S9072

233-0185

Shiffs, Graves & Associates, Inc.

15 March 1983

Clyde E. Williams & Associates
1843 Commerce Drive
South Bend, Indiana 46628

ATTN: James Brush

RE: Soil Borings
Excel Industries
Elkhart, Indiana

Gentlemen:

As requested by Mr. Brush we have made 13 soil borings 16.5 to 40 feet deep at the subject project. We have also made four grain-size analyses of typical soils that we encountered in the borings. We have also studied the geology of the area and read the agricultural soil map covering the site.

Geology

Geology tells us that the site is in the Kankakee Drainage path of glacial times. This drainage path carried glacial meltwater for so long that it silted up as rivers do and the St. Joseph River is all that is left of this drainage path which was many miles wide. Stratified sands and gravels were deposited in the path when the waters were flowing fast and silts and clays were deposited when the waters were blocked or moving slowly. Two soil borings 75 feet deep were made in 1982 on the west side of Main Street across from the Durakool plant. These borings found 42.5 to 44.5 feet of stratified sand and gravel over silt or clay. Well logs have shown the silt and clay to be 50 to 80 feet thick and that it is underlaid by sand and gravel which can supply water. Shale bedrock is 160 to 200 feet below the surface.

Soil Map

The agricultural soil map of Elkhart County shows that the natural surface soils at the site are uniformly Oshtemo loamy sand. This is described as a deep, well drained soil developed on glacial outwash. The typical soil profile is up to 14 inches of sand topsoil underlaid by about 34 inches of silty or clayey sand and then stratified sand and gravel. The soils are quite permeable and water tables are more than 6 feet below the surface.

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Soil Borings

The logs of the 13 soil borings together with graphic logs are attached hereto. Samples of all soils encountered are stored in our laboratory awaiting your instructions for their disposal.

The boring logs show that the soil is stratified sand and gravel to depths of 37.5 to 39.5 feet where clayey silt is encountered. The top surface of the sand has been disturbed by the use of the ground to depths of 5 or 6 feet. The sand is loose to depths of up to 9.0 feet and medium to dense below that. The clayey silt is very stiff. Water was encountered 11.4 to 19.2 feet below the surface at elevation 727 to 730. As was expected the water table sloped downward toward the interceptor wells that were installed on the west side of Main Street. The normal direction of the water table would be to the south toward the St. Joseph River. The top of the clay layer also slopes that direction so pollutants heavier than water would tend to go down to the clay layer and travel toward the west.

Grainsize Analyses

The grainsize analyses were made to check the visual soil classification and to help estimate the soil permeability. The results of the analyses are shown on the attached grainsize curves. The fine sand would have an estimated permeability of 0.04 cm/sec. The fine to medium sand would have an estimated permeability of 0.06 cm/sec. The fine to coarse sand and gravel would have an estimated permeability of 0.09 cm/sec. The clayey silt would have an estimated permeability of 3.6×10^{-7} cm/sec. Pollutants tend to travel downward and to move laterally in the more permeable layers of soil so the highest concentration of pollutants should be in the most permeable layers nearest the source.

Discussion

Visually the highest concentration of pollutants is in the area of Boring 13 in the coarser sand layer below a finer sand layer. The visual pollution was higher up in Borings 4, 7, 8, 9, 19 and 27 indicating more recent pollution. The chemical tests may show a different distribution. We will be glad to discuss the distribution of pollutants when you have the results of the chemical tests.

Sincerely,

SHILTS, GRAVES & ASSOCIATES, INC.

Leroy D Graves

Leroy D. Graves, P.E.
Vice-President & Treasurer

LDG:pk
Enclosures

TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-1
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 748.35
Weather Sunny, cool Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 18.9 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	3.8	SAND - brown fine sand trace silt.	1	0.0	1.5	100	2-1-1	Very loose.
			2	1.5	3.0	100	2-1-1	Very loose.
3.8	5.2	SILTY SAND - dark brown to black silty fine sand.	3	3.0	4.5	100	1-1-5	Loose.
5.2	9.7	SAND - brown fine sand some gravel.	4	4.5	6.0	100	4-5-5	Loose.
			5	6.0	7.5	100	3-3-2	Loose.
			6	7.5	9.0	44	2-5-8	Medium.
9.7	13.7	SAND - light brown fine sand.	7	9.0	10.5	100	8-9-11	Medium.
			8	10.5	12.0	100	9-11-12	Medium.
			9	12.0	13.5	100	11-13-16	Medium.
13.7	21.2	SAND and GRAVEL - brown fine to coarse sand and gravel.	10	13.5	15.0	78	12-13-15	Medium.
			11	15.0	16.5	100	13-13-15	Medium.
			12	16.5	18.0	78	10-10-9	Medium.
			13	18.0	19.5	78	8-11-14	Medium, wet @ 18.9 Ft.
			14	19.5	21.0	100	10-13-11	Medium, wet.
21.2	22.5	SAND - brown fine to medium sand some gravel.	15	21.0	22.5	100	7-7-9	Medium, wet.
								End of boring: 22.5 Ft.

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TEST BORING LOG

Shiltz, Graves & Associates, Inc.

Boring No. E-2
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries

City Elkhart County Elkhart State Indiana

Boring Location As shown on location sketch Datum Mean sea level

Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 748.14

Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH

Sampler: Type Split-barrel Size 2.0" O.D. At Completion 19.2 Ft.

Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	0.3	TOPSOIL - dark brown to black sand topsoil.	1	0.0	1.5	100	2-2-1	Very loose.
0.3	5.0	SAND - brown fine sand.	1	0.0	1.5	100	2-2-1	Very loose.
			2	1.5	3.0	100	2-1-2	Very loose.
			3	3.0	4.5	78	1-1-1	Very loose.
5.0	5.8	SAND and GRAVEL - black silty fine sand and gravel.	4	4.5	6.0	100	5-7-7	Medium.
5.8	6.3	SAND - medium brown fine sand trace gravel.	5	6.0	7.5	100	6-5-4	Loose.
6.3	9.0	SAND - brown fine to medium sand some gravel.	5	6.0	7.5	100	6-5-4	Loose.
			6	7.5	9.0	100	4-4-3	Loose.
9.0	14.8	SAND - light brown fine sand.	7	9.0	10.5	100	4-6-8	Medium.
			8	10.5	12.0	100	7-8-12	Medium.
			9	12.0	13.5	100	12-13-13	Medium.
			10	13.5	15.0	100	9-13-15	Medium.
14.8	19.2	SAND - medium brown fine to coarse sand some gravel.	11	15.0	16.5	100	9-11-17	Medium.
			12	16.5	18.0	78	23-21-27	Dense.
			13	18.0	19.5	17	23-17-14	Medium.
19.2	22.5	SAND - medium brown medium to coarse sand some gravel.	14	19.5	21.0	78	8-6-8	Medium, wet.
			15	21.0	22.5	100	5-7-4	Medium, wet.
								End of boring: 22.5 Ft.

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TEST BORING LOG

Shiits, Graves & Associates, Inc.

Boring No. E-3
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries

City Elkhart County Elkhart State Indiana

Boring Location As shown on location sketch Datum Mean sea level

Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 747.51

Weather Sunny, mild Boring Method Hollow stem auger GROUND WATER DEPTH

Sampler: Type Split-barrel Size 2.0" O.D. At Completion 18.1 Ft.

Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Hole caved 12.2 Ft.

Soil Layer Limits From	To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	3.8	SAND - brown fine sand.	1	0.0	1.5	100	3-6-5	Medium.
			2	1.5	3.0	100	3-4-4	Loose.
3.8	4.3	SILTY SAND - black silty fine sand gravel and cinders.	3	3.0	4.5	100	5-17-13	Medium.
4.3	7.4	SAND - brown fine to medium sand trace silt and gravel.	4	4.5	6.0	100	10-8-7	Medium.
			5	6.0	7.5	100	7-6-8	Medium.
7.4	14.0	SAND - light brown fine sand.	6	7.5	9.0	100	9-11-14	Medium.
			7	9.0	10.5	100	8-10-10	Medium.
			8	10.5	12.0	100	14-16-18	Dense.
			9	12.0	13.5	100	12-14-24	Dense.
14.0	18.1	SAND and GRAVEL - brown fine to medium sand and gravel.	10	13.5	15.0	100	16-18-12	Medium.
			11	15.0	16.5	78	8-8-12	Medium.
			12	16.5	18.0	78	12-16-12	Medium.
18.1	21.0	SAND and GRAVEL - brown medium to coarse sand and gravel.	13	18.0	19.5	67	7-9-9	Medium, wet.
			14	19.5	21.0	78	5-5-7	Medium, wet.
								End of boring: 21.0 Ft.

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3. ANALYTICAL PROCEDURES AND RESULTS

Laboratory analysis of soil samples was performed by Measurement Science Corporation (MSC), 300 Garden City Plaza, Garden City, New York. The samples were shipped UPS next day service and upon arriving at the laboratory were extracted and analyzed according to protocol established in the Federal Register "Guidelines Establishing Test Procedures for Analysis of Pollutants", 40 CFR Part 136 (December 3 and 18, 1979). Quality assurance was performed as described in the Federal Register and in the Handbook for Analytical Quality Control in Water and Wastewater Laboratories (EPA-600/4-79-019. In addition, analytical procedures were consistent with:

U.S. EPA "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants", April 1977.

U.S. EPA "Methods for Chemical Analysis of Water and Wastes" (EPA-600/4-79-020).

U.S. EPA "Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue Analysis of Sediment for Volatile Organics", Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Accordingly, trichloroethylene (TCE) concentrations were determined using currently accepted, standardized analytical methodology, consistent with the purge and trap gas chromatography (GC) procedure for purgeable volatile halocarbons (EPA Method 601).

Samples were extracted with methanol. A portion of each extract was diluted with water and extracted with isooctane. The final extracts were analyzed by electron-capture gas chromatography.

The gas chromatography (GC) analysis utilized three Varian Model 3700 gas chromatographs. (Varian Associates, Palo Alto, CA).

The GC analysis of the samples from 13 soil borings showed the presence of trichloroethylene in 67 out of 68 samples collected from depths at ground surface to 40 feet. The concentrations of TCE detected are listed in Table 3-1.

Illustration 2-1 shows the locations of the borings.

Illustrations 3-1 and 3-2 indicate spot TCE concentrations at the borings and the zones of contaminated soil in the top 4 feet of soil and at the 4 foot interval from 12 to 16 feet of soil at the water table surface.

Illustrations 3-3 and 3-4 indicate cross sectional views of the vertical contaminant concentrations of TCE.

Soil boring graphic logs found in the Appendix visually indicate the vertical distribution of the visible and odorous hydrocarbons observed during boring operations.

TABLE 3-1
CONCENTRATIONS OF TRICHLOROETHYLENE (TCE)
DETECTED IN SOIL FROM TEST BORINGS
(MICROGRAMS PER KILOGRAM, ug/kg) (PARTS PER BILLION, ppb)
SAMPLES COLLECTED WEEK OF FEBRUARY 14, 1983

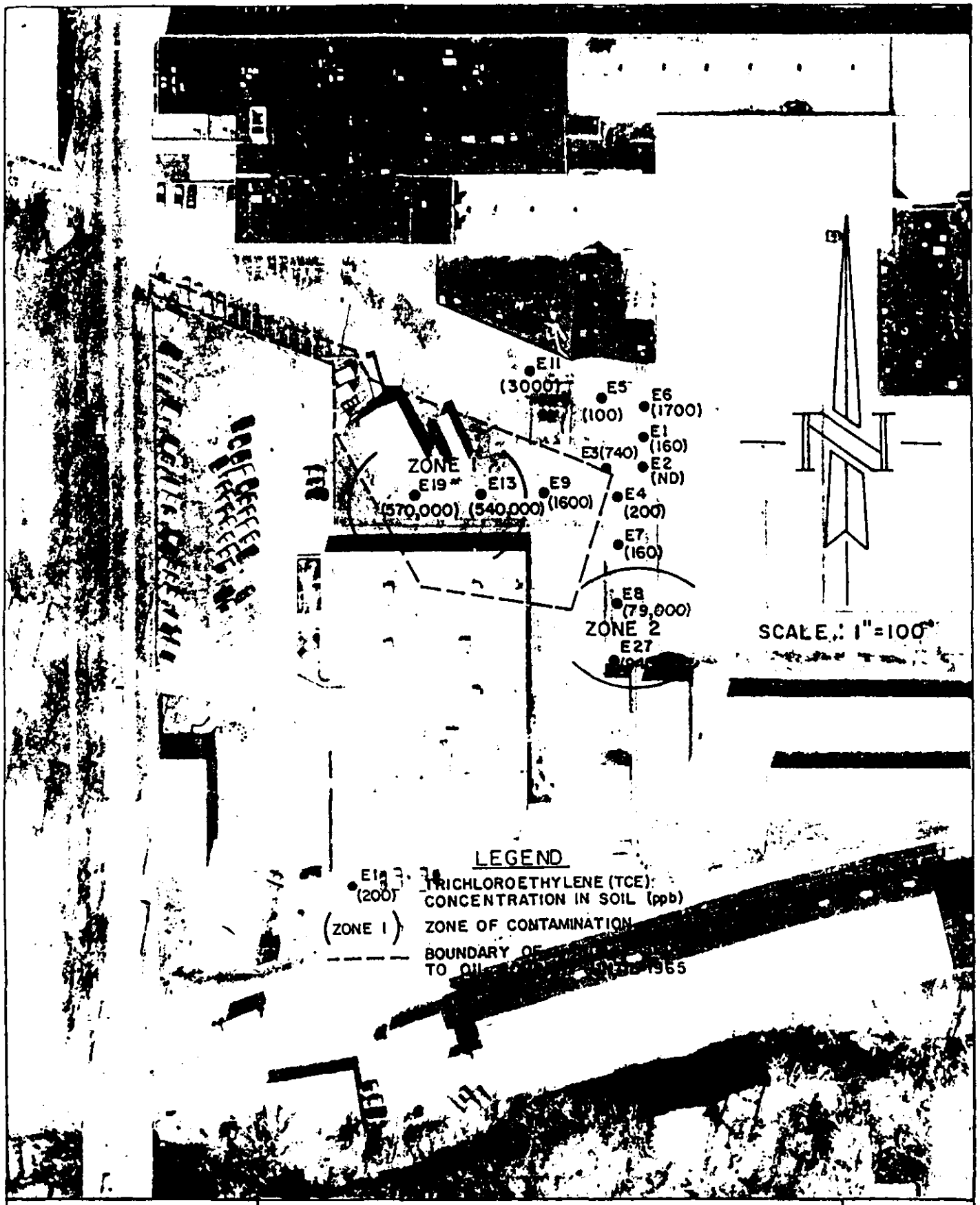
Depth From Surface (Feet)	Test Boring Designations												
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E11	E13	E19	E27
0-4	160	ND	740	200	100	1700	160	79,000	1600	3000	540,000	570,000	940
4-8	13,000	410	50	1200	100	180	60	1,600	160	70	82,000	270,000	140
8-12	260	80	560	240	1000	330	290	1,200	130	390	1,300	23,000	410
12-16	340	340	80	300	3800	540	820	3,400	340	210	520	4,100	2000
16-20	300	520	620	-	920	250	-	-	-	130	-	2,200	4200
23.5-25	-	-	-	-	-	-	-	-	-	-	-	850	1100
28.5-30	-	-	-	-	-	-	-	-	-	-	-	590	1700
33.5-35	-	-	-	-	-	-	-	-	-	-	-	2,200	240
37.5-40	-	-	-	-	-	-	-	-	-	-	-	5,300	50

ND = Nondetectable at less than 50 ppb
- = No sample collected

Test results based on sample as received.

Organic free soil field blank was less than 50 ppb.

Method blank was less than 50 ppb.



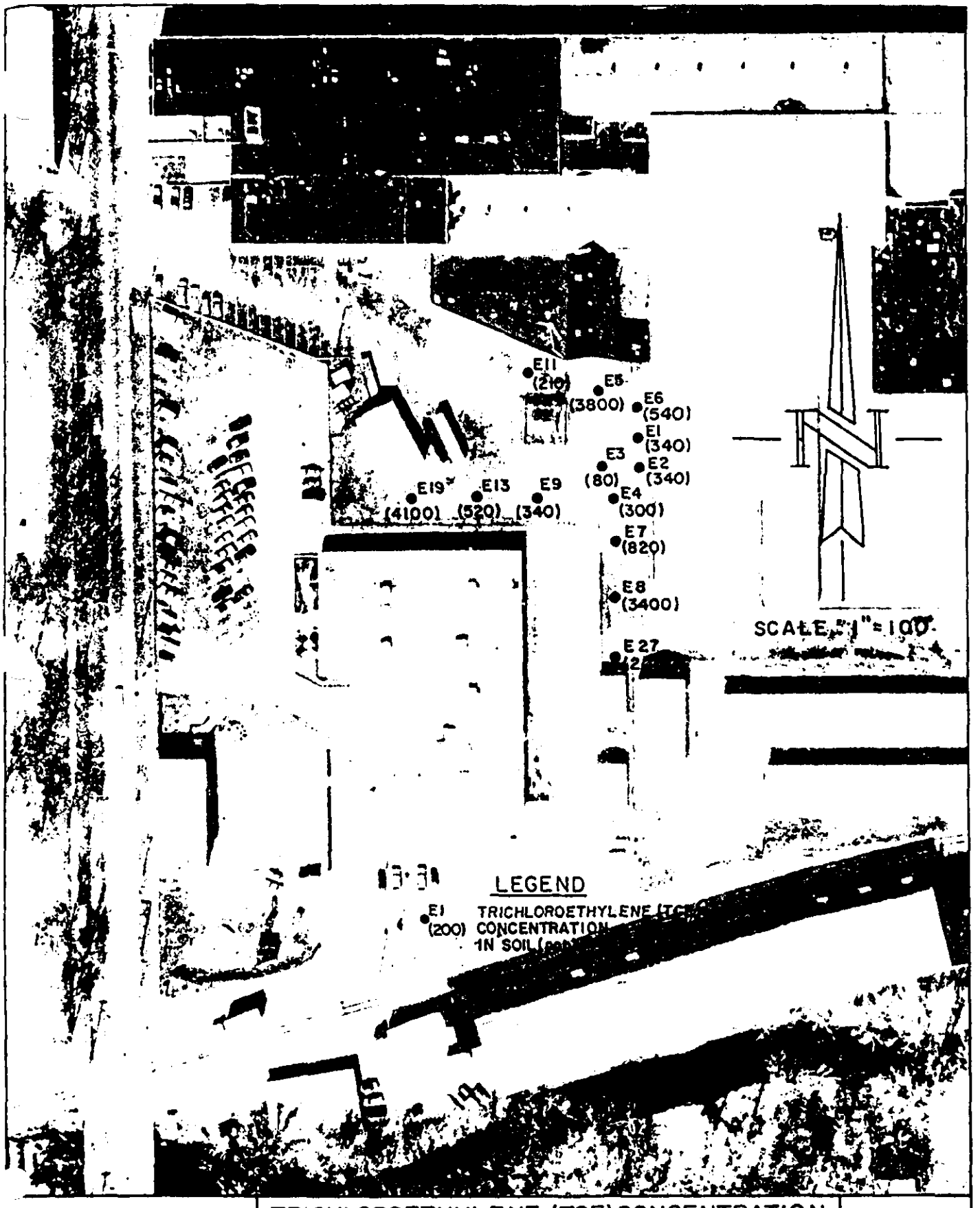
CEWA

CLYDE E. WILLIAMS
& ASSOCIATES, INC.
PROFESSIONAL ENGINEERS

TRICHLOROETHYLENE (TCE) CONCENTRATION IN SOIL AT DEPTH OF 0 TO 4 FEET

EXCEL CORP. SOILS INVESTIGATION
ELKHART, INDIANA

ILLUSTRATION



CEWA

CLYDE E. WILLIAMS & ASSOCIATES, INC.
PROFESSIONAL ENGINEERS

TRICHLOROETHYLENE (TCE) CONCENTRATION IN SOIL AT DEPTH OF 12 TO 16 FEET

EXCEL CORP. SOILS INVESTIGATION
ELKHART, INDIANA

ILLUSTRATION 3-2

4. DISCUSSION OF RESULTS

Trichloroethylene (TCE) concentrations correlate well with visual and odor characteristics of the soil being sampled. The field observations are recorded in Illustrations 3-3 and 3-4 on the right hand side of the graphical boring log and indicate at which depths visible and/or odorous hydrocarbons were encountered.

Rainfall infiltration directly affects the contaminant migration serving as the driving force for a contaminant plume. The concentration gradient of contaminants (i.e. the difference in contaminant concentration between two points) and the hydraulic gradient (difference in water surface elevations between two points) are the two main influential components for diffusion and mass transport of the contaminants.

The hydraulic gradient across the study area which slopes toward the west was measured to be 0.0044 foot per foot.

An approximation for groundwater velocity at the site in the strata of sand and gravel at about 12 to 16 feet deep may be calculated using Darcy's Equation:

$$V = K\ dh/dl \times \frac{1}{NE}$$

where: K = hydraulic conductivity

dh/dl = hydraulic gradient

NE = Effective porosity

Hydraulic conductivity (K) based on the grain size determination for the fine to coarse sand and gravel is estimated to be 0.09 cm/sec.

Hydraulic gradient, dh/dl = 1.11'/250' = 0.0044.

Effective porosity is about 0.35 (visual observation)

[redacted] conditions the groundwater flow velocity is about

$$V = 0.09\ cm/sec \times 0.0044 \times \frac{Ft}{30.48\ cm} \times \frac{86400\ sec}{day} \times \frac{1}{.35}$$ [redacted]

As indicated by water table elevations measured in the bore holes, the water table slopes downward toward the west and toward the existing interceptor wells. Though groundwater velocity is estimated to be about 3 ft/day the rate of contaminant migration may not be equivalent to the groundwater velocity.

The organic material may form a separate phase not totally solubalizing into the groundwater and lag behind the actual groundwater flow. Furthermore, large quantities of contaminant moving through the soil may leave residues in capillaries that leach for an extended period of time.

Advance of contaminant in sand layers and lenses of different permeability may produce a pattern commonly referred to as fingering. In this case the contaminant is transported more rapidly in the lenses or beds of higher hydraulic conductivity. (after Freeze and Cherry, 1979)

This may explain why pockets of high TCE concentrations are found at distances from the identified contaminate zones and at varying depths.

5. SUMMARY AND CONCLUSIONS

5.1 SUMMARY

This report summarizes the findings of a soils investigation conducted within the Excel Corporation property in Elkhart, Indiana. Soil samples were collected at locations in the open areas on Excel property. Soil borings ranged in depth from zero (0) to 40 feet with samples being taken with a 2-inch diameter split spoon sampler. Samples consisted of four foot cores throughout the depth of the boring. Samples represent the vertical TCE concentration profile of the soil. The soil samples were analyzed for trichloroethylene (TCE).

5.2 CONCLUSIONS

Based upon the interim results of soil borings, laboratory analyses and interpretations, the following conclusions are drawn:

1) There exists two areal zones of heavily contaminated soil containing trichloroethylene (TCE). One zone is located near the southwest corner of Excel property near the locations of former oil storage tanks (Zone 1) and one zone is located near the southwest corner of the Excel Building 1966 Addition (Zone 2). An isolated high concentration of trichloroethylene (13,000 ppm) was detected in Boring E1 at the 4 to 8 foot depth.

2) The most heavily TCE contaminated soil (20,000 ppb to 570,000 ppb) in these areal zones extends from the location of the topsoil to a depth of 12 feet.

3) The deep soil borings (to 40 feet) indicate that the trichloroethylene, being denser than water, has vertically leached and settled to the gray clayey silt layer where it forms a zone of contaminated soil on and above the layer underlying the site in the vicinity of the boring.

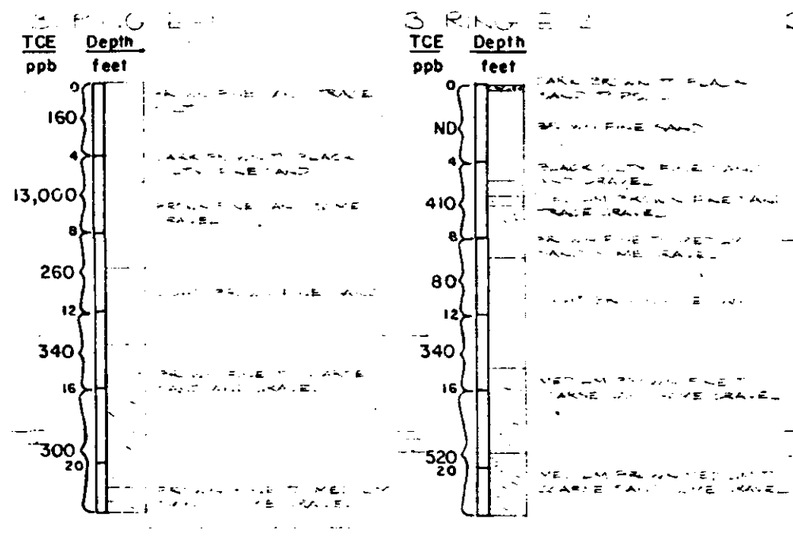
4) As indicated by water table elevations measured in the bore holes, [redacted]

APPENDICES

SOIL INVESTIGATION

Excel
Elkhart, Indiana

March 1983



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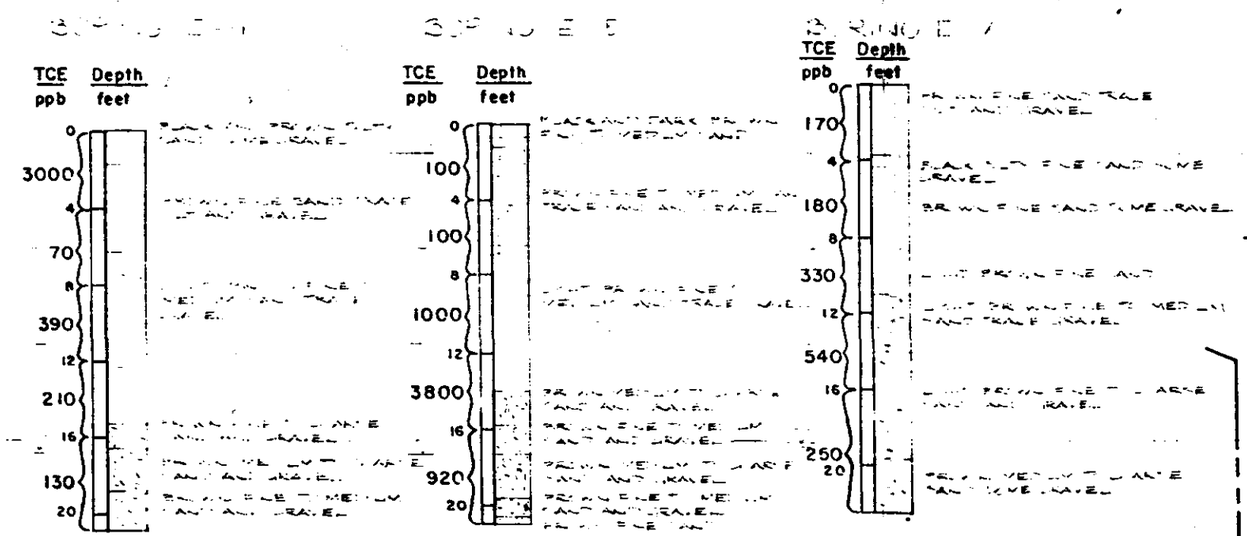

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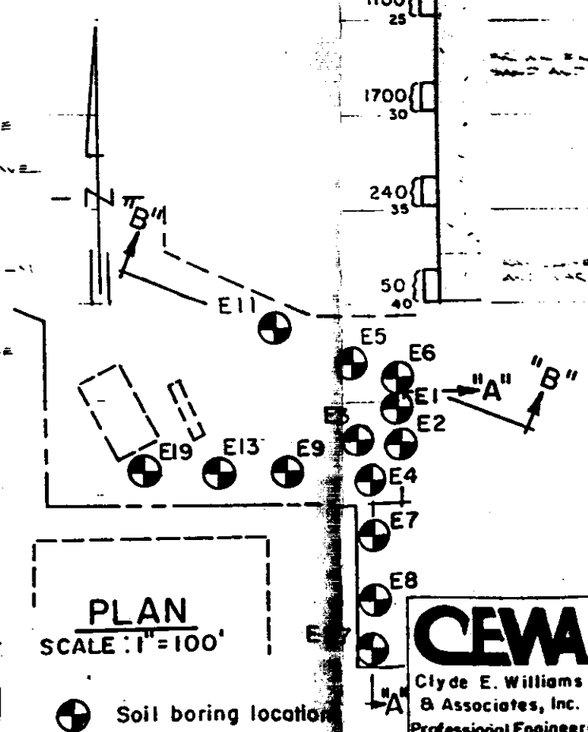


PLAN
SCALE: 1" = 100'

Soil boring location

LEGEND

TCE ppb — Trichloroethylene concentration in soil collected week of February 7 & 14, 1983. (ppb = parts per billion)

Depth feet — Depth from surface of ground and interval of soil sample collected with 2-inch O.D. splitspoon soil sampler.

ND — Non-detectable at less than 50 ppb

GROUND WATER DEPTH OF COMPLETION POINT AT WHICH SAMPLES BECAME WET

HYDROCARBON OR OIL ODOR

SLIGHT OIL OR SLIGHT HYDROCARBON ODOR

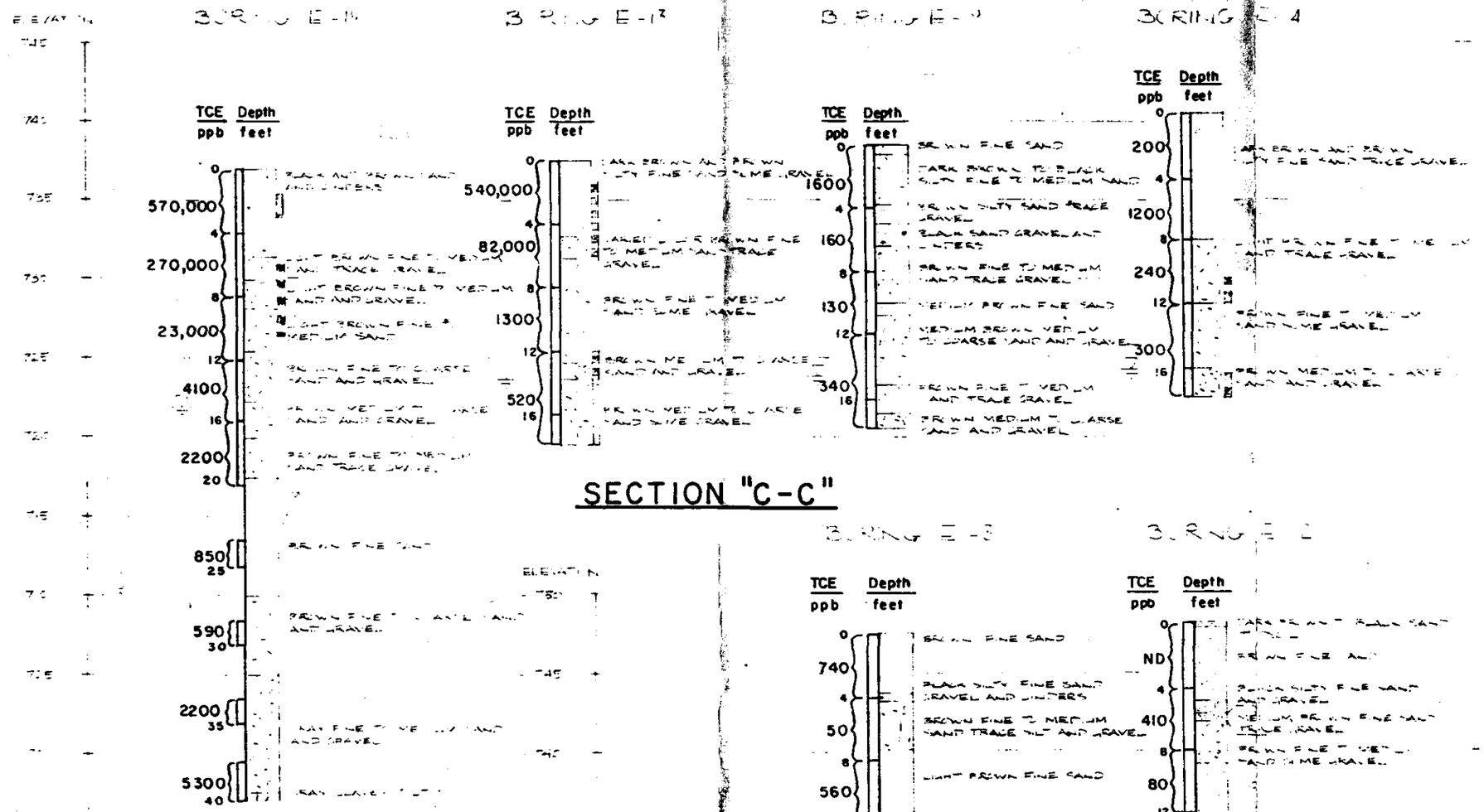
ILLUSTRATION 3-3

CEWA
Clyde E. Williams & Associates, Inc.
Professional Engineers

SOIL INVESTIGATIONS
EXCEL INDUSTRIES
ELKHART, INDIANA
JOB NO. 85-100

APRIL, 1983

GRAPHIC LOGS



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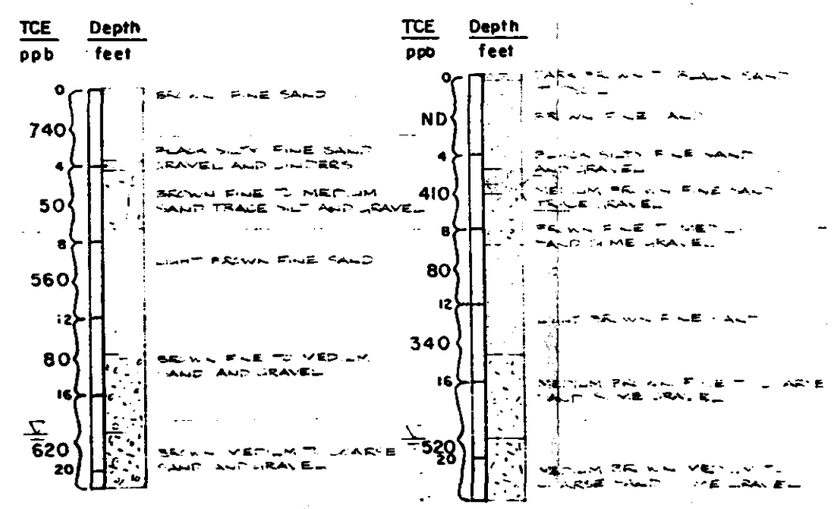

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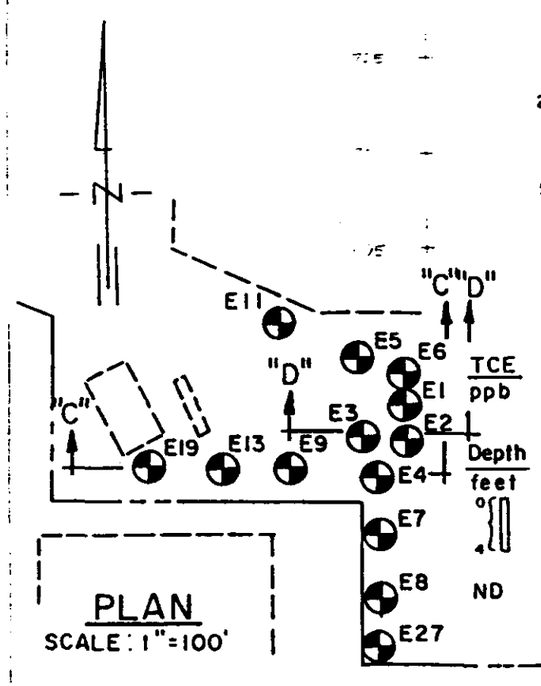

PLAN
SCALE: 1"=100'

LEGEND

Trichloroethylene concentration in soil collected week of February 7, 1983. (ppb = parts per billion)

Depth from surface of ground and interval of soil sample collected with 2-inch O.D. splitspoon soil sampler.

ND Non-detectable at less than 50 ppb

Soil boring location

ILLUSTRATION 3-4

CEWA
Clyde E. Williams & Associates, Inc.
Professional Engineers

SOIL INVESTIGATIONS
EXCEL INDUSTRIES
ELKHART, INDIANA
JOB NO. 83-186 SHEET 2 OF 2
APRIL, 1983

TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-4
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries

City Elkhart County Elkhart State Indiana

Boring Location As shown on location sketch Datum Mean sea level

Date Started 2-11-83 Date Completed 2-11-83 Surface Elevation 745.57

Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH

Sampler: Type Split-barrel Size 2.0" O.D. At Completion 16.2 Ft.

Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	8.0	SILTY SAND - dark brown brown and brown silty fine sand trace gravel.	1	0.0	1.5	100	3-2-2	Very loose.
			2	1.5	3.0	67	1-1-1	Very loose.
			3	3.0	4.5	67	1-1-1	Very loose.
			4	4.5	6.0	100	2-6-6	Medium.
			5	6.0	7.5	44	3-5-6	Medium.
8.0	12.1	SAND - light brown fine to medium sand trace gravel.	6	7.5	9.0	11	8-9-11	Meidum.
			7	9.0	10.5	100	9-12-12	Medium.
			8	10.5	12.0	100	12-13-15	Medium, slight oil odor.
12.1	16.2	SAND - brown fine to medium sand some gravel.	9	12.0	13.5	100	7-8-12	Medium.
			10	13.5	15.0	100	12-15-18	Dense.
			11	15.0	16.5	100	16-18-17	Dense.
16.2	18.0	SAND and GRAVEL - brown medium to coarse sand and gravel.	12	16.5	18.0	100	8-6-5	Medium, slight oil odor.
								End of boring: 18.0 Ft.

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-5
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries

City Elkhart County Elkhart State Indiana

Boring Location As shown on location sketch Datum Mean sea level

Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 746.52

Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH

Sampler: Type Split-barrel Size 2.0" O.D. At Completion 17.3 Ft.

Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	1.2	SAND - black and dark brown fine to medium sand.	1	0.0	1.5	78	3-4-4	Loose.
1.2	6.4	SAND - brown fine to medium sand trace sand and gravel.	2	1.5	3.0	22	3-3-4	Loose.
			3	3.0	4.5	100	3-2-3	Loose.
			4	4.5	6.0	78	2-2-2	Very loose.
6.4	14.0	SAND - light brown fine to medium sand trace gravel.	5	6.0	7.5	100	2-3-5	Loose.
			6	7.5	9.0	100	9-12-14	Medium.
			7	9.0	10.5	100	10-14-15	Medium.
			8	10.5	12.0	100	14-15-15	Medium.
			9	12.0	13.5	100	8-12-15	Medium.
14.0	15.8	SAND and GRAVEL - brown medium to coarse sand and gravel.	10	13.5	15.0	100	10-15-19	Dense.
15.8	17.3	SAND and GRAVEL - brown fine to medium sand and gravel.	11	15.0	16.5	100	11-15-16	Dense.
17.3	19.6	SAND and GRAVEL - brown medium to coarse sand and gravel.	12	16.5	18.0	100	15-13-10	Medium, wet.
			13	18.0	19.5	0	7-10-13	Medium, wet.
19.6	20.6	SAND and GRAVEL - brown fine to medium sand and gravel.	14	19.5	21.0	100	7-12-15	Medium, wet.
20.6	21.0	SAND - brown fine sand.	14	19.5	21.0	100	7-12-15	Medium, wet.
								End of boring: 21.0 Ft.

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-6
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 748.65
Weather Sunny, mild Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 18.8 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	3.7	SAND - brown fine sand trace silt and gravel.	1	0.0	1.5	100	2-1-1	Very loose.
			2	1.5	3.0	100	2-2-2	Very loose.
3.7	4.3	SILTY SAND - black silty fine sand some gravel.	3	3.0	4.5	100	4-4-3	Loose.
4.3	9.2	SAND - brown fine sand some gravel.	4	4.5	6.0	0	3-4-6	Loose.
			5	6.0	7.5	11	6-8-9	Medium.
			6	7.5	9.0	11	7-12-14	Medium.
9.2	11.0	SAND - light brown fine sand.	7	9.0	10.5	100	7-10-11	Medium.
11.0	14.0	SAND - light brown fine to medium sand trace gravel.	8	10.5	12.0	100	13-16-17	Dense.
			9	12.0	13.5	100	9-14-16	Medium.
14.0	19.6	SAND and GRAVEL - light brown fine to coarse sand and gravel.	10	13.5	15.0	100	8-12-14	Medium.
			11	15.0	16.6	100	11-11-13	Medium.
			12	16.5	18.0	67	16-18-24	Dense.
			13	18.0	19.5	17	11-17-20	Dense, wet @ 18.8 Ft.
19.6	22.5	SAND - brown medium to coarse sand some gravel.	14	19.5	21.0	67	10-9-5	Medium, wet.
			15	21.0	22.5	100	4-7-7	Medium, wet.
								End of boring: 22.5 Ft.

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TEST BORING LOG

Shiltz, Graves & Associates, Inc.

Boring No. E-7
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries

City Elkhart County Elkhart State Indiana

Boring Location As shown on location sketch Datum Mean sea level

Date Started 2-11-83 Date Completed 2-11-83 Surface Elevation 741.05

Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH

Sampler: Type Split-barrel Size 2.0" O.D. At Completion 12.3 Ft.

Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Hole caved 12.3 Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	2.5	SILTY SAND - dark brown silty fine sand trace gravel.	1	0.0	1.5	67	2-2-2	Very loose.
			2	1.5	3.0	100	3-4-3	Loose, Hydrocarbon odor.
2.5	3.3	SAND - brown fine sand.	2	1.5	3.0	100	3-4-3	Loose, Hydrocarbon odor.
3.3	4.8	SILTY SAND - dark brown, brown and black silty sand.	3	3.0	4.5	100	12-10-9	Medium, Hydrocarbon odor.
.8	9.3	SAND - brown fine to medium sand trace gravel.	4	4.5	6.0	100	6-6-7	Medium.
			5	6.0	7.5	100	6-6-5	Medium.
			6	7.5	9.0	100	4-5-6	Medium.
9.3	16.5	SAND and GRAVEL - brown medium to coarse sand and gravel.	7	9.0	10.5	67	10-8-8	Medium.
			8	10.5	12.0	67	16-12-8	Medium.
			9	12.0	13.5	78	7-5-6	Medium, wet @ 12.3 Ft.
			10	13.5	15.0	100	5-5-9	Medium, wet.
			11	15.0	16.5	100	7-9-9	Medium, wet.
								End of boring: 16.5 Ft.

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TEST BORING LOG

Shills, Graves & Associates, Inc.

Boring No. E-8
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-11-83 Date Completed 2-11-83 Surface Elevation 740.45
Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 11.7 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.
Hole caved 12.0 Ft.

Soil Layer Limits From	To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	1.3	SILTY SAND - dark brown silty fine sand.	1	0.0	1.5	78	2-4-4	Loose.
1.3	4.7	SILTY SAND - dark brown silty fine sand some gravel	2 3	1.5 3.0	3.0 4.5	100 100	4-4-3 4-13-13	Loose, Hydrocarbon odor Medium, Hydrocarbon odor.
4.7	6.3	SAND - light brown fine sand trace gravel.	4	4.5	6.0	100	11-11-11	Medium, slight Hydrocarbon odor.
6.3	8.0	SAND and GRAVEL - light brown fine sand and gravel.	5	6.0	7.5	100	7-12-9	Medium, slight Hydrocarbon odor.
8.0	9.2	SAND and GRAVEL - medium brown medium to coarse sand and gravel.	6	7.5	9.0	78	7-6-7	Medium.
9.2	11.7	SAND - brown fine to coarse sand some gravel.	7 8	9.0 10.5	10.5 12.0	89 100	13-16-14 12-12-13	Medium. Medium.
11.7	12.5	SAND and GRAVEL - brown fine to coarse sand and gravel.	9	12.0	13.5	100	11-11-10	Medium, wet @ 11.7 Ft.
12.5	16.5	SAND - brown fine to medium sand some gravel.	9 10 11	12.0 13.5 15.0	13.5 15.0 16.5	100 100 17	11-11-10 7-10-10 8-9-10	Medium, wet. Medium, wet. Medium, wet.
								End of boring: 16.5 Ft.

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-9
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-11-83 Date Completed 2-11-83 Surface Elevation 743.53
Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 14.6 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.
Hole caved 7.0 Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	0.6	SAND - brown fine sand.	1	0.0	1.5	100	2-2-3	Loose.
0.6	3.8	SILTY SAND - dark brown to black silty fine to medium sand.	2	1.5	3.0	100	5-5-7	Medium.
3.8	5.0	SILTY SAND - brown silty sand trace gravel.	3	3.0	4.5	100	5-4-4	Loose.
5.0	6.4	SAND - black sand gravel and cinders.	4	4.5	6.0	100	4-3-2	Loose.
6.4	10.0	SAND - brown fine to medium trace gravel.	5 6 7	6.0 7.5 9.0	7.5 9.0 10.5	100 100 100	3-4-7 11-10-11 10-10-10	Medium. Medium. Medium.
10.0	10.8	SAND - medium brown fine sand.	7	9.0	10.5	100	10-10-10	Medium.
10.8	15.2	SAND and GRAVEL - medium brown medium to coarse sand and gravel.	8 9 10	10.5 12.0 13.5	12.0 13.5 15.0	67 100 100	8-9-10 8-10-14 14-15-12	Medium. Medium. Medium, wet @ 14.6 Ft.
15.2	17.0	SAND - brown fine to medium sand trace gravel.	11	15.0	16.5	100	9-8-8	Medium, wet.
17.0	18.0	SAND and GRAVEL - brown medium to coarse sand and gravel.	12	16.5	18.0	100	7-10-10	Medium, wet.
								End of boring: 18.0 Ft.

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. B-11
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-14-83 Date Completed 2-14-83 Surface Elevation 746.18
Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 16.7 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.
Hole caved 10.0 Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	1.8	SILTY SAND - black and brown silty sand some gravel.	1	0.0	1.5	100	6-7-3	Loose.
1.8	6.4	SAND - brown fine sand trace silt and gravel.	2	1.5	3.0	89	3-4-3	Loose.
			3	3.0	4.5	55	3-2-3	Loose.
			4	4.5	6.0	33	3-2-3	Loose.
6.4	15.4	SAND - light brown fine to medium sand trace gravel.	5	6.0	7.5	44	3-6-7	Medium.
			6	7.5	9.0	100	8-8-9	Medium.
			7	9.0	10.5	100	9-10-12	Medium.
			8	10.5	12.0	100	12-14-13	Medium.
			9	12.0	13.5	100	8-12-15	Medium.
			10	13.5	15.0	100	11-13-16	Medium.
15.4	16.7	SAND and GRAVEL - brown fine to coarse sand and gravel.	11	15.0	16.5	100	11-15-17	Dense.
16.7	18.9	SAND and GRAVEL - brown medium to coarse sand and gravel.	12	16.5	18.0	100	9-7-7	Medium, wet @ 16.7 Ft.
18.9	21.0	SAND and GRAVEL - brown fine to medium sand and gravel.	13	18.0	19.5	100	6-9-12	Medium, wet.
			14	19.5	21.0	100	11-11-15	Medium, wet.
								End of boring: 21.0 Ft.

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TEST BORING LOG

Shiltz, Graves & Associates, Inc.

Boring No. E-13
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-11-83 Date Completed 2-11-83 Surface Elevation 742.57
Weather Sunny, cold Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 13.8 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	4.8	SILTY SAND - dark brown and brown silty fine sand some gravel.	1	0.0	1.5	100	2-5-6	Medium.
			2	1.5	3.0	100	5-4-4	Loose, slight Hydrocarbon odor.
			3	3.0	4.5	55	2-2-2	Very loose, slight Hydrocarbon odor.
4.8	6.2	SAND - varied color brown fine to medium sand trace gravel.	4	4.5	6.0	100	3-5-5	Loose, slight Hydrocarbon odor.
6.2	12.8	SAND - brown fine to medium sand some gravel.	5	6.0	7.5	100	7-10-16	Medium.
			6	7.5	9.0	78	15-15-16	Dense.
			7	9.0	10.5	100	5-8-10	Medium.
			8	10.5	12.0	100	7-9-7	Medium.
12.8	13.8	SAND and GRAVEL - brown medium to coarse sand and gravel.	9	12.0	13.5	100	9-12-9	Medium, slight Hydrocarbon odor.
13.8	18.0	SAND - brown medium to coarse sand some gravel.	10	13.5	15.0	55	5-5-6	Medium, wet, oil odor.
			11	15.0	16.5	78	6-7-7	Medium, wet, oil odor.
			12	16.5	18.0	100	6-6-4	Medium, wet, oil odor.
								End of boring: 18.0 Ft.

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-19
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-16-83 Date Completed 2-16-83 Surface Elevation 742.00
Weather Cloudy; cool Boring Method Hollow stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 14.7 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Hole caved 13.4 Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	5.5	SILTY SAND - black and brown sand and cinders.	1	0.0	1.5	78	9-4-5	Loose.
			2	1.5	3.0	67	3-7-6	Medium, oil odor.
			3	3.0	4.5	44	3-3-3	Loose.
			4	4.5	6.0	55	2-4-10	Medium.
5.5	7.0	SAND - light brown fine to medium sand trace gravel.	5	6.0	7.5	78	11-13-17	Medium.
7.0	8.8	SAND and GRAVEL - light brown fine to medium sand and gravel.	6	7.5	9.0	100	16-13-12	Medium.
8.8	11.5	SAND - light brown fine to medium sand.	7	9.0	10.5	100	6-6-8	Medium.
			8	10.5	12.0	78	7-7-15	Medium.
11.5	14.7	SAND and GRAVEL - brown fine to coarse sand and gravel.	9	12.0	13.5	28	12-16-15	Dense.
			10	13.5	15.0	0	15-18-16	Dense.
14.7	17.0	SAND and GRAVEL - brown medium to coarse sand and gravel.	11	15.0	16.5	100	6-6-8	Medium, wet.
17.0	19.5	SAND - brown fine to medium sand trace gravel.	12	16.5	18.0	100	10-12-11	Medium, wet.
			13	18.5	20.0	78	6-8-10	Medium, wet.
19.5	27.0	SAND - brown fine sand.	14	23.5	25.0	100	15-17-26	Dense, wet.
27.0	32.0	SAND and GRAVEL - brown fine to coarse sand and gravel.	15	28.5	30.0	22	12-15-15	Medium, wet.
32.0	39.5	SAND and GRAVEL - gray fine to medium sand and gravel.	16	33.5	35.0	55	28-23-18	Dense, wet.
			17	38.5	40.0	100	10-9-9	Medium, wet.
39.5	40.0	CLAYEY SILT - gray clayey silt.	17	38.5	40.0	100	10-9-9	Very stiff, moist.
								End of boring: 40.0 Ft

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TEST BORING LOG

Shilts, Graves & Associates, Inc.

Boring No. E-27
Sheet 1 of 1
Job. No. 83-842

PROJECT Excel Industries
City Elkhart County Elkhart State Indiana
Boring Location As shown on location sketch Datum Mean sea level
Date Started 2-16-83 Date Completed 2-16-8 Surface Elevation 740.25
Weather Cloudy, cold Boring Method Hollow-stem auger GROUND WATER DEPTH
Sampler: Type Split-barrel Size 2.0" O.D. At Completion 11.4 Ft.
Hammer: Wt. 140 lb. Drop 30 inches After ____ Hours ____ Ft.

Soil Layer Limits From	Soil Layer Limits To	Soil Description	Sample Data No.	From	To	% Rec	Blows per 6"	Remarks
0.0	2.7	SILTY SAND - dark brown to black silty fine sand.	1	0.0	1.5	100	2-2-3	Loose, Hydrocarbon odor.
			2	1.5	3.0	100	2-3-6	Loose, Hydrocarbon odor.
2.7	3.2	SAND - brown fine to medium sand some gravel.	2	1.5	3.0	100	2-3-6	Loose, Hydrocarbon odor.
3.2	4.7	SILTY SAND - black silty sand, gravel and brick	3	3.0	4.5	39	7-10-9	Medium, Hydrocarbon odor.
4.7	7.0	SAND - light brown fine to medium sand trace gravel.	4	4.5	6.0	100	8-8-9	Medium.
			5	6.0	7.5	78	7-8-7	Medium.
7.0	16.1	SAND and GRAVEL - brown fine to coarse sand and gravel.	6	7.5	9.0	78	8-7-10	Medium.
			7	9.0	10.5	0	15-16-19	Dense.
			8	10.5	12.0	100	17-15-11	Medium, wet @ 11.4 Ft.
			9	12.0	13.5	78	7-8-11	Medium, wet.
			10	13.5	15.0	100	10-13-24	Dense, wet.
			11	15.0	16.5	100	11-11-11	Medium, wet.
16.1	17.5	SAND - brown fine sand.	11	15.0	16.5	100	11-11-11	Medium, wet.
17.5	23.0	SAND - brown medium sand trace gravel.	12	18.5	20.0	100	6-8-11	Medium, wet.
23.0	37.5	SAND and GRAVEL - brown fine to coarse sand and gravel.	13	23.5	25.0	55	6-6-11	Medium, wet.
			14	28.5	30.0	44	12-17-14	Dense, wet.
			15	33.5	35.0	44	5-5-7	Medium, wet.
37.5	40.0	CLAYEY SILT - gray clayey silt with sand varves.	16	38.5	40.0	100	5-8-10	Very stiff, moist.
								End of boring: 40.0 Ft.

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GRAIN SIZE DISTRIBUTION

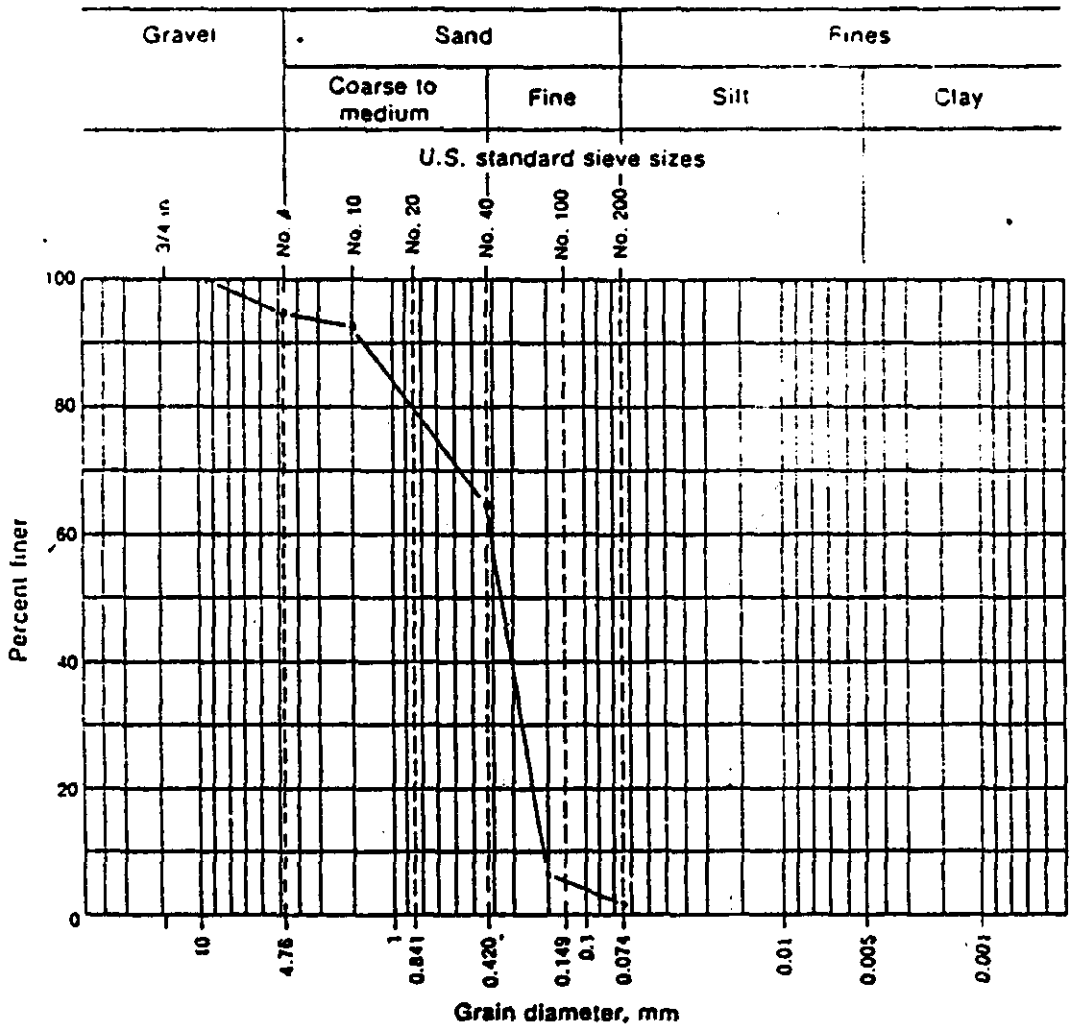
Data Sheet 5

Project Excel Industries Job. No. 83-842

Location of Project Elkhart Boring No. E-1 Sample No. 9

Description of Soil Sand Depth of Sample 12.0 - 13.5 Ft.

Tested By L. R. Date of Testing 2-22-83



Visual soil description Light brown fine sand

Soil classification:

SP System Unified

GRAIN SIZE DISTRIBUTION

Data Sheet 5

Project Excel Industries

Job. No. 83-842

Location of Project Elkhart

Boring No. E-1

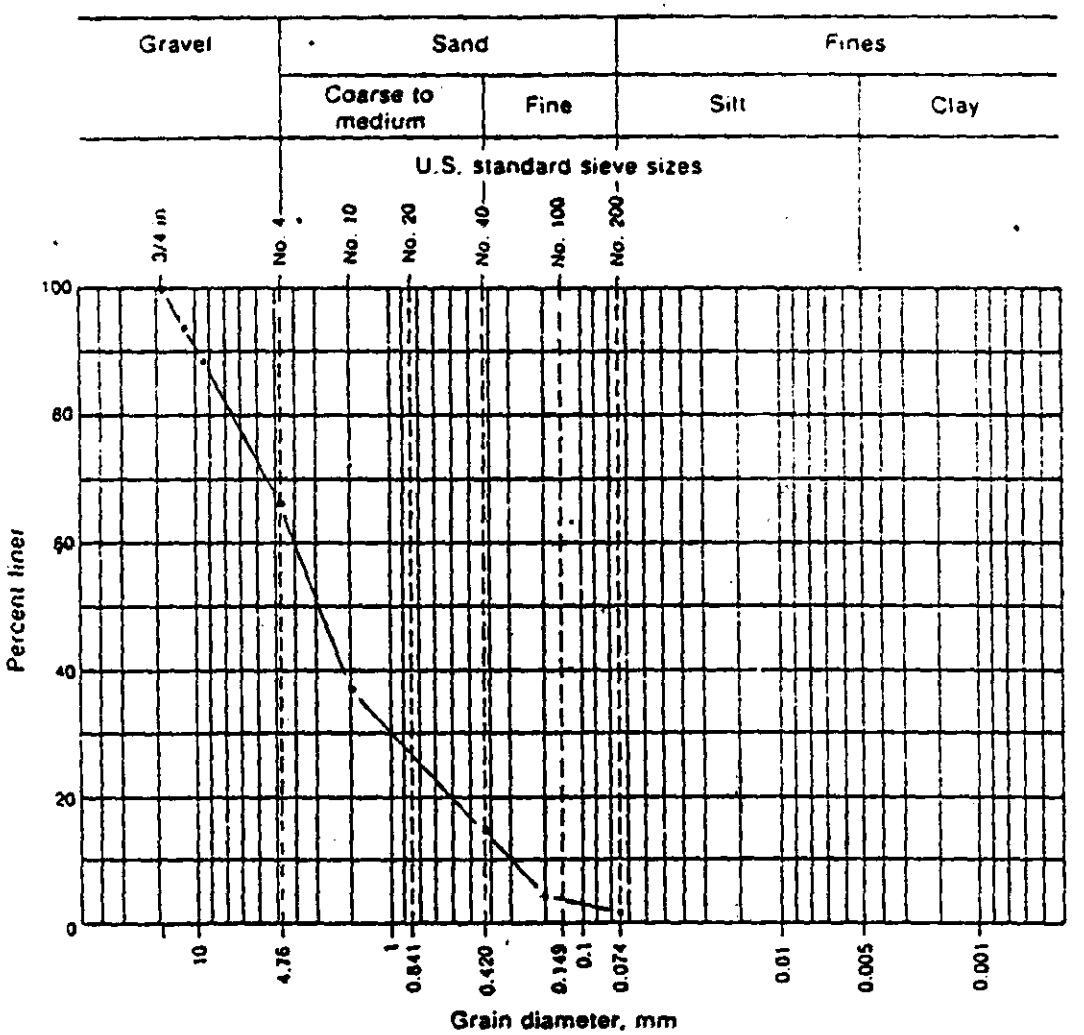
Sample No. 12

Description of Soil Sand and Gravel

Depth of Sample 16.5 - 19.0 Ft.

Tested By. L. R.

Date of Testing 2-22-83



Visual soil description Brown fine to coarse sand and gravel

Soil classification:

SW-GW

System Unified

GRAIN SIZE DISTRIBUTION

Data Sheet 5

Project Excel Industries

Job. No. 83-842

Location of Project Elkhart

Boring No E-6

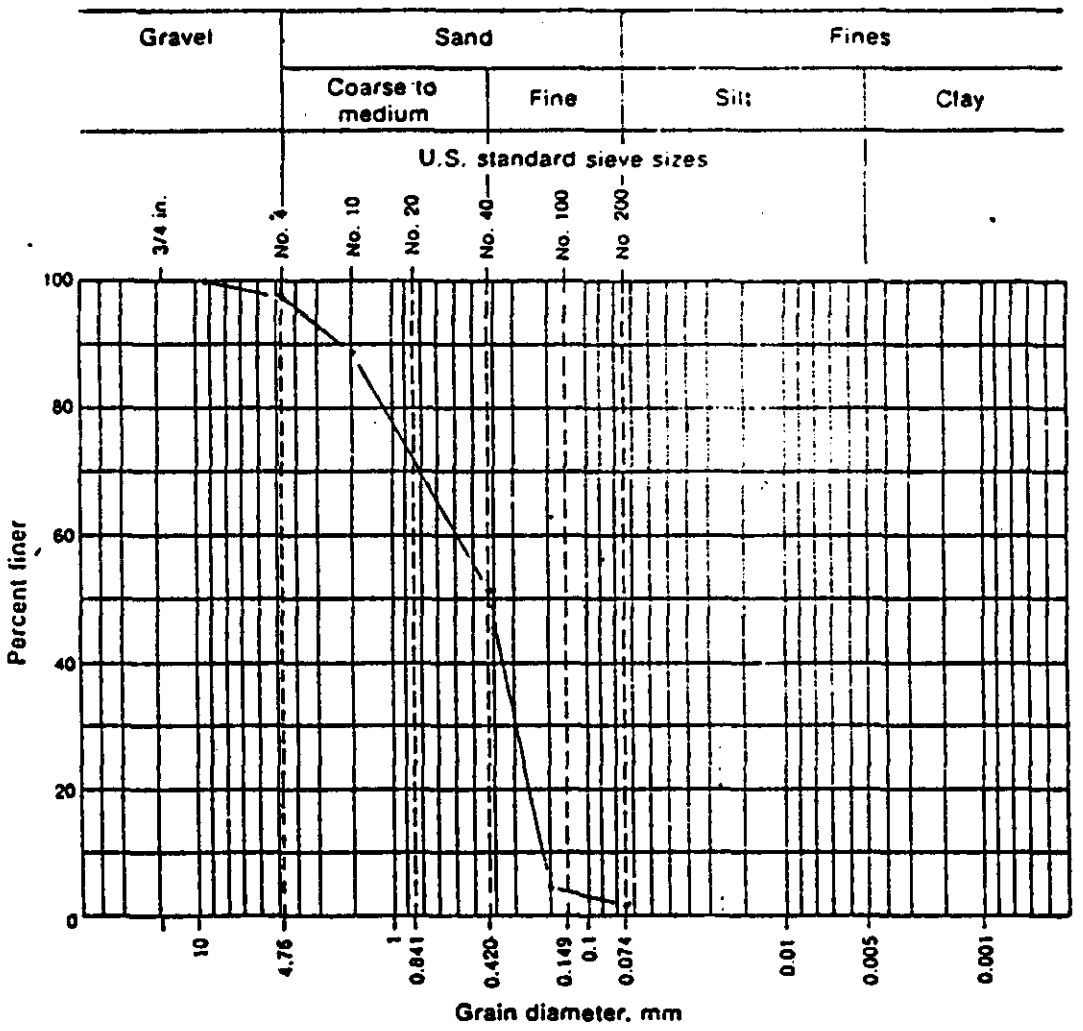
Sample No. 8

Description of Soil Sand

Depth of Sample 10.5 - 12.0 Ft.

Tested By. L. R.

Date of Testing 2-22-83



Visual soil description Light brown fine to medium sand trace gravel

Soil classification:

SP System Unified

GRAIN SIZE DISTRIBUTION

Data Sheet 5

Project: Excel Industries

Job. No.: 83-842

Location of Project: Elkhart

Boring No.: E-27

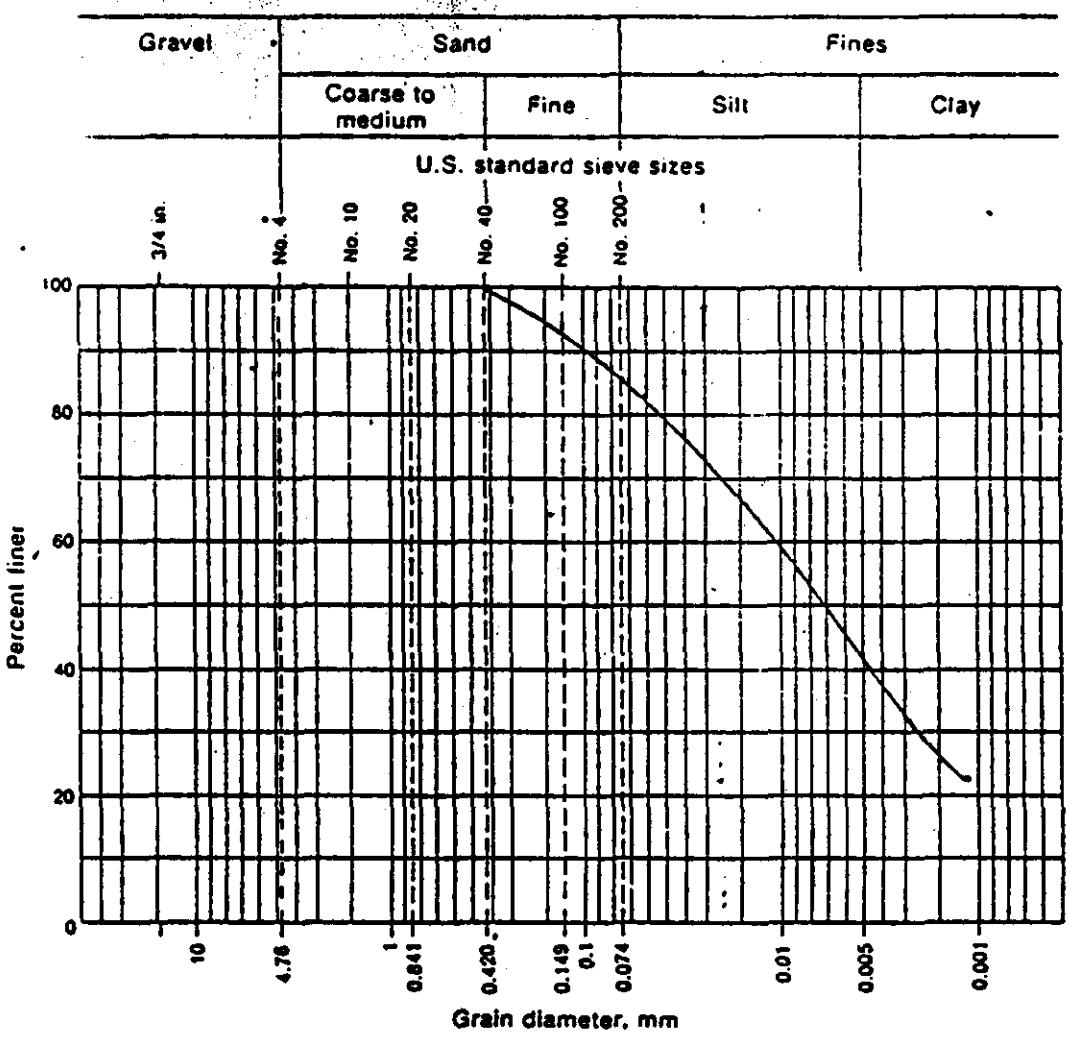
Sample No.: 16

Description of Soil: Clayey silt

Depth of Sample: 38.5 - 40.0 Ft.

Tested By: L. R.

Date of Testing: 2-23 ^3



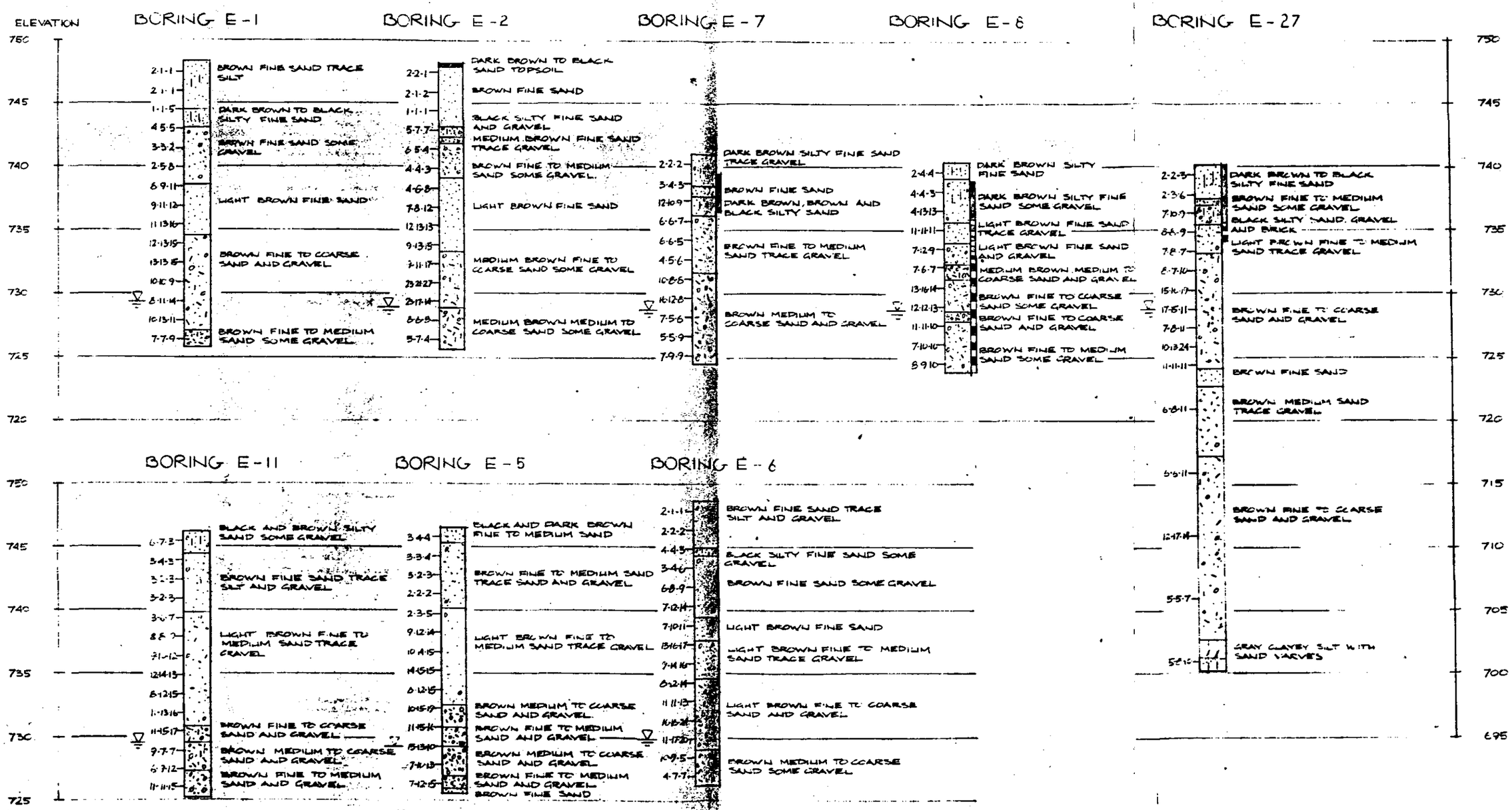
Visual soil description: Gray clayey silt with sand varves

Soil classification:

ML

System: Unified

GRAPHIC LOGS



NOTE — NUMBERS TO LEFT OF COLUMNS INDICATE NUMBER OF BLOWS REQUIRED TO ADVANCE SAMPLER AT SIX-INCH INTERVALS

▽ — GROUND WATER DEPTH @ COMPLETION

— POINT AT WHICH SAMPLES BECAME WET —

— HYDROCARBON, OR OIL ODOR

SLIGHT OIL, OR SLIGHT HYDROCARBON ODOR —

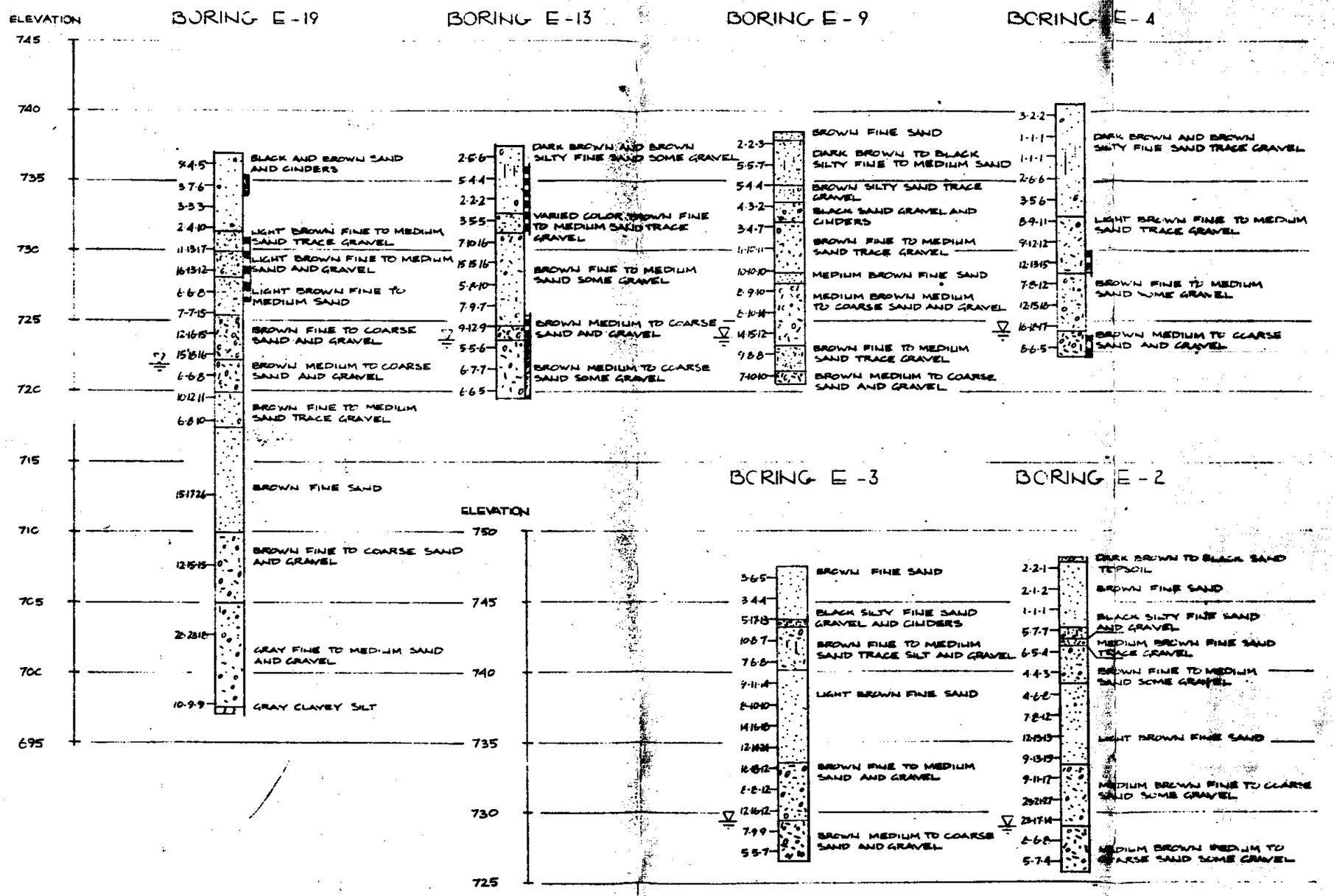
SOIL INVESTIGATIONS

EXCEL INDUSTRIES
ELKHART, INDIANA

JOB NO 83-842 | SHEET 1 OF 2

SHILTS, GRAVES & ASSOC. INC.

GRAPHIC LOGS



NOTE — NUMBERS TO LEFT OF COLUMNS INDICATE NUMBER OF BLOWS REQUIRED TO ADVANCE SAMPLER AT SIX-INCH INTERVALS

— GROUND WATER DEPTH @ COMPLETION POINT AT WHICH SAMPLES BECAME WET —

— HYDROCARBON, OR OIL ODOR

SLIGHT OIL, OR SLIGHT HYDROCARBON ODOR —

SOIL INVESTIGATIONS
EXCEL INDUSTRIES
ELKHART, INDIANA
JOB No. 83-842 | SHEET 2 OF 2
SHILTS, GRAVES & ASSOC. INC.

SAMPLE I.D.	mg/kg (ppm) TCE found
E6 (4)	1.7
E6 (8)	0.18
E6 (12)	0.33
E6 (16)	0.54
E6 (20)	0.25
E7 (4)	0.16
E7 (8)	0.06
E7 (12)	0.29
E7 (16)	0.82
E8 (4)	79
E8 (8)	1.6
E8 (12)	1.2
E8 (16)	3.4
E9 (4)	1.6
E9 (8)	0.16
E9 (12)	0.13
E9 (16)	0.34
E11 (4)	3.0
E11 (8)	0.07
E11 (12)	0.39
E11 (16)	0.21
E11 (20)	0.13
E13 (4)	540
E13 (8)	82
E13 (12)	1.3
E13 (16)	0.52
E19 (4)	570
E19 (8)	270
E19 (12)	23
E19 (16)	4.1
E19 (20)	2.2
E19 (25)	0.85
E19 (30)	0.59
E19 (35)	2.2
E19 (40)	5.3
E27 (4)	0.94
E27 (8)	0.14
E27 (12)	0.41
E27 (16)	2.0
E27 (20)	4.2
E27 (25)	1.1
E27 (30)	1.7
E27 (35)	0.24
E27 (40)	0.05

QUALITY CONTROL
DOCUMENTATION

(Data to follow when available)

$35-50/hour

239-5846
S. Bend

Aaron A. Jennings

Assistant Professor
Department of Civil Engineering
University of Notre Dame
Notre Dame, IN 46556

Personal Information:

Born: January 25, 1949
Citizenship: United States
Married

Educational Background

Adirondack Community College, Associate of Applied Sciences, A.A.S., 1972
Rochester Institute of Technology, Engineering Technology in Civil Engineering, B.E.T., 1975
University of Massachusetts, Civil Engineering, M.S., 1977
University of Massachusetts, Environmental Engineering, Ph.D., 1980

Professional Registration

P.E., Indiana

Professional Experience

Assistant Professor, Department of Civil Engineering, University of Notre Dame, 1980 - present.
University Fellow, Department of Civil Engineering, University of Massachusetts, 1979-1980.
Research and Teaching Associate, Department of Civil Engineering, University of Massachusetts, 1975-1979.
Designer, Hershey Malone and Associates, Consulting Engineers, Penfield, New York, 1972-1975.

Academic and Professional Societies

American Geophysical Union
American Society of Civil Engineers
Water Pollution Control Federation
Association of Environmental Engineering Professors
American Water Resources Association
Phi Kappa Phi

Major Teaching and Research Interests

Groundwater and groundwater quality
Numerical analyses and mathematical modeling
Hazardous waste disposal
Surface water hydraulics and hydrology
Water resources engineering

Awards

Battalion Commendation for Professional Expertise, United States Marine Corps, May 1970.

James T. Gleason Memorial Scholarship to attend the Rochester Institute of Technology, Sept. 1972.

Twice presented with the Ralph B. Kepner Technical Writing Award by the Rochester Society for Technical Communications for papers entitled:

"Final Report on the Black Creek Gauging Station" (1975)

"Developments in Virus Research Related to the Fields of Advanced Water and Wastewater Treatment" (1976)

Selected as Rochester Institute of Technology Distinguished Alumnus, Institute College, October 18, 1980.

Professional Activities

Member, Environmental Protection Agency Chemistry and Physics Review Panel
Reviewer of Proposals, Environmental Protection Agency
Member, American Society of Civil Engineers, Environmental Engineering Division, Hazardous Waste Management Committee
Manuscript Reviewer, Environmental Science and Technology
Manuscript Reviewer, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

Research Experience

Department of Energy, "Hydrodynamic and Chemical Modeling of Heavy Metals in Ash Pond Leachates," DOE# DE-AC02-79EV10253, July 1, 1979 - Dec. 21, 1982, $220,282, Co-Principal Investigator.

Environmental Protection Agency, "Full-Scale Study of Sequencing Batch Reactors," Grant No. R-806598-01-1, April, 1979 - March, 1982, $346,547, Project Consultant.

Environmental Protection Agency, Industrial Waste Elimination Research Center, "Identification of Research and Planning Needs for Industrial Waste Management," IIT 5-54670-8001 - (ND), November 15, 1980 - November 14, 1982, $32,681, Principal Investigator.

National Science Foundation, "Improved Physical Description of the Saltwater Intrusion Problem," NSF# CME81-05549, April 15, 1981 - March 30, 1983, $47,996, Principal Investigator.

Department of Energy, Multi-solute Subsurface Transport Modeling for Energy Solid Wastes," DOE# DE-AC02-79EV10253, January 1, 1982 - December 31, 1982, $117,863, Co-Principal Investigator.

University of Notre Dame Faculty Research Fund, "Acid Rain Impacts on Groundwater Aquifers," FRF81-01, March 15, 1982 - April 30, 1983, $1,833, Principal Investigator.

State of Maryland Department of Natural Resources, "Potential for Coal-Related Groundwater Contamination in the Coastal Soils of Maryland," February 1, 1983 - May 30, 1984, $84,057, Principal Investigator.

Department of Energy, "Multi-Solute Subsurface Transport Modeling for Energy Solid Wastes," DOE# DE-AC02-79EV10253, A006, January 1, 1983 - December 31, 1985, $388,256, Co-Principal Investigator.

The Charles A. Lindbergh Fund, Inc., "Regional Hazardous Waste Management Planning to Minimize Risk," March 1, 1983 - March 1, 1984, $10,580, Principal Investigator.

Consulting

Project Consultant, Mitre Corporation, Bedford, Mass. on the following projects:

Hazardous Waste Investigation of the Picillo Property, Coventry, Rhode Island

Management of Hazardous Waste Cleanup Operations, Wade Property, Chester, Pennsylvania

Preliminary Reconnaissance, Uncontrolled Hazardous Waste Disposal Site, Nashua, New Hampshire

Project Consultant, Miles Laboratories, Inc., Elkhart, Indiana;

Analysis of a Non-Contact Cooling Water Groundwater Discharge System.

Project Consultant, City of Elkhart, Indiana;

Plum and Randolph Street Sewer Replacement Project (11/82)

Journal Publications

(R) Jennings, A.A., Kirkner, D.J., Theis, T.L., "Multi-Component Equilibrium Chemistry in Groundwater Quality Models," Water Resources Research, 18(4), 1089-1096, 1982.

(R) Jennings, A.A., "Profiling Hazardous Waste Generation for Management Planning," Journal of Hazardous Materials, in press.

Conference Proceedings

Jennings, A.A., Tirsch, F.S., Adrian, D.D., "Soil Attenuation Capacity and Transport Potential of Solid Waste Leachates," Proceedings of the 33rd Annual Purdue Industrial Waste Conference, Purdue University, West Lafayette, Indiana, May 9-11, 1978 (255-262).

Jennings, A.A., Tirsch, F.S., Adrian, D.D., "Methods for Evaluating the Leachate Attenuative Capacity of Soil," Proceedings of the First Annual Conference of Applied Research and Practice on Municipal and Industrial Waste at Madison, Wisconson, Sept. 10-13, 1978 (153-168).

(R) Jennings, A.A., Male, J.W., Adrian, D.D., "An Expanded Solute Transport Model for Simulating Groundwater Contamination Episodes," in Finite Elements in Water Resources, ed. S.Y. Wang et al. Prbceedings of the Third International Conference on Finite Elements in Water Resources, University of Mississippi, May 19-23, 1980 (2.147-2.156).

Jennings, A.A., "Leachate Transport Through Soil," in Sanitary Landfill Leachate Collection and Treatment, Proceedings from the 1977 Symposium, Univ. of Massachusetts, Amherst, MA, Dec. 1981 (77-96).

Jennings, A.A., Tirsch, F.S., Adrian, D.D., "Methods for Evaluating the Leachate Attenuative Capacity of Soil" in Geotechnology in Massachusetts ed. O.C. Farquhar, proceedings of a conference in March, 1980, University of Massachusetts, 1982 (413-424).

Leser, C C., Jennings, A.A., Theis, T.L., "Multi-Component Modeling of the Groundwater at an Indiana Coal-Fired Power Plant," In Water - Indiana's Abundant Resource, ed. J.W. Delleur, Proceeding of the 1982 Indiana Water Resources Association Symposium, June 1982 (12-23).

Significant Reports

Tirsch, F.S., Jennings, A.A., Leachate Reaction with Soils under Anaerobic Conditions, Report No.: Env. E. 60-78-3, University of Massachusetts, September 1979, 104 p.

Jennings, A.A., Analysis of the National Industrial Residual Flow Problem, Final Report, EPA #IIT-5-54670-8001-(ND), University of Notre Dame, Jan., 1982, 129 p.

Jennings, A.A., ed., Sanitary Landfill Leachate Collection and Treatment, Proceedings from the 1977 Symposium, University of Massachusetts, Amherst, MA. Report No. ENV. E. 67-81-2, Dec., 1982, 189 p.

Theis, T.L., Kirkner, D.J., Jennings, A.A., Multi-Solute Subsurface Transport Modeling for Energy Solid Wastes, Technical Report, DOE DE-AC02-79EV10253, Aug., 1982, 140 p.

Major Presentations

Jennings, A.A., Kirkner, D.J., Theis, T.L., "Soluble Complexation and Competitive Adsorption in Groundwater Quality Models," Presented at the Second Annual Water Resources Symposium of the Indiana Water Resources Association, Spencer, Ind., June 24-26, 1981.

Kirkner, D.J., Theis, T.L., Jennings, A.A., "A Solution of the Mass Transport Equations with Chemical Reactions by the Finite Element Method," presented at 18th Annual Meeting of the Society of Engineering Science, Inc., Brown University, Providence, R.I., Sept. 2-4, 1981.

Jennings, A.A., "Industrial Waste Treatment Versus Residual Generation," Presented at the Americal Institute of Chemical Engineers 1981 Annual Meeting, New Orleans, Lousiana, Hov. 9, 1981.

Kirkner, D.J., Jennings, A.A., Theis, T.L., "Multi-Solute Mass Transport with Chemical Interaction Kinetics," Presented at the 4th International Conference on Finite Elements in Water Resources, Hannover, Germany, June 21-25, 1982.

Theis, T.L., Kirkner, D.J., Jennings, A.A., "A Coupled Chemical and Hydrodynamic Model for Multi-Solute Transport in Groundwater," Presented at the 184th National Meeting of the American Chemical Society, Kansas City, Missouri, Sept., 1982.

Lectures, Seminars, Workshops

Jennings, A.A., "The History of Two Unauthorized Hazardous Waste Disposal Sites," Earth Day 80 Teach-In Lecture, University of Notre Dame, April 22, 1980.

Participant, Panel Discussion on "Wastewater Elimination Versus Treatment," American Institute of Chemical Engineers 1981 Annual Meeting, New Orleans, Louisiana, Nov. 8-12, 1981.

Participant, Panel Discussion on "Alternatives to Wasting Waste" sponsored by the League of Women Voters, South Bend, Indiana, March 9, 1982.

Chairman, Organizer of the Symposium, "Hazardous Waste Management" sponsored by the Environmental Division of the American Institute of Chemical Engineers, 1983 National AIChE Meeting, March 31, 1983, Houston, Texas.

Masters Theses/Special Projects Directed

Catherine Leser, "Ranges of Applicability of Formulae for 1-D Convection-Diffusion in a Domain of Finite Length," Special Project, 1981.

Catherine Leser, "Multi-Component Modeling of Groundwater Contamination by Coal and Fly Ash Pond Leachate from a Coal-Fired Utility," Thesis, 1982.

Robert Sholar, "Optimal Hazardous Waste Flow Through Networks: An Analysis of Cost and Risk Inherent to Management Schemes," Thesis, 1982.

Submissions Under Review

Jennings, A.A., Sholar, R.L., "Hazardous Waste Disposal Network Analysis for Evaluating Management Alternatives," for presentation at the 1983 National Conference on Environmental Engineering, Boulder, CO, July 6-8, 1983.

Jennings, A.A., Kirkner, D.J., "Criteria for Selecting Equilibrium or Kinetic Sorption Descriptions in Groundwater Quality Models," for presentation at the ASCE Hydraulic Division Specialty Conference, MIT, Aug. 9-12, 1983.

Kirkner, D.J., Jennings, A.A., Theis, T.L., "Multi-Component Non-Linear Solute Transport," Advances in Water Resources.

Measurement
Sciences
Corporation

March 17, 1983

Clyde E. Williams & Associates
1843 Commerce Dr.
South Bend, IN. 46628

Analysis of soil samples received March 4, 1983 for trichloroethylene (TCE)

METHOD

Subsamples were extracted with methanol. A portion of each extract was diluted with water and extracted with isooctane. The final extracts were analyzed by electron-capture gas chromatography.

RESULTS

SAMPLE I.D.	mg/kg (ppm) TCE found
E1 (4)	0.16
E1 (8)	13
E1 (12)	0.26
E1 (16)	0.34
E1 (20)	0.30
E2 (4)	<0.05
E2 (8)	0.41
E2 (12)	0.08
E2 (16)	0.34
E2 (20)	0.52
E3 (4)	0.74
E3 (8)	0.05
E3 (12)	0.56
E3 (16)	0.08
E3 (20)	0.62
E4 0-4	0.20
E4 4-8	1.2
E4 8-12	0.24
E4 12-16	0.30
E5 (4)	0.10
E5 (8)	0.10
E5 (12)	1.0
E5 (16)	3.8
E5 (20)	0.92

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