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Du Pont - Kentec

Final Draft

Groundwater Assessment - Phase 2

by

CH2M HILL

October 1988

DU PONT KENTEC GROUNDWATER ASSESSMENT
PHASE 2

INTRODUCTION

This groundwater assessment report summarizes Phase 2 field activities performed by CH2M HILL for Du Pont at the Kentec facility from May 16, 1988, through July 7, 1988. Phase 1 field activities were summarized in a 1987 CH2M HILL report. This report also summarizes and interprets data gathered from Phase 1 and Phase 2 activities. Included in this report are discussions of drilling and installation of monitoring wells; descriptions of sampling of groundwater, surface water, and soil; presentation of analytical results; interpretation of hydrogeologic and chemical analytical data; and a discussion of preliminary conclusions and recommendations. The location of the Kentec site is given in Figure 1. The Kentec site plan and sampling locations are given in Figure 2.

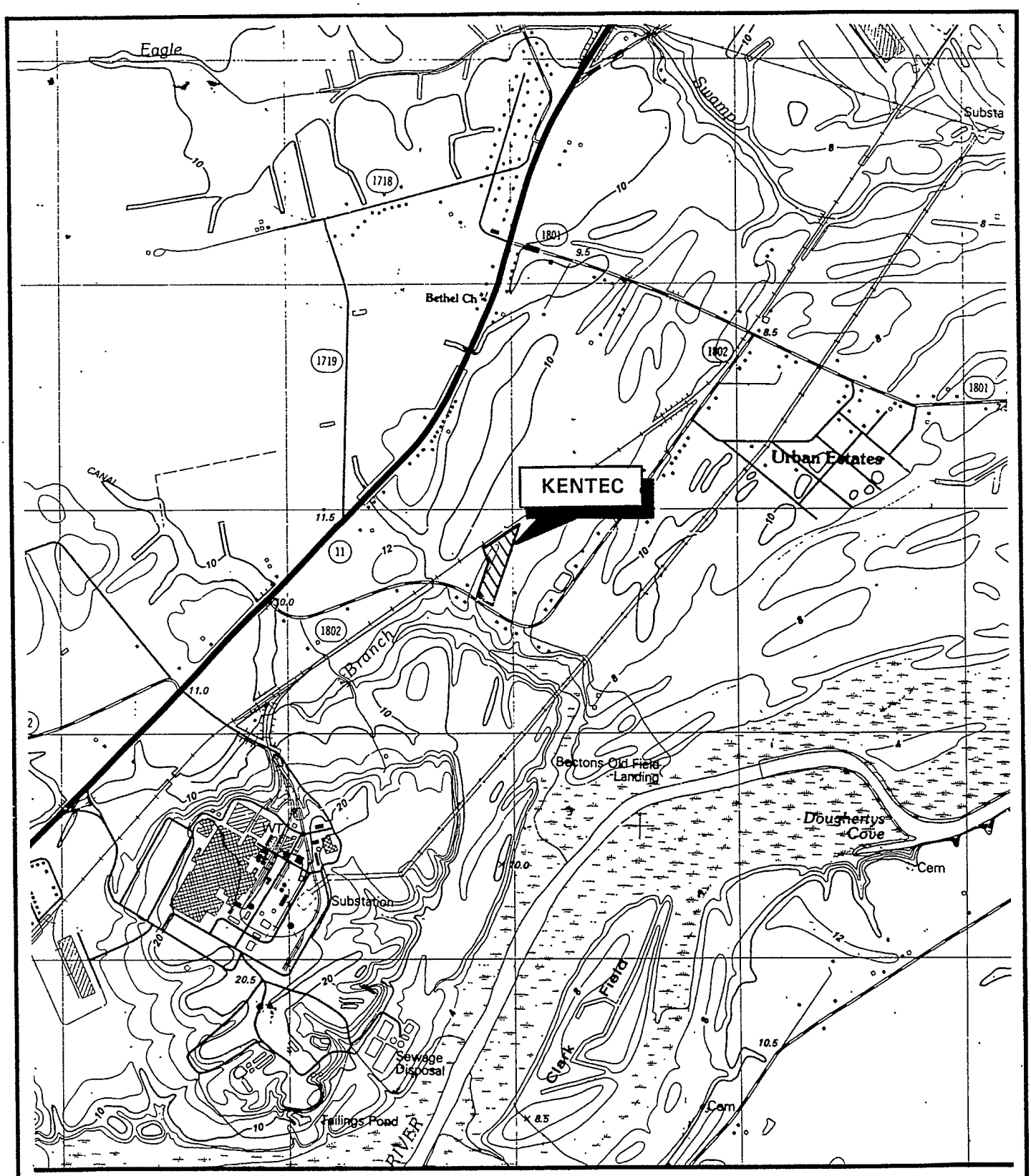
Phase I 1987
Phase II May 88

FIELD ACTIVITIES

DRILLING AND INSTALLATION OF MONITORING WELLS

This section describes the procedures, materials, and equipment used in drilling, sampling of subsurface soils, and well installation at Kentec. Drilling and well installation services were provided by Law Engineering of Charlotte, North Carolina, under supervision by D. Dronfield and A. Bryda of CH2M HILL.

Drilling and installation of two shallow monitoring wells (MW7 and MW8) were performed between May 25 and May 27, 1988. Each 6-inch borehole was drilled using hollow stem augers to a depth of approximately 10 feet below land surface. During the drilling, soil samples were obtained from each borehole using an 18-inch split spoon sampler. Two-inch diameter PVC monitoring well screens and pipe were installed in each borehole. A sand pack was placed in the annulus between the borehole and well screen to a depth approximately 1 foot above the top of the well screen. A one-half foot to one foot bentonite seal was placed on top of the sand pack to prevent infiltration of surface water through the annulus. The remainder of the annulus was grouted to the surface with cement. A protective locking steel casing was placed over each well, with three guard posts surrounding the steel casing. All drilling equipment



LEGEND

Source: USGS Grifton Quadrangle
North Carolina, 1983

Contour Interval — 2 Meters

SCALE:

1000 0 1000

1 inch equals 1000 feet

- N -

Figure 1
KENTEC SITE LOCATION

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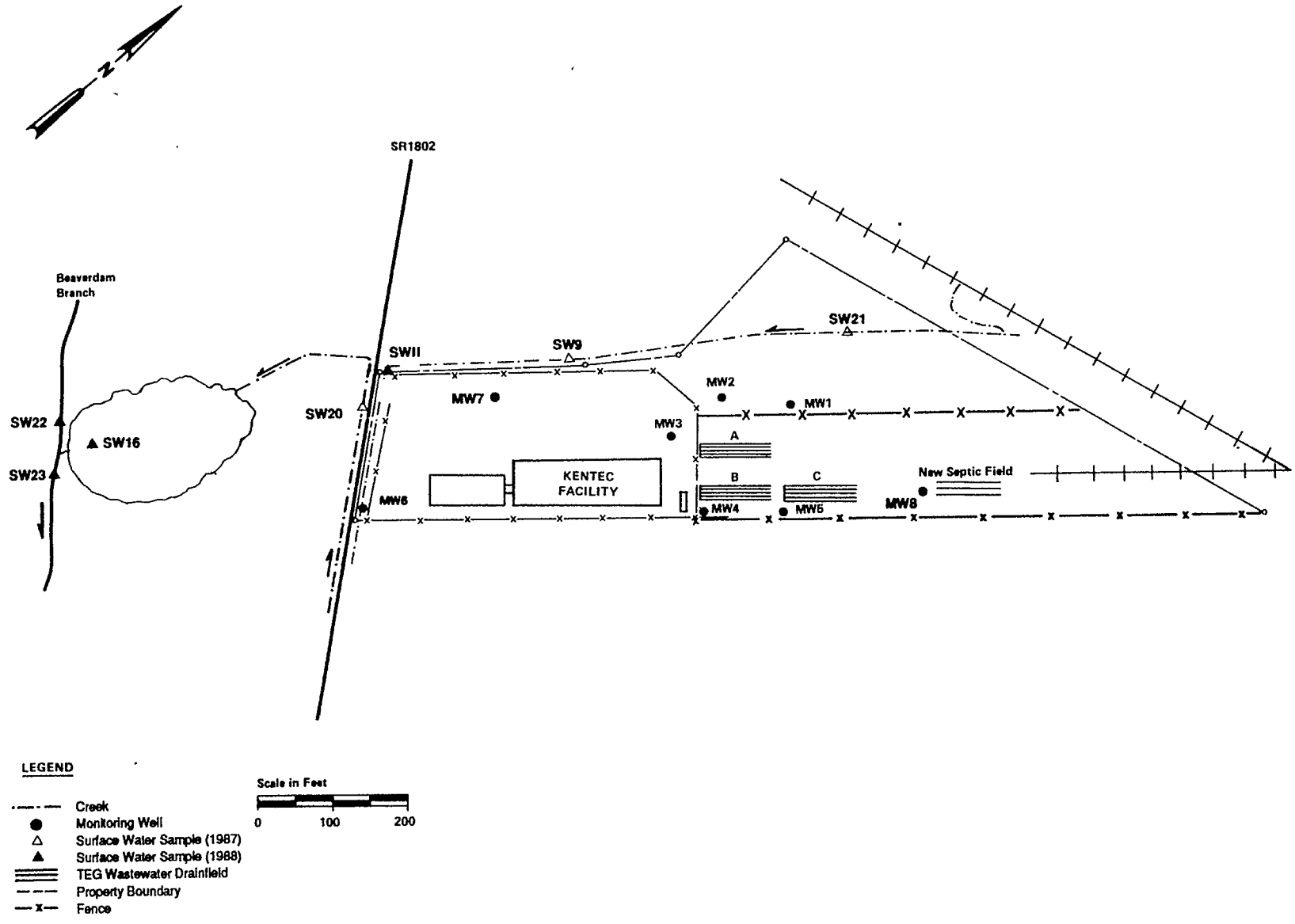

Figure 2
KENTEC SITE PLAN AND SAMPLING LOCATIONS
Dupont Kentec Facility

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was steam-cleaned between boreholes. Each well was developed by surging and pumping with a suction pump. Barrow Surveying and Mapping surveyed elevations for each monitoring well from June 6-11, 1988.

GROUNDWATER AND SURFACE WATER SAMPLING

CH2M HILL collected groundwater and surface water samples between June 6 and June 9, and on July 7, 1988. Water levels were measured on June 6, 1988, in each of the eight monitoring wells. Monitoring wells MW3, MW4, MW5, and MW8 were sampled on June 7, 1988; MW1 was sampled on June 8, 1988; and MW6, MW7, and surface water samples SW11, SW16, SW22, and SW23 were collected on June 9, 1988. On July 7, 1988, the four surface water locations were resampled for volatile organic compounds (VOCs) analysis, because acceptable holding times for the surface water samples that were collected on June 9 had been exceeded.

Each of the wells, except MW6, was purged with a teflon and stainless steel positive-displacement bladder pump prior to sampling until pH, Eh, conductivity, and temperature of the groundwater had stabilized for three well volumes. Groundwater samples were then collected with the pump. At well MW6, the recharge of the well was too slow to allow purging with the pump, so the well was bailed dry with a teflon bailer and then sampled with the bailer after groundwater had recharged to the well.

At each surface water sampling location, pH, Eh, conductivity, temperature, and dissolved oxygen were measured prior to sample collection. Surface water samples were then collected directly into sample jars.

All samples of groundwater to be analyzed for metals were filtered with a 0.45 micron filter prior to preservation in the field. All samples were preserved in the field as specified by the laboratory. All sampling equipment was cleaned between wells with a rinse of trisodium phosphate solution, then potable water, then 10 percent methanol in water solution, and then deionized water. At the end of each day, the samples were shipped by Federal Express to the CH2M HILL Laboratory in Montgomery, Alabama.

All samples were analyzed for volatile organic compounds, acid and base/neutral extractable compounds, chemical oxygen demand (COD), total organic carbon (TOC), total dissolved solids (TDS), iron, and manganese by the CH2M HILL Laboratory. Law and Company Laboratory of Wilmington, North Carolina, analyzed aliquots of the samples for triethylene glycol (TEG).

IN SITU HYDRAULIC CONDUCTIVITY

From June 7 to 8, 1988, in situ hydraulic conductivity values were determined in five of the eight monitoring wells located at Kentec. Data from these tests provide a measure of the capacity of the shallow deposits at the site to transmit water. The data are reported and discussed in the next section. A detailed discussion of the in-situ hydraulic conductivity testing is given in Appendix A.

HYDROGEOLOGY

GENERAL

The relief of the site is relatively flat with an elevation of approximately 30 feet above mean sea level (Figure 1). The ground surface slopes downward toward the creek northwest of the site and more steeply across SR 1802 toward Beaverdam Branch southwest of the site.

The surficial geology of the Kentec site is described from boring logs of the monitoring well construction. Soil boring logs and well completion information are given in Appendix B. A geologic cross section of the site (Figure 4) was prepared from the interpretation of these data. A map showing the cross section location is given in Figure 3.

The uppermost stratigraphic unit consists of a silty sand to a coarse sand with gravel. The depth of the unit is between 5 and 10 feet below ground surface; it is thickest at MW4 and MW5. Beneath this sand zone is a clayey silt with some sandy silt and sand. The thickness of this zone is not known, but is at least 5 to 10 feet thick beneath the site based on the boreholes depths.

0-10 silty sand/gravel clay

The first important aquifer in the site vicinity is the Lower Peedee. The top of this formation is estimated to be approximately 50 to 80 feet below land surface in the site vicinity. While all residents near Kentec along SR 1802 are believed to be on public water supply, any existing domestic wells would probably be screened within this aquifer.

HYDRAULIC CONDUCTIVITY

Hydraulic conductivity is a measure of the capacity of a material to transmit water. To estimate hydraulic conductivity in the surficial deposits, in-situ hydraulic conductivity tests were performed in the field. Rising head tests were performed in five of the eight monitoring wells (see Appendix A). Hydraulic conductivities calculated from these tests are given in Table 1.

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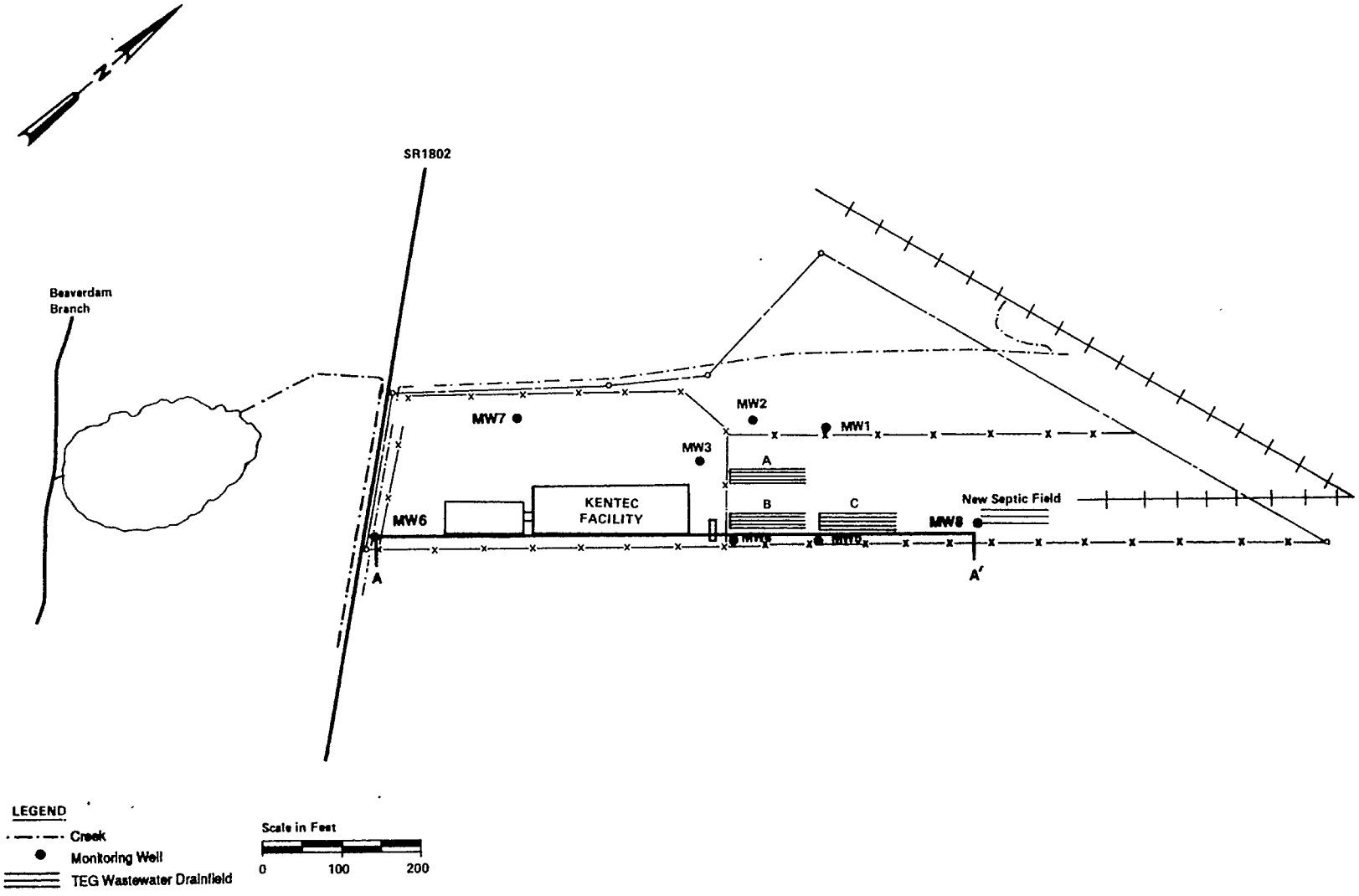

Figure 3
LOCATION OF GEOLOGIC CROSS SECTION
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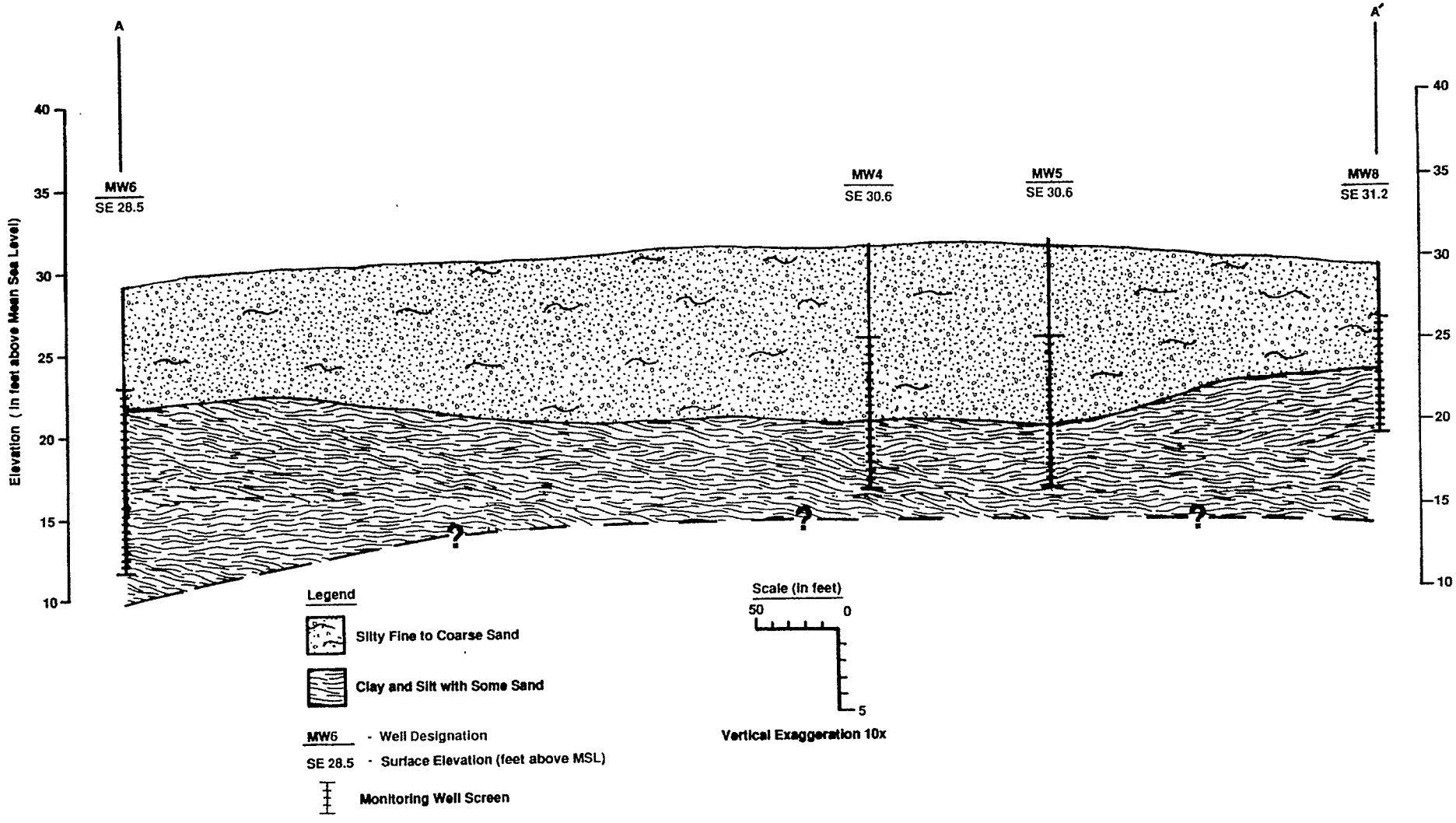

Figure 4
GEOLOGIC CROSS SECTION A-A'
Dupont Kentec Facility

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Table 1
HYDRAULIC CONDUCTIVITY VALUES

Monitoring Well	Hydraulic Conductivity (K)[a] in cm/sec	
MW3	8×10^{-4}	
MW4	1×10^{-3}	2.8 ft/day
MW5	3×10^{-3}	8.5 ft/day
MW7	6×10^{-3}	17.0 ft/day
MW8	4×10^{-2}	113 ft/day

[a]Results given are an average of two tests within each well. See Appendix A for calculations.

WDR311/060

GROUNDWATER FLOW

Water levels were measured in all monitoring wells on May 14, 1987 and June 6, 1988. These measurements are given in Table 2. Figures 5 and 6 are interpretive pieziometric maps of water levels in the surficial deposits. Groundwater flow directions in homogeneous, isotropic porous media are perpendicular to the gradient of the pieziometric surface, or essentially down the slope of the contour lines. This would indicate that the general direction of the horizontal component of groundwater flow in the surficial deposits is from the northeast to the southwest, toward Beaverdam Branch. However, on June 6, 1988, horizontal flow near the drain field was toward the north and west.

not very far

These observations suggest that horizontal groundwater flow directions in the vicinity of the drain fields vary during the year, perhaps because of the flatness of the surface topography. Where the topography is flat, differences in the rates of infiltration of rainwater at different locations are more likely to cause the shape of the flow system to vary. MW8 and locations farther east on the property may, in fact, not be consistently upgradient of the drain field. The influence of the drain field when it was operating (1982-1986) on the groundwater flow system is unknown.

The hydraulic gradient in the surficial deposits (difference in water levels divided by the distance between the water level measurements) across the site toward Beaverdam Branch is approximately 0.007. The average linear velocity of groundwater is a measure of the average rate of movement of a particle of water parallel to the flow direction. Average linear velocity is calculated by multiplying the hydraulic conductivity by the hydraulic gradient divided by the effective porosity. Using a gradient of 0.007, hydraulic conductivities like those in Table 1, and assuming an effective porosity typical for sands and silty sands of approximately 0.25, the rate of movement of groundwater in the surficial deposits would range between 20 feet and 1,100 feet per year.

RESULTS OF CHEMICAL ANALYSIS

ANALYTICAL RESULTS

Chemical analytical results from both Phase 1 and Phase 2 of the Kentec investigation are summarized in this section. A complete listing of the chemical analytical data is given in Appendix C. Parameters measured in the field on groundwater and surface water samples are given in Tables 3 and 4, respectively.

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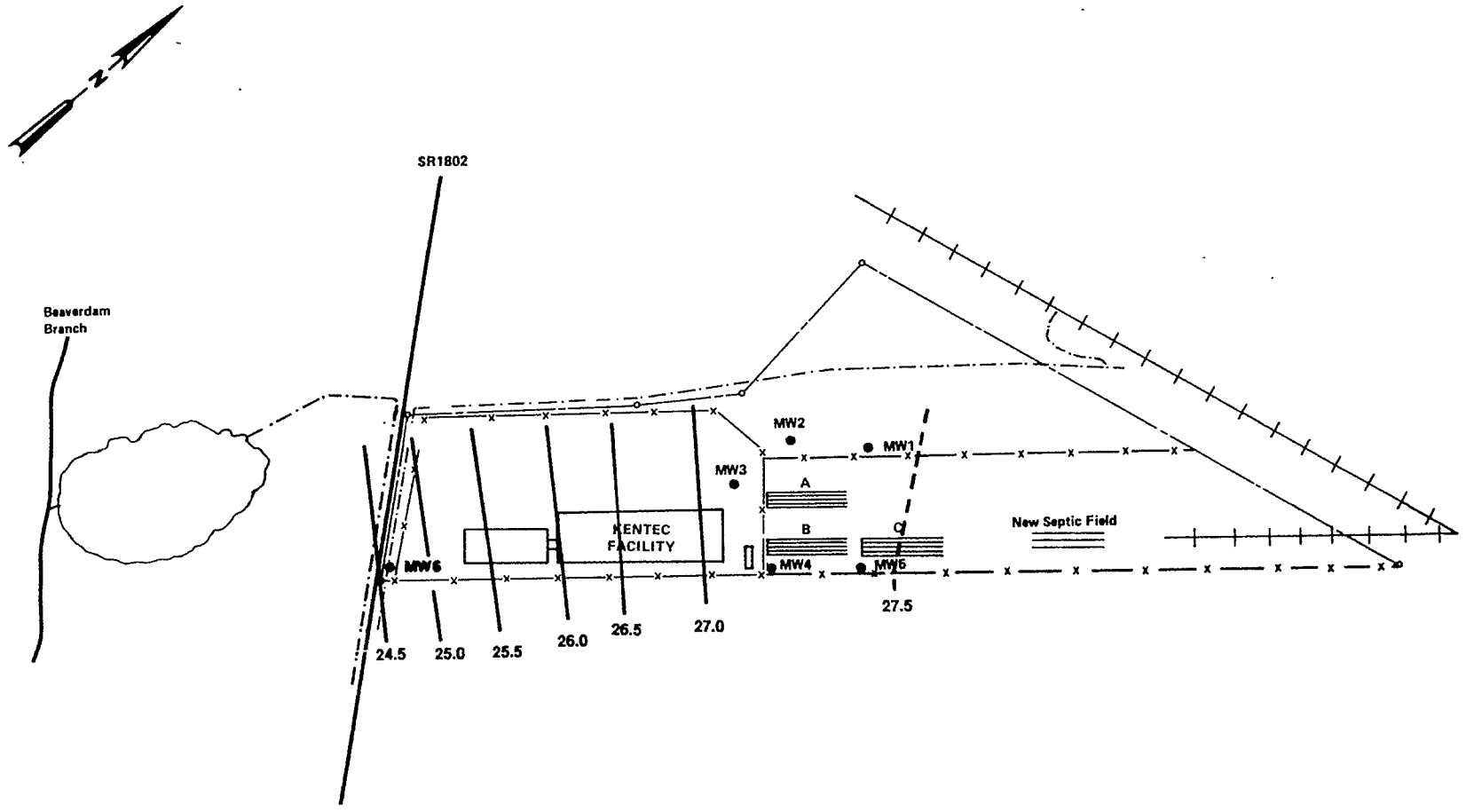

LEGEND

- Creek
- Monitoring Well
- TEG Wastewater Drainfield
- --24-- Equipotential Line (in feet above MSL)
- —24— Inferred Equipotential Line (in feet above MSL)
- Contour Interval is 0.5 feet
- Contour Lines are Interpolated Between Data Points

Scale in Feet: 100 200

Figure 5
PIEZOMETRIC SURFACE IN THE SURFICIAL DEPOSITS
MAY 14, 1987
Dupont Kentec Facility

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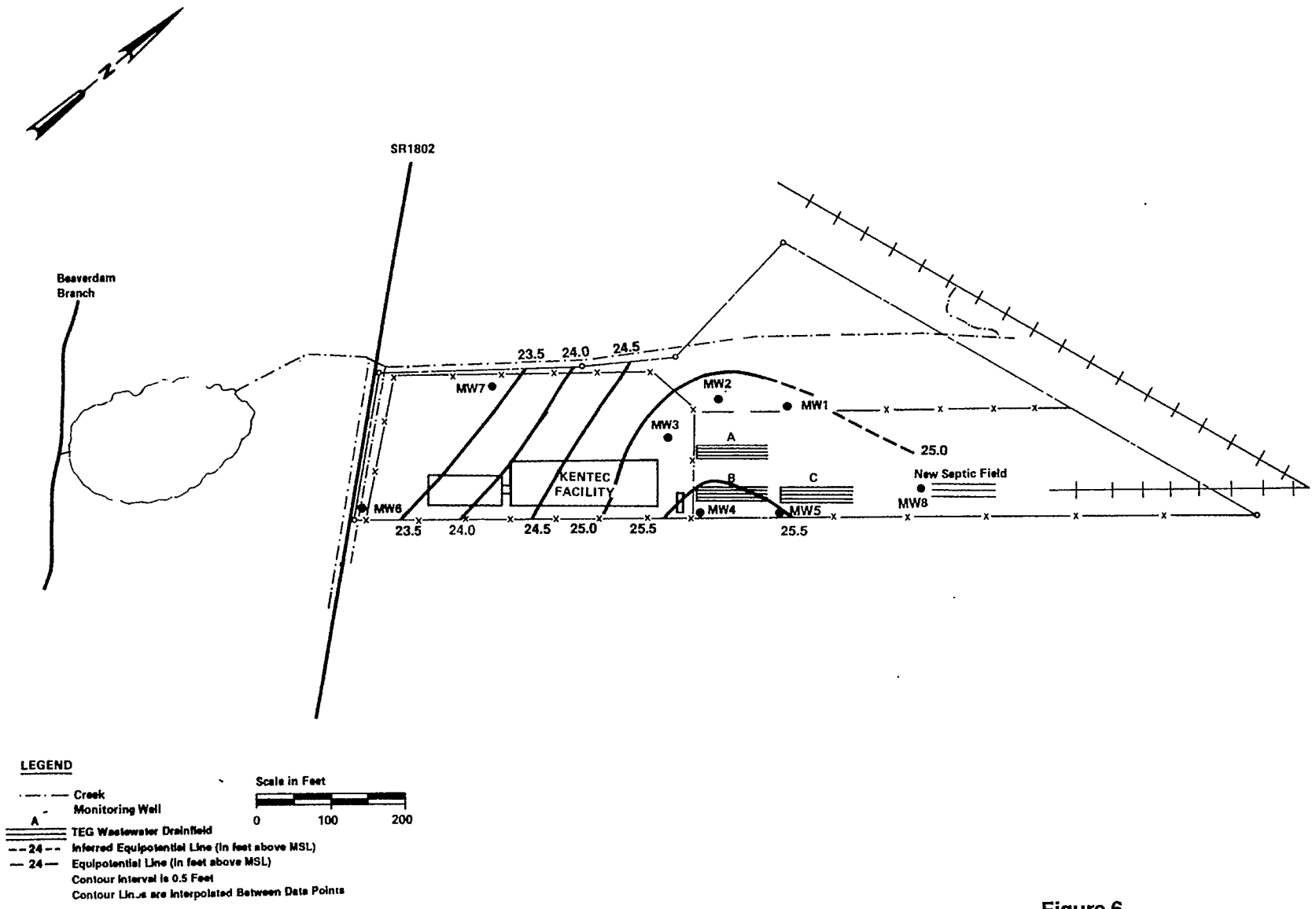


Figure 6
PIEZOMETRIC SURFACE IN THE SURFICIAL DEPOSITS, JUNE 6, 1988
Dupont Kentec Facility

Table 2
WATER LEVELS IN MONITORING WELLS

Well Number	Water Level (Feet above MSL) May 14, 1987	Water Level (Feet above MSL) June 6, 1988	Ground Elevation (Feet above MSL)
MW1	27.43	25.10	29.0
MW2	27.44	25.26	30.0
MW3	27.28	25.27	29.5
MW4	27.42	25.70	30.6
MW5	27.47	25.54	30.6
MW6	24.59	23.19	28.5
MW7	-	23.20	27.9
MW8	-	25.21	29.0

Water level measurements are accurate to ±0.02 feet, which includes ±0.01 feet for top of protective casing measurements.

Elevations are N.C.G.S. vertical control.

Dash (-) indicates water level not measured.

WDR311/061

Table 3
FIELD PARAMETERS FROM MONITORING WELL
GROUNDWATER SAMPLES

Well Number	Date	pH	Eh* (mv)	Conductivity (µmhos)	Temperature (°C)
MW1	05/87	6.5	-234	750	15
	06/88	6.4	-104	490	19.5
MW2	05/87	6.6	-393	550	16
	06/88	-	-	-	-
MW3	05/87	6.7	-85	510	16
	06/88	6.6	-76	210	21.5
MW4	05/87	6.3	-164	1,270	16
	06/88	6.9	-185	1,850	22
MW5	05/87	6.6	-146	720	18.5
	06/88	6.0	-111	690	22.5
MW6	05/87	6.1	-167	1,790	17.5
	06/88	7.0	-165	1,350	21.0
MW7	05/87	-	-	-	-
	06/88	6.2	-64	720	22.0
MW8	05/87	-	-	-	-
	06/88	6.6	4	330	21.0

*Uncorrected field measurement
(-)Dash indicates parameter not measured

WDR311/062

Table 4
FIELD PARAMETERS FOR SURFACE WATER SAMPLES
JUNE 1988

Sample Number	pH	Eh* (mv)	Conductivity (µmhos)	Temperature (°C)	Dissolved Oxygen (mg/l)
SW11	6.2	-46	460	30.1	4.1
SW16	6.2	-64	190	22.9	1.4
SW23	6.8	-68	151	22.5	3.5
SW24	6.2	-50	148	22.2	3.2

* Uncorrected field measurement

WDR311/063

The results of organic analyses of groundwater from Phases 1 and 2 are given in Table 5. These results indicate that 1,4-dioxane detected during the Phase 1 sampling was observed during Phase 2 sampling at concentrations above the proposed state groundwater standard of 7 ppb. (See Table 8 for applicable standards.) Concentrations observed in Phase 2 samples were nearly equal to or higher than concentrations found during Phase I in all monitoring wells. MW8 had a 1,4-dioxane concentration of 820 ppb, suggesting that this well is not upgradient from the contamination.

Acetone concentrations in Phase 2 samples were near or below detection limits, indicating that elevated concentrations of acetone in Phase 1 samples were a result of the acetone wash during decontamination of equipment.

Traces of other organic compounds were detected during both phases of sampling. During Phase 2, samples from MW3 and MW4 contained 1,1-dichloroethane (280 ppb and 900 ppb) and 2-butanone (58 ppb and 140 ppb). However, the concentrations of these compounds were near or below detection limits at these wells during Phase 1. At MW6, trace amounts of a number of organic compounds were detected during Phase 1, but not during Phase 2.

Inorganic chemical analyses for Phases 1 and 2 are summarized in Table 6. The concentrations of iron and manganese were elevated in most samples during both phases. As it appears that MW8 is not consistently upgradient of the site, it is unclear as to whether the concentrations found were elevated above natural conditions. However, the highest concentrations of iron were observed in samples with the highest concentrations of organic compounds: MW3, MW4, MW6, and MW7. There is no apparent correlation between manganese concentrations and sample locations.

Inorganic and organic chemical analyses for surface water samples collected during both phases are given in Table 7. Iron concentrations were elevated in water samples near the Kentec facility. Manganese concentrations were low in all surface water samples.

The compound 1,4-dioxane was present in two surface water samples taken during Phase 2. SW11, adjacent to Kentec, and SW16, located in a marsh area southwest of the facility, had concentrations of 1,4-dioxane of 25 ppm and 11 ppm, respectively. Trace concentrations of carbon disulfide, toluene, and 1,1-dichloroethane were found in sample SW11.

Table 5
ORGANIC CHEMICAL ANALYSES
GROUNDWATER
PHASES 1 AND 2

Analysis / Well No./ Date/	MW1		MW2		MW3		MW4		MW5		MW6		MW7		MW8	
	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88
TOC (ppm)	110	24.9	75	-	65	55.6	83	313	26	19	600/609	100	-	31.9	-	10.7
COD (ppm)	194	61	154	-	169	139	206	660	52	35	1,570/1,790	464	-	96	-	27
TEG (ppm)	<10	<5	<10	-	<10	<5	<10	<5	<10	<5	<10/<10	<5	-	<5	-	<5
Acetic Acid (ppm)	<2	-	<2	-	<2	-	<2	-	3	-	7/3	-	-	-	-	-
Buteric Acid (ppm)	<2	-	<2	-	<2	-	<2	-	<2	-	<2/3	-	-	-	-	-
BNAs (ppb)[a]																
4 Methylphenol	-	<10	-	-	-	<10	-	90	-	<10	-	<10	-	<10	-	<10
VOCs (ppb)[a]																
1,4 Dioxane	1,700*	2,000*	1,600*	-	1,000*	5,900*	1,900*	5,400*	300*	230*	16,000*	33,000*	-	11,000*	-	810*
Acetone	35	<10	1,400	-	900	<50	3,000	60	140	<10	1,300	22	-	<10	-	<10
Chloroethane	<5	<10	<5	-	11	<50	1.5	<50	<5	<10	43	<10	-	<10	-	<10
Toluene	<5	<5	<5	-	<5	<25	1.1	<25	<5	<5	4.3	10	-	<5	-	<5
1,1 Dichoroethene	<5	<5	<5	-	<5	<25	<5	<25	<5	<5	1.7	<5	-	<5	-	<5
1,1 Dichoroethane	<5	5	<5	-	1.6	280	<5	900	<5	<5	11	<5	-	9	-	<5
2-Butanone	<10	<10	<10	-	<10	58	<10	140	<10	<10	130	<10	-	<10	-	<10
Benzene	<5	<5	<5	-	<5	<25	<5	<25	<5	<5	2.1*	<5	-	<5	-	<5
4 Methyl-2 Pentanone	<10	<10	<10	-	<10	<50	<10	<50	<10	<10	2.1	<10	-	<10	-	<10
Trichlorotrifluoromethane	<5	<5	<5	-	<5	<25	<5	<25	<5	<5	<5	<5	-	5	-	<5
1,4 Dichlorobenzene	-	<5	-	-	-	<25	-	<25	-	<5	-	<5	-	7*	-	<5
Carbon Disulfide	<5	<5	<5	-	<5	<25	<5	<25	<5	<5	<5	6	-	<5	-	<5

[a]Compounds in this group that are not shown in this table were below detection limits. See Table 9 for a list of the organic compounds analyzed in this group and their detection limits.
<--Below detection limit shown
Dash (-) indicates constituent not analyzed
<2/<2--indicates sample result and a duplicate sample result
BNA--Base/neutral and acid extractable compounds
*Concentration exceeds state or federal standard (see Table 8)

WDR311/064

Table 6
INORGANIC CHEMICAL ANALYSES
GROUNDWATER
PHASES 1 AND 2
(Results in ppm)

Analysis	Well No./ Date/	MW1		MW2		MW3		MW4		MW5		MW6		MW7		MW8	
		5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88	5/87	6/88
Antimony		<0.3	-	<0.2	-	<0.2	-	<0.2	-	1.0	-	<0.2/<0.2	-	-	-	-	-
Chromium		<0.025	-	<0.025	-	<0.025	-	<0.025	-	<0.025	-	<.025/<0.025	-	-	-	-	-
Cobalt		<0.025	-	<0.025	-	<0.025	-	<0.025	-	<0.025	-	<.025/<0.025	-	-	-	-	-
Iron		25*	16.2*	30*	-	63.8*	35.9*	37.5*	20.0*	8.1*	4.17*	57.5/58.8*	48.9*	-	47.3*	-	11.3*
Manganese		0.69*	0.59*	0.9*	-	1.38*	1.11*	8.55*	2.61*	2.55*	6.58*	1.32/1.32*	1.26*	-	0.52*	-	0.47*
Titanium		<0.3	-	<0.3	-	<0.3	-	<0.3	-	<0.3	-	<0.3/<0.3	-	-	-	-	-
Ammonia		2.4	-	1.3	-	0.1	-	31.1	-	18.1	-	<0.05/<0.05	-	-	-	-	-
Chloride		19	-	15	-	9	-	10	-	9	-	26/18	-	-	-	-	-
Nitrate		<0.2	-	<0.2	-	<0.2	-	<0.2	-	<0.2	-	<0.2/<0.2	-	-	-	-	-
Total Phosphorus		0.13	-	0.2	-	0.1	-	0.03	-	0.15	-	0.51/0.77	-	-	-	-	-
Total Dissolved Solids		-	357	-	-	-	579*	-	1,522*	-	341	-	996*	-	334	-	177

<--Below detection limit shown
Dash (-) indicates constituent not analyzed
<0.2/<0.2--indicates sample result and a duplicate sample result
*Concentration exceeds a state or federal standard (see Table 8).

WDR311/065

Table 7
INORGANIC AND ORGANIC CHEMICAL ANALYSES
SURFACE WATER
(Results in ppm)

Analysis	May 1987			June/July 1988[b]			
	SW9[a]	SW20	SW21	SW11	SW16	SW22	SW23
Iron	17.5	3.75	2	12.1	3.35	0.58	0.82
Manganese	0.40	0.20	0.10	0.42	0.21	0.03	0.06
TEG	<10	<10	<10	<5	<5	<5	<5
TOC	62	57	34	103	17.6	<1	16.7
COD	116	371	71	350	69	26	52
Total Dissolved Solids	-	-	-	342	151	128	113
BNA[a]	-	-	-	BMDL	BMDL	BMDL	BMDL
VOC[a]							
1,4 Dioxane	-	-	-	26	11	<0.05	<0.05
Carbon Disulfide	-	-	-	0.012	<0.005	<0.005	<0.005
1,1 Dichloroethane	-	-	-	0.014	<0.005	<0.005	<0.005
Methylene Chloride	-	-	-	<0.01	<0.01	0.016	<0.01
Toluene	-	-	-	0.004	<0.005	<0.005	<0.005

[a]Compounds in this group that are not shown in this table were below detection limits
[b]VOC samples were collected on July 7, 1988, all other samples were collected June 15, 1888
<--Below detection limit shown
Dash (-) indicates constituent not analyzed
BMDL--Below method detection limit
BNA--Base/neutral and acid extractable compounds

WDR311/066

Table 8
APPLICABLE NORTH CAROLINA GROUNDWATER STANDARDS
and FEDERAL DRINKING WATER LEVELS

Parameter	NC Groundwater Standard	Proposed NC Groundwater Standard	Safe Drinking Water Act: Maximum Contaminant Level	Safe Drinking Water Act: Maximum Contaminant Level Goal	Safe Drinking Water Act: Proposed Maximum Contaminant Level Goal
1,4-dioxane (ppb)	-	7	-	-	-
Benzene (ppb)	0	0.7	5	0	-
1,4-Dichlorobenzene (ppb)	-	1.8	75	75	-
Iron (ppm)	0.3	0.3	0.3[a]	-	-
Manganese (ppm)	0.05	0.05	0.05[a]	-	-
TDS (ppm)	500	500	500[a]	-	-

[a]Secondary standard based on aesthetic quality only.

Note: Not all volatile organic compounds found in groundwater have state and federal standards established.

WDR311/067

Table 9
ORGANIC COMPOUNDS ANALYSES AND DETECTION LIMITS

Base/Neutral Compounds	Method Detection Limit Water (ppb)
Aniline	10
Bis(2-chloroethyl)ether	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
1,2-Dichlorobenzene	10
Bis(2-Chloroisopropyl)ether	10
Hexachloroethane	10
N-nitroso-di-n-propylamine	10
Nitrobenzene	10
Isophorone	10
Bis(2-chloroethoxy)methane	10
1,2,4-Trichlorobenzene	10
Naphthalene	10
Hexachlorobutadiene	10
Hexachlorocyclopentadiene	10
2-Chloronaphthalene	10
Acenaphthylene	10
Dimethylphthalate	10
2,6-Dinitrotoluene	10
Acenaphthene	10
2,4-Dinitrotoluene	10
Fluorene	10
4-Chlorophenyl phenyl ether	10
Diethyl phthalate	10
N-nitrosodiphenylamine 3	10
Benzoic Acid	50
4-Bromophenyl phenyl ether	10
Hexachlorobenzene	10
Phenanthrene	10
Anthracene	10
Dibutyl phthalate	10
Fluoranthene	10
Pyrene	10
Benzy Alcohol	10
Butyl benzyl phthalate	10
2,3,7,8-Tetrachlorodibenzo-p-dioxin	10
Benzo (a) anthracene	10
Chrysene	10
3,3'-Dichlorobenzidine	40
Bis (2-ethylhexyl) phthalate	10
Di-n-octyl phthalate	10
Benzo (b) fluoranthene	10
Benzo (k) fluoranthene	10
Benzo (a) pyrene	10
Indeno (1,2,3-cd) pyrene	10
Dibenzo (a,h) anthracene	10

Table 9
(Continued)

Base/Neutral Compounds	Method Detection Limit Water (ppb)
Benzo (g,h,i) perylene	10
4-Chloroaniline	10
2-Nitroaniline	50
3-Nitroaniline	50
2-Methylnaphthalene	10
Dibenzofuran	10
Diethyl Phthalate	10
4-Nitroaniline	50
Acid Compounds	
Phenol	10
2-Chlorophenol	10
2-Nitrophenol	10
2-4-Dimethylphenol	10
2-4-Dichlorophenol	10
4-Chloro-3-methylphenol	10
2,4,6-Trichlorophenol	10
2,4,5-Trichlorophenol	50
2,4-Dinitrophenol	50
4-Nitrophenol	10
2-Methyl-4,6-dinitrophenol	50
Pentachlorophenol	10
2-Methylphenol	10
4-Methylphenol	10
Volatile Compounds	
Chloromethane	10
Bromomethane	10
Vinyl Chloride	10
Chloroethane	10
Methylene Chloride	10
Acetone	10
Carbon Disulfide	5
Trichlorofluoromethane	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
Trans-1,2-Dichloroethene	5
Chloroform	5
1,2-Dichloroethane	5
2-Butanone	10
1,1,1-Trichloroethane	5
Carbon Tetrachloride	5
Vinyl Acetate	10

Table 9
(Continued)

Volatile Compounds	Method Detection Limit Water (ppb)
Bromodichloromethane	5
1,2-Dichloropropane	5
Trans-1,3-Dichloropropene	5
Trichloroethene	5
Dibromochloromethane	5
1,1,2-Trichloroethane	5
Benzene	5
Cis-1,3-Dichloropropene	5
2-Chloroethyl vinyl ether	10
Bromoform	5
4-Methyl-2-Pentanone	10
2-Hexanone	10
Tetrachloroethene	5
1,1,2,2-Tetrachloroethane	10
Toluene	5
Chlorobenzene	5
Ethylbenzene	5
Styrene	5
Total Xylenes	5
1,3-Dichlorobenzene	5
1,4-Dichlorobenzene	5
1,2-Dichlorobenzene	5
1,4-Dioxane	50
PCBs	
PCB - 1016	0.80
PCB - 1221	2.00
PCB - 1232	2.00
PCB - 1242	0.80
PCB - 1248	0.40
PCB - 1254	0.20
PCB - 1260	0.20

NOTE: The detection limits listed were not always achievable if matrix interferences are present. See lab data sheets for sample specific detection limits.

WDR393/055

CONTAMINANT MIGRATION

The analytical results from Phases 1 and 2 indicate elevated concentrations of 1,4-dioxane in the groundwater. The compound probably originated from the breakdown of TEG disposed in the drain field between 1982 and 1986. Inasmuch as 1,4-dioxane is miscible in water and probably is poorly adsorbed in soil, concentrations would be expected to decrease with time near the drain field, which is no longer operating. However, concentrations of 1,4-dioxane did not decrease between 1987 and 1988, suggesting that 1,4-dioxane may still be leaching from the drain field and surrounding soil and/or some 1,4-dioxane is migrating more slowly than expected as a result of being bound up with other slow moving non-identified organic compounds (elevated TOC and COD values).

1,4-Dioxane is probably migrating off the Kentec facility toward Beaverdam Branch, as evidenced by concentrations observed in the groundwater at the boundary of the property. However, concentrations of 1,4-dioxane found at MW6 may reflect past spills and disposal in that area rather than migration from the drain field discharge. The extent of 1,4-dioxane contamination in the groundwater is currently unknown. Consequently, 1,4-dioxane found in downgradient surface water may be a result either of contaminated groundwater discharging to the surface water or past spills and direct disposals into surface water ditches.

Other volatile organic contamination observed at MW3 and MW4 in 1988 may be the result of an offsite, but nearby, source. The change in groundwater flow direction between the 1987 and 1988 measurements suggests that, at times, groundwater flows onto the site from the southeast in the vicinity of MW4. However, the land adjacent to Kentec along the southeastern boundary is an open field with no evidence of a contamination source.

Elevated iron concentrations in groundwater appear to coincide with elevated concentrations of 1,4-dioxane. Levels are highest at downgradient locations (MW3, MW6, and MW7) and lowest where 1,4-dioxane is low (MW5 and MW8). Inasmuch as iron was not disposed in the drain field, the elevated iron levels in groundwater may be the result of increased dissolution of the iron naturally found in the soils. Increased dissolution of iron may be the result of changes in the groundwater geochemical environment induced by the drain field disposal. Changes may include a lowering of pH, lowering the oxidation-reduction potential, or greater solubility of iron in the presence of the organic compounds. However, the background concentration of iron in the groundwater is not known.

Manganese does not appear to migrate with the organic compounds and iron. Elevated manganese concentrations do not correlate with elevated 1,4-dioxane levels. The source for elevated manganese concentrations at Kentec may be the drain field, offsite (southeast), or naturally occurring.

DISCUSSION AND RECOMMENDATIONS

Analysis of geochemical and hydrogeologic data from Phases 1 and 2 of the groundwater investigation indicates that 1,4-dioxane is found in groundwater onsite; the compound has also been found in offsite surface water. Residual 1,4-dioxane may also still be present at the drain field; it may be leaching into the groundwater. Another source of volatile organic compounds in groundwater may be seasonally upgradient of the property. Dissolved iron and manganese concentrations were also elevated locally and may, in part, be a result of disposal at the drain field. Elevated TOC levels may reflect other organic compounds disposed in the drain field, such as glycol, that are not analyzed as part of the EPA hazardous substance list.

There does not appear to be an upgradient location throughout the year on the Kentec property. The extent of contamination offsite and beneath the surficial deposits is not known.

The following actions are recommended to help determine the extent of contamination:

- Collect two soil samples at each of five locations within the drain field. These samples will indicate if the drain field vicinity is still a source of contamination. Samples at each location should be from depths of 1 to 2 feet and 3 to 4 feet. Chemical analysis should include VOCs, iron, and manganese.

- Collect eight sediment and eight surface water samples from drainage ditches upgradient and downgradient of the site. This will help define the extent of contamination in both the surface water and sediment. Sediment samples should be collected at a depth of zero to 1 foot. Chemical analysis should include VOCs.

- Sample any residential wells downgradient of the site, even if not in use. Chemical analysis should include VOCs, iron, manganese.

- Install seven shallow wells (10 to 15 feet deep) and three deeper wells (50 to 70 feet) to determine the extent of horizontal and vertical contamination. The location of these proposed wells is given in Figure 7.

- Sample all groundwater monitoring wells except MW2. Chemical analysis should include VOCs, iron, manganese, and TOC.

- Prepare a topographic map of the site. This map will help determine the directions of contaminant migration and accurately locate points of interest.

WDR377/011

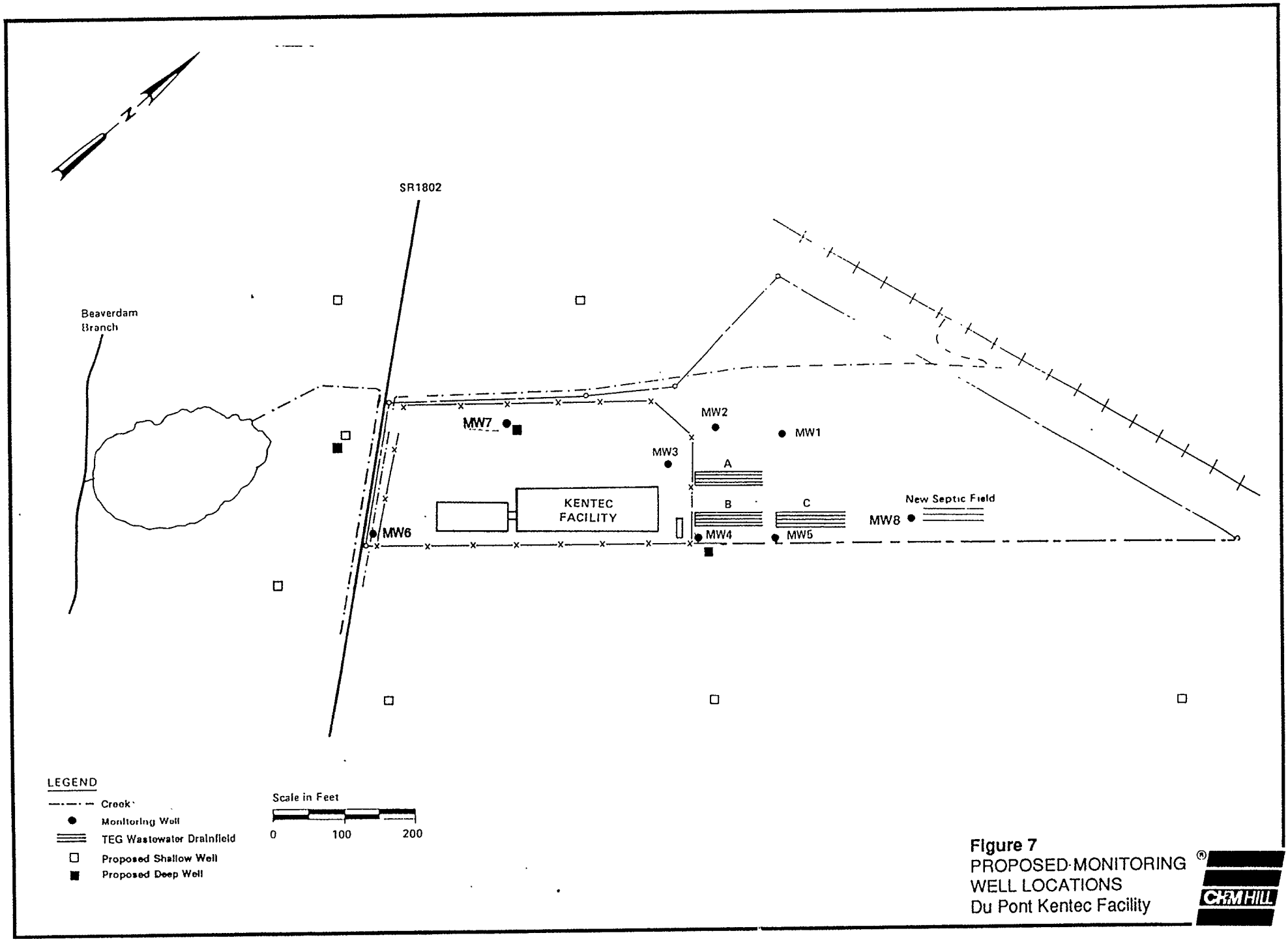


Figure 7
PROPOSED MONITORING WELL LOCATIONS
Du Pont Kentec Facility

CH2M HILL

Appendix A

Appendix A
IN-SITU HYDRAULIC CONDUCTIVITY TESTING

From June 7 to 8, 1988, in-situ hydraulic conductivity values were determined in five of the eight monitoring wells located at the Kentec facility. Data from these wells provide a measure of the capacity of the surficial unconsolidated deposits at the site to transmit water.

In general, each well tested is subjected to a rapid (in theory, instantaneous) drop in water level. Data on the water-level recovery are then continuously recorded through time until recovery is near the original static water level. The rate of recovery is the basis for determining a particular value of hydraulic conductivity. This value represents an average over the formation that is influenced by the drawdown in the well. This approach to in-situ hydraulic conductivity testing is commonly referred to as the rising-head, or bail test, method.

The decline in water level was initiated at each well by removing one 3-foot bailer full of water from the well. The water level recovery was measured by a pressure transducer and then recorded on a Campbell 21X micrologger. Each well was tested twice to ensure that at least one representative data set was available. Monitoring wells in which tests were performed were MW3, MW4, MW5, MW7, and MW8.

The recovery data were analyzed by the method developed by Hvorslev (1951). The method involves fitting a regression line to a semilog plot of normalized hydraulic heads versus time. The normalized hydraulic heads are defined as (H-h)/(H-Ho), where H is the initial head prior to drawdown, Ho is the head after drawdown, and h is the head at specified time during the recovery. The following formula was then used to determine the hydraulic conductivity (K).

$$K = \frac{R^2}{2L(t_2-t_1)} \ln \frac{L}{R} \ \ln \frac{h_1}{h_2}, \text{ for } \frac{L}{R} > 8$$

where:

R = well radius
L = screen length
t_1 = time when recovery equals h_1
t_2 = time when recovery equals h_2
h_1 = recovery at t_1
h_2 = recovery at t_2

Four important assumptions must be satisfied for these equations to be valid. First, the head in the formation is assumed to be constant. Second, groundwater flow to the well follows Darcy's law. Third, the effects of the sand pack around the well and any dewatering of the pack during the test are assumed to be negligible; and fourth, the water level response reflects flow from the more permeable sand zone and not from the silt.

The results of each test are summarized in Table A-1.

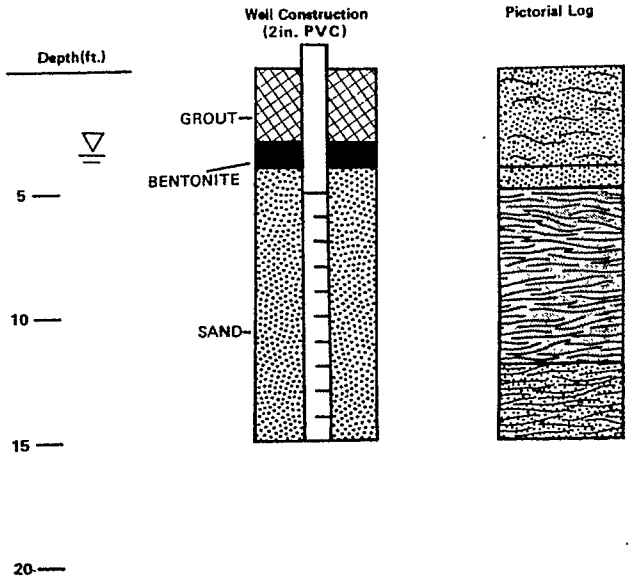
WDR377/052

Table A-1
IN SITU HYDRAULIC CONDUCTIVITY CALCULATIONS

Well	K (cm/sec) Test 1	Test 2	Average
MW3	$8x10^{-4}$	$9x10^{-4}$	$8x10^{-4}$
MW4	$1x10^{-3}$	$1x10^{-3}$	$1x10^{-3}$
MW5	$3x10^{-3}$	$3x10^{-3}$	$3x10^{-3}$
MW7	$7x10^{-3}$	$6x10^{-3}$	$6x10^{-3}$
MW8	$4x10^{-2}$	$3x10^{-2}$	$4x10^{-2}$

WDR377/053

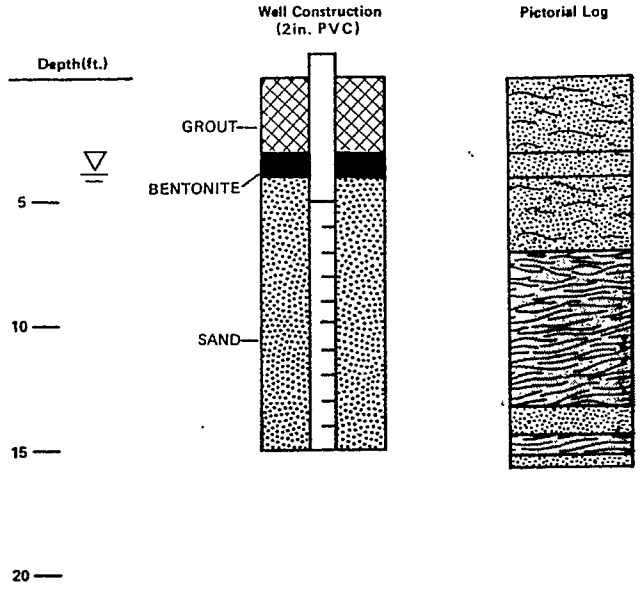
Appendix B



Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
					29.0
S1	0–1.5	11	3–3–4	Fine silty sand, dusky brown (5YR 2/2)– gray orange (10YR 7/4), moist.	
S2	3.5–5	18	7–9–11	M – c. sand, gray-orange (10YR 7/4), to fine silty sand, green gray (5GY 4/1), wet.	24.0
S3	8.5–10	24	12–16–22	Clayey silt with trace sand, green-black (5G 2/1), dense, sl. plastic, moist.	19.0
S4	13.5–15	20	5–9–12	Sandy silt with trace clay, green black (5G 2/1), dense, v. sl. plastic, some glauconite, v. moist.	14.0
					9.0

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 1
Du PONT – KENTEC

CH2M HILL



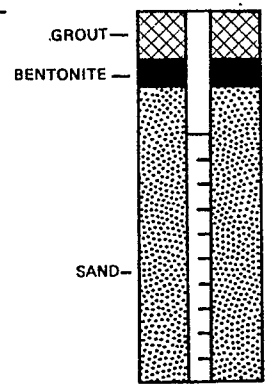
Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
					30.0
S1	0–1.5	14	2–1–2	Fine sand with some silt, dusky yel. br. (10YR 2/2) gray orange (10YR 7/4) sl. moist.	
S2	3.5–5	15	2–5–8	Fine –m sand, trace silt, yel. orange (10YR 6/6), wet.	
				Fine –m silty sand, trace clay, green gray (5G 2/1), sl. plastic, dense, v. moist.	25.0
S3	8.5–10	24	2–6–7	Clayey silt, trace sand, green-black (5G 2/1), sl. plastic, dense, v. moist.	20.0
S4	13.5–15	10	17–29–14	Fine –m. sand with some gravel, grey-green (5GY 4/1), wet.	
				Clayey sandy silt, green-black (5G 2/1), dense, sl. plastic, v. moist.	15.0
S5	14–15.5	24	6–14–15	M–c. sand, gray (N4), wet.	
					10.0

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 2
Du PONT – KENTEC

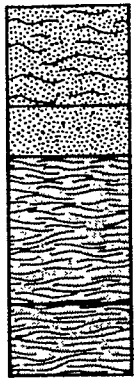
CH2M HILL

Depth(ft.)

Well Construction (2in. PVC)



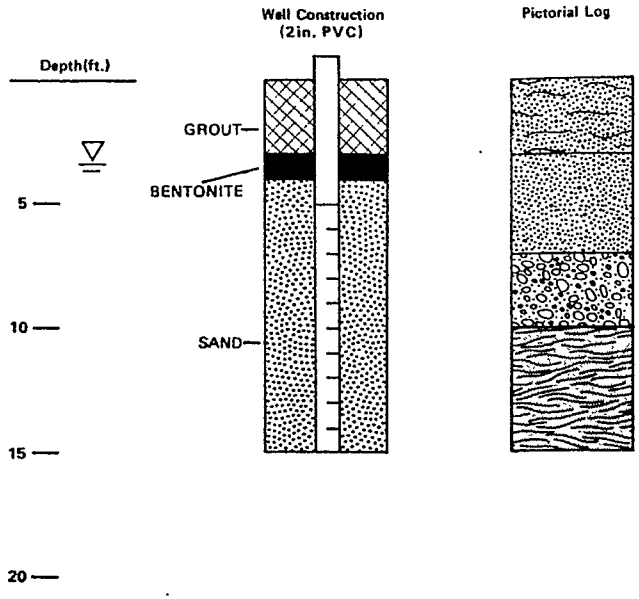
Pictorial Log



Depth (ft.)	Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
						29.5
					Fine silty sand, yellow orange (10YR 6/6)–gray orange (10YR 7/4) moist-wet.	
5	S1	3.5–5	17	5–8–9	Fine–c. sand, with some silt, color as above, wet.	24.5
10	S2	8.5–10	18	3–6–10	Clayey sandy silt, gray (N3), dense, sl. plastic, v. moist.	19.5
15	S3	13.5–15	18	7–12–12	As above, with more sand, with some glauconite, moist.	14.5
20						9.5

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 3
Du PONT – KENTEC

CH2M HILL



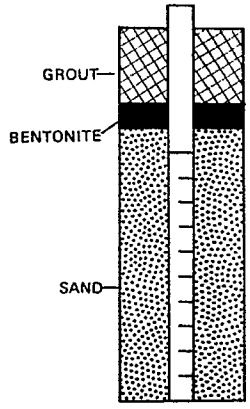
Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
					30.6
S1	0–1.5	18	3–2–2	Fine silty sand, yell. br. (10YR 4/2)–yell. orange (10YR 6/6), moist.	
S2	3.5–5	17	4–5–6	Fine–c. sand, trace silt, yell. orange (10YR 6/6), gray orange (10YR 7/4), wet.	25.6
S3	8.5–10	24	3–4–5	M–c. sand with some gravel, gray (N4–N5)–black ((N1), wet.	20.6
S4	13.5–5	24	8–10–14	Clayey silt with some sand, green black (5G 2/1)–gray (N4), dense, moist-wet.	15.6
					10.6

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 4
Du PONT – KENTEC

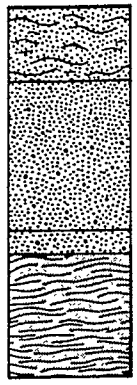
CH2M HILL

Depth(ft.)

Well Construction (2in. PVC)



Pictorial Log



Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
					30.6
S1	0–1.5	24	3–2–2	Fine silty sand, dusky yell. br. (10YR 4/2)–yell. orange (10YR 6/6), moist.	
S2	3.5–5	18	2–2–4		25.6
				M–c. sand, gray orange (10YR 7/4), wet.	
S3	8.5–10	24	2–3–4	As above but black (N1), wet.	20.6
				Clayey sandy silt, green black (5G 2/1), wet.	
S4	13.5–15	18	6–8–11		15.6
					10.6

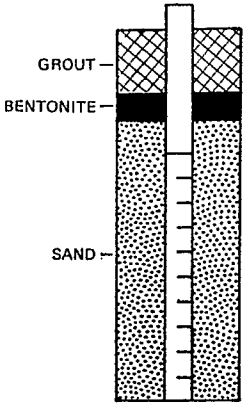
5
10
15
20

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 5
Du PONT – KENTEC

CH2M HILL

Depth (ft.)

Well Construction (2 in. PVC)



Pictorial Log

Sample Number	Interval (ft.)	Recovery (in.)	Blow Counts 6"–6"–6"–6"	Written Log	Elevation (ft.)
					28.5
				Fine–c. sand, gray orange (10YR 7/4) wet.	
S1	3.5–5	15	7–9–11	Fine–m. silty sand, gray green (5G 6/1), sl. cohesive, wet.	23.5
S2	8.5–10	20	7–10–14	Clayey sandy silt, green-black (5G 2/1), sl. plastic, dense, v. moist	18.5
S3	13.5–15	18	7–13–18	Silty sand, green black (5G 2/1), wet	13.5
					8.5

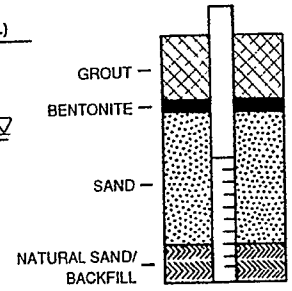
WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 6
Du PONT – KENTEC

CH2M HILL

SAT 22398 B0

Depth (ft.)

Well Construction (2 " PVC)



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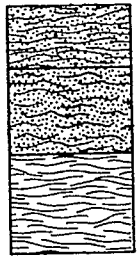


5

10

15

Sample Number	Interval (ft.)	Recovery (in.)	Blow Count 6"-6"-6"	Written Log	Elevation (ft.)
					27.9
				Top soil: clayey silty sand, light brown.	25.7
S1	3.5-5	17	6-11-11	Silty fine to medium sand with trace clay, brown (5 YR 3/2) to greenish gray (5 GY 6/1).	21.7
S2	8.5-10	24	11-9-14	Clayey silt, greenish black (5 GY 2/1), moist, sl. plastic.	

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 7
Du PONT - KENTEC

CH2M HILL

SAT 22398 B0

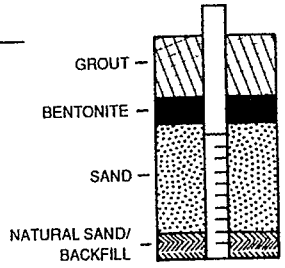
Depth (ft.)

5

10

15

Well Construction (2" PVC)



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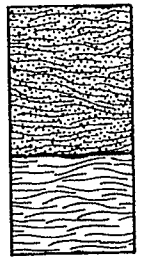

Sample Number	Interval (ft.)	Recovery (in.)	Blow Count 6"-6"-6"	Written Log	Elevation (ft.)
					29
S1	3.5-5	11	3-4-9	Silty c. sand, dark yellowish orange (10 YR 6/6), wet.	23
S2	8.5-10	20	3-5-6	Silty clay with some fine sand, several thin c. sand seams, black (N1), moist, plastic.	

WELL CONSTRUCTION AND GEOLOGIC LOG
MONITORING WELL 8
Du PONT - KENTEC

CH2M HILL

Appendix C