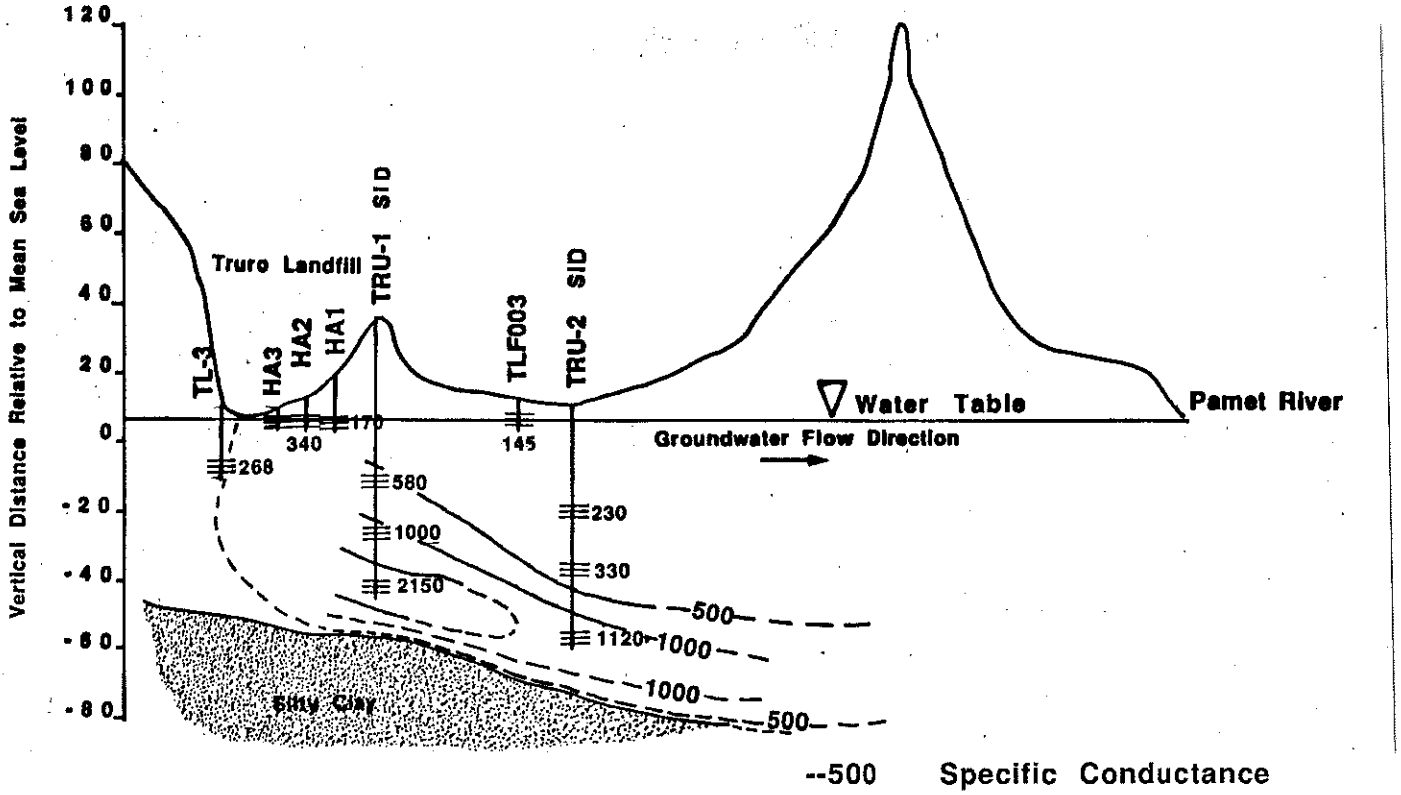
HYDROGEOLOGIC ASSESSMENT OF THE TRURO LANDFILL

TRURO, MASSACHUSETTS

NOVEMBER 1989



Prepared for the town of Truro

by the Water Resources Office of the Cape Cod Planning and Economic Development Commission

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November 13, 1989

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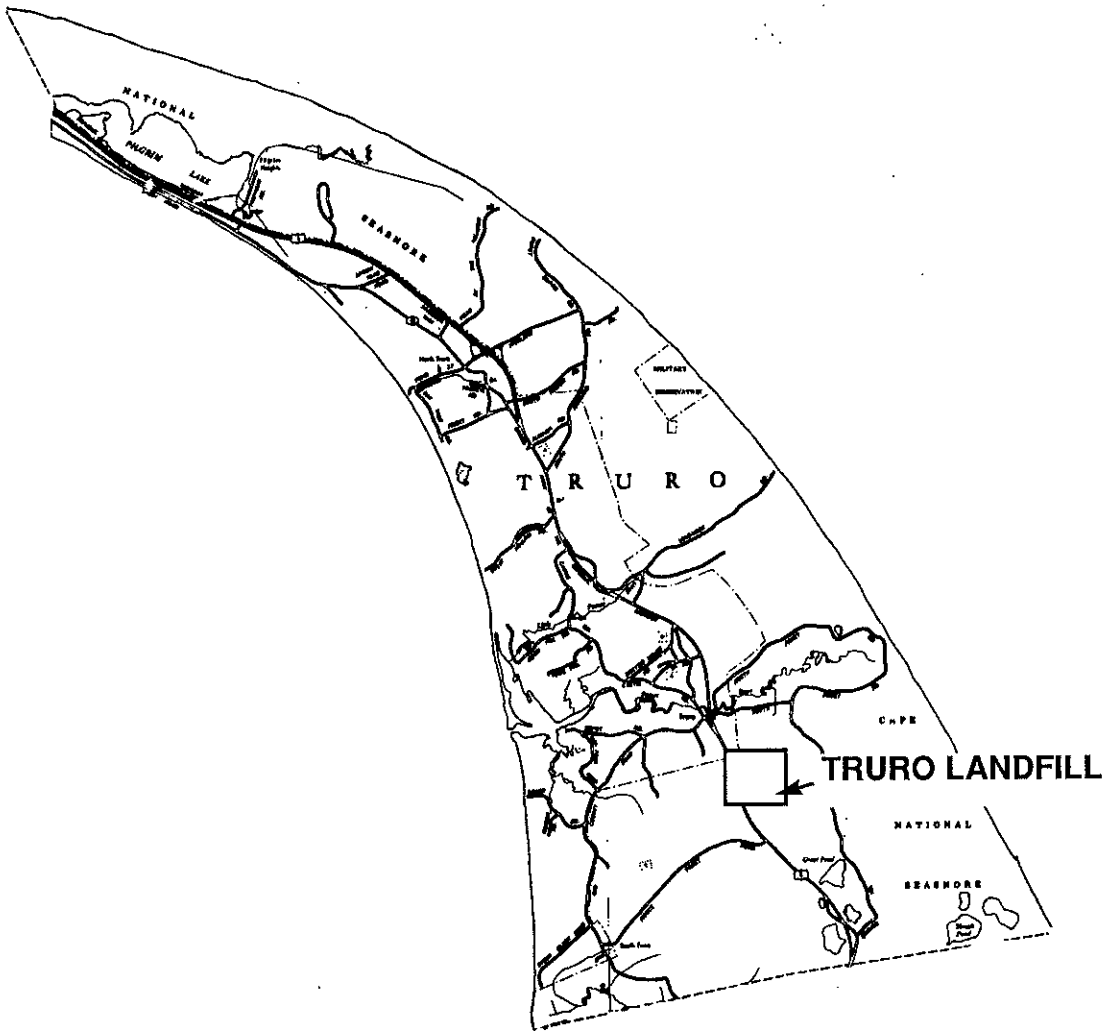
INTRODUCTION

The Cape Cod Planning and Economic Development Commission (CCPEDC) Water Resources Office in cooperation with Barnstable County Health and Environmental Department (BCHED) conducted a hydrogeological and hydrochemical assessment of the Truro Landfill in the winter of 1988-1989 as part of the Truro/ Provincetown Aquifer Assessment and Groundwater Protection Plan. The objective of this study is to further define the chemical composition and extent of the landfill leachate plume in order to determine its impacts on the nearby water resources. A total of thirteen shallow wells were installed and surveyed in order to obtain the water level information to prepare a water table map of the area. Three multilevel monitoring wells were installed based on the results of the water table map, and water quality analyses of these wells were conducted. The details and results of this investigation are described below.

BACKGROUND

The Truro landfill is located to the east side of Route 6 in the Southern portion of Truro (fig.1). The site is within the Chequesset Lens of the Cape Cod Aquifer within the boundaries of the Cape Cod National Seashore (CCNS) in an undeveloped area. The landfill has been in operation for approximately 35 years and is also the site of the town's septage lagoons. Several homes are located in the area which are served by private wells. A Groundwater Management Study prepared for the Town of Truro by IEP, Inc. (1985) recommended that a study of the landfill be conducted to define the nature and extent of groundwater contamination, including the potential impacts on downgradient private wells and the Pamet River. In response to these recommendations, a preliminary hydrogeologic study was conducted for the town in 1987 by Metcalf and Eddy.

FIGURE 1: STUDY AREA



CAPE COD PLANNING
AND
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Metcalf and Eddy completed their report in February of 1988 entitled, "Hydrogeologic Investigation of the Town Landfill, Truro, Massachusetts". The basic components of the report were 1) performing an electromagnetic survey around the site, 2) installation of four shallow monitoring wells, 3) the determination of local groundwater flow direction and 4) analysis of well water samples to determine groundwater quality. The report includes a thorough site description with historic site operation details.

The most important component of any hydrogeologic study is the preparation of an accurate, up-to-date water table map. The Metcalf and Eddy investigation chose to conduct an electromagnetic geophysical survey to develop an understanding of the subsurface conditions in order to site several monitoring wells. Two areas were identified to the northwest of the landfill, where leachate plumes were suspected. Metcalf and Eddy subsequently installed four shallow monitoring wells at the site based on these suspicions.

Water quality analysis of samples taken from the four shallow wells did not show any signs of gross contamination that is typically associated with landfill leachate. Only one well, (TL-3) which is located to the east of the landfill had slightly elevated levels of several inorganic components. The report recommended that sampling and analysis of the four monitoring wells be conducted on a yearly basis and the installation of several deep wells to better characterize groundwater flow direction.

BCHED performed an additional round of sampling in January-February 1989. In addition, CCPEDC sampled several of the hand auger wells for preliminary analysis (Table One). As in the first round of samples taken by Metcalf and Eddy, none of the samples obtained revealed any gross contamination of organic or inorganic constituents. The upgradient well (TL-3) did however contain slightly elevated levels of inorganic and organic compounds. The boring log indicates that this well was drilled through garbage and while this well location was poorly chosen to represent background water quality, it does characterize a portion of the leachate contaminated groundwater as having high specific conductance,

Table One

PRELIMINARY WATER QUALITY RESULTS

WELL	TL-1	TL-2	TL-3	TL4	HA1*	TL003*	HA2*	TL001*
DATE	(2/8/89)	(1/26/89)	(1/26/89)	(1/26/89)	(3/17/89)	(3/17/89)	(3/17/89)	(3/17/89)
pH	4.9	4.5	5.54	5.31	5.2	5.5	5.4	4.7
Temp-C	8.7	10.4	9.7	10.9				
Conductivity (umhos/cm)	139	105	268	86	170	145	340	137
Alkalinity (ppm)	12.2	2.6	62.5	37.4				
Ammonia (ppm)	<1	<1	4.9	<1				
Calcium (ppm)	1.9	3.8	1.6	1.9	0.1	0.1	0.2	0.7
Nitrate (ppm)	0.9	1.2	2.0	0.5	.02	<0.1	0.1	<0.5
Iron (ppm)	2.0	0.1	29.4	0.1	0.3	0.8	15.5	1.7
Magnesium (ppm)	1.3	3.0	2.0	3.0	8.0	13.5	5.5	3.5
Manganese (ppm)	0.47	0.15	0.35	0.02				
Sodium (ppm)	8	7	22	7	13	17	48	14

* Sampled by CCPEDC Water Resources Staff

sodium, ammonium, iron, and chloride with the presence of trace levels of volatile organic compounds (VOC).

HYDROGEOLOGY

In order to produce a detailed water table map the existing monitoring wells were supplemented by ten shallow monitoring wells which were installed using a hand auger. Five foot lengths of 1.25 inch well casing and screen were set at the water table. The location of the monitoring wells are shown on figure 2. The boring logs of these are included in Appendix A. Each of the wells was surveyed and tied into an established benchmark with a known elevation relative to mean sea level. Water level measurements in each of the wells were obtained on March 10, 1989. The water table map indicates that groundwater flow is essentially north toward the Pamet River (fig. 3). Groundwater is probably under confining conditions in well #HA3 where ground water elevations are one foot higher than would be expected. This measurement was therefore ignored in contouring the data. The elevations are included in Appendix A.

The strategic locations of the three monitoring well sites were determined from the March 10, 1989 water-table map. In order to detect the plume at depth, three wells were clustered in each borehole and screened at 3 different depths. The well locations take advantage of a low topographic north trending trough to minimize drilling depth and therefore maximize the study's limited resources. The wells were installed using a hollow stem auger by Desmond Drilling of Brewster. The wells were constructed of two inch PVC wells using a five foot 10 slot screen with flush threaded joints. A bentonite seal was set and a curb box was cemented into place at the land surface to cover and protect the well clusters. The boring logs and construction details for these wells are included in Appendix A. The wells were subsequently developed with the use of an air compressor and/or centrifugal pump.

The Truro landfill, is located in the Wellfleet Outwash, which was deposited during the Late Wisconsinan deglaciation, approximately 15,000 years ago (Oldale, 1964). The deposits are comprised of permeable

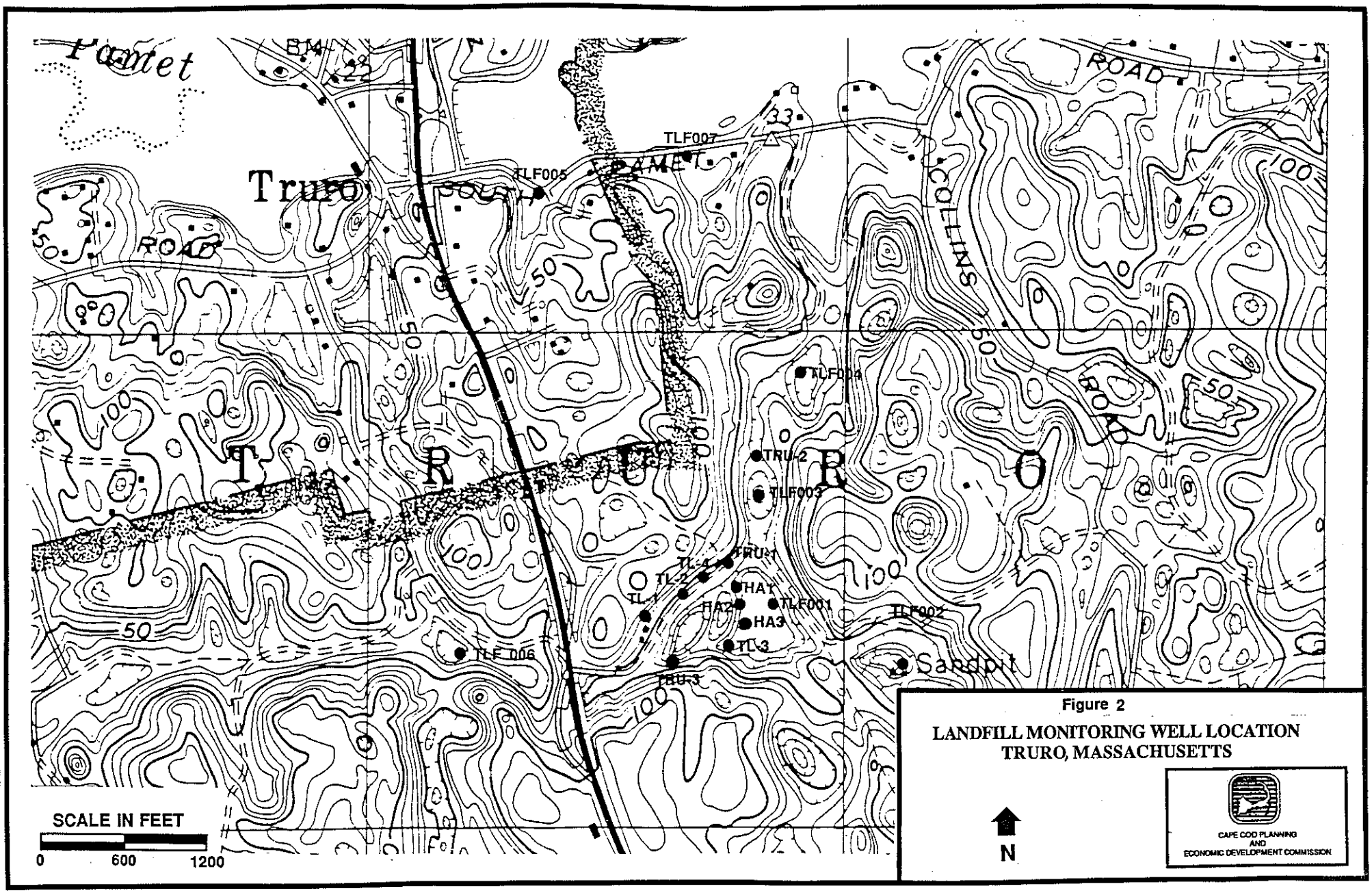


Figure 2

LANDFILL MONITORING WELL LOCATION
TRURO, MASSACHUSETTS

CAPE COD PLANNING AND ECONOMIC DEVELOPMENT COMMISSION

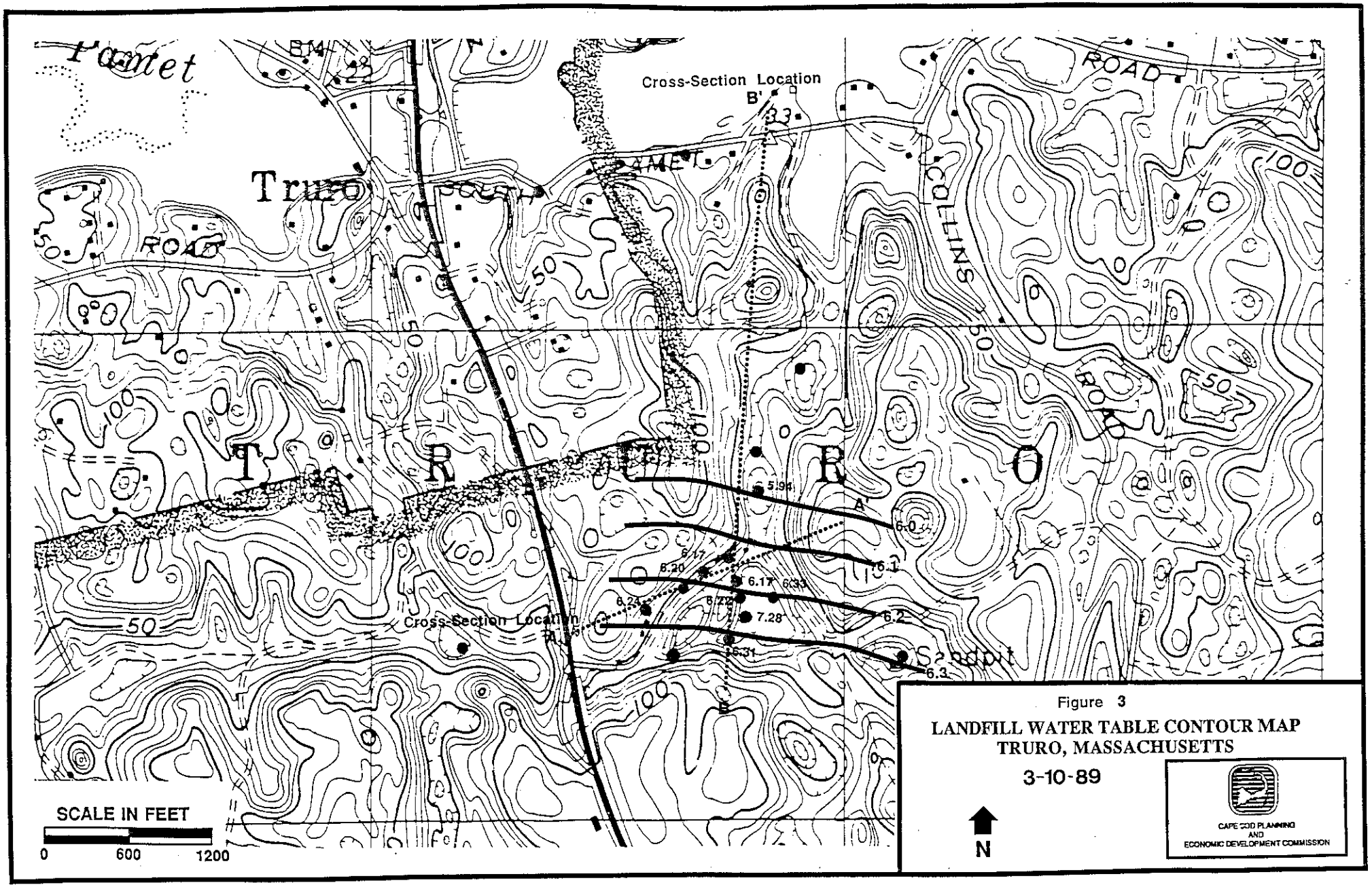


Figure 3

LANDFILL WATER TABLE CONTOUR MAP
TRURO, MASSACHUSETTS

3-10-89

CAPE COD PLANNING AND ECONOMIC DEVELOPMENT COMMISSION

gravels and sands with irregular occurrences of silts and clay. The subsurface geology in the immediate vicinity of the landfill was investigated by reviewing the thirteen borings conducted for this study. A generalized cross section of the geology is shown in Figure 4. The soils consist mostly of medium to coarse sand, however a layer of very fine sand to silt and clay was encountered in deep borings of TL-2 & TL-4. This layer of less permeable material was encountered at approximately 10 feet below sea level at Well TL-2 and based on the interpretation of the boring logs dips down in a northerly direction to 50 feet below sealevel at well TRU-1. The slope of the silty-clay unit may be a subsurface collapse feature caused by the melting ice block that occupied the original kettle hole of the landfill area. The low permeability of these fine grained materials impedes groundwater movement and to a large extent controls groundwater flow direction. The water table measurements at the wells in each cluster varies only by several 100ths of a foot, indicating that the three dimensional flow component is essentially horizontal with a slight downward gradient at TRU-1 and TRU-2 (fig. 4).

The hydraulic gradient of the water table is gentle (.0003) which is reflective of highly permeable aquifers. Hydraulic conductivity is a measure of the relative ease of water to flow through the aquifer matrix. The estimated hydraulic conductivity of the subsurface deposits is approximately 200 feet/day. The ground water flow velocity is calculated by a modified Darcy equation where:

$$\bar{v} = Ki/n$$

$\bar{v}$ is the average linear ground water flow velocity, K is the hydraulic conductivity, n is the percent void space of the sand matrix (approximately .30 for coarse-medium sand), and i is the hydraulic gradient as measured on the water table map. Two flow velocities were calculated for the study area. One for the measured gradient at the site and one for the sub-regional gradient between the landfill and the Pamet River. The sub-regional gradient (.0017) is steeper than the site gradient. This is to be expected because the water table gradient becomes markedly

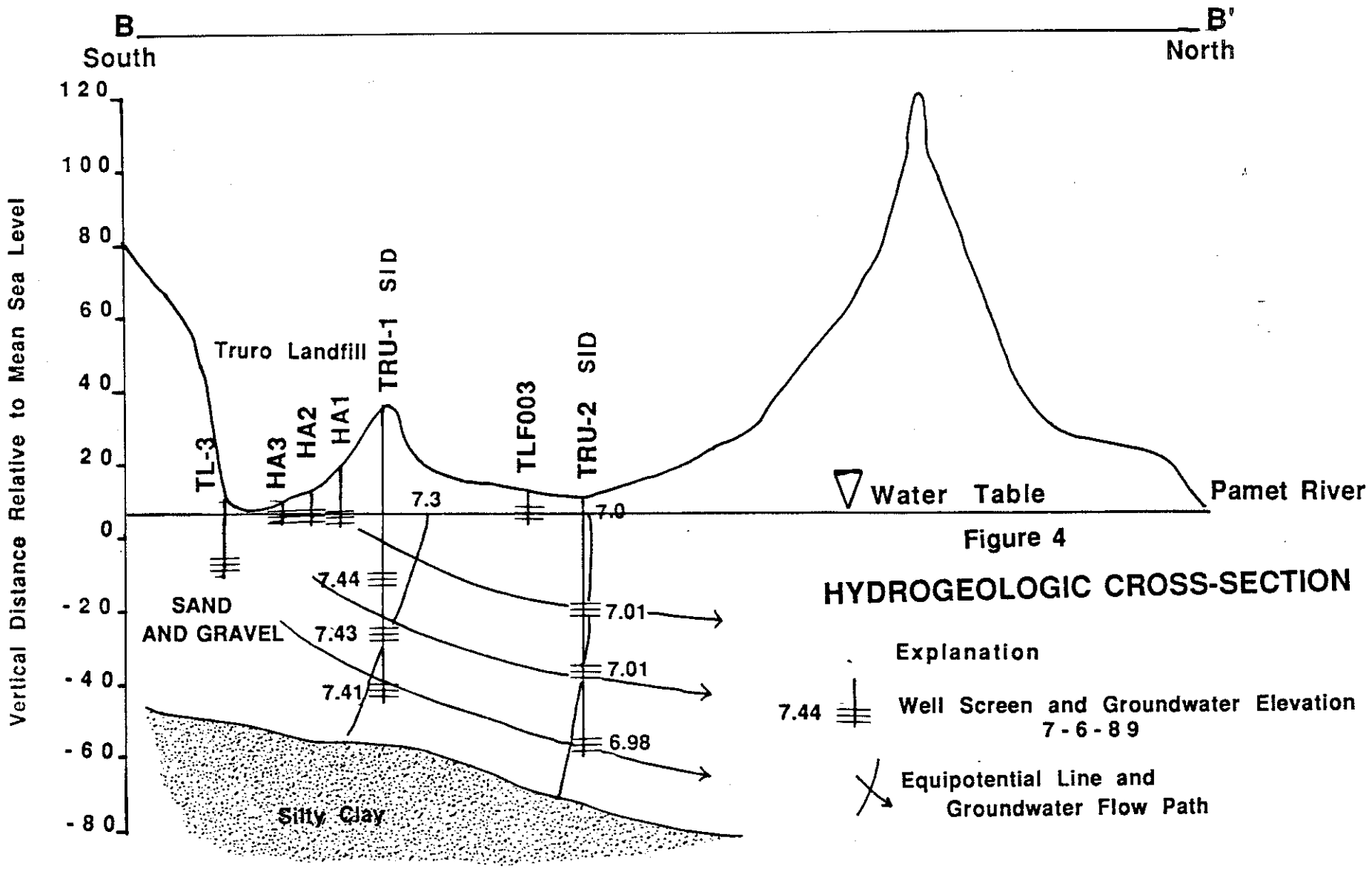


Figure 4

HYDROGEOLOGIC CROSS-SECTION

steeper along the regional discharge zones at the margin of the Pamet and Chequessett lenses (Cambareri et al, 1989).

site velocity: $i = .0003$

$\bar{v} = 200(.0003)/.30$

$\bar{v} = 0.2$ feet/day

sub-regional velocity: $i = .0017$

$\bar{v} = 200(.0017)/.30$

$\bar{v} = 1.11$ feet/day

Groundwater travel times were calculated for the distance of 3,600 feet from the landfill to the Pamet River using the sub-regional velocity.

Travel Time = 3,600 feet/1.11 feet/day

= 3,243 days

= 8.89 years

The calculation indicates that the ground water migrates the distance from the landfill to the Pamet River in approximately 9 years. Given the 35 plus year of operation of the landfill, it is likely that contaminants from the landfill have been discharging into the river for at least the last two decades.

WATER QUALITY

Sources of contamination at the Truro landfill include disposal of solid waste and septage. Both are serious threats to groundwater quality. As precipitation and melting snow infiltrate the decomposing landfill material, contaminants leach down through the soil eventually reaching the water table. The resulting contaminated water is referred to as leachate. The landfill leachate then migrates in the direction of groundwater movement. The area of contaminated water is called a plume. The chemical composition of the plume is highly variable in nature, depending on the disposed materials. The town of Truro landfill contains

primarily domestic waste. However, organic chemicals are also contributed by the disposal of household hazardous wastes such as cleaning compounds, pesticides and fertilizers, paints and waste oil. Septage disposed at the landfill contains high levels of ammonia, nitrate, BOD, bacteria and virus. In addition, the leaching septage increases the volume of water infiltrating the area and may cause a slight groundwater mound.

Water samples were taken from wells TRU-1, TRU-2, TL-2 and TL-4 in July of 1989. The samples were obtained after three standing volumes of water had been removed by bailing. Samples were collected in sterilized containers provided by BCHED laboratory and immediately placed on ice for transport back to the county lab. The results of these analysis are shown in Table 2 and the laboratory analysis are included in Appendix B.

Table 2

Water Quality Analysis*

Sample	pH	Conductivity (umhos/cm)	Nitrate - Nitrogen (ppm)	Iron (ppm)	Sodium (ppm)	Alkalinity (mg CaCO3/l)
TRU2-S	5.5	230	5.0	0.3	19	16
TRU2-I	6.2	330	2.0	0.1	24	26
TRU2-D	6.7	1120	0.3	19	66	310
TRU1-S	6.3	580	16.0	0.1	50	54
TRU1-I	6.7	1000	2.4	0.1	78	250
TRU1-D	6.7	2150	0.3	0.1	297	290
TL2-D	5.9	1300	0.2	0.1	116	82
TL4-S	5.6	212	0.9	0.2	14	48
TL4-I	6.4	1900	0.2	0.2	52	527
TL4-D	6.7	1680	0.2	0.1	150	320

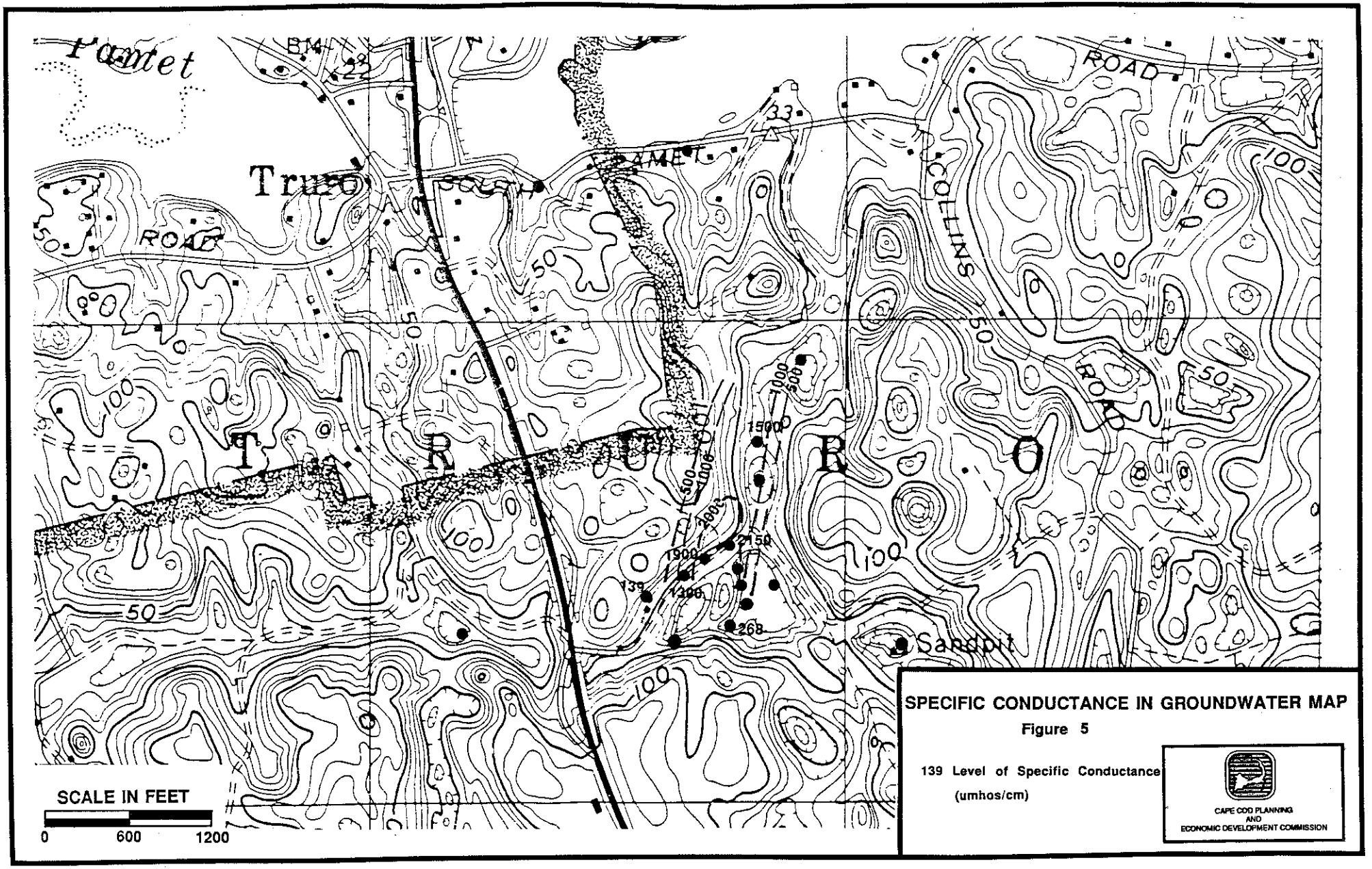
* sampled by CCPEDC Water Resources Staff

Specific Conductance

Specific conductance is a measure of waters ability to conduct an electric current and is directly proportional to the concentration of dissolved ionic substances (LeBlanc, 1984). In general uncontaminated waters on Cape Cod have a low specific conductance of less than 150 umhos/cm (Frimpter and Gay, 1979). Elevated levels may be associated with areas of high salt spray or salt water intrusion, as well as areas of contamination from septic systems or landfill leachate.

The average level of specific conductance in the Truro landfill plume is l050 umhos/cm and has been mapped in figure 5 and 6. The plume is well defined by the specific conductance concentrations. The horizontal and vertical cross sections indicate that the plume is being depressed by vertical flow at a rate of approximately l0 feet for l50 feet of flow in a horizontal direction. The top of the plume is overlain by a wedge of uncontaminated water (at TLF003) which is recharge derived from precipitation. The plume generally follows the groundwater flow path and decends in a vertical direction due to the slight downward vertical gradient and perhaps the greater density of the contaminated water as compared to uncontaminated water (Kimmel and Braids, 1980). The maximum depth of the plume is determined by the configuration of the less permeable material underlying the sandy soils. The plume width, as defined by the l,000 foot specific conductance contour is approximately 600 feet wide and l/4 mile long, and is oriented in a general northerly direction along the dominant groundwater flow path (fig. 6). As discussed previously there is little doubt that the plume has migrated the additional 2,000 feet to discharge into the Pamet River.

The data indicate that the contaminants are carried from the site by flowing groundwater. This method of contaminant transport is known to as advection. Dispersion is a secondary transport process that describes the transverse spread of the plume as it flows. LeBlanc (1984) has found very little transverse dispersion of contaminants in similar hydrogeologic conditions therefore the plume probably does not exhibit much spreading in the distance from its source to the Pamet River. Inspection of the map



SPECIFIC CONDUCTANCE IN GROUNDWATER MAP

Figure 5

139 Level of Specific Conductance (umhos/cm)

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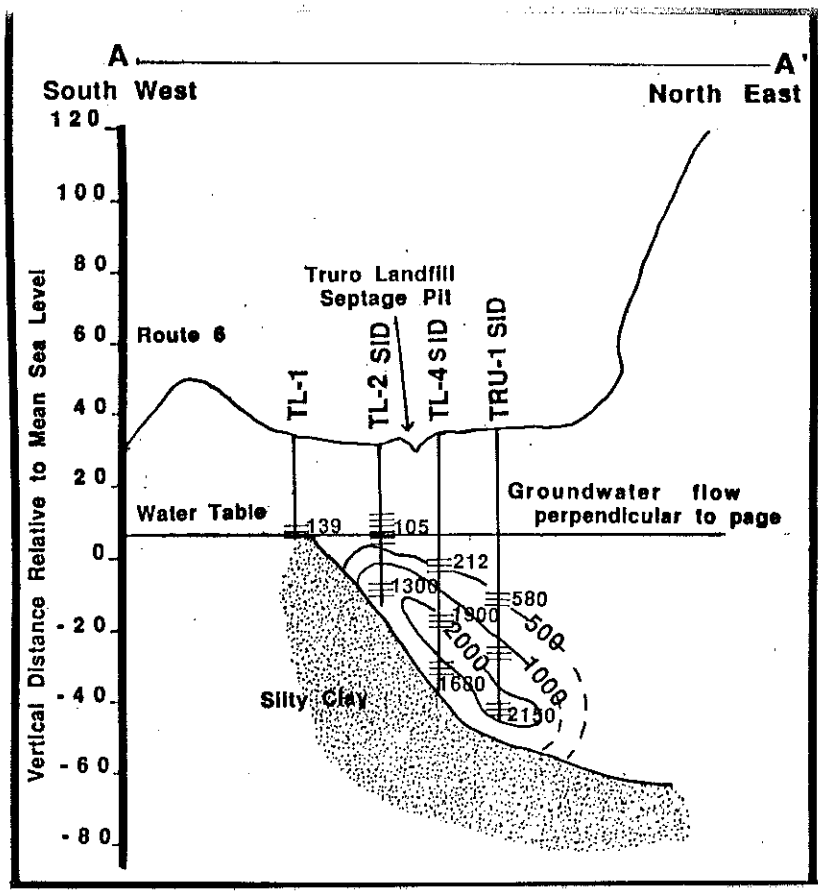


Figure 6

SPECIFIC CONDUCTANCE IN GROUNDWATER

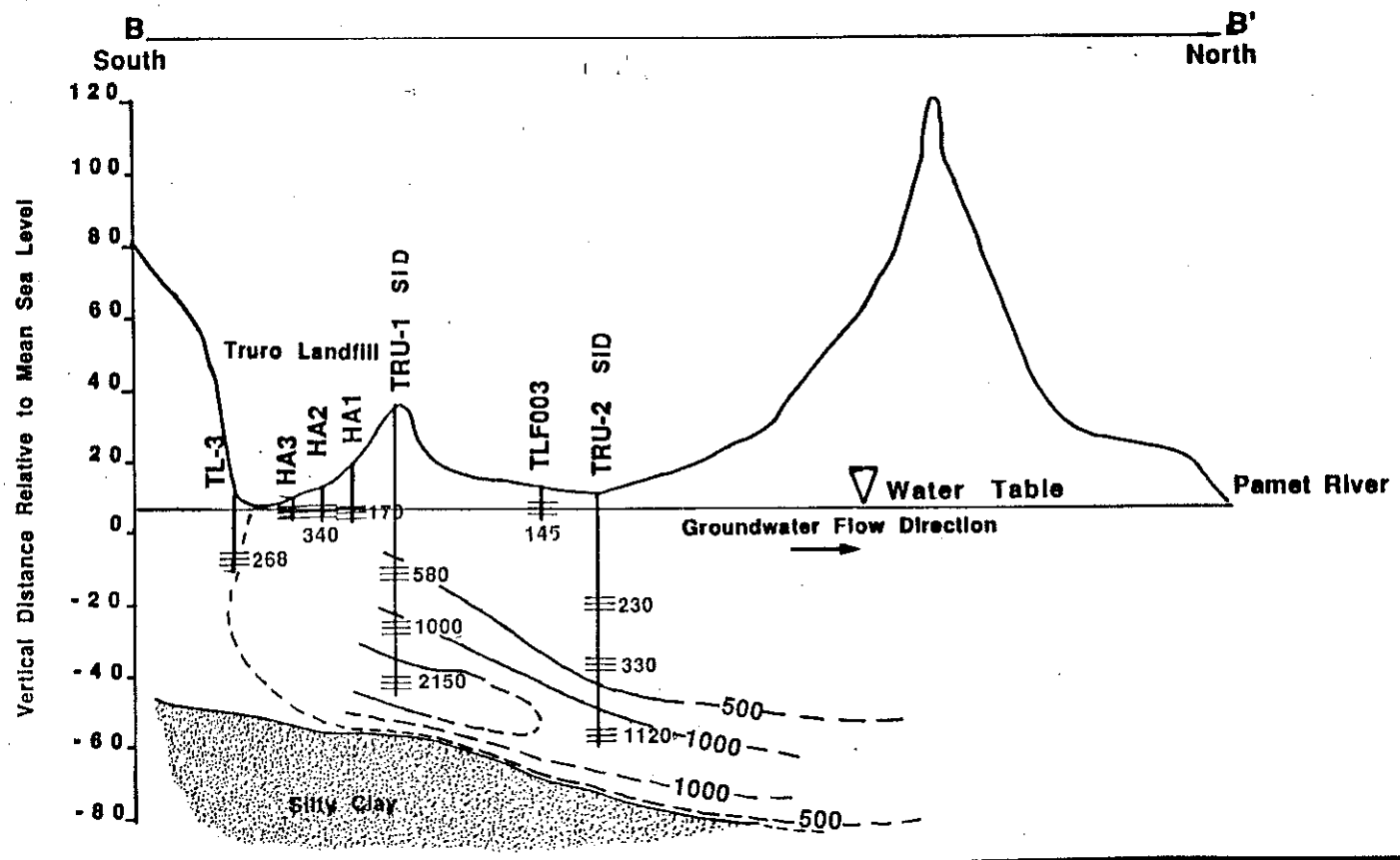
Explanation

139 **Monitoring well screen** and level of specific conductance (μmhos/cm)

-500---Line of equal specific conductance (μmhos/cm) Dashed where inferred

SCALE IN FEET

0 500 1000



view of specific conductance which was developed from both the water quality data and groundwater flow indicates that the core of the plume is slightly off-set from the TRU-2 well site by approximately 100 feet. Therefore it may be possible that the plume core as defined by a specific conductance of 2000 umhos/cm extends further north than the longitudinal section indicates.

Alkalinity

The alkalinity of groundwater on Cape Cod is typically very low (approximately less than 10 ppm) due to the small amount of carbonate material found in the aquifer. Elevated concentrations in contaminated groundwater are attributed to the abundance of dissolved ionic substances that is contributed by the decaying garbage and septage . Kimmel and Braids (1980) report that bicarbonate, one of the best indicators of landfill leachate, is indirectly generated by anaerobic decomposition. The decomposition produces CO_2 which yields carbonic acid (H_2CO_3). The carbonic acid in turn dissociates to bicarbonate ion (HCO_3-) and hydronium (H_3O+).

$$CO_2 + H_2O = H_2CO_3\text{-}$$
$$H_2CO_3 + H_2O = H_3O\text{+} + HCO_3\text{-}$$

The levels of alkalinity detected in the samples, reported as milligrams of $CaCO_3$/liter, ranges from 16 to 527 ppm with an average concentration of 192 ppm. A hydrochemical cross section showing the concentration gradients of alkalinity clearly defines the leachate plume. The distribution of alkalinity in groundwater is similar to specific conductance indicating similar source and contaminant transport processes (fig. 7). The core of the plume is mapped to be 500 feet wide and 1750 feet long based on alkalinity greater than 100 ppm.

High alkalinity is associated with an increase of pH. pH is elevated in landfill leachate as a result of the generation of HCO_3, NH_3 and CH_4 (Baedecker and Back, 1979). Typical pH levels of uncontaminated water

are quite low on Cape Cod, ranging from 4.7-5.2 (Frimpter and Gay, 1979). The average pH of the plume is 6.3.

Nitrogen and Dissolved Oxygen

Although nitrogen exists as three separate species only nitrate-nitrogen was analyzed and therefore forms the basis of this discussion. Nitrate is stable in oxidizing (aerobic) groundwater and because of its anionic form is very mobile and thus can migrate with little retardation (Freeze and Cherry, 1979). The use of nitrate concentration alone to indicate the presence of groundwater contamination can be misleading because in areas of reduced dissolved oxygen (D.O.) organic nitrogen is biologically reduced to ammonia and/or denitrified to N_2 or N_2O (Baedecker and Bach, 1979). For these reasons some limited D.O. analysis was performed in the field on the multilevel wells TRU-1 and TRU-2 to expand our understanding of nitrogen in the leachate plume. Figure 8 shows the levels of $N\text{-}NO_3$ and D.O. in the wells located along the longitudinal and transverse cross sections. Uncontaminated groundwater that is oxygenated usually has a D.O. concentration approximately of 11 ppm. The lowest D.O. levels appear at an intermediate level, in the core of the contaminant plume. Conversely nitrate-nitrogen is greater at the shallower levels and declines with depth at these well sites. The data indicates that a separate shallow plume is emanating from the septage pits. In particular the high nitrate concentration of 16.0 ppm and 5.0 at TRU-1S and TRU-2S respectively, are located above the leachate plume as defined by high specific conductance. Furthermore, there is a lack of elevated nitrate nitrogen levels in TL-4 and TL-2, which otherwise shows signs of leachate contamination from specific conductance, sodium, and alkalinity. Groundwater at these well sites however, may have very high concentrations of ammonia as indicated by the anaerobic hydrochemical conditions. Further analysis of D.O. and ammonia would be useful to fully explain the source and transport of nitrogen. In any case it appears that the nitrate plume is depressed approximately 20 feet below the water table at TRU-1S and therefore may not be intercepted by shallow private wells in the immediate downgradient region.

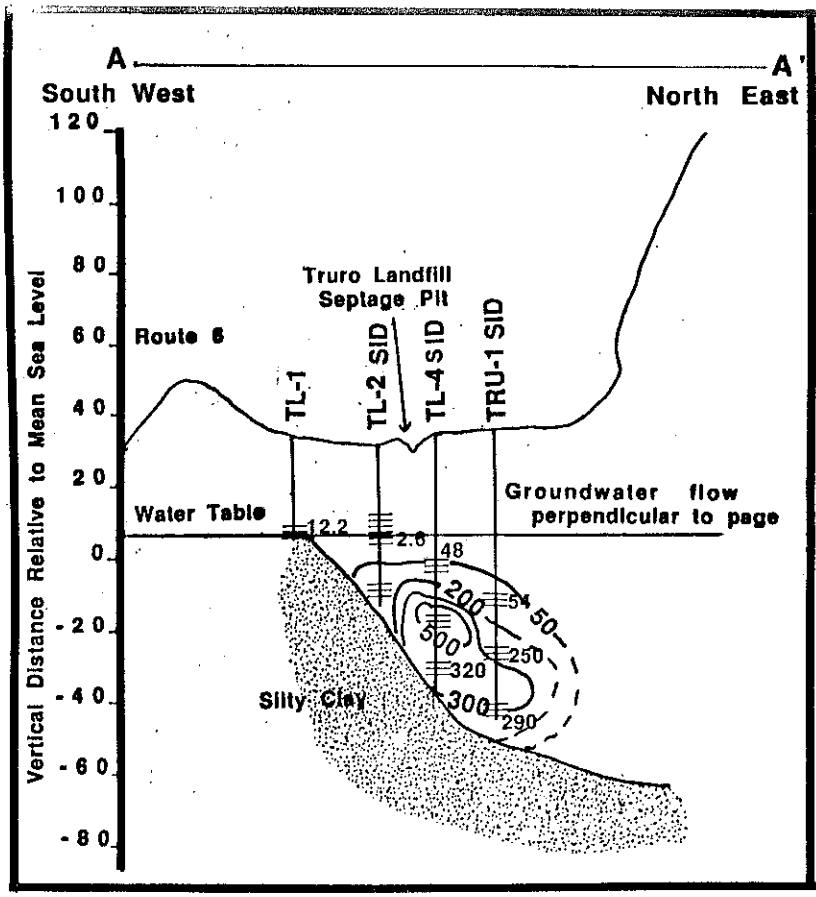


Figure 7

ALKALINITY (as $CaCO_3$) IN GROUNDWATER

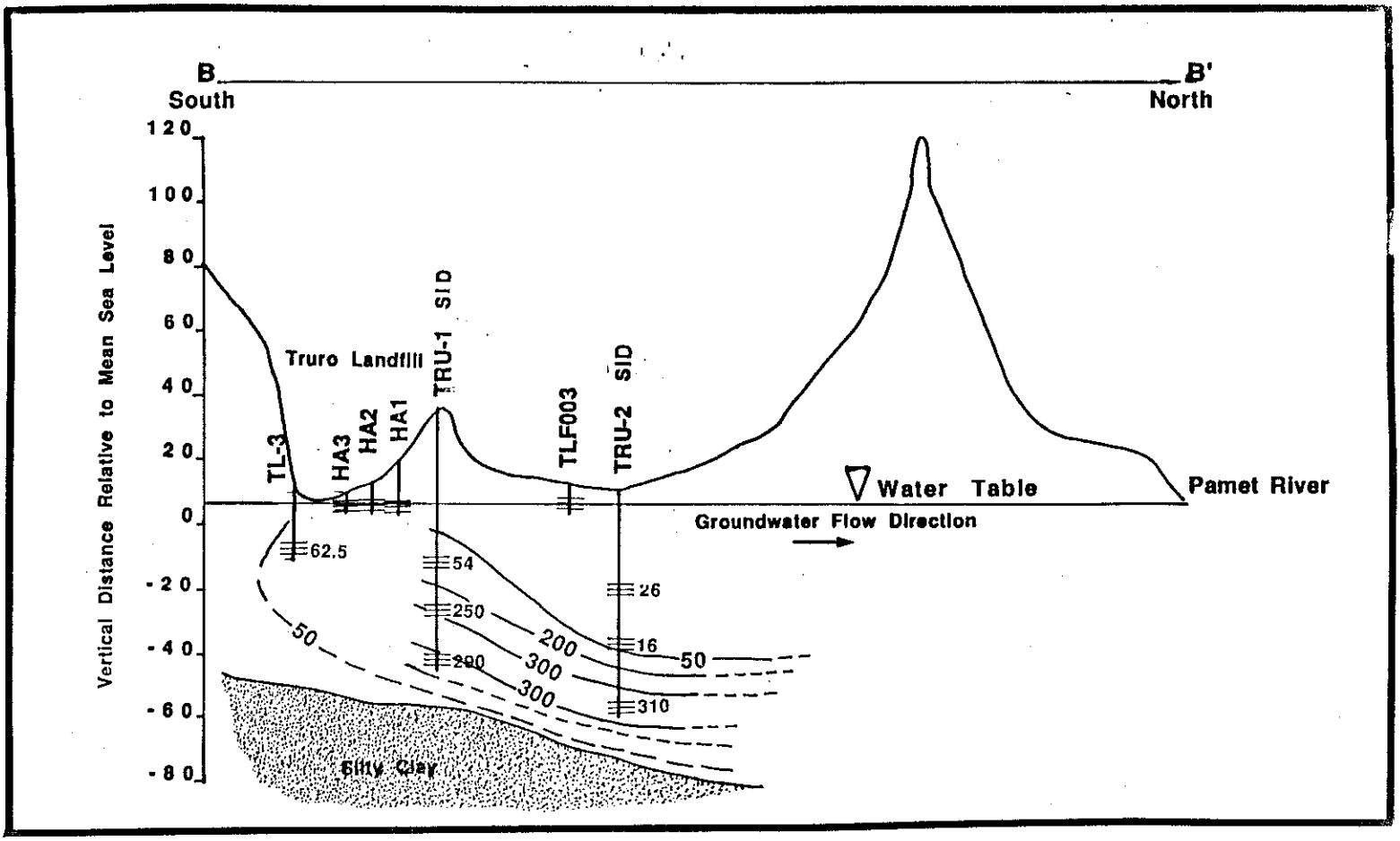
Explanation

54 **Monitoring well screen** and concentration of Total Alkalinity (as CaCO3) in ppm

-50---Line of equal alkalinity (as CaCO3) in ppm
Dashed where inferred

SCALE IN FEET

0 500 1000



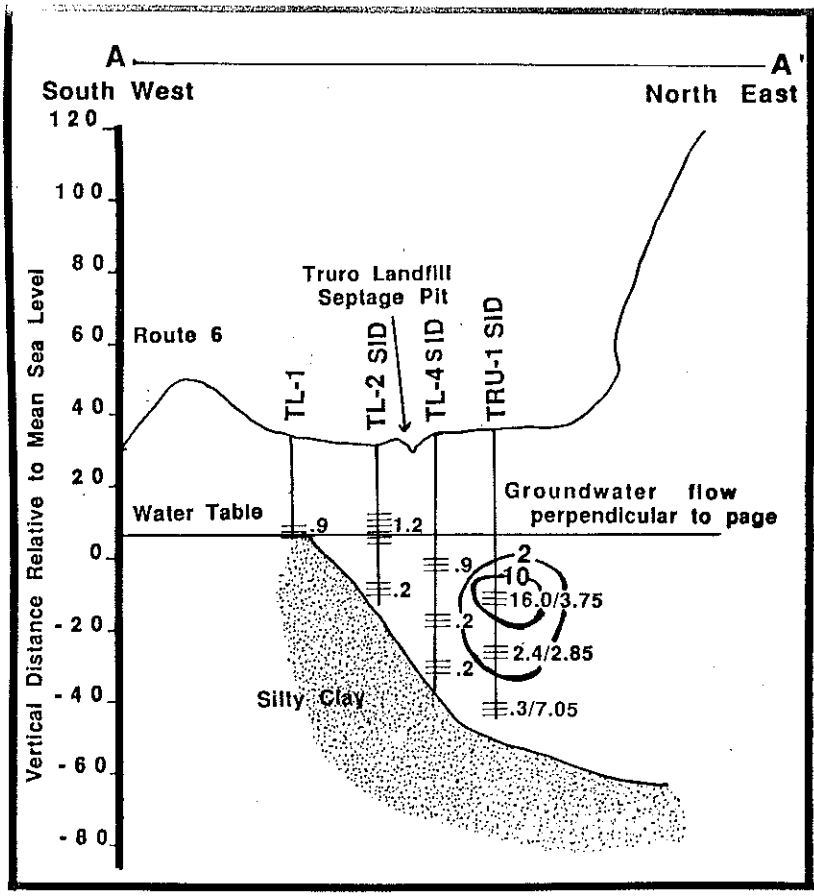


Figure 8

NITRATE/NITROGEN AND DISSOLVED OXYGEN IN GROUNDWATER

Explanation

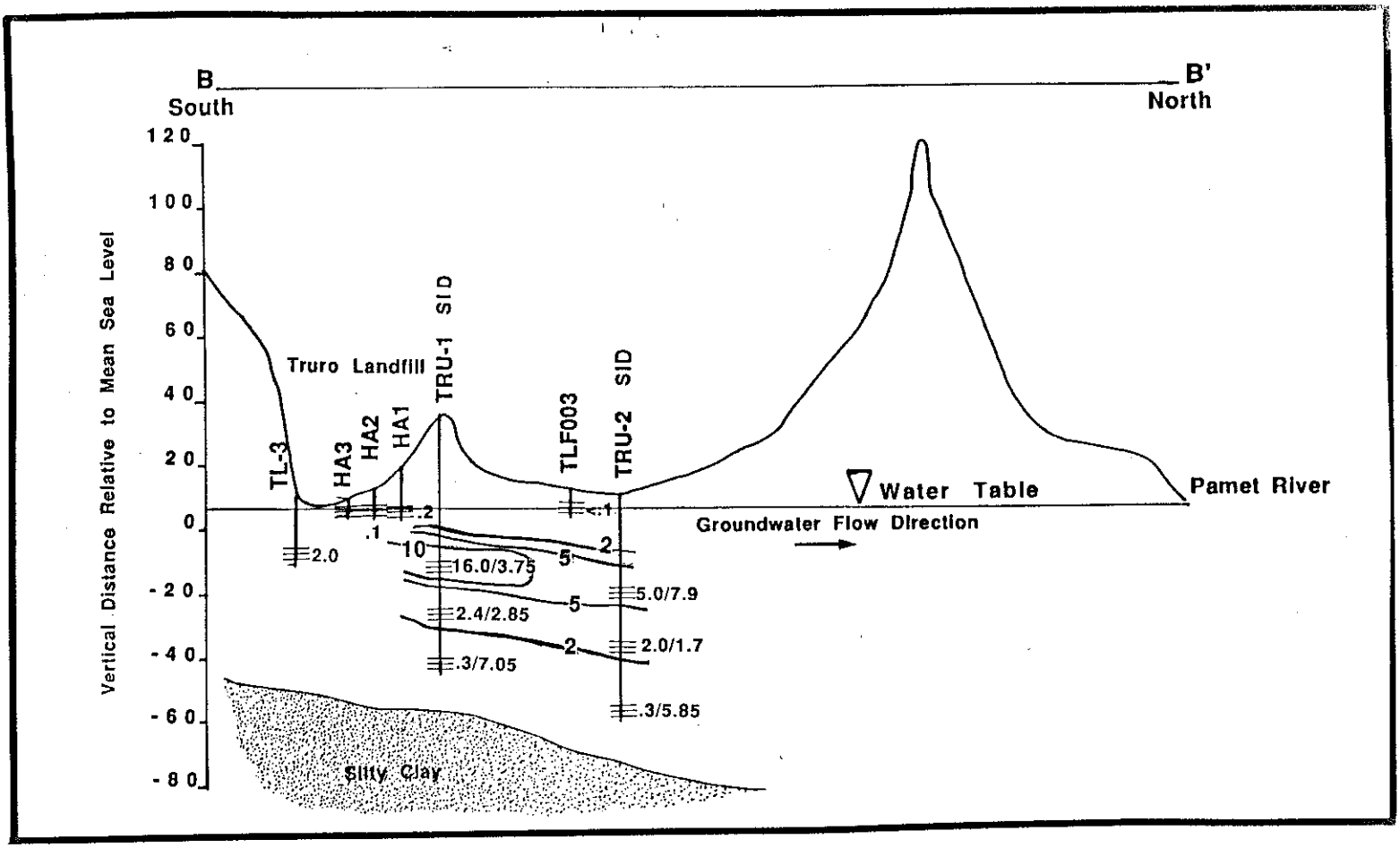
≡ Monitoring well screen

16.0/3.75 Concentration of NO3-N/D.O. (ppm)

-10- line of equal nitrate concentrations (ppm)

SCALE IN FEET

0 500 1000



Sodium and Iron

The median concentration of sodium in the Chequesset Lens is 21.00 mg/l based on data from 302 private wells (Janik, 1987). Sodium in the lower Cape lenses occurs naturally from sources such as ocean spray and areas where wells are located too close to the edge of the freshwater lens causing salt water to intrude into the well. Anthropogenic sources include contamination from landfills, septic systems and road salt. Sodium will move through the aquifer without significant retardation by chemical reactions or absorption and has been used for many years as a conservative tracer in groundwater contamination studies (Kimmel and Braids, 1980). The levels of sodium, while not excessively high are consistently elevated and well above ambient levels. The distribution of sodium and iron is shown in the cross sections of figure 9. The leachate plume can be defined by the elevated sodium concentration ranging from 14 to 297 ppm. It is probable that the high specific conductance of the leachate is due to the sodium and chloride contribution of the dissolved ionic substances. The configuration of sodium in groundwater is similar to that of specific conductance and alkalinity.

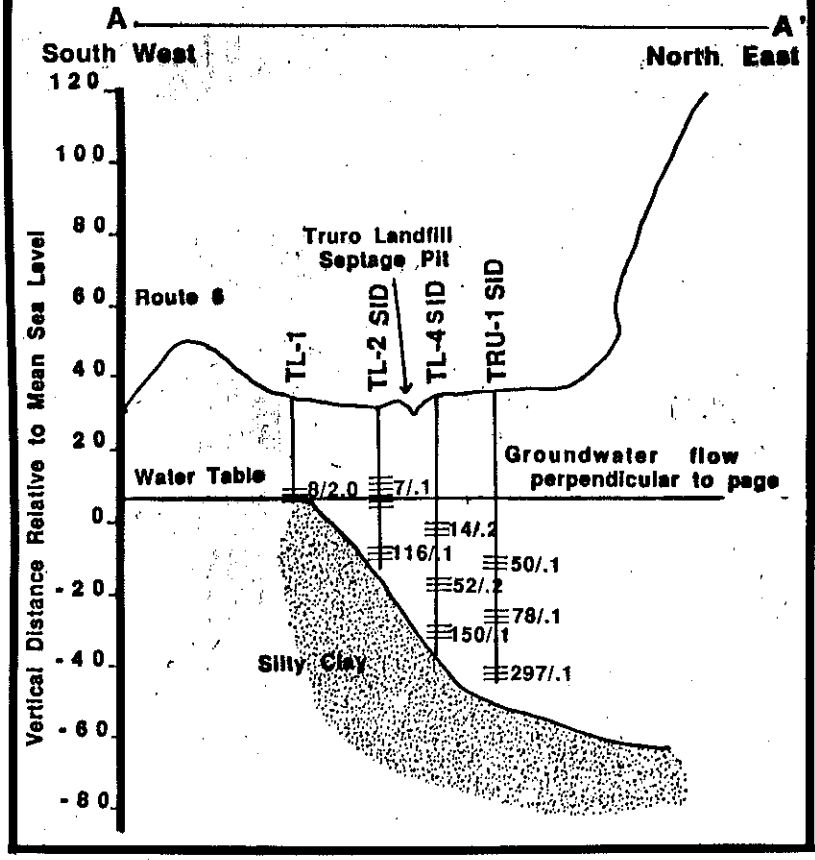
Iron is a naturally occuring and is the fourth most abundant element of the earth's cust. It is particularly prevalent in groundwater of glaciated terrains. Iron is attached onto the sand grains of the aquifer in its ferric form. However in reducing conditions the iron becomes mobile in its ferrous form. Iron in groundwater will typically occur in high concentrations beneath wetlands, and where it is stripped off the sand grains in anerobic contaminant plumes. The iron concentration in groundwater in the plume ranges from 0.1 to 19.0 ppm.

Volatile Organic Compounds

Volatile Organic Compounds (VOC) were analzed by the BCHED by EPA method 502.1. The concentration of VOC ranges from 0.3 to 23.8 ppb. A majority of the concentration was detected as chloroform. Chloroform is typically detected in many groundwater samples that are assumed to be

Figure 9

SODIUM AND IRON IN GROUNDWATER



Explanation

≡ Monitoring well screen

50/.1 Concentration of Na+/Fe (ppm)

SCALE IN FEET

0 500 1000

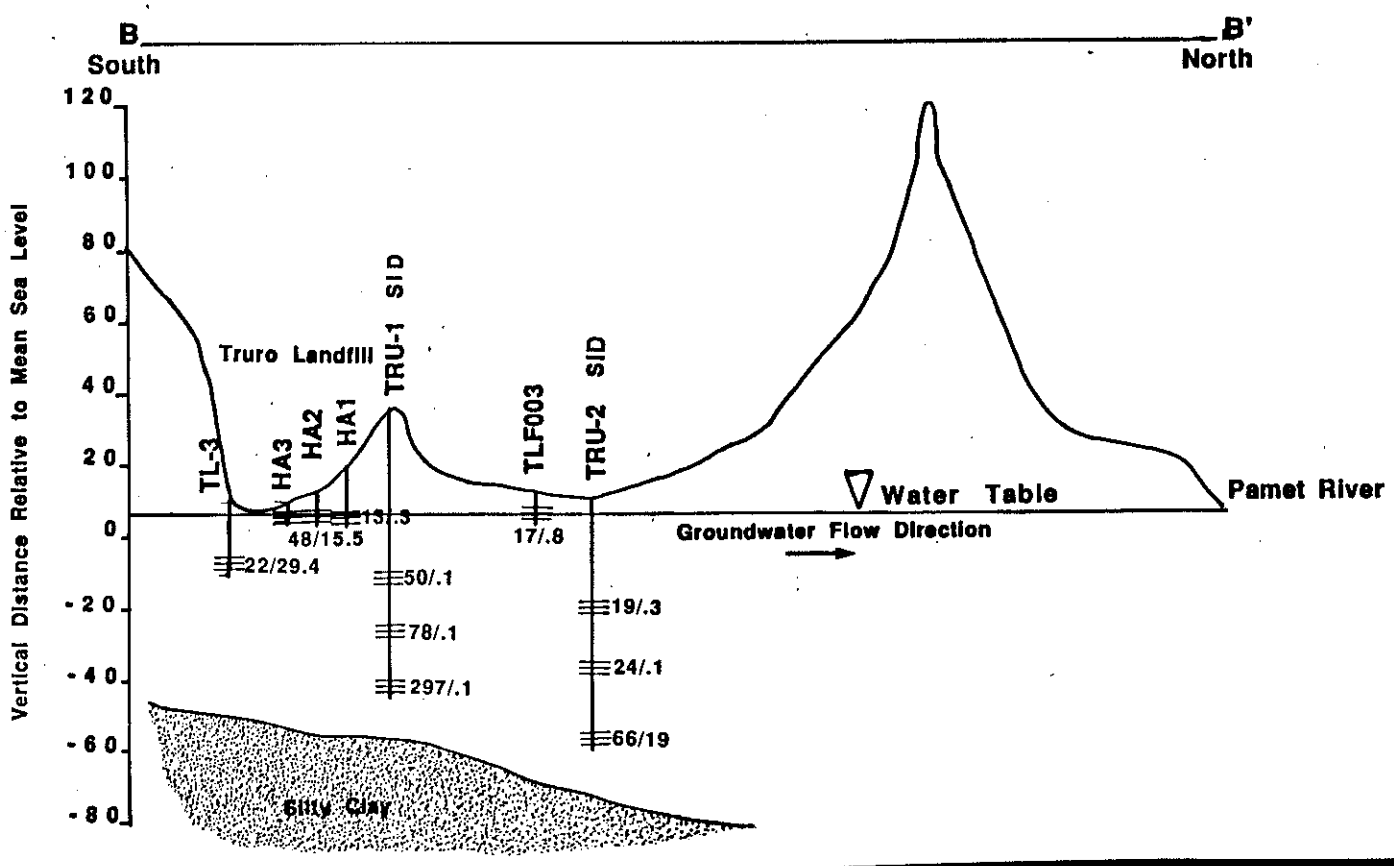
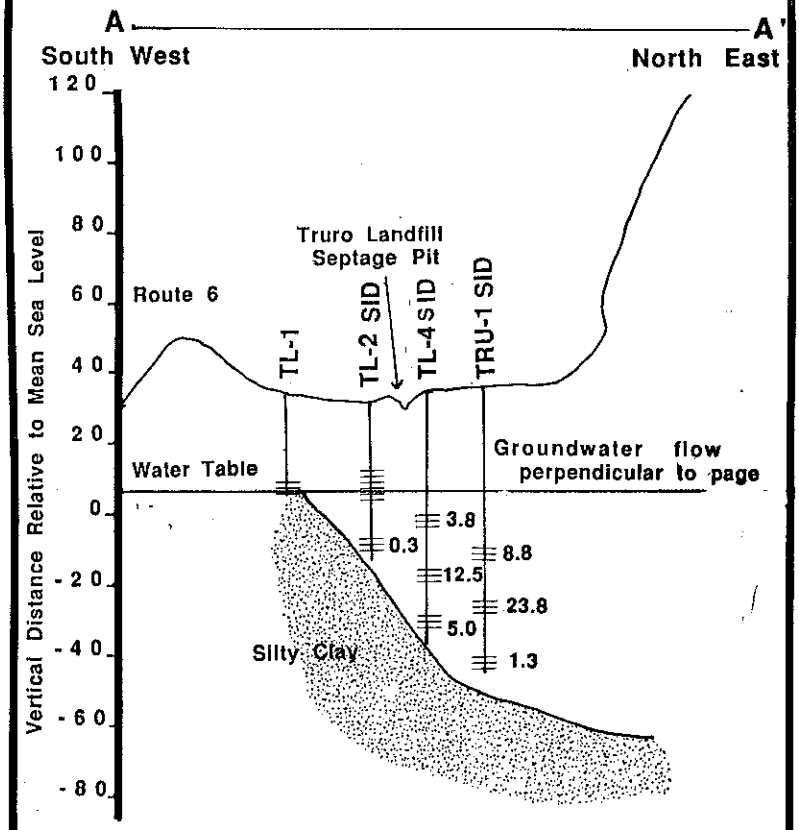


Figure 10

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER

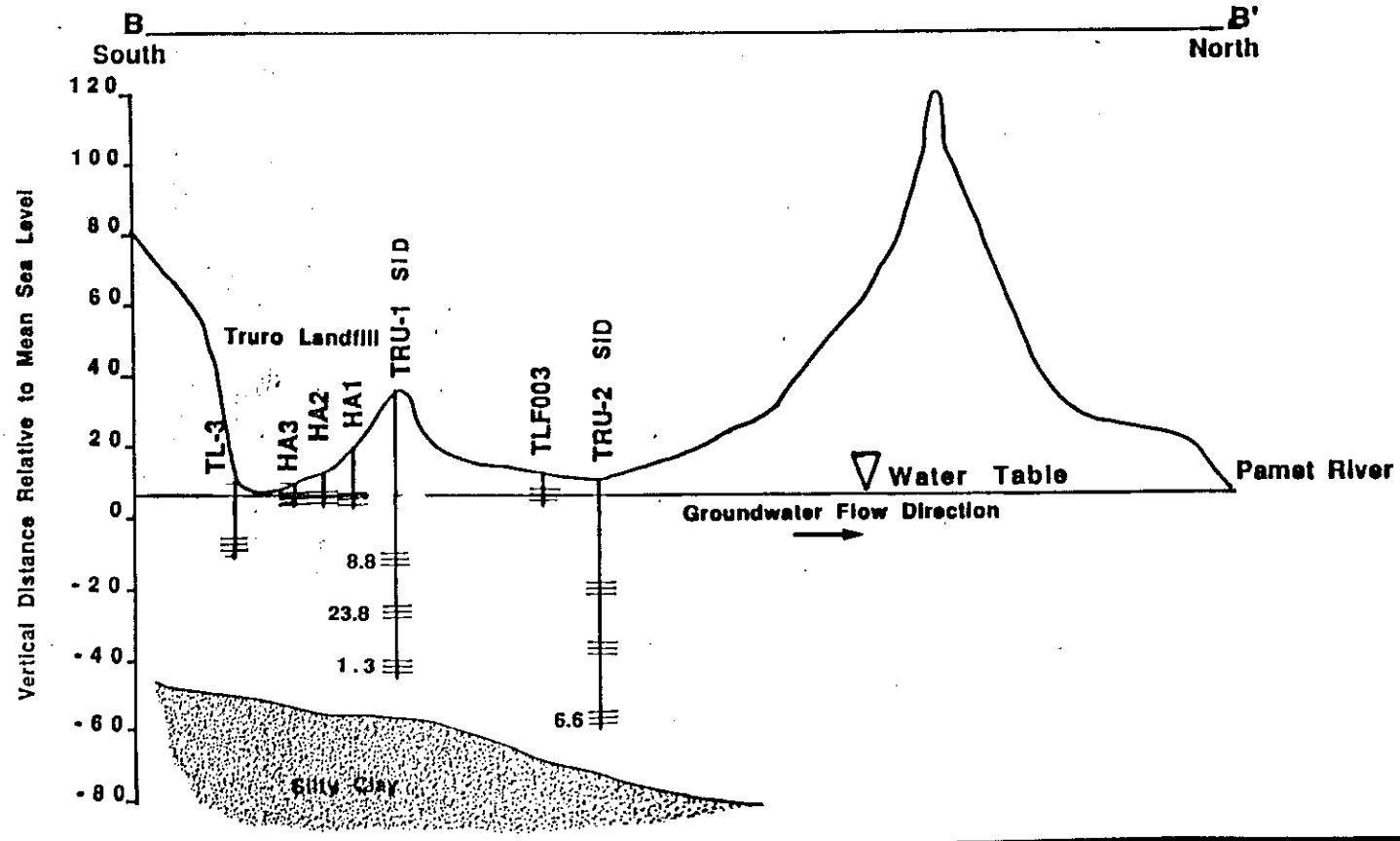


Explanation

8.8 monitoring well screen and level of total volatile organic compounds

SCALE IN FEET

0 500 1000



uncontaminated. The origin of this chloroform may be due to naturally occuring organic acids. Although this may be the case for some of these analyses, several of the chloroform results are highly elevated (14 ppb at TRU-1I) indicating anthropogenic origin. The remainder of the VOCs are a variety of chlorofloro-carbons and solvents such as 1,1,1-trichloroethane and its breakdown component dichloroethane. While none of the concentrations are elevated above the maximum contaminant limits, the highest levels coincide with the nitrate plume. Sampling for VOC's at TRU-2S & I is recommended since these compounds may occur at a higher concentration at shallow downgradient locations.

CONCLUSIONS AND RECOMMENDATIONS

The plume of contamination emanating from the Truro landfill has been identified by the elevated concentrations of specific conductance, alkalinity, pH, nitrate, sodium, iron and volatile organic compounds. The highest concentration of these compounds are 2150 micromhos/cm for specific conductance, 527 ppm for alkalinity, 6.7 pH, 16.0 ppm nitrate, 297 ppm sodium, 19 ppm iron and 23.8 ppb volatile organic compounds. Nitrate values are highest in wells TRU-1S and TRU-2S indicating separate and shallower plume of groundwater contamination emanating from the septage pits.

The plume has been mapped approximately 1,000 feet north of the landfill. The plume is migrating to the north and has probably been discharging into the Pamet River for the last two decades. Any private wells located in the general path of the plume may be screened in the wedge of uncontaminated fresh water that overlies the plume. As the plume progresses nearer to the River it probably surfaces and may affect shallow wells located near the Pamet. The ultimate path of the plume is dictated by the configuration of the less permeable silty layer found under the sandy soils. Additional recommendations are as follows:

1) Continue to monitor water quality in the established monitoring wells in the plume at TL-2, TL-4, TRU-1, and TRU-2 for inorganic and organic parameters on an annual basis. This should include D.O. and ammonia.

2) Perform water quality tests of any private wells located to the north of the plume and south of the Pamet River on an annual basis.

3) The occurrence of this plume and its projected discharge into the Pamet River offers a unique opportunity to study the hydraulic mechanics of contaminant flux from fresh groundwater into marine waters at a regional aquifer discharge area. Therefore several additional cluster wells should be installed downgradient of TRU-2 and at the projected discharge area near the Pamet River. This work should include efforts to further explore the margin of the plume

4) Further study of the contaminant plume should be reviewed by a contaminant hydrogeologist.

REFERENCES

Baedecker, M.J. and W. Back, 1979. Hydrogeological Processes and Chemical Reactions at a Landfill. In Groundwater, Vol. 17, No. 5.

Barnstable County Health and Environmental Department, 1988 Truro Landfill Report.

Cambareri, T. C., 1986. Hydrogeology and Hydrochemistry of a Sewage Effluent Plume in the Barnstable Outwash of the Cape Cod Aquifer, Hyannis,Massachusetts. Masters Thesis, Department of Geology, University of Massachusetts. 130p.

Cambareri, T.C., Belfit, G.C. Janik, D.S., Irvin, P.L., 1989. Truro/Provincetown Aquifer Assessment and Groundwater Protection Plan, Cape Cod Planning and Economic Development Commission.

Freeze, R.A. and Cherry, J.A., 1979. Groundwater, Prentice-Hall.

Frimpter, M.H., and F. Gay, 1979. Chemical Quality of Groundwater on Cape Cod, Massachusetts. USGS WRI 79-65.

IEP, INC, 1985. Water Resources Protection Plan for the Town of Truro, Massachusetts.

Janik, D, 1987. State of the Aquifer Report, Cape Cod Plannning and Economic Development Commission.

Kimmel, G.E. and O.C. Braids, 1980. Leachate Plumes in Groundwater from Babylon and Islip Landfills, Long Island, NY. USGS Professional Paper 1085.

LeBlanc, D.,1984. Sewage Plume in a Sand and Gravel Aquifer, Cape Cod, Massachusetts; USGS WSP 2218.

Metcalf and Eddy, Inc. 1988. Hydrogeologic Investigation of the Town Landfill, Truro, Massachusetts.

Oldale, R.N., 1964. Geologic Map of the Wellfleet Quadrangle, U.S. Geological Survey, GQ-750.

APPENDIX A

BORING LOGS
AND
WATER TABLE ELEVATIONS

APPENDIX B

WATER QUALITY RESULTS

Note: Upon review of the July 6 1989 sampling results of the multilevel wells it is apparent that the bottles were mislabeled. On August 18 CCPEDC staff conducted field sampling of specific conductance to verify sample collection points. By comparing that field data with previous specific conductance measurements of June and January the correct sampling points were verified as indicated below:

Inorganic

TL2-S	☞	TL2-D
TL4-I	☞	TL4-S
TL2-I	☞	TL4-I

Organic

TL1-I	☞	TL4-I
TL4-I	☞	TL4-S
TL4-S	☞	TL2-D

This was also the case with 2 sampling points of the June 6 1989 sampling round. Upon review and field verification the correct sampling points are as indicated.

TRU2-S	☞	TRU2-I
TRU2-I	☞	TRU2-S

Field Data of 8-18-89

	Conductivity	D.O.	Temperature
TRU-2S	123	7.9	9.5
TRU-21	232	1.7	10.2
TRU-2D	1520	5.85	10.0
TRU-1S	345	3.75	10.9
TRU-11	1284	2.85	11.8
TRU-1D	3370	7.05	11.8
TL-4S	127		
TL-4I	1970		
TL-2D	982		

APPENDIX B

WATER QUALITY RESULTS

MONITORING WELLS LOCATED IN S. TRURO

DATE OF INSTALLATION: 12/6/88

INSTALLER: DAVID JANIK

WELL #	WELL LENGTH (CASING TOP TO SCREEN BOTTOM	≈ STICKUP ABOVE GROUND	DEPTH TO WATER FROM TOC	≈ TIME OF INSTALLATION	COMMENTS
TLF 009	DID NOT MEASURE BUT PROBABLY 7.19 FT	0.92'	3.0 - 0.91 = 2.09'	1:00 PM	NEAR A WETLAND COULD BE TIDAL INFLUENCE.
TLF 010	DID NOT MEASURE BUT PROBABLY 7.19 FT MINUS 0.10' BECAUSE OF BROKEN THREADS ∴ 7.09'	0.47'	4.0 - 0.10 = 3.90'	3:15 PM	CRACKED THREADING OFF DURING INSTALLATION

MONITORING WELLS LOCATED NEAR TRURO LANDFILL

DATE OF INSTALLATION: 10/27/88, WEDNESDAY AFTERNOON
INSTALLERS: DAVID JANIK & DOUG HEATH

WELL #	WELL LENGTH (CASING TOP TO SCREEN BOTTOM)	≈ STICKUP ABOVE GROUND	DEPTH TO WATER FROM TOC	≈ TIME OF INSTALLATION	COMMENTS
TLF 003	9.57'		7-0.72 = 6.28'	12:00 PM	
TLF 001	7.18'	0.75'	3.50'	12:50 PM	
TLF 002	7.19'	0.63'	5-0.97 = 4.03'	1:20 PM	
TLF 004	7.28' (INCLUDING GRAY PART OF CAP)	1.10'	6-1.05 = 4.95' 5-0.05 = 4.95'	2:15 PM	PARTIALLY DAMAGED TOP OF CASING DURING INSTALLATION. USE GRAY PART OF CAP AS MEASURING PT.
DATE OF INSTALLATION: 11/1/88 INSTALLERS: DAVID JANIK & PAM IRVIN					
TLF 005	9.57'	1.09'	6-0.39 = 5.61'	12:15 PM	NEXT TO SMALL DRAINAGE DITCH
TLF 006	12.06' - 0.10' = 11.96'	1.73'	5-0.05 = 4.95'	11:30 AM	THREADED PART OF CASING BROKE WHILE HAMMERING IN. ∴ SUBTRACTED 0.1' FROM WELL LENGTH AND ONLY USED WHITE CAP AS A LID.
DATE OF INSTALLATION: 11/4/88 INSTALLERS: DAVID JANIK & BRUCE RASMUSSEN					
TLF 007	7.18+2.38 = 9.56'	0.50'	2-0.36 = 1.64'	2:30 PM	
DATE OF INSTALLATION: 11/15/88 INSTALLERS: DAVID JANIK & PAM IRVIN					
TLF 008	DIDN'T MEASURE BUT PROBABLY 7.19' MINUS 0.10' WHEN THREADS BROKE LEAVING ≈7.09' 7.09'	1.40'	4 - 0.44 = 3.56'	2:15 PM	FORGOT TO MEASURE BEFORE INSTALLATION. USED SCREEN AND ONE 5FT SECTION. BROKE THREADS HAMMERING INTO GROUND.

BORING NO. TL-4

BORING LOG

SHEET 1 OF 1

PROJECT: Truro Landfill	PROJECT
LOCATION: TL-4 s, i, d	ELEVATION AND DATUM
BORING CONTRACTOR: T E Desmond	DATE: 5-25-89 / COMPLETION DEPTH: 75
BORING EQUIPMENT: Hollow Stem Auger	OBSERVED WATER LEVEL DATA: ~ 26

ELEV.	DESCRIPTION	DEPTH SCALE	WELL DETAILS	SAMPLE NO.	REMARKS
	m SAND m SAND ORANGE m S m SAND ORANGE m-c SAND ▽ m SAND some fs m+f SAND some uf SAND B o H	10, 20, 30, 40, 50, 60, 70			3 wells set using 5 foot 10 slot screens w/ flush threaded joint 2 inch PVC Bentonite seal Buffalo box grouted into place w/ cement

INSPECTOR: CAMBARERI

BORING NO. ____

BORING LOG

SHEET __ OF ____

PROJECT: Truro Landfill	PROJECT
LOCATION: TRU-1 s, i, d	ELEVATION AND DATUM
BORING CONTRACTOR: T.E. Desmond	DATE: 5-24-89 / COMPLETION DEPTH: 80 feet
BORING EQUIPMENT: Hollow Stem Auger	OBSERVED WATER LEVEL DATA: ≈ 24 feet

ELEV.	DESCRIPTION	DEPTH SCALE	WELL DETAILS	SAMPLE NO.	REMARKS
	DARK LOAMY SAND DARK BRN/ORANGE Med SAND BRN Med SAND LIGHT med SAND BRN m-c SAND ▽ Wet c-m SAND C-m SAND m-c SAND some F s trace MICA B o H	10 20 30 40 50 60 70 80	s I d		3 wells set using 5 foot 10 slot screens w/ flush threaded joint 2 inch PVC Buffalo box grouted into place with cement Bentonite seal

INSPECTOR:
CAMBARERI

APPENDIX A

WATER TABLE ELEVATIONS

(March 3, 1989)

Well #	Elevation of Measuring Point	Groundwater Elevation Feet above Mean Sea Level
HA 3	9.86	7.28
HA 2	12.63	6.22
HA 1	18.79	6.17
TL2	33.01	6.20
TL1	34.35	6.24
TL3	16.15	6.31
001	10.08	6.33
003	12.14	5.94
002	10.54	6.29

Cluster Well Water Table Elevations (July 6, 1989)

Well #	Elevation of Measuring Point	Groundwater Elevation Feet Above Mean Sea Level
TL4-S	35.29	7.86
TL4-I	35.29	7.86
TL4-D	35.29	7.84
TRU2-S	18.82	7.44
TRU2-I	18.82	7.43
TRU2-D	18.82	7.41
TRU1-S	32.45	7.01
TRU1-I	32.45	7.01
TRU1-D	32.45	6.98

Log Number: _____ Bottle # BC426A FEB 22 1989 Date: Jan 26, 1989

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
Ext. 337

~~DRINKING~~ WATER LABORATORY ANALYSIS

Client: Tom Cambareri
Mailing Address: Cape Cod Planning
District Court House
Barnstable, MA 02630
Telephone: 362-2511 X470
Sample Location: Truro Landfill Well W
TL 1

Collector: Tom Cambareri
Affiliation: CCPEDC
Time & Date of Collection: 1/11/89 12:00 pm.
Type of Supply: monitoring well
Well Depth: 31'
Date of Analysis: 1/12/89

PARAMETER	SAMPLE RESULT	RECOMMENDED LIMITS
Total Coliform Bacteria/100 ml		0
pH	5.2	
Conductivity (micromhos/cm)	73	500.0
Iron (ppm)	0.9	0.3
Nitrate-Nitrogen (ppm)	1.3	10.0
Sodium (ppm)	7	20.0
Total Alkalinity mg $CaCO_3$/liter	5.4	

I. _____ Water sample meets the recommended limits for drinking of all above tested parameters.

II. Based only on results of the parameters tested for this sample, the water is suitable for drinking but may present the problems checked below:

A. _____ Water sample has higher than average levels of Nitrate. Future monitoring is recommended (2-3 times per year) to establish any upward trends.

B. _____ The low pH of the water may shorten the useful life of the house's plumbing.

C. _____ Water may present aesthetic problems (taste, odor, staining) due to _____.

D. _____ Water sample has high levels of sodium. Persons on low sodium diets should consult their doctor.

III. Due to one or more of the reasons checked below, this water sample is unfit for human consumption: A. _____ High Bacteria B. _____ High Nitrates

REMARKS: RESULTS ONLY.

~~The Barnstable County Health and Environmental~~ Department shall not endorse any statements, interpretations or conclusions made by anyone else concerning these results without written consent.

CC:
CC:

E Butler
Laboratory Director

1/7/85

Log Number: _____ Bottle # D394 Date: Jan. 26, 1989

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

JAN 27 1989

PHONE: 362-2511
Ext. 337

~~DRINKING~~ WATER LABORATORY ANALYSIS

Client:	Tom Cambareri	Collector:	Dave Janik
Mailing Address:	Cape Cod Planning First District Court House Barnstable, MA 02630	Affiliation:	CCPEDC
		Time & Date of Collection:	1/11/89 11:45 a.m.
Telephone:	362-2511 X470	Type of Supply:	monitoring well
Sample Location:	Truro Landfill Well M TL2	Well Depth:	31'
		Date of Analysis:	1/12/89

PARAMETER	SAMPLE RESULT	RECOMMENDED LIMITS
Total Coliform Bacteria/100 ml		0
pH	4.9	
Conductivity (micromhos/cm)	100	500.0
Iron (ppm)	1.0	0.3
Nitrate-Nitrogen (ppm)	1.5	10.0
Sodium (ppm)	7	20.0
Total Alkalinity mg $CaCO_3$/liter	5.4	

I. _____ Water sample meets the recommended limits for drinking of all above tested parameters.

II. Based only on results of the parameters tested for this sample, the water is suitable for drinking but may present the problems checked below:

A. _____ Water sample has higher than average levels of Nitrate. Future monitoring is recommended (2-3 times per year) to establish any upward trends.

B. _____ The low pH of the water may shorten the useful life of the house's plumbing.

C. _____ Water may present aesthetic problems (taste, odor, staining) due to _____.

D. _____ Water sample has high levels of sodium. Persons on low sodium diets should consult their doctor.

III. Due to one or more of the reasons checked below, this water sample is unfit for human consumption: A. _____ High Bacteria B. _____ High Nitrates

REMARKS: RESULTS ONLY.

The Barnstable County Health and Environmental Department shall not endorse any statements, interpretations or conclusions made by anyone else concerning these results without written consent.

CC:
CC:

Laboratory Director

1/7/85

Log Number: _____ Bottle # BC438A

Date: Jan. 26, 1989

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

DRINKING WATER LABORATORY ANALYSIS

PHONE: 362-2511
Ext. 337

Client: Tom Cambareri
Mailing Address: Cape Cod Planning
District Court House
Barnstable, MA 02630
Telephone: 362-2511 X470
Sample Location: Truro Landfill Well E
TZ 4

Collector: Tom Cambareri
Affiliation: other
Time & Date of Collection: 1/11/89 12:00 p.m.
Type of Supply: monitoring well
Well Depth: 31'
Date of Analysis: 1/12/89

PARAMETER	SAMPLE RESULT	RECOMMENDED LIMITS
Total Coliform Bacteria/100 ml		0
pH	5.4	
Conductivity (micromhos/cm)	77	500.0
Iron (ppm)	1.0	0.3
Nitrate-Nitrogen (ppm)	0.6	10.0
Sodium (ppm)	6	20.0
Total Alkalinity mg $CaCO_3$/liter	38	

I. _____ Water sample meets the recommended limits for drinking of all above tested parameters.

II. Based only on results of the parameters tested for this sample, the water is suitable for drinking but may present the problems checked below:

A. _____ Water sample has higher than average levels of Nitrate. Future monitoring is recommended (2-3 times per year) to establish any upward trends.

B. _____ The low pH of the water may shorten the useful life of the house's plumbing.

C. _____ Water may present aesthetic problems (taste, odor, staining) due to _____.

D. _____ Water sample has high levels of sodium. Persons on low sodium diets should consult their doctor.

III. Due to one or more of the reasons checked below, this water sample is unfit for human consumption: A. _____ High Bacteria B. _____ High Nitrates

REMARKS:
RESULTS ONLY.

CC:
CC:

E Bullen
Laboratory Director

1/7/85

Date: April 7, 1989

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 331

Date of collection: March 17, 1989 Town: Truro

Collector: David Janik Analyst: Amy Deans Amy J. Deans CB

SANITARY LANDFILL GROUNDWATER MONITORING REPORT

WELL #	TLF 011	TLF 003	TLF 012	TLF 001							
BOTTLE #	443A	451A	273A-1	447A							
	HA1		HA2								
Alkalinity	5.5	7.2	0	0.8							
pH	5.2	5.5	5.4	4.7							
Conductivity	170	145	340	137							
Iron	0.3	0.8	15.5	1.7							
Nitrate-Nitrogen	0.2	<.1	0.1	<.5							
Sodium	13	17	48	14							
Calcium	0.1	0.1	0.2	0.7							
Magnesium	8.0	13.5	5.5	3.5							

Results are expressed in parts per million (mg/l).

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT
SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

Date of Collection: June 6, 1989 Town: Truro (landfill)

Collector: Cape Cod Planning & Economic Development Analyst: Amy Deans Amy L. Deans

SAMPLE	pH	CONDUCTIVITY (micromhos/cm)	NITRATE-NITROGEN (ppm)	IRON ** (ppm)	SODIUM (ppm)	ALKALINITY (ppm)
/ Corrected						
Tru 2S / 2I	6.2	330	2.0	.1	24	26
Tru 2I / 2S	5.5	230	5.0	.3	19	16
Tru 2D	6.7	1120	.3*	.1	66	310
Tru 1S	6.3	580	16.0	.1	50	54
Tru 1I	6.7	1000	2.4*	.1	78	250
Tru 1D	6.7	2150	.3*	.1	297	290
TL 4D	6.7	1680	.2*	.1	150	320

NOTE: *greater than 10 percent interference.

**laboratory filtered.

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

OCT 30 1989

Date of Collection: July 6, 1989 Town: Truro (landfill)

Collector: Tom Cambareri, CCPDEC Analyst: Amy Deans Amy L. Deans

WELL #	pH	CONDUCTIVITY (micromhos/cm)	NITRATE-NITROGEN (ppm)	IRON (ppm)	SODIUM (ppm)	ALKALINITY (ppm)
(correct sample label)						
TL2-S / TL2D	5.9	1300	0.2*	0.1	116	82
TL4-I / TL4S	5.6	212	0.9	0.2	14	48
TL2-I / TL4-I	6.4	1900	0.2*	0.2	52	527

*greater than 10% interference

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT

SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

OCT 18 1989

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

VOLATILE ORGANIC COMPOUNDS REPORT

Client:	Tom Cambareri	Collector:	Tom Cambareri
Mailing Address:	Cape Cod Planning and Economic Development First District Court Barnstable, MA 02630	Type of Supply:	monitoring wells
		Date Collected:	6/6/89
Telephone:		Date Received:	6/6/89
Sample Location:	Truro Landfill, Truro, MA	Analyst:	S. Williams EB
		Date Analyzed:	6/20/89

	LOCATION			
	C367	C311	C112	C346
COMPOUND	TRU2D	TRU1S	TRU1I	TRU1D
Chlorofluoromethane	0.8*		1.2*	0.9*
Ethyl Chloride			0.8	
Chlorodifluoromethane		0.2*		
Trichlorofluoromethane				
Methylene Chloride	0.3	0.2	1.6	0.2
1,1-Dichloroethane		0.2	4.7	
cis/tr-1,1-Dichloroethene			0.6	
Chloroform	4.7	7.9	14	0.2
1,1,1-Trichloroethane	0.6		0.2	
Bromodichloromethane	0.2	0.3	0.2	
tert butyl methyl ether			0.5	

*ECD normalized response - tentative identification

All values are in micrograms per liter (equivalent to parts per billion, or ppb). EPA Method 502.1 was used and only those compounds listed above were detected. Attached is a list of chemicals which the method is capable of detecting. Detection limits for these compounds are stated on the attachment. Chloroform is commonly found in Cape Cod groundwater at levels ranging from 0.2 to several ppb. The drinking water limit for Total Trihalomethanes, of which chloroform is an example, is 100 ppb.

4.6 8.8 23.8 1.3

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT
SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

VOLATILE ORGANIC COMPOUNDS REPORT

Client:	Tom Cambareri	Collector:	Tom Cambareri
Mailing Address:	Cape Cod Planning and Economic Development	Type of Supply:	monitoring wells
		Date Collected:	6/6/89
Telephone:	First District Court	Date Received:	6/6/89
Sample Location:	Barnstable, MA 02630	Analyst:	S. Williams
	Truro Landfill Truro, MA	Date Analyzed:	6/20/89

	LOCATION			
	C366			
COMPOUND	TL-4D			
Chlorofluoromethane	2.7*			
Ethyl Chloride				
Chlorodifluoromethane				
Trichlorofluoromethane				
Methylene Chloride				
1,1-Dichloroethane	0.6			
cis/tr-1,2-Dichloroethene	0.2			
Chloroform	1.2			
1,1,1-Trichloroethane				
Bromodichloromethane				
tert butyl methyl ether	0.3			
*ECD normalized response -	tentative identification			

All values are in micrograms per liter (equivalent to parts per billion, or ppb). EPA Method 502.1 was used and only those compounds listed above were detected. Attached is a list of chemicals which the method is capable of detecting. Detection limits for these compounds are stated on the attachment. Chloroform is commonly found in Cape Cod groundwater at levels ranging from 0.2 to several ppb. The drinking water limit for Total Trihalomethanes, of which chloroform is an example, is 100 ppb.

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT
SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

VOLATILE ORGANIC COMPOUNDS REPORT

Client:	Tom Cambareri	Collector:	Tom Cambareri
Mailing Address:	Cape Cod Planning and Economic Development	Type of Supply:	monitoring wells
		Date Collected:	7/6/89
Telephone:	First District Court	Date Received:	7/6/89
Sample Location:	Barnstable, MA 02630	Analyst:	S. Williams SW
	Truro Landfill Truro,MA	Date Analyzed:	7/7/89

	LOCATION C63	C310	C368	
COMPOUND	4 TL1-I	5 TL4-I	2 P TL4-S	
Correct sample label	TL-4I	TL4S	TL2-D	
Chlorofluoromethane	0.5*	3.3*		
Ethyl Chloride		0.3		
Chlorodifluoromethane	0.4*			
Trichlorofluoromethane			0.3	
Methylene Chloride				
1,1-Dichloroethane	0.2	0.2		
cis/tr-1,2-Dichloroethene				
Chloroform	11			
1,1,1-Trichloroethane				
Bromodichloromethane	0.4			
tert butyl methyl ether				
*ECD normalized response -	tentative identification			

All values are in micrograms per liter (equivalent to parts per billion, or ppb). EPA Method 502.1 was used and only those compounds listed above were detected. Attached is a list of chemicals which the method is capable of detecting. Detection limits for these compounds are stated on the attachment. Chloroform is commonly found in Cape Cod groundwater at levels ranging from 0.2 to several ppb. The drinking water limit for Total Trihalomethanes, of which chloroform is an example, is 100 ppb.

12.5 3.5 3

BARNSTABLE COUNTY HEALTH AND ENVIRONMENTAL DEPARTMENT
SUPERIOR COURT HOUSE
BARNSTABLE, MASSACHUSETTS 02630

PHONE: 362-2511
EXT. 330
LAB 337
CLINIC 340

TABLE 1. Compounds Detectable by EPA Method 502.1*

COMPOUND	D.L.	COMPOUND	D.L.
Benzene	0.5	1,1-Dichloroethane	0.5
Carbontetrachloride	0.5	1,1-Dichloropropene	0.5
1,1-Dichloroethylene	0.5	1,3-Dichloropropene	0.5
1,2-Dichloroethane	0.5	1,2-Dichloropropane	0.5
para Dichlorobenzene	0.5	1,3-Dichloropropane	0.5
Trichloroethylene	0.5	2,2-Dichloropropane	0.5
1,1,1-Trichloroethane	0.5	Ethylbenzene	0.5
Vinyl Chloride	0.5	Styrene	0.5
Bromobenzene	0.5	1,1,2-Trichloroethane	0.5
Bromodichloromethane	0.5	1,1,1,2-Tetrachloroethane	0.5
Bromoform	0.5	1,1,2,2-Tetrachloroethane	0.5
Bromomethane	0.5	Tetrachloroethylene	0.5
Chlorobenzene	0.5	1,2,3-Trichloropropane	0.5
Chlorodibromomethane	0.5	Toluene	0.5
Chloroethane	0.5	para Xylene	0.5
Chloroform	0.5	ortho Xylene	0.5
Chloromethane	0.5	meta Xylene	0.5
ortho Chlorotoluene	0.5	Bromochloromethane	0.5
para Chlorotoluene	0.5	Dichlorodifluoromethane	0.5
Dibromomethane	0.5	Fluorotrichloromethane	0.5
meta Dichlorobenzene	0.5	Hexachlorobutadiene	0.5
ortho Dichlorobenzene	0.5	Isopropylbenzene	0.5
trans-1,2 Dichloroethylene	0.5	n-Propylbenzene	0.5
cis-1,2 Dichloroethylene	0.5	Sec-butylbenzene	0.5
Dichloromethane	0.5	Tert-butylbenzene	0.5

D.L. is Detection Limit in micrograms per liter or parts per billion (ppb). This table lists our normal limits of detection. If we report a smaller amount, then our detection limit was lower for that analysis.

*A photoionization detector is used in series with the electroconductivity detector, thus allowing for the analysis of most of the compounds listed in EPA Method 503.1 as well.

TABLE 2. Compounds which have Maximum Contaminant Levels (MCLs) set by the Environmental Protection Agency.

COMPOUND	MCL (in ppb)
Benzene	5.0
Carbontetrachloride	5.0
1,2-Dichloroethane	5.0
1,1-Dichloroethylene	7.0
para Dichlorobenzene	75
1,1,1-Trichloroethane	200
Trichloroethylene	5.0
Vinyl Chloride	2.0
Total Trihalomethanes	100

Chloroform, Bromodichloromethane, Chlorodibromomethane, and Bromoform comprise the total trihalomethanes.

BORING NO. TRU-2

BORING LOG

SHEET 1 OF 1

PROJECT: Truro LANDFILL	PROJECT
LOCATION: TRU-2 S, I, d	ELEVATION AND DATUM
BORING CONTRACTOR: T. E. Desmond	DATE: 5-24-89 / COMPLETION DEPTH: 70
BORING EQUIPMENT: Hollow Stem Auger	OBSERVED WATER LEVEL DATA: ~13 feet

ELEV.	DESCRIPTION	DEPTH SCALE	WELL DETAILS	SAMPLE NO.	REMARKS
	DARK LOAM DARK BRN M S AND SILT BRN ORANGE SAND DARK BRN SAND + cobble ▽ BRN SAND BRN M SAND SOME SILT BRN C-M SAND BoH	10, 20, 30, 40, 50, 60, 70			3 wells set using 5 Foot 10 slot screens w/ flush threaded joint 2 inch PVC Buffalo box grouted into place with cement Bentonite seal

INSPECTOR: CAMBARERI

BORING NO. Tru-3

BORING LOG

SHEET 1 OF 1

PROJECT Truro Landfill	PROJECT
LOCATION Tru-3	ELEVATION AND DATUM
BORING CONTRACTOR TE Desmond	DATE 5-25-89 / COMPLETION DEPTH 60
BORING EQUIPMENT Hollow Stem Auger	OBSERVED WATER LEVEL DATA ~48

ELEV.	DESCRIPTION	DEPTH SCALE	WELL DETAILS	SAMPLE NO.	REMARKS
	m SAND				
	m-c SAND AND REFUSE	10			
		20			
		30			1 well set using 5 foot, 10 slot screen w/ flush thread joint 2 inch PVC
		40			
	gray c-m SAND	50			
		60			

INSPECTOR: CAMBARERI

BORING NO. TL-2d

BORING LOG

SHEET 1 OF 1

PROJECT: Truro Landfill	PROJECT
LOCATION: TL-2d	ELEVATION AND DATUM
BORING CONTRACTOR: TE Desmond	DATE: 5-25-89 / COMPLETION DEPTH: 75
BORING EQUIPMENT: Hollow Stem Auger	OBSERVED WATER LEVEL DATA: ~25

ELEV.	DESCRIPTION	DEPTH SCALE	WELL DETAILS	SAMPLE NO.	REMARKS
	m-C SAND	10			
	ORANGE MED SAND Some Coarse	20			
	C-m SAND	30			
	m SAND, Some f	40			1 well set using 5 foot 10 slot Screen w/ Flush threaded joint 2 inch PVC
	m-f SAND, Some SILT MICACCOUS	50			
	vf SAND AND SILT (GRAY)	60			Locking steel cover grouted into place
	SILT AND vF SAND	70			Bentonite seal
	BoH				

INSPECTOR: CAMBARERI