Not Detected

UNIONTOWN INDUSTRIAL EXCESS LANDFILL SITE

LOCATION. The Uniontown Industrial Excess Landfill is located in northwestern Lake Township, Stark County, Ohio, within the glaciated portion of the Allegheny Plateau (Delong and White 1963). The thirty-acre site is in the west half of the SE quarter, Section 7, Lake Township TWP 12N Range 10W and is about 500 m south of the intersection of Ohio Route 619 (Edison Street) and Ohio Route 800 (Cleveland Avenue) (Fig. 1).

SITE DESCRIPTION. Sandstone and shale bedrock of the Uniontown Industrial Excess Landfill area belong to the lower Pottsville Group of the Pennsylvanian strata. Preglacial erosion had developed a north-northeast trending ridge that was flanked by two lateral valleys sloping to the north. The crest of the bedrock ridge is generally to the east and roughly parallel to Cleveland Avenue (DeLong and White 1963). Weathering of the various glacial and post-glacial deposits resulted in development of extensive Chili, Conotton, Carlisle and Wheeling soils along with smaller areas of Wooster, Sebring and Linwood soils (Christman 1971). Pedologic soils developed in the various glacial deposits have a wide range of hydrologic conductivities. The well-drained gravels and sands have hydrologic conductivities that may exceed 1×10^2 cm/sec, while glacial till has measured rates of 10^{-4} to 10^{-12} cm/sec (Freeze and Cherry 1979).

Annual precipitation on the site averages about 89.2 cm (36.4 in) per year and is well-distributed throughout the year. Average January temperature is 27.1°F, while the average July temperature is 72.4°F (Christman 1965).

BACKGROUND INFORMATION. J. Bauder observed a coal tipple in 1963 along Cleveland Avenue and to the west side of the area now occupied by the Uniontown Industrial Excess Landfill site. A local resident stated that the tipple was used to sell coal that was mined outside of the area and trucked to the site.

The site of the Uniontown Industrial Excess Landfill was an active sand and gravel pit before 1955. Waste disposal began at this site in 1959. From 1959 into 1964 the site was known as the Kittenger Landfill. The materials approved for inclusion in the Kittenger Landfill by the Ohio Department of Health included fly ash, masonry rubble, paper, scrap lumber, and other non-toxic materials (Dopler 1987, pers. commun.).

The ownership of the site changed and the Uniontown Sanitary Dump opened in 1966. It was not until 1969 that the site was approved by the Ohio Department of Health and subsequently licensed by the Stark County Health Department (SCHD). Records of the SCHD indicate that there were few complaints about the site until 1971, when residents near the site began to complain of fire hazards. About 1971, the Ohio Department of Health approved a procedure for the landfilling of liquid wastes in which the liquids were to be lagooned at the site, mixed with soil and the resultant mix was to be buried. Mr. Joseph Dopler, Chief Sanitarian for the SCHD, stated that before the soil was mixed with the liquid wastes, the lagoon caught fire with an apparent total loss of the liquid wastes. The plan to mix the liquid wastes with soil was abandoned.

In 1978, after lengthy controversies, IEL ceased operation. Residents continued to complain that dumping of materials was occurring at night. The SCHD attempted to close the landfill per requirements of the Ohio Department of Health which included a final cover of clayey materials. Litigation resulted in a court ruling that the final cover of this landfill could be soil materials obtained at or near the site.

In 1983, local residents voiced concerns about the pollution from the Uniontown Industrial Excess Landfill site to township officials, the Stark County Commissioners, the SCHD, the Ohio EPA and other governmental units.

SITE STUDIES. At the request of the SCHD in 1984, J. Bauder utilized available data to review the Uniontown Industrial Excess Landfill site. The first phase of the study was the review of a few water well logs which indicated a rather complex association of glacial deposits over an irregular bedrock topography. After discussion of the initial findings and options for further study, the SCHD requested a more detailed study which consisted of the construction of nine stratigraphic cross-sections using roughly 200 water well logs as the primary data base.

At the same time as the SCHD study, the United States Environmental Protection Agency (USEPA) and the Center of Disease Control performed a preliminary review of water from five water wells with a finding that "the sampled wells were apparently unaffected by the Uniontown Industrial Excess Landfill" (Mohr and Khourey 1984). A more thorough water well study was subsequently performed by the Ohio Environmental Protection Agency in 1984. Although the water quality from the sampled wells was satisfactory, the total dissolved solids and some trace levels of phenols in a few wells suggested the need for further study (Mohr and Khourey 1984). Continued complaints by some of the local citizens led to a major study of the site and the designation of the Uniontown Industrial Excess Landfill site as a "Superfund" site (Johnson & Associates 1985).

Ground water samples obtained from the monitoring wells installed in 1987 (Fig. 5) were split among C. C. Johnson & Associates, IT Corporation, and J. Jackson. The extensive data from the analyses of the numerous samples are being studied. In the meantime, the USEPA has proposed providing a separate water supply system from outside the Uniontown area (Johnson & Associates 1987).

Geologic interpretation of the site should determine the best remedies to what has become a significant public concern. Initially the USEPA released only one of the monitoring well logs, well 10 (Fig. 5). Two of the present authors, J. Jackson and J. Bauder, were on the site at various times before and during the Superfund Study activities. A sample of the gray, compacted, unoxidized till was obtained by coring at a depth of approximately 12 m in the area of the middle depth monitoring well 11 (Fig. 5). Analyses of the till sample indicated a hydraulic conductivity of 4.22×10^{-7} cm/sec. The authors have not had direct access to any other sample cores. Well logs were received from USEPA 14 April 1988. The well logs report textures.

In general, "till" was not reported. The authors believe that was the choice of the contractor.

GEOLOGIC INTERPRETATION OF THE IEL SITE. Summary of the regional and site conditions of the Uniontown Industrial Excess Landfill site included literature searches, personal experiences, and the development and interpretation of nine geologic cross-sections from a data base of 200 water well logs selected from a four square-mile area. Information from 200 water wells was correlated with topographic maps with a scale of 1 to 2400 and a contour interval of 0.6 m, water well test data and other observations. Sketches were prepared with a horizontal scale of 1 to 2400.

The network pattern of the cross sections include part of Sections 6, 7, 8, 17, and 18 of Lake Township, Stark County, Ohio (Fig. 6).

Development of geologic cross-sections using data contained in water well logs has been used for decades. The accuracy of such cross-sections depends on the number of observations or well logs, completeness and accuracy of data from water well logs and interpretation and graphic representation of the data. Limitations include differences introduced by different drilling dates (measured in years), possible errors reported on well logs, fluctuations in the water table and location of the wells for domestic water rather than geologic interpretation.

Analysis of the available data suggest the following sequence of events:

The original pre-glacial topography was characterized by a SW-NE trending bedrock ridge flanked by two parallel valleys.

The valley to the east of this ridge was filled with sand and gravel outwash.

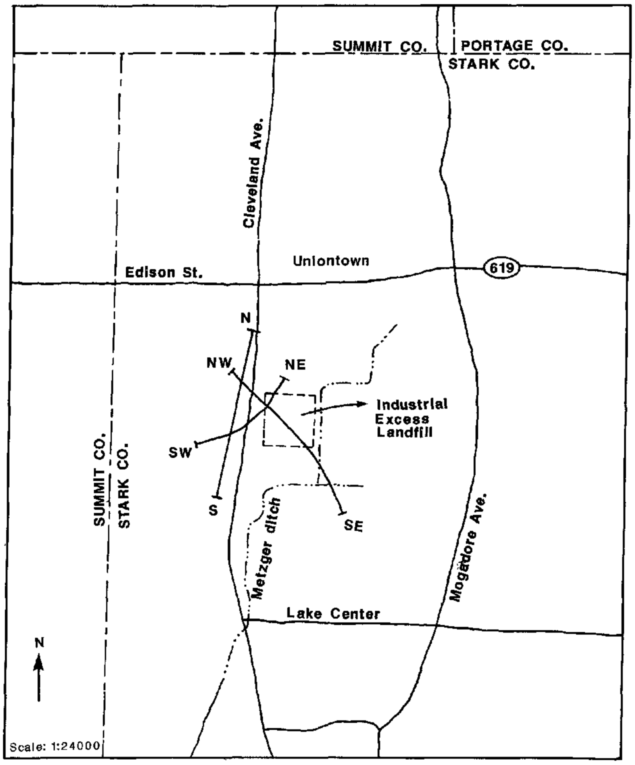

FIGURE 6. Orientation of three cross-sections through, or close by, the IEL site.

As the ice advanced to the west into Summit County, the glacier deposited a layer of very dense and very slowly permeable basal till as it passed over the sand-and-gravel-filled valley, the bedrock ridge and the valley to the west.

The ice front "retreated" to the east to about the alignment of Cleveland Avenue and during ablation, outwash sands and gravels were deposited over the till deposit (Figs. 7, 8, 9).

The ice front then readvanced to the west, moving over the sand and gravel outwash and depositing another layer of gray, dense basal till. There are indications of multiple glacial events within the study area (White 1982).

The ice sheet stalled, melted in place, and deposited ablation drift (melt-out till).

Isolated lenses and kames of sands and gravels were deposited in and adjacent to the landfill area before and during the ablation phase.

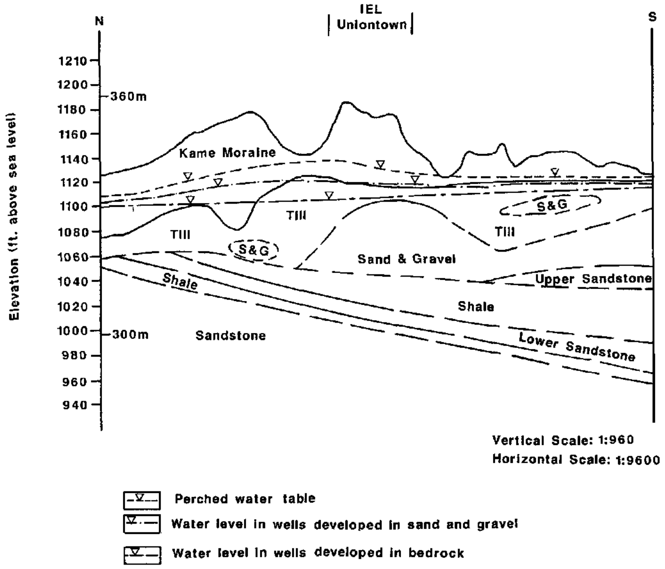

FIGURE 7. NS cross-section west of and nearly parallel to Cleveland Avenue. Refer to Fig. 6 for location relative to IEL.

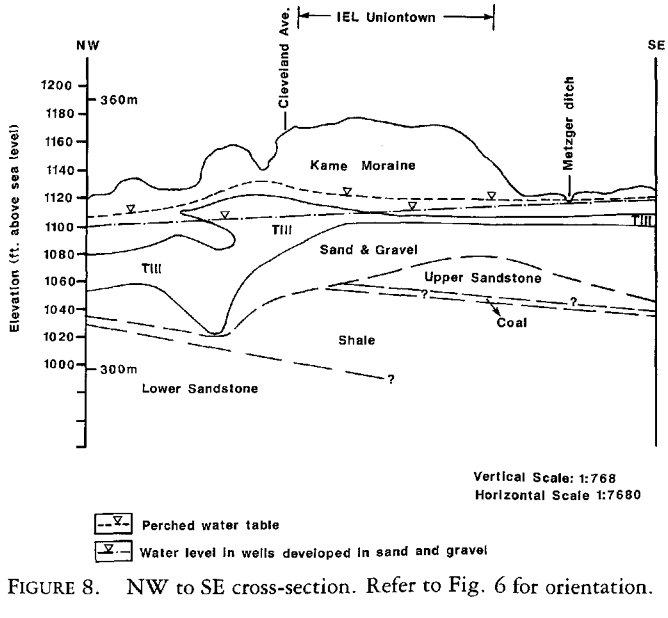

FIGURE 8. NW to SE cross-section. Refer to Fig. 6 for orientation.

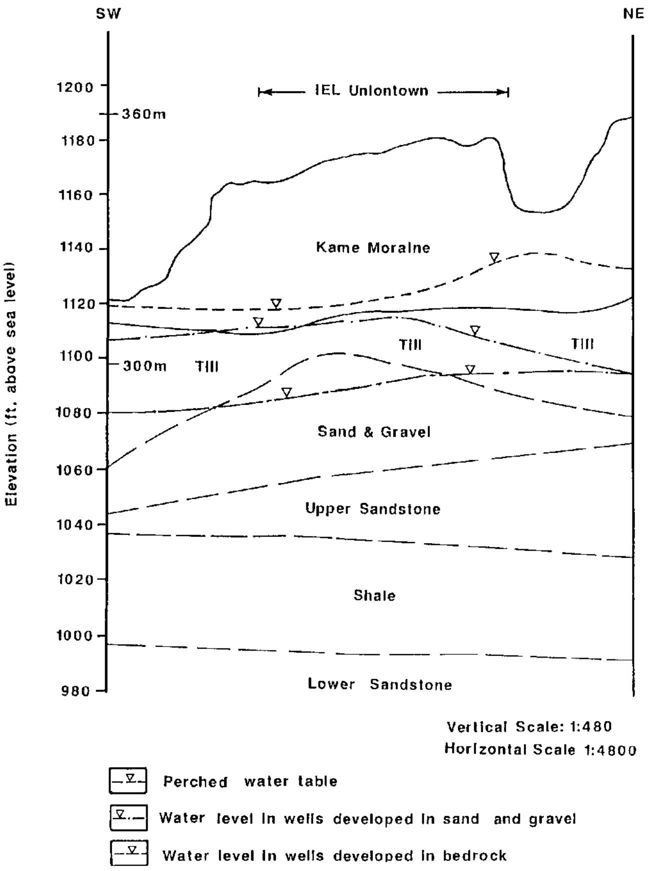

FIGURE 9. NE to SW cross-section. Refer to Fig. 6 for orientation.

A lateral ice contact deposit of sand and gravel was deposited on top of the lodgment till. The entire area was then blanketed by a deposit of loess with thickness of about one meter.

SITE CHARACTERIZATION. The Industrial Excess Landfill is on the crest and east flank of a sand and gravel ridge above a bedrock ridge. Sand and gravel were deposited first over the bedrock and/or basal till and was then covered by a layer of dense, gray basal till. Thickness of the gray basal till beneath the area of the landfill ranges from 1.4 to over 2 m thick unless it was not deposited or was eroded during the ice advance. The ice contact deposit above the lodgment till provided the bulk of the sand and gravel removed during the gravel pit operations. The landfill is on the east flank of the nearly N-S trending ridge (Fig. 6).

The surface of the ridge is quite irregular and includes several large depressions, i.e., kettles, which occur to the north, northwest and west of the landfill site. Depressions prevent surface run-off water from escaping the area and infiltration is enhanced. Depressions act as ground water recharge areas for the shallowest water table perched over the clayey horizon(s) (Fig. 7).

Areas of shallow depressions and flattened slopes occur in the existing surface grade of the western third of the landfill site. The depressions enable water to infiltrate into the soil material while the flattened areas allow somewhat less surface water infiltration into the landfilled materials. Evapotranspiration measurements have not been made. Average slopes in the general area permit 15-25% of the precipitation to infiltrate into the soil.

The basal till layer acts as the barrier upon which the infiltrating (perched?) water collects and moves. The lodgment till has an effective permeability of less than 1×10^{-6} cm/sec. This perched water will be referred to as the upper aquifer. It is involved in the water sampling from shallow monitor wells.

The perched water flows down gradient from the depressions, ground water recharge points, radiating in all directions. Water well log data suggest part of the perched water flows to the south and east toward and parallel to the landfill.

The next lower aquifer, the middle aquifer, is the outwash sand and gravel deposits beneath the dense basal till. This ground water aquifer is recharged east of the landfill site, and the water flows toward the west. The water well logs indicate the sand and gravel aquifer to be artesian, and when it was tapped by a water well, the water rose in the well casing to about the top of the overlying basal till. If the sand and gravel aquifer have experienced a loss of head and are no longer artesian under the study site, the loss of artesian pressure could enable increased movement of leachate through the bottom of the landfill and into the underlying sand and gravel aquifer. The medium depth water monitor wells were to sample the middle aquifer.

The sandstone bedrock units, which comprise the deep aquifer, dip to the southeast while the apparent direction of ground water flow is to the south.

Water supply wells which suggested low levels of water pollution in the study by Mohr and Khourey (1984) probably receive all or most of their water supply from the shallowest, perched water table flowing on top of the dense basal till deposit.

Numerous anecdotal comments about a coal mine on the site of the Uniontown Industrial Excess Landfill are unsubstantiated. Correlation of bedrock data indicates that a coal seam(s) could lie beneath the landfill. If the coal was present after glaciation, the coal seam would have been overlain by up to 9 m of water-saturated sand and gravel making a coal-mining operation very unlikely.

Most of the soil materials used in final cover material for IEL came from an area adjacent to the southwest corner of the site. These aggregate materials generally contained less than 20% fines and were apparently similar to the aggregate materials sold from the prior sand and gravel pit operations at IEL. Earth-moving activities caused the aggregate cover material to become much more compacted and less porous. In 1986, J. Bauder observed depression areas on top of the cover material that held surface water for significant periods of time.

DISCUSSION

Analysis of the cross-sections verified the lateral extent of the very slowly permeable, generally gray-colored basal till in and adjacent to the large ridge upon which IEL is located. Analysis of the cross-sections was unable to determine that the dense till deposit is continuous in all places. Isolated openings in the basal till deposit could occur as the result of natural erosive actions, lack of deposition or human activity.

Originally the perched water table generally radiated from the ground water recharge points located to the north and west of the Uniontown Industrial Excess Landfill site and flowed to the southeast, east and south directions in the area of the landfill. It is possible that the landfill activity at the study site has altered the flow directions of the uppermost perched water table.

Grading and compaction of the landfilled materials have lessened the effective hydraulic conductivity of the fill to much less permeable conditions than the original sand and gravel deposit. Lessened internal permeability acts to slow the rate of water movement through the Uniontown Industrial Excess Landfill site and create a higher free water mound condition in the landfilled materials than occurred in the original sand and gravel materials. The heightened free water mound very probably alters the preceding radial flow pattern by diverting the perched water table flow around the landfilled materials.

The heightened free water mound associated with the landfilled materials is augmented by the increased water infiltration into the site caused by the extensive areas of nearly level and depressionary areas occurring in the western third of the Uniontown Industrial Excess Landfill site. The areas of the level and depressionary slopes are apparently the result of the decomposition and settlement of the landfilled materials. Heightened mounded water condition could effect a change in water table movement in the overall area by reversing the direction of free water flow in the western portion of the landfilled materials from the previous east-southeast to the west-southwest directions.

Leachate flowing westward out of the IEL would mingle with the perched water table and tend to flow in the general southward direction along the west side of the site. The mingling of the possible leachate and water of the perched water table may create a second but lower perched water condition that would divert the perched water table flow to a more westerly direction.

REMEDIAL ACTIVITIES (IEL)

Already completed is the USEPA control of gas migration (not addressed in this study). Residents along the west boundary of IEL have ceased to use their wells for drinking water. A central water system for at least 100 homes has been proposed.

In addition the authors suggest:

1. Correlation in more detail of existing water well test data with the differing aquifer(s);
2. Determination of the water budget for the site and development of a system to control the waste on site;
3. Optimization of system use with minimal maintenance;
4. Continuation of selective water sampling and monitoring to determine the longer term changes in ground water quality of the different aquifers;
5. Determination of the length of casing of the water wells that did not have drilling logs and verify the length of casing of a number of water wells whose drilling logs are available if the wells are to be used for future water tests;
6. Conduction of a magnetic survey of the Uniontown Industrial Excess Landfill site and the surrounding area to determine the estimated amounts of buried ferrous metals as compared to the background magnetic levels. (A magnetic survey should enable a check of the frequent reference of thousands of drums of waste buried at this site. Anomalies would be checked, and citizens' concerns about buried drums would be alleviated); and
7. Establishment of a less permeable cap and completion of the final cover over the Uniontown Industrial Excess Landfill site, and establishment of a final grade to maintain positive surface drainage of the site.

SUMMARY

Geologic descriptions of the Hardy Road Landfill and the Industrial Excess Landfill have been provided. Concerns about ground water contamination and gas migration were put in a context of known geological conditions at the two sites. Adverse environmental impacts of both sites are lessened by the natural geologic conditions at depth relative to highly permeable sands and gravels at the surface.

The presentation of site-specific data suggests future monitoring and risk assessment. Our ground water analyses at IEL were based on one sampling of the monitoring wells, and more sampling should be done. Relatively low levels of contamination from waste placed in sand and gravel, with no liner below or along the side of the waste, suggest natural control of contamination that must be thoroughly interpreted and exploited before final remedial work is begun on the site.

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