SHAKTI CONSULTANTS INC.
185, Gatzmer Avenue
Jamesburg, NJ 08831
(201) 521-2322

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August 12, 1990

Mr Walter Stern
General Switch Co.
Middletown, New York 10940

Martin Baker, Esq.
Stroock, Stroock and Lavan
Seven Hanover Square
New York, New York 10004

Dear Walter and Martin,

Attached is the revised Pump Test Plan for the General Switch site.

Yours Sincerely,

John Bee

JOHN BEE
President, Shakti Consultants, Inc.

Senior Geologist
CPG#6173 American Institute of Professional Geologists

PUMP TEST PLAN AUGUST 1990

GENERAL SWITCH
MIDDLETOWN/WALLKILL, NEW YORK

ENGINEERING AND TECHNOLOGY SERVICES
SHAKTI CONSULTANTS, INC.
CHARLESTON, WEST VIRGINIA & JAMESBURG, NEW JERSEY

John Bee
Senior Geologist, Shakti Consultants, Inc.
CPG#6173 American Institute of
Professional Geologists

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1.0. Background Information

The site is located on the border of Middletown and Wallkill, New York. A pump test is required for the Parella well, now owned by Fluoro Cuison at 320 Highland Avenue (see site plan, Figure 1-4) under the Consent Decree entered in US v. General Switch Corporation, 87 Civ 8789 (RJW). The Parella well is 200 feet east of the eastern corner of the General Switch building.

1.1. Site Hydrogeology

The stratigraphy of the site is a silty glacial till overlaying a sandstone and shale formation: the Austin Glen Series. The building of General Switch sits upon fill and the parking lot to the south east of the facility is composed of fill that contains some metal objects and is in part reworked till that contains cobbles. A magnetometer survey conducted by Fred C. Hart Associates in 1984 identified four major magnetic anomalies in the fill of the parking lot. Test pits were dug in each of the four locations and metal objects were found in two of the pits. The metal objects buried in the parking lot were trolleys, several old generators, and a compressor (Figure 4A and 4B, See also Reference 1: Hydrogeologic Investigation of General Switch Site, Fred C. Hart Associates, Nov. 1984).

There is approximately 40 feet of unconsolidated material under the building (Reference 1). As indicated by the soil borings completed by Fred C. Hart, there is an apparent shallow trough below the General Switch plant, that is oriented in a northeast-southwest direction. The trough lies approximately parallel to the long axes of folds in the area, and may have originated as a structurally weak area that was subsequently traversed and scoured out by the glaciers. The bedrock in general slopes down to the northwest (Figure 2 and 5). In the area, there are several exposures of the glacial soils and underlying shale to be found near the Parella well (320 Highland Avenue). A massive sandstone and shale is found to outcrop at the surface on the northern end of Watkins Avenue and near Lubricants, Inc. on Industrial Place, 450 feet southeast of the General Switch building. It is noted that in these outcrops the degree of fracturing of the bedrock is visible along with the regional fracture pattern that has a significant influence upon the available avenues of groundwater flow and site hydrogeology.

Glacial Till

From profiles of the soils at these locations, it can be noted that the soil horizons of the Washington Heights section of the Town of Wallkill belong to the Mardin gravelly silt loam series (Reference 3: Orange County Soil Survey). The Mardin soils are formed from a gravelly, sandy silt glacial till which in turn is derived from the sandstone, shale and slate of the bedrock of this area. The till lies unconformably on the Austin Glen Grit and Shales.

Permeability in the upper soil zones formed from the till is described in the literature as moderate in the surficial layer and upper part of the subsoil and is slow or very slow in the underlying substratum. The till below the upper soil zones is generally unsorted and unstratified and consists primarily of clay, silt and boulders. The permeability of this till is very low and the values range from 1.3 x 10^{-7} cm/sec to 6.4 x 10^{-7} cm/sec. (Reference 3: Orange County Soil Survey and 4: Frimpter, M.H. Groundwater Resources of Orange and Ulster Counties, NY, U.S. Geological Survey Paper - 1985.)

Available water capacity in the till is low and runoff is slow to medium. A perched water table has been observed in the months of November, December and January in the till. This perched water table was noted in the till that is tapped by poorly yielding dug wells: on the Continental Telephone property (abandoned), on the Stout Property (abandoned), and at 208 Watkins Ave (used for watering vegetables). When the Technical Assistance Team first arrived on-site on October 15, 1983, a survey of wells near the Parella Well was made by John Bee. Two shallow dug wells were noted on the property belonging to Janice Stout (Stout Lot #4). The two wells were 11 feet and 16 feet deep, were dug into the glacial till soils, and were dry to the bottom. Following a major storm event, the water levels were measured on December 16, 1983. Water, within a 2 day period, had reached to within 1 foot of the ground surface. The water levels in these wells then continued to hold a level within 2 feet of the surface through November, December and January. Water was found consistently through these winter months to be close to the ground surface in the shallow dug wells on Commonwealth, Watkins and Highland Avenues as well as in sumps and depressions along Industrial Place Extension. This perched water was noted filling the dug wells in the winter. The water levels in these dug wells were observed to fall through the summer months. The adjacent deep wells, between 40 and 250 feet, tapping the shale aquifer had water levels between ten to twenty feet below the perched water levels in the till in the shallow dug wells as reported in the Pump Test Tables 1, 2 and 3 and in the Summary of Water Level Measurements, 11/15/83 to 2/3/84.

Argument that the soil flush will not work

Transmission of water and contaminants through the glacial till is likely to be retarded by the slow percolation rate operating in the surficial till.

The water in the glacial till is found in the soil pores between the unconsolidated soil grains. Contouring of the water table elevations in the till in 1984 indicated a flow direction in the till from north to south, generally following the ground level elevations (Figure 3).

As we propose to infiltrate treated groundwater through the till to flush out the Tetrachloroethylene in the glacial overburden at General Switch, the planned pump test must prove that the water will infiltrate through the contaminated soil and that the Parella well will capture the leachate so produced.

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From the plot of water table levels in shallow dug wells (Figure 3) and in depressions throughout the site area, the water table contours in the till follow the topography of the site and intersect the topography at approximately the 600 foot piezometric contour, with groundwater issuing out at the base of the hill as a spring line and forming a wetlands in the valley bottom as noted on Figure 3. The general lateral direction of groundwater flow in the till was from north to south in contrast to the groundwater flow direction in the shale that was influenced in 1983-84 by the overpumping of the groundwater reserves on Highland Avenue, described in detail in Figure 6. Fred C. Hart has provided water contours in the glacial till specifically on the General Switch property (Figure 4). It may be noted that Figures 3 and 4 do not coincide precisely. This is because Figure 3 is a plot of the piezometric head in shallow dug wells less than 10 feet deep measured in January 16, 1984 and Figure 4 is a plot of the piezometric head in the glacial till measured in monitor wells in September 14, 1984.

Austin Glen Grit and Shale

The Austin Glen Grit and Shale consists of interbedded massive sandstones grading with increasing micaceous minerals through to thinly-bedded fissile shales (Ref: Frimpter, M.H. Groundwater Resources of Orange and Ulster Counties, NY, U.S. Geological Survey Paper - 1985.) As noted in outcrops on Industrial Place to the south of General Switch there is no primary porosity in the massive sandstone and shale exposed.

The fissile weathered shale is observed along the railroad grade to the east of General Switch while the more massive sandstone, fractured with regional fissures, is seen immediately to the southeast at Lubricants, Inc. The trend of the regional fissures at this outcrop is predominantly northeast-southwest. The strike of bedding for the Austin Glen Series is northeast-southwest as can be seen from the Goshen Quadrangle Map (Figure 5) and the regional dip is 26-40° NW. From the cross section included with the quadrangle, the site is located on the northeast limb of a major anticline.

Shale Aquifer

A second aquifer is found beneath the till in the Austin Glen Series sandstone and shale. This is a confined bedrock aquifer in that the bedrock is covered with 25 feet of dense glacial till under General Switch and water levels in wells cased into the shale are observed to have risen to elevations ten feet into the glacial till. For instance, the water levels were noted in December 1983 and January 1984 in the General Switch well at or about 623 feet MSL, 12 feet below ground and 13 feet into the till. Following weathering and erosion of the overlying soil and rock, there has been a pressure release in the Austin Glen Series and fissures in the rock have opened as the overburden (the amount of rock above) has been reduced. In addition, earth movements have caused faults to develop in the sandstone and shale formation. These fault lines observed in the outcrops cut across all the regional structures of bedding planes and fissures and these fractures have a major influence on the flow of groundwater in the confined aquifer. Thus, in the sandstone and shale, the groundwater is not found between the mineral grains but is found in the secondary fissures and fractures cutting through the rock. These secondary fissures and fractures influence the abundance and direction of flow of the groundwater under the motive force of the difference in potentiometric head from one point to another. Groundwater will pass more slowly through rock with tight joints. Permeability and well yields in the Austin Glen Series can vary greatly within a short distance. This is determined in part by the degree of fracturing and openness of the joints and also by the interconnection of fractures.

The groundwater in the shale is contained in this fractured bedrock aquifer. The following data obtained in 1984 is presented to indicate how the fractured bedrock aquifer responds to pumping. The potentiometric pressures in the shale represented by the composite groundwater contours plotted for the shale in 1984 indicated drawdown due to overpumping along Highland Avenue, a groundwater divide between Highland and Watkins Avenue and a groundwater mound in the vicinity of the Electra Manufacturing, General Switch and Pitt properties from which water moves away in a radial pattern westward to Cosmo Optic, southeastward along Highland Avenue and southward towards Guild Molders (Figure 6, a blue line drawing that represents the best available figure, now six years old).

Between November 15, 1983 and February 3, 1984 water levels were taken by John Bee of the Technical Assistance Team in wells that supplied residents with drinking water in the Washington Heights section of the Town of Wallkill and from Industrial Place in the City of Middletown.

Water levels were taken under the following conditions: Water levels used for plotting the regional groundwater flow pattern were taken only when whole streets and city blocks had stopped pumping their wells for at least 12 hours. The highest elevation of the groundwater found in the wells was taken as that most nearly approaching static. These water levels were contoured and plotted on February 18, 1983 and represented the static water levels of the Washington Heights section for the confined aquifer in the shale during a period of aquifer use for drinking water (Ref: Wallkill New York, Table, Summary of Water Level Measurements). We note that indeed 12 hours may not be sufficient time for some of these wells to recover to static levels. However, this limiting condition was presented above in order to judge the limits of accuracy of the data, imposed by daily need for the homeowners to use this aquifer.

Composite static groundwater levels: The composite water levels plotted for this site are taken from wells open along a large portion of their saturated profile. Note that this composite water level may differ from the true water level if the well penetrates a zone of rock in which the hydraulic potential changes with depth. The term composite is used to denote this difference. (Ref: Errors in Interpretation of Groundwater Level Data GWMR, Spring 1981, p56). The resultant water level is a function of the head differential, the permeabilities and the rate of recharge to the system. The true groundwater table can be determined by constructing piezometers screened no more than 5 feet in length and penetrating the aquifer only sufficiently to be below the dry season water level. In interpreting the water contour map attached, it should be noted that in a recharge area, a deep open hole will show an anomolously lower water level reading than that found in a shallower comparable borehole. It is only in areas of lateral flow that data from deep and shallow holes, and open and cased holes (piezometers) can be plotted on the same groundwater level map.

Any contaminants located in the shale near General Switch would tend to move towards the Parella well if a suitable fissure was available. The force moving the contaminants would be the difference in head between the General Switch well 624.77' (static) and the Parella well 615.61' (static). Note that even moderate (4 gpm) pumping of wells in the shale causes large drawdowns as much as 50 feet in the Parella well and 77 feet in the Pitt well. The General Switch well had not been pumped since it was drilled because it was such a poor yielding well, as reported by John Braghirol, the Plant Engineer. Thus, the potentiometric head around General Switch would maintain its elevated position. Pumping of the surrounding wells such as Osbourne, Lobb, Parella and Pitt greatly change the potentiometric contours as shown in the pump tests conducted at the site, greatly increasing the potentiometric head difference between the General Switch Well and the pumped wells.

Since 1962, when municipal sewers were constructed, until 1986, when municipal water was supplied to Highland Avenue, the discharge of well water pumped from this aquifer into the municipal treatment plants reduced the overall potentiometric head in the shale by about 20 feet throughout the area, according to local well drillers. There appears to be correlation between areas of extensive pumping and long-term drawdown of water wells. Although the water levels plotted for 1984 are static conditions for individual wells, the groundwater elevations in the shale show long-term drawdown anomalies where extensive pumping has occurred. There has been extensive pumping of water from the aquifer under Highland Avenue. Thus, in the 1984 plot of groundwater levels, the 620 and 610 feet groundwater contours crossing Highland Avenue between the Knapp (317 Highland Avenue) and Merle (331 Highland Avenue) residences show drawdown of the water levels in this location. As indicated by the composite groundwater contour map (Figure 6), groundwater was moving away from the groundwater mound near Electra Manufacturing properties and curving to the south, running along the line of Highland Avenue. A groundwater divide was located in the vicinity of Van Pelt and Gilbert where potentiometric head decreased to the east towards Highland Avenue and west towards the 590 foot contour observed along Watkins and Commonwealth Avenues. Little water is extracted from the aquifer along most portions of Watkins Avenue; many residences in 1984 were provided with municipal water supply. In general, groundwater flowed from Watkins Avenue towards Commonwealth Avenue in a north-westerly direction under residences located north of Electric Avenue (between numbers 208-251 on Watkins and numbers 200-244 on Commonwealth).

The tight concentric contours centered on the Morse and Perry residences reflected local drawdown in the potentiometric surface by overpumping of these two wells in a formation that is of limited extraction capacity and limited communication with major fractures. These wells did not recover to static levels within 12 hours. This fact alone indicates that the well does not yield much water and is isolated from the major water bearing fractures in the shale and from significant recharge. While groundwater data is scarce in the area immediately northwest of the Industrial Place Extension, the potentiometric head difference between General Switch elevation (624.77 feet) and Guild Molders (594.81 feet) would mean that groundwater would tend to flow from General Switch towards Guild Molders.

The pumping of individual wells has a great effect upon potentiometric heads in the shale and hence groundwater movements. While pumping of the Parella, Stout, Lobb and Osbourne wells will tend to increase the potential for groundwater flow from the Electra Manufacturing/General Switch groundwater mound, the fact that the well at Guild Molders had not been extensively used, according to information supplied by the facility, would tend to minimize the flow of groundwater from General Switch to Guild Molders. The mobilizing force for the groundwater flow would have been the difference in static head between the wells.

Since 1986 many of the wells have been abandoned and it is expected that the regional water levels along Highland Avenue have recovered. The proposed measurement of static water levels taken prior to the pump test in wells along Highland Avenue will provide the new regional direction of groundwater flow.

This discussion of hydrogeology in the shale aquifer is based upon data acquired during 1983-1984 by the author, John Bee, a certified professional geologist, and is the only site-specific data available concerning the shale aquifer collected by any of the parties. These were original observations during well sampling and water level measurement and are reported in the table " Wallkill Well Data" and in sampling report "Wallkill New York, Summary of Water Level Measurements" submitted to the USEPA in March 1984.

At this time, as we have previously noted, many of the residences and commercial facilities used well water. As previously noted many of the residences and facilities have converted to municipal water supply and have abandoned their individual wells. The discussion of groundwater flow characteristics based on 1986 data may have little relevance to the flow patterns at present. This is why we have proposed to take groundwater level readings during the well survey before the pump test and contour the data to determine the present groundwater gradients in the shale.

1.2. Previous Pumping Tests

Pumping of the Parella Well

Between November 15 and December 26, 1983, the Parella well at 320 Highland Avenue, was pumped at between 1/2 to 4 gpm. The Parella well was the most contaminated well at that time and was employed as an extraction well to remove contaminants from the bedrock aquifer, in an attempt to limit the spread of the plume and to prevent the contamination of clean wells in the vicinity of the Parella well.

From the plot of concentration of the Parella well water pumped between November 15 and December 26, there is an indication that pumping at 1/2 gpm to 1 gpm recovered the most contaminated groundwater of that pumped from the Parella well by the USEPA, Figure 7. We note that this is an indication and not a conclusion that pumping the well at 1/2 gpm to 1 gpm recovered the most contaminated groundwater during the 3 months of pumping by the USEPA.

There seemed to be a general lowering of tetrachloroethylene levels with time in the water being recovered, after a peak of 260 ppm on November 15, 1983. The concentration of tetrachloroethylene from the Parella well pumping at 4 gpm after 3 months was at 95 ppm. There also appears to be a recovery and increase in concentration of tetrachloroethylene in samples taken during pumping after the well was rested, without pumping for one day as observed on November 26, 1983. The concentration of Tetrachloroethylene increases towards the end of the pumping from 61.4 ppm to 95 ppm as the pumping rate was increased from 1 to 4 gpm. The graph depicted in Figure 7 represents information obtained during three months of pumping of the Parella well during which time highly contaminated groundwater was recovered from the aquifer and indicates that the Parella well was a good choice as a pumping and recovery well. No other findings seem warranted by the limited data.

Pumping the Parella well from November 15 to December 25, 1983, extracted 33,400 gallons of contaminated water from the bedrock aquifer. At an average of 74.5 ppm tetrachloroethylene, this recovered 20.75 lbs. of tetrachloroethylene or 1.55 gallons of pure product extracted during the pumping. It is unfortunate that this pumping was not continued to the present time.

Parella Well Pump Test #1

The following data is presented to indicate how the Parella well operates and is interconnected to some of the nearby wells. On December 21, 1983, a pump test was conducted on the Parella well. The well had not been pumped for the previous 30 hours. At 1445 hours, a static level was taken in the Osbourne, Lobb, Fiore, Electra Manufacturing and Continental Telephone wells. At that time, these wells were abandoned: the residences were either supplied by a temporary municipal water line or the wells were previously abandoned.

It was assumed after 30 hours that the water levels in the shale had time to return to the static conditions. At 1500 hours, the Parella well was pumped at 12 gpm. At 1505 hours, the pump rate was reduced to 6 gpm as the well was losing suction. At 1535 hours, the pump rate was further cut back and held at 4 gpm for the remainder of the test.

Figure 8 and Table 1 presents a summary of the data collected during the pump test. From the data plotted, the effect that pumping the Parella well had on other wells can be observed. The water level in the Parella well was pulled down an estimated 50 feet, and the water levels in three of the surrounding wells belonging to the Osbourne, Lobb and Fiore families were pulled down appreciably.

The water level in the Lobb well after approximately 2.5 hours was pulled down 23.19 ft., Fiore 11.7 ft., and Osbourne over 7.61 ft. Thus the Lobb, Fiore, and Osbourne wells appear to be in intimate hydraulic connection with the Parella well, probably being fed by the same fissure in the shale. However, it should be noted that the Lobb and Osbourne wells are highly contaminated, but that the Fiore well contains only a trace of tetrachloroethylene contamination. The drawdown in the Fiore well may have been the result of homeowner water withdrawal during the pump test. This apparent contradiction may be answered during the planned pump test. A time/concentration pump test for the Fiore well was not completed. The abandoned well at Electra Manufacturing did not respond in this 2.5 hour pump test and is judged not be in direct and intimate connection with the Parella well fissure system. The Continental Telephone well water level dropped .18 feet during this test.

Thus, the zone of influence of pumping the Parella well does not propagate in all directions equally, but follows preferred flow paths through fissures in the shale. This zone has a general effective radius of influence of 350 ft. (based on .18 ft. drop at a distance of 350 ft. for the Continental Telephone Well). It is understood that this test was taken after pumping the Parella well since October 17 at rates between 1/2 to 1 gpm for the recovery of tetrachloroethylene-contaminated groundwater and that the pump test was taken in non-equilibrium conditions. The pump test was to determine if pumping the Parella well had an effect on the surrounding wells under these conditions.

General Switch Pump Test #1

The General Switch well is not a candidate for a groundwater recovery well. On February 2, 1984, the General Switch well was pumped at 2 gpm. At or before 1213 hours, a static water level was taken in the General Switch well and neighboring wells which had been rested for at least 12 hours. After 1 hour 40 minutes of pumping at 2 gpm the drawdown in the General Switch well was measured at more than 286′ below the static water level, deeper than the 300′ maximum depth from ground surface that could be measured using an M-scope water indicator. The specific capacity (gallons per minute/foot of drawdown) of the General Switch well is very small (less than 2gpm/300 feet = 0.0067) in that pumping at 2 gpm for a period of 100 minutes during the initial drawdown pulled the water table down to 300 feet+.

The General Switch well yields very little water. It is estimated that the General Switch well delivers only 1/2 gpm, although it is 480 feet deep. During the pumping test, water levels in nearby wells were recorded. There appears from the test to be hydraulic connection between the Parella and Osbourne wells and the General Switch well (Table 2).

During the pump test of the General Switch well the water levels in the Parella and Osbourne wells fell significantly. The Guild Molders, Perez and Pitt wells were unaffected. Water levels in the Electra Manufacturing, Perry and Wand wells rose during the test.

Ruppert Well Pump Test #1

The Ruppert well was pumped on February 3, 1984, the day after the General Switch pump test. The well was pumped at a flow rate of 11 gpm. This flow rate was sufficient after one hour to break suction on the pump set at 180' depth (147' below the static water level). One hour into the test the pump lost suction at 11 gpm and was then throttled back to 6 gpm. The pump again lost suction 1 hr. 23 minutes into the test at 6 gpm. At this point the pump was throttled back to 2 gpm and drawdown continued in the Barry (neighbor's) well. The drawdown in neighboring wells during 3 hours of pumping the Ruppert well is noted in Table 3.

Pumping the Ruppert well drew down the water levels appreciably in the Ruppert and Barry wells. Water levels in the Knapp, Van Pelt, Morse, Winner and Palermo wells rose during the test indicating that the wells were recovering to static level during the test and that these wells were not in intimate hydraulic connection with the Ruppert well, and any drawdown due to pumping was masked by this recovery.

The pumping data generated during the initial well contamination period is subject to interference from individual well use during the test. However, there is indication that pumping the Parella well will have a substantial effect of plume capture and intercept the flow of contaminated groundwater flowing to downgradient wells.

It is this hypothesis that the proposed pump test is intended to further investigate. Now that few wells are still being used, the possibility is more remote that pumping of the observation wells by a homeowner during the pump tests will influence the useful data. If the Parella well is to be used to capture the plume, the pumping of the Parella well will pull down the water levels in the surrounding wells on Highland Avenue and in monitor wells on the General Switch property, indicating its ability to intercept the groundwater from the area of soil contamination.

1.3. Wallkill Well Data

A survey of wells within 1/4 mile of the site was completed for the USEPA by John Bee, a certified professional geologist, between October 1983 and February 1984. The data presented in a tabular form was updated with marginal notes in September 1989. (See Appendix D, Table "Wallkill Well Data"). We propose to update this information and use it to confirm the number and location of wells to be monitored during the pump test.

1.4. Extent of Soil Contamination and the Resulting Plume

Contamination of soils with solvents including tetrachloroethylene has been detected in three locations: TP6 and TPD in soils in the facility yard and at TPA, a remote cul-de-sac at the northern side of the plant, Figures 9-13 and Reference: Soils Investigation to Determine the Extent of PCE Contamination at the General Switch Site, Fred C. Hart Associates, 1986.

In December 1983, the NYSDEC sampled soil from 0-2.5 feet at a site just south of the plant building. The results of the chemical analyses showed relatively low concentrations of tetrachloroethylene at the top and bottom of the hole and higher concentrations (100 ppm) at depths of one to two feet. A second round of soil samples was taken from within a 100 foot radius of the plant in March, 1984.

The most contaminated sample (1,000 ppm tetrachloroethylene) was found on the northwest side of the plant. Two other samples from the southwestern corner of the plant contained 95 and 400 ppm tetrachloroethylene, while the other soil samples contained only 10 ppm.

The Fred C. Hart reports define the extent of contamination and contaminant transport in the unconsolidated soils on the General Switch property as shown in Figures 9, 10, 11, 12 and 13.

Fred C. Hart has conducted a program to define the lateral and vertical extent of contamination of the unconsolidated soils and fill material at General Switch.

A correlation was developed between the laboratory data compared to data produced using a Photovac, a portable gas chromatograph with a photoionization detector and data generated using the portable OVA, a gas chromatograph using a flame ionization detector. It appears that the instruments were not calibrated to the same standards.

The results indicated that the concentrations of tetrachloroethylene in the headspace as identified through the Photovac analysis was approximately one order of magnitude greater than the actual concentration of tetrachloroethylene in the soil as identified by the standard laboratory method. This is consistent with our experience of use of the Photovac as a sensitive field method. It is from sampling results obtained by laboratory analysis that all USEPA and State environmental quality criteria are derived.

The OVA data produced poor correlation with soil laboratory data except to indicate high-level soil contamination. When the OVA scan of the split spoon indicated a high concentration of total volatile organics (greater than 1000 ppm) it was assumed that the sample was highly contaminated and a Photovac analysis was not performed. Based on the OVA results from this study and laboratory analytical results from previous studies, tetrachloroethylene concentrations in the soil around TPA and TPD are known to be higher than 200 ppm.

The Photovac results are the most numerous and we have used this data along with the OVA data to establish the horizontal and vertical extent of soil that requires treatment.

The following discussion addresses only the Photovac results which, based on the laboratory correlation, showed concentrations of 200 ppm or less. There are three areas of soil contamination indicated by previous investigations that are displayed in Figure 9: Soil around TP6, TPA and TPD.

TP6

Soil samples taken from the area around TP6, which included Test Borings T-1 through T-4, showed tetrachloroethylene concentrations in the range of less than 1 to approximately 20 ppm.

With respect to contamination in the vertical direction, the higher concentrations were found at depths of 2 to 7 feet, as indicated in Test Borings T-2, T-3, and T-4. The tetrachloroethylene contamination that was found below a depth of 10 feet extends to a depth of 17 feet at the range of 1 to 5 ppm for all samples analyzed in this area. If the soil solidification alternative is adopted, soil will be treated to 4 feet depth in this area as defined by Cross Section A-A'.

With respect to the lateral extent of tetrachloroethylene contamination in this area, all four test borings generally showed the same degree of contamination. It appears that tetrachloroethylene contamination at concentrations of less than 20 ppm extends laterally beyond the area investigated with Test Borings T-1 through T-4. It is proposed to treat the area detailed on Figures 10-13 that include locations T-1, T-4 and TP6.

TPD

Soil samples taken from the area around TPD, which included Test Borings T-5 through T-11, showed tetrachloroethylene contamination in the range of less than 1 ppm to approximately 200 ppm.

With respect to contamination in the vertical direction in this area, the higher concentrations were found at depths of 0 to 12 feet, with the highest concentrations generally at depths of less than 10 feet. Concentrations in samples taken at depths of 12 to 17 feet were in the range of approximately 5 to 16 ppm.

With respect to the lateral extent of tetrachloroethylene contamination in this area, the highest concentrations were found in Test Borings T-7, T-8, T-9, T-10 and T-11, at levels of up to approximately 200 ppm with the Photovac and greater than 1000 ppm with the OVA. The lowest concentrations were found in Test Borings T-5, T-8, T-12, T-13 and T-11, in a range of less than 1 ppm to approximately 20 ppm. It appears that these test borings roughly define the lateral extent of tetrachloroethylene contamination in this area. For the solidification alternative, soil will be treated to 4 feet depth in T-5, T-6, to 6 feet depth near T-7, T-8, T-9 and T-10 and 2 feet near T-12, T-13.

TPA

Soil samples taken from the area around TPA, which included Test Borings T-15 through T-20, showed tetrachloroethylene contamination in a range of less than 1 ppm to approximately 200 ppm.

It appears that there is significant contamination in the vertical direction in this area to at least a depth of 10 to 12 feet. The highest concentrations were found in Test Borings T-15, T-18, T-17, and T-20, at levels of up to approximately 200 ppm with the Photovac and greater than 1000 ppm with the OVA. However, Test Boring T-19 had a maximum concentration of approximately 5 ppm and all three concentrations in T-18 were less than 1 ppm. It appears that Test Boring T-19 roughly defines the lateral extent of tetrachloroethylene contamination parallel to the building in this area. The area at the side of the General Switch building is a cul-de-sac, a depression that is lower than the neighboring slope from Highland Avenue and is bounded on the north by a property boundary. For the soil solidification alternative the depth of soil treatment in this area will be to 6 feet and extend from T-15 to T20, bounded by the property boundary. The foundations of the building will be undermined if excavation proceeds below the footings.

Groundwater Contamination

From October 17, 1983 to March 16, 1984 water samples from potable wells within a one-mile radius of the General Switch plant were analyzed for tetrachloroethylene. The data generated from over 300 groundwater samples indicated that twenty wells on Highland and Watkins Avenues had detectable concentrations of tetrachloroethylene.

Seven domestic wells and one industrial well (at General Switch) contained concentrations of tetrachloroethylene that exceeded the NYSDOH 1984 maximum permissible concentration (50 ppb) for any single synthetic organic chemical as shown on Figure 14.

In 1984, the tetrachloroethylene contamination of wells in the Washington Heights Section of the Town of Wallkill was restricted to wells drawing water from the Austin Glen Series and not in the shallow dug wells in the area. Permeability in this formation is determined by the degree of fracturing, openness of joints and bedding planes, and the interconnection of joints. The distribution of contaminants in the area indicate transmission of the contaminants are along regional fractures. Those wells that obtain the highest level of contaminant concentration are on a regional fracture that connects to the source of contaminants.

Many of the residences on Highland Avenue have been supplied with municipal water, as noted in Figure 14, and have abandoned their wells, including all those residences with greater than 50 ug/l tetrachloroethylene.

As of July 1988, the nearest residences to General Switch that use the aquifer as a drinking water source are: The Perry residence that has historically been unaffected by the groundwater contamination and the Ogden (now Wood), Seeley and Gilbert residences at 319, 321 and 323 Highland Avenue. These wells in November 1983 to April 1984 received 1 ppb to non-detected concentrations of tetrachloroethylene, indicating that these wells were not on a major fissure carrying the contaminants.

In November 1983 to April 1984 the residences on Watkins Avenue that were supplied from wells were Hammerquist, Wegenroth, Rassmussen, Morse, Winner, Prior King Press, Cosmo Optics, Radivoy, Campbell, Jehovahs Witness, Wand and Saxton. All the other residences on Watkins Avenue were supplied with municipal water from Middletown. In November 1983 to April 1984 all the wells on Watkins Avenue were free from tetrachloroethylene contamination except Prior King Press (ND, 2 and 3 ug/l), Winner (ND and 1.1 ug/l), Rassmussen (12 ug/l and ND), Morse (4 ug/l and ND) and Wand (2 ug/l and ND).

All the wells tested in 1983-1984 on Commonwealth Avenue were <1 ug/l or non-detected for tetrachloroethylene.

Water well testing was conducted by Fred C. Hart between June and September 1984. The results of potable water analysis are presented in the Appendix. During the four months of sampling by Fred C. Hart, the most contaminated wells encountered were at the homes of: Ruppert, Liska, Barry, Stout, Parella, General Switch and Lewis. With the exception of Liska and Lewis, all the other wells had previously been identified as contaminated with over 50 ug/l of tetrachloroethylene. Tetrachloroethylene concentrations in excess of 50 ug/l were first noticed in the Lewis and Liska wells on July 17, 1984. Another set of samples were taken on August 28, 1984 to confirm the previous results. This increase in these wells downgradient in terms of groundwater flow from the Parella well occurred after the Parella and Stout residences were provided with city water and ceased to pump their wells.

When the results of the August 28, 1984 sampling trip were received, the Liska and Lewis homes were put on alternate water. Aside from the wells mentioned above, all the other wells in the General Switch vicinity remained uncontaminated.

In general, the concentrations and distribution of tetrachloroethylene had changed very little since EPA's last samples were taken in March of 1984. The trend of tetrachloroethylene distribution had remained in a northwest-southeast orientation and the contamination found in the Liska and Lewis wells conformed to this pattern.

do not agree

The additional data from the Technical Assistance Team studies fills a gap in the knowledge of the hydrogeology of the area and the nature and extent of groundwater contamination in the shale.

Retesting of selected wells during cleanup is included in the Sampling Plan along with a commitment by General Switch to provide municipal water to any residence impacted by the site with a well containing more than the Safe Drinking Water Act MCL.

We have begun the survey of wells adjacent to General Switch. The Wood well, identified in August 1989 as being used for private supply, was sampled on August 17, 1989 along with other neighboring wells of households, such as Stout, on city water.

Owner	Volatile Organics (Method 624)		
Ernest	353 Highland Avenue		ND
Seeley	321 Highland Avenue	Toluene	3.5 ug/l
Gilbert	323 Highland Avenue	Toluene	3.1 ug/l
Stout	316 Highland Avenue	Tetrachloroethylene	1300 ug/l
		Trichloroethylene	190 ug/l
Wood	319 Highland Avenue	ND	
Guild Molders	Industrial Place	1,1-Dichloroethane	44 ug/l
		1,1,1 Trichloroethane	12 ug/l

Following this review of the contaminated soil on General Switch property and the plume of tetrachloroethylene found in the shale, it would appear that the Parella well is the well to choose as the pumping well for plume capture. This assumption will be tested by the Pump Test Plan described in the following section.

2.0. Scope of Work

The Parella well was selected as the pumping well in this Pump Test Plan because this well in 1983 and 1984 consistently demonstrated the highest concentrations of tetrachloroethylene observed in homeowners' wells. During the long-term pump test of the Parella well, water levels will be taken in the observation wells on Highland Avenue and on the General Switch property to assess the degree of interconnection of these wells in the glacial till and bedrock aquifer with the Parella well and the effect of pumping the Parella well on the surrounding bedrock and perched aquifers.

2.1. Data Quality Objectives

The pump test will provide information to address the following data quality objectives:

- Two types of pump test will be conducted on the Parella wells and the surrounding observation wells. Initial short-term pump tests will be completed lasting 12 hours during which the performance characteristics of each well will be determined. A long-term pump test of the Parella well will be conducted in which the long-term performance of the Parella well may be determined and the aquifer characteristics of transmissivity and storage in the shale obtained.

how many surrounding observation wells. Sampling is required before accepting as observation wells

- Hydrologic information concerning the shale aquifer under the site will be obtained to determine if pumping the Parella well will clean up the aquifer. The long-term pump test of the Parella well will attempt to determine if the cone of influence of the Parella well encompasses the tetrachloroethylene plume observed in homeowners wells sampled prior to and during the pump test. One round of water samples will be taken from the observation wells surrounding the Parella well prior to the pump test on the Parella well and one round will be taken after the pumping to assess the water quality changes caused by the pumping.

- The effectiveness of the groundwater plume capture will be assessed by sampling the concentration of the influent water quality of the pumping well analyzed for volatile organics according to the attached sampling program. This will allow us to determine how much of the Tetrachloroethylene and trace volatiles are being removed from the aquifer by pumping the Parella well. By sampling the groundwater pumped into the air stripper and comparing it to the effluent discharge concentration from the air stripper, we will obtain information on the effectiveness of the air stripper in treating the groundwater recovered from the Parella well.

design is necessary before installation ?

This data will be used in order to obtain long-term authorization from the NYSDEC and the Town of Wallkill to discharge the effluent treated groundwater during groundwater cleanup.

- We will analyze the air quality of the exhaust from the air stripper cleaning the water drawn from the Parella well. This data will be presented to the Air Branch of the NYDEC to obtain their authorization to discharge the exhaust during groundwater cleanup.

Air ✓

- The pump test report will present details of the depth and condition of the pumping well that will include: static depth to water, well volume, depth of pump, pump capacity, power supply and pump control devices.
- The operating parameters of the Parella pumping well will be determined in terms of optimum pumping rate, yield and specific capacity.
- Data concerning the observation wells will be obtained that include the depth and condition of each well and the static water levels along Highland Avenue immediately prior to the pump test. The yield of individual wells provisionally selected as observation wells will be determined in order to assess the degree of connection these wells have to the regional fractured bedrock aquifer. Poorly yielding wells will be rejected as observation wells in a program of short-term pump tests prior to the pump test of the Parella well.

  An attempt will be made to limit the use of nearby wells during the pump test as interferences and additional drawdown will result from any use of nearby wells. There are only three wells on Highland Avenue at present used for drinking water supply.

- The drawdown of the pumping well under the optimum sustainable pumping rate will be observed along with the response in terms of drawdown in neighboring wells. This optimum sustainable pumping rate is that rate of groundwater pumping that the well can provide for the period of the pump test without drawing the well down to uncover the pump intake. It will be the pumping rate that removes most groundwater from the shale aquifer and has the most extensive impact on the water resources surrounding the well. We will report data comparing the pumping rate and the concentration of solvent withdrawn at that pumping rate. It is noted that the pump test is not a substitute for extended well pumping and that the initial optimum pumping rate may differ later in the groundwater recovery process.

- Part of the proposed remedial action involves flushing contamination from the hot-spots of soil contamination through the glacial till to the bedrock aquifer. The pump test plan includes monitoring of wells installed by Fred C. Hart in the glacial drift to determine if pumping the Parella well and drawing water from the bedrock aquifer will draw the water levels down in the wells screened in the glacial till. In this way, we will evaluate the degree of interconnection between the till and the fractured bedrock aquifer.

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Observation Wells

Based on the information concerning the hydrogeology of the aquifers at General Switch and the data quality objectives presented above, we are to conduct a pump test in the vicinity of General Switch where the Parella well is the pumping well and the observation wells are ten other wells along Highland Avenue and on the General Switch property and eight monitor wells in the glacial till.

For the observation wells, we will seek to use 10 abandoned wells in the shale of Barry, Rupert, Robaina, Stout, Osbourne and Lobb, Wood (now Ogden) or Lewis, Crooks, Electra Manufacturing, Roselli or Perez (Figure 24) and eight monitor wells installed by Fred C. Hart: MW1 through MW-8 (Figure 25) One shallow dug well on the Stout property may be used if it contains water. The observation wells along Highland Avenue that are provisionally selected have been the wells adjacent to the Parella well that have historically demonstrated tetrachloroethylene contamination and drawdown during the prior pumping of the Parella well and are adjacent to General Switch. The wells in the shale are supplemented with monitor wells screened in the glacial till above the shale in order to evaluate the interconnection of groundwater removal in the shale and drawdown in the till above.

Well flow (discharge) is a combination of water pumped from the standing column of water in a well (the well storage contribution) and the water flowing into the well from the aquifer (the aquifer contribution). In the evaluation of any well provisionally selected as a recovery well, such as the Parella Well, it is necessary to recognize that the well acts as a water storage chamber. Water is taken from well storage during peak demand times and gradually replenished during off-peak times. The impact of these two contributions was observed in the the wells in Wallkill drawing water from the shale. In those wells sampled that tapped few regional fractures, the aquifer contribution was low: less than 1 gpm. These wells were quickly exhausted once the well storage volume had been removed and had to be rested for a period of more than 1 hour before any significant well recovery was observed and the well could be pumped again.

2.2. Procedure

We will monitor the drawdown over time in the pumping well and observation wells. The wells will be instrumented with an electro-piezometer system and the data will be collected on a data logger for transfer into an IBM compatible PC for graphing by Lotus software. The test will extend for a minimum of 3 days (72 hours). The pump test will begin within 21 days of receipt of USEPA approval of the plan. The pump test of the Parella well will begin with a series of short-term pump tests on wells surrounding the Parella well to demonstrate the effectiveness of these wells as observation wells and the deployment of the electropiezometer system. In the Pump Test, the electro-piezometers will be installed and the Parella well will be started once the required permits are obtained from the township and State, a necessary prerequisite for the pump test that we can only request once the parameters of the pump test are agreed upon. We have identified the necessary local and State permits and regulations in the Section: Applicable Laws and Permits. We will notify the USEPA not less than 10 days in advance of any sampling activity.

The prepump
of observation
wells will
change the
static
condition
it should
recover
100%
before
Parella
well pump
test start

The tasks to be completed prior to the Parella well pump test are:

o **Community Well Survey**

We will first update the Wallkill Well Data survey of the wells on Industrial Place, Highland Avenue Extension, Electric Avenue and Watkins Avenue and Commonwealth Avenue. The survey will obtain the names and phone numbers of the present owners. The survey will be a door-to-door survey of all wells on these streets in order to ascertain the present source of water supply: whether well or city water supplies each residence. The survey will also determine the condition of the wells in regard to ease of access to the well for sampling and water level measurement and whether the pump is still in place and working. The survey is an essential prerequisite for the Pump Test of the Parella well as it will update the information on the observation wells obtained in 1983-84 regarding water levels, well depth and well status in terms of access and usefulness for the pump test.

Short-Term Pump Tests for Parella Well and Observation Wells

The selection of the wells to be used as observation wells was based on the location of the well relative to the Parella well and General Switch and the plume of contaminated groundwater observed in homeowners wells to date. Those wells with the closest proximity to the Parella well and to General Switch and that have the highest sustainable yields have been selected as monitor wells for the Pump Test. There are wells in the project area that are nested together. On the Stout property there is a deep well and a shallow dug well approximately 200 feet downgradient from the Parella well. These two wells may be included among the observation wells to assess the relative effects of pumping the Parella well on the well in the shale and the adjacent well in the glacial till. Similarly, monitor well MW1, a shallow well screened between 15 to 20 feet to the top of bedrock and the Electra Manufacturing well, a 100 foot+ well in the shale, are located on an open lot 100 feet to the north of the General Switch building.

The interconnection of wells indicated by the short-term pump test completed in 1983-84 will be assessed in light of further short-term pump tests planned for the observation wells surrounding the Parella well and General Switch, as an integral part of the Pump Test Plan and completed before the pump test of the Parella well. We need to know how the wells interconnect to determine which wells are to be chosen as observation wells for the Parella well pump test. Each well that has been provisionally selected as a monitoring well, including the Parella Well, will be pumped to determine the maximum sustainable yield, in order to confirm that the well is productive enough and that the well is in direct hydraulic connection to the regional fractures of the area. A short-term (12 hour) step-drawdown pump test of the Parella well will be conducted to determine the optimum pumping rate for the Parella well. The observation wells will also be subject to such step-drawdown tests. For these well-performance tests, the yield and drawdown will be recorded so that the specific yield can be calculated. Significant drawdown of more than 5 feet in neighboring wells on adjacent lots will be taken as an indication that the pumped well has hydraulic connection to the regional fractures. Each well provisionally selected as a monitor well will be pumped at 2 gpm and the water level drawdown will be monitored. If the well can sustain a drawdown of 2 gpm and reaches a constant head (constant drawdown) condition, the pump rate will be increased to 4, 6 and 10 gpm increments resulting in an increased drawdown, until the well fails to perform adequately when the water level in the well is drawn down to the pump intake and the pump loses suction. For the purposes of this plan a constant head condition exists when the pumping rate is held steady and the water level changes at a rate of less than 6 inches per hour.

Yeild test
to be done
on all
wells?

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The short-term pump tests will follow the protocol outlined in The technical reference Appendix F: New Jersey Geological Survey, Groundwater Report Series #1, Two Part Pump Test for Evaluating the Water Supply Capabilities of Domestic Wells. Once the well fails to produce water by exposing the pump, the return of the water level to 90% of the original static level will be measured to determine the response of the well in the recovery period. The data will be reduced and calculations made according to those presented in Reference: "Pumping Test Analysis for Low Yielding Formations", The Johnson Drillers Journal, Nov-Dec 1980, Appendix F.

Samples of the pumped water will be collected at the end of the pumping period of each increment of 2, 4, 6 and 10 gpm and tested on the Photovac to analyze the concentration of groundwater contamination in the well effluent at each rate. One sample in ten will be analyzed in the laboratory by USEPA Method 624 for priority pollutant volatile organics.

From observation of the wells during well sampling it appears that a well that yields more than 4 gpm in this area is a productive well and is connected to regional fissures. Wells that have less than this yield may supply 4 or more gpm to the homeowner for periods up to an hour but rely upon drawing down the storage capacity in the well to provide water during peak withdrawal. As observed by the homeowners, these wells need to be rested for several hours before the next well use in order to replenish the water removed from storage before the next pumping event. These wells are drilled in areas with few fractures and would not serve well as monitor wells.

The above testing of wells will identify those poorly yielding wells that have insufficient storage capacity and a poor connection to the aquifer that will be culled (eliminated) from the candidates of observation wells.

> According to Section VI. 3. Alternative Water Supply, the USEPA requires a report identifying those wells which are or may be affected by releases of Tetrachloroethylene at or from the site and have not been connected to any municipal water supply during or after the USEPA prior Removal Action. We are required to determine the levels of Tetrachloroethylene in the well water and offer to any present and future well owner to connect any wells which contain 5 ppb or more of Tetrachloroethylene.

not enclosed
Appendix F

1 in 10 to lab for 624 method test

Photovac accu
[illegible]

less than 4gpm low yield. not fit for observation well?

Appendix E. gives Transmissivity of aquifer

whereas yield of well (4gpm) less than 4 gpm is proposed not to be used as observation well.

Historically, we have in 1983-84 been able to identify a circle of clean wells outside the affected wells. To provide up-to-date information regarding the water quality in the aquifer, while we are conducting the survey, water samples will be taken from all the existing wells on Industrial Place, Highlands Avenue, Electric Avenue and Watkins Avenue and analyzed for volatile organics by USEPA Method 524.2. One month after the sample results of the wells are made available to the USEPA, we will submit a plan to identify a circle of clean wells around any contaminated well that in the judgment of the USEPA may be considered to be at risk and will be added to the sampling round. The results will be portrayed in a table and presented to the USEPA, one month after completing the survey and will include a map depicting the location of such wells. The sampling will be conducted according to the standard procedures for well sampling presented in Appendix B.

sampling should be from all the wells
check number & location from old reports
What is 524.2 method

- **Permissions from Well Owners**

Permission to use the wells for the pump test will be obtained in writing from each homeowner. Permission is required from several home owners and a refusal is not anticipated. However, alternate wells may be substituted for the observation wells to provide adequate data, with the concurrence of the USEPA On-Scene-Coordinator or designate, prior to the start of the pump test.

- **Continuing Normal Operation of Any Private Well**

In this initial test we do not propose to introduce a second variable in the continued operation of any private well within 500 feet of the Parella well during the pump test. Before the Parella well pump test, General Switch proposes to ask permission to hook up to public water supply the remaining homeowners along Highland Avenue that still use well water, specifically: Wood (319), Ernest (353), DeCarlo (357) and Fisher (361) in the vicinity of General Switch. If any well is not hooked up to public water supply before the test, the homeowner will be asked not to use their water for the duration of the test. Temporary water will be provided and the well will be monitored with an electro-piezometer.

- **Recondition the Wells and Provide a 4000-gallon Temporary Holding Tank at the Parella Well.**

All the wells within 400 yards of the Parella well, except the Wood well, are inoperative and will need to be reconditioned for use. Once permission is obtained, we will have a pump contractor modify those wells in the project area that have difficult access for water level measurement. We will pull those pumps that are inoperable and that prevent easy access to the well. We will install a pump in those wells selected for well sampling and short-term pump testing.

The Parella well will need to be uncovered as it is located at a depth of three feet at the eastern corner of the house and will need to be fitted with a submersible pump and piping in a ditch below the frost line across to General Switch.

A 4000-gallon temporary storage tank will be provided adjacent to the Parella well, in addition to the 2 x 4000 gallon tank trucks. The storage tanks will be used to accumulate the water from the first day of the pump test.

- **Arrange for Waste Water Treatment**

If the Parella well is pumped at 4 gpm each day of the Parella well pump test approximately 6000 gallons of contaminated groundwater will be recovered. We will have the problem of dealing with the disposal or treatment of this waste. We propose to address the issue of disposal of this water in the following manner:

Air Stripper

Treat the discharge from the Parella Well to <5 ppb Tetrachloroethylene and any other trace volatile components by pumping the water recovered during the pump test through a full-scale prototype air stripper installed in a trailer on site (Appendix F). The air stripper will be sized to take additional well discharges if necessary. The air exhaust will be piped through activated carbon. Samples will be taken of the air after passing through activated carbon. The pump test will be used to monitor the effectiveness of the air stripper.

disposal of activat carbon

Imbiber Beads

The discharge from the air stripper will be piped through a bed of imbiber beads and into two 4000 gallon tanker trucks on site. The imbiber beads are a polystyrene beads marketed under the name of Expandbeads that are effective in adsorption petroleum fuels and solvents. Details of the beads are attached in Appendix F.

disposal of Imbiber beads.

- **Take Samples of the Exhaust from the Air Stripper and Effluent Treated Groundwater**

A minimum of 2 water samples of the pumped water will be collected each day after treatment by the air stripper at the discharge of the storage during the 3-day operation of the air stripper and analyzed with the Photovac 10S50 calibrated against standards supplied by the Laboratory. A minimum of 1 duplicate effluent discharge sample per day will be analyzed by Method 524.2 on a one-day turnaround. Verbal results will be provide to the Project Coordinator and Wallkill POTW to enable a decision on the release of the stored pump-test water (see Sampling: Section 4.0). One sample of the air stripper exhaust will be taken and analyzed by NIOSH Method 1003.

To CLP lab?

CLP lab?

The drawdown water level will be stabilized close to the bottom of the pumping well, five to ten feet above the pump in order to stress the aquifer.

- o Monitor any changes in the surrounding wells with a dual system of readings: by hand measurements of water level as well as by recording the data on the data logger.
- o Discharge the treated water provided the effluent is below 5 ppb of tetrachloroethylene.
- o Water discharging from the air stripper will be sampled and analyzed by USEPA method 524.2
- o **Obtain the Required Permits**

A temporary discharge permit to air will be sought from Neil Isabel of the NY State DEC for the operation of the air stripper. As the Pump Test Plan includes an engineering design for the deployment of an air stripper, we will supply to NYSDEC, during the permit application, engineering drawings detailing the air stripper, certified by an engineer licensed to practise in New York State. A temporary discharge permit to groundwater will be obtained from Caesar Manfredi of the NY State DEC. As a further safeguard we will approach the Town Supervisor of Wallkill and the Wallkill sewer authority and the NY State DEC for temporary permission to discharge the pumped water into the Wallkill sewer along Highland Avenue. Additional background information is provided in Section 5.0. Permits.

Permit application is necessary
?

- o **Use of Data**

If the treated groundwater is shown to be consistently below 5 ppb during the test, permission may be sought from the USEPA and NYDEC to discharge treated water from the Parella well onto the ground on General Switch Property at a location up gradient in terms of the groundwater flow. This discharge will be used to determine the percolation rate of water discharged into the upper till and, if successful, will form a groundwater mound upgradient of the site that may be identified in the monitor wells on site to further investigate the feasibility of the proposal to flush the contaminants from the hot spots of Tetrachloroethylene in site soils previous identified. Such a proposal outlining the scope of the test may be submitted to the USEPA in the Pump Test Report.

- o **Notice to USEPA, Wallkill and the Laboratory**
- o We will provide 10 days notice to the USEPA and Wallkill of the date of the pump test and notice to the laboratory of the sampling schedule.
- o Pick up prepared sample containers and standards of 100 ppb and 1 ppm of benzene, toluene, tetrachloroethylene and xylene from the laboratory.

What for
for PID?

Electro-piezometer

The Terra 8 is a microcomputer data logger connected by cables to a number of pressure sensitive transducers that are submerged in the wells to be monitored. Changes in water levels in the wells are noted by the pressure transducers that are read by the data logger at programmable time intervals of every 1/10 of a second to once per 24 hours. The data logger stores the information that is then down-loaded to a portable IBM compatible PC.

- **Installation of the Data Logger**

- **Check out the data logger to see that it is operational.**
- **Set up the data logger system**

Set up the data logger system with leads into the pumping well and observation wells. Set up the background barometric pressure gauge. The data loggers will be set up and run for 2 days before the pump on the Parella well is started to establish a good base line of water elevations. The data from the base line will be collected, graphed and reviewed before starting the Parella well pump.

The leads for the data logger are 1/4" thick microvolt electrical transmission wires that will be protected from abrasion and vandalism by suspending them overhead, 20 feet above ground from the trees along Highland Avenue. The pressure transducers are pressure sensitive in that they record changes in water level in the well, but the leads are not pressure sensitive to being walked upon or driven over and they are not affected by taking water level measurements by hand. It is prudent to use two methods to measure the water levels in the wells.

- **Begin the data logger recording. Register static water levels and synchronize the watches of the observers.**

- **Groundwater Level Measurements**

Water level elevations using the electro-piezometer system will be taken at semi-logarithmic time intervals from the pumping well and each of the observation wells periodically during the pump test, with closely timed readings at the beginning of the test, as follows:

Prior to the Pump Being Started in Hours		Time Interval Between Measurements in Minutes
minus 2880-T^0 48 hr		60 min
Time Since Pumping Started (T^0) (or stopped) in Minute		
T^0	0-10 min	0.5-1 min
	10-15	1
	15-60	5
	60-300	30
	300-4320	60
4320 End of Test 72 hrs.		

Hand Measurement

Hand measurement of the water levels in the pumping well and observation wells will be taken to confirm and calibrate the readings obtained with the electro-piezometer system and used to check that the water level is not being drawn so far down in the Parella well as to uncover the pump.

Prior to starting the pump test, two rounds of static water levels will be obtained by hand to measure groundwater levels and plot flow direction. Static water level measurements of monitoring wells will be separated by a minimum period of 1 day. Initially, care will be taken to measure water levels under non-pumping (static) conditions, where the water well is not influenced by local drawdown due to pumping at or near the well. After the pump is started, these hand readings will be taken on the same schedule as the electro-piezometer readings for the first four hours and at a minimum of twice per day during the rest of the pump test.

Two rounds of water level before pumping to determine flow direction

Relative to the surveyed elevation of the top of the inner casing (riser pipe) of each well, the depth to water will be measured using a chalked tape (see Figure 2b) or hand-held electric water-level gauge. Individual water level measurements will be repeated to confirm water level elevations.

- **Groundwater Contour Map**

Water levels will be compared before and after the pumping of the Parella well. Water levels taken in the monitor wells and any water levels taken in neighboring wells and from local standing water will be compared to define the potentiometric head in the formations present on site and plotted to develop a groundwater contour map to obtain groundwater gradients to compute direction and rate of flow.

It is important to compare wells that are screened at the same depth and in the same formation for horizontal groundwater gradients and water quality.

3.0. Pump Test: Standard Operating Procedures

o Pump the Parella Well

Once the groundwater levels in all the wells have recovered from the short-term pump tests, the Parella Well will be pumped to produce drawdown of the pumping well in a constant-rate pump test at the maximum sustainable pumping rate. The response in drawdown of the water levels in the observation wells will be measured. Any unusual events such as stoppage of pumping, Changes of weather or the passage of heavy equipment will be noted. The test will be run when clear weather is forecast. The pump test of the Parella well will be divided into three parts. The falling-head test, the constant-head test where the pumping is continued until equilibrium is reached and the recovery stage of the water level in the wells after the pump is switched off.

o Pump Test Duration

The pump test of the Parella well will extend for a minimum of 3 days (72 hours). This choice was made based upon the apparent response of the wells surrounding the Parella well such as the Osbourne and Lobb wells that responded within 1.5 hours of pumping the Parella well during the initial pump test of December 21, 1983 and similar responses of the Barry well during the short-term pump test of the Ruppert well indicating that such wells should serve as responsive monitor wells for the Parella well pump test.

Characteristics of the wells in the shale are presented in the Wallkill Well Data table. The use of these observation wells will be contingent upon initial testing and observation conducted in the well survey detailed in the next section.

Methods for Determining the Pump Rate of a Well

Bucket and Stop Watch

A 5 gallon bucket and stop watch will be used to determine the flow rate from the wells being tested. The time in minutes that it takes to fill a 5 gallon bucket from the well will be divided by 5 to obtain the rate of pumping in gallons per minute.

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Flow Meter

A flow meter and totalizer will be installed on the Parella Well to indicate the discharge rate of the well and the total gallons pumped.

Pump Flow Rates

The discharge rate from the Parella well will be set initially at the rate determined by the short-term pump test, checked every hour during the first 12 hours of the test, after which the rate will be checked every 12 hours.

Method for Regulating the Pump Rate of a Well

Flow Restriction Valve

A flow restriction valve will be installed on the end of the discharge hose from the pump to control the rate of discharge of the well pump. Repeated well measurements and valve adjustments will be employed to regulate the discharge from the well to control the pumping rate and hence the drawdown in the Parella well. In the second part of the pump test this method will be used to provide a constant head level in the well.

Background Well Data

We will measure any change in water level in two background wells on Watkins Avenue to monitor background changes in barometric pressure so that any barometric influence on the water levels in the wells may be discounted. Watkins Avenue has been supplied with city water since before 1983 and the interference in water levels by pumping wells will be remote and insignificant. Two wells will be chosen from the wells at #202, #208 and #214 Commonwealth Avenue based upon data from the updated well survey and the ease of access to the wells. These wells are over 500 feet from the Parella well and are shallow abandoned wells that should be unaffected by pumping on Highland Avenue.

o Data Reduction and Review

The electro-piezometer data will be transferred into an IBM PC for display and print-out. Preliminary data from the hand measurements will be plotted during the pump test to indicate any anomalies or boundary conditions encountered and when equilibrium conditions are reached.

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s = drawdown in ft at any point in the vicinity of a well discharging at a constant rate

Q = Pumping rate in gpm.

T = Coeff of Transmissivity of aquifer in gpd/ft.

W(u) = is read well function of u and represents an exponential integral.

~~u = 1.87~~

r = distance in ft from the center of a pumped well to a point where the drawdown is measured

S = Coff of Storage (dimensionless)

t = time since pumping started in days

Non-Equilibrium Well Formula (Theis)

Questions:

(1) potentiometric surface has no slope

3

(2) The pumped well penetrates and receives water from the full thickness of the water bearing formation

From the time pumping is begun in a well, the resulting drawdown follows a logarithmic relationship over the time of the pumping. Upon first beginning the pump, the drawdown is large and this rate of drawdown falls off exponentially as the pumping continues.

When this relationship is plotted on a log/log graph the computer program plots a curve that is solved by obtaining a match with typical pump test data stored in memory, called a type curve, to obtain a match. The Theis formula may be used to solve for T, the aquifer transmissivity. Transmissivity (T) is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

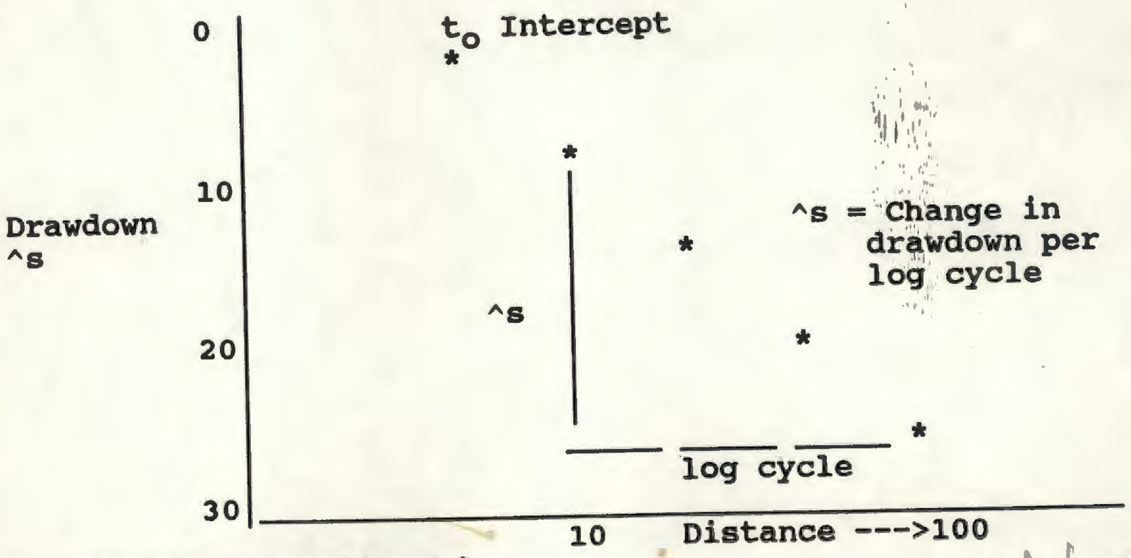
$$T = \frac{114.6\ Q}{s} \cdot W(u)$$

Once T is obtained, S, the aquifer storativity, is calculated from the following relationship

$$S = \frac{uTt}{1.87r^2}$$

Modified Non-Equilibrium Formula

When the time-drawdown relationship is plotted on a semi-logarithmic scale the relationship plots as a straight line:



Time - Drawdown Relationship

Time since pump started (min)

The slope of the drawdown is dependent upon Q, the pumping rate in gpm; K, the hydraulic conductivity in gpd/ft2; and m the aquifer thickness in ft. The coefficient of transmissivity, T in gpd/ft, is the product of the hydraulic conductivity and thickness of the aquifer. The relationship of transmissivity to pumping rate and drawdown for a time-drawdown slope can be written as

$$T = \frac{264\ Q}{\cancel{K}s} \cdot \log \frac{0.3\ Tt}{r^2 S}$$

Equation applicable when t is large and r is small.

The computer program plots the drawdown with time on a graph and solves the equation for T using the above non-equilibrium modification of the Theis formula (Figure 20).

$$T = \frac{264\ Q}{\Delta s}$$

ΔS = slope of the time draw down graph expressed as the change in drawdown between any two times on the log scale whose ratio is 10 (one log cycle)

The Storativity formula used is

$$S = \frac{0.3Tt_o}{r^2}$$

Where r is the distance from the pumping well to the monitor well in feet and t_o is the intercept of the straight line of the graph at zero drawdown, in days.

3.1. Contingencies

If, on the basis of the Pump Test Report, the Parella Well will not satisfactorily serve as an interceptor well, General Switch will submit to EPA for review and approval a plan for reconditioning the well or for use of alternative or additional interceptor wells, or a plan to develop the Parella well by means such as hydro-fracturing so that it may serve as an adequate interceptor well.

4.0. Sampling Plan for the Pump Test

The Pump Test Plan includes provision for the following chemical analyses:

- **Groundwater Samples from the Short-Term Pump Tests**

Samples of the pumped water will be collected at the end of the pumping period of each increment of 2, 4, 6 and 10 gpm and tested on the Photovac to analyze the concentration of groundwater contamination in the well effluent at each rate. One sample in ten will be analyzed in the laboratory by USEPA Method 624 for priority pollutant volatile organics.

1 in 10 will be analyzed by USEPA method 624

- **Groundwater Samples Before and After the Pump Test**

To determine if the cone of influence of the Parella well encompasses the tetrachloroethylene plume observed in homeowners wells, these wells will be sampled prior to and after the pump test. It is anticipated that this sampling will identify a circle of clean wells outside the affected wells. The sampling round of wells will include all the existing wells on Industrial Place, Highlands Avenue, Electric Avenue and Watkins Avenue including the observation wells surrounding the Parella well. The samples will be analyzed for volatile organics by USEPA Method 524.2. The round of samples will be taken after the pumping to assess the water quality changes caused by the pumping.

Prior and after the pump test

sampling should include wells on Industrial Place ext. and Commonwealth Ave.
method 524.2

One month after the sample results of the wells are made available to the USEPA, we will submit a plan to identify a circle of clean wells around any contaminated well that in the judgment of the USEPA may be considered to be at risk and will be added to the sampling round. The results will be portrayed in a table and will include a map depicting the location of such wells.

- **Influent Samples of Raw Water from the Parella Well**

Each day of the pump test, the effectiveness of the groundwater plume capture will be assessed by sampling the concentration of the influent water quality of the pumping well. The samples will be analyzed for volatile organics

- **Effluent Samples of Treated Water from the Air Stripper**

A minimum of 2 water samples of the pumped water will be collected each day after treatment by the air stripper at the discharge of the storage tanks into the sewer during the 3-day operation of the air stripper and analyzed with the Photovac 10S50 calibrated against standards supplied by the Laboratory.

A minimum of 1 duplicate effluent discharge sample per day will be analyzed by Method 524.2 on a one-day turnaround. Verbal results will be provide to the Project Coordinator and Wallkill POTW to enable a decision on the release of the stored pump-test water.

The laboratory will determine in one day if any volatiles are present in the discharge with one day turnaround to a detection limit of 5 ppb by Method 524.2. The QA/QC data will probably be available in 28 days. Samples from the first day will be hand delivered to the laboratory personnel who will have the equipment calibrated in advance.

detection limit 5ppb OK lab should be CLP.

Duplicate samples will be analyzed with the Photovac 10S50 gas chromatograph. The Photovac will be calibrated against standards of known concentration supplied by the laboratory. The Photovac results will be available in seven minutes at the well head. According to the manufacturer, the Photovac is capable of detecting 10 ppb of tetrachloroethylene at a gain setting of 10. For lower detection limits the gain may be increased to 100. The laboratory will call the USEPA Project Coordinator and Wallkill POTW with the results the following day so that a decision can be made to discharge the water to the sewer.

Photovac 10S50 gas chromatograph. accuracy?

If the air stripper does not treat the effluent to below 5 ppb Tetrachloroethylene, the system will be shut down subject to the direction of the USEPA Project Coordinator. We will sample the influent concentration for volatile organics pumped into the sewer and the influent concentration into the Wallkill treatment plant and at the Wallkill River discharge once per day during the test by running duplicate samples on the Photovac and at the certified laboratory. The Photovac results will be available the same day and will be confirmed verbally the following day by Method 524.2. The QA/QC package should be available in one month after analysis. If the concentration of Tetrachloroethylene in the discharge to the sewer is more than 5 ppb, we will cease the discharge to the sewer, subject to the direction of the USEPA Project Coordinator. This process will be repeated on the first, second and third days of the test.

Can they discharge contaminat water in sewer wit out treatm

o **Air Samples of Exhaust**

During operation of the air stripper one sample of the air stripper exhaust after passing through activated carbon will be taken each day of the pump test and analyzed by NIOSH Method 1003.

Groundwater and air samples will be taken using the protocols included in the appendix A, B and C of the Pump Test Plan.

Analytical Parameters

The Photovac 10S50 is most sensitive to the specific volatile compounds at this site down to detection limits of 2 ppb and thus will be used to screen the water and air samples. The procedures to be used for the Photovac analysis are those used by USEPA Region 1 laboratory and the USEPA National Response Team and are presented in Appendix F.

Water Samples

A duplicate sample of one in ten of the Photovac samples will be taken to the Laboratory for Volatile Priority Pollutant analysis. The Laboratory will analyze the water samples by USEPA Method 624 or 524.2 (for lower detection limit) to detect the full spectrum of volatile priority pollutant compounds.

After the initial water sample rounds, once the potential contaminants are identified and documented to the satisfaction of the USEPA On-Scene Coordinator, the duplicate water samples may be analyzed by Method 601 for the target volatile organic parameter tetrachloroethylene.

As the Sampling Plan includes volatile organic analysis, travel blanks will be analyzed for volatile organics. Field blanks will be analyzed each day for volatile organics.

Specific conductance and pH will be obtained in the field.

Air Samples

The Photovac will screen all air samples obtained from the exhaust of the air stripper by the filling of tedlar bags. A Tedlar bag is connected to an industrial hygiene air sampling pump filling the Tedlar Bag with exhaust gas. The bagged sample is now ready to be analyzed by the portable gas chromatograph according to the protocol detailed in Appendix F.

Confirmatory air samples will be collected by NIOSH Method 1003 on activated charcoal, according to the protocol detailed in Section Appendix C.

Table 4. PUMP TEST SAMPLING PLAN SUMMARY TABLE - Sampling Parameters and Analytical Methods

Location/Matrix	Analytical Parameter	Sample Number	Method Reference	Sample Preservn	Holding Time	Unit Cost	Cost
Water							
Groundwater Samples - Short Term Pump tests							
	Photovac	4 per well x 10	Region I USEPA	Cool/4C	2 days	$500/day rental	$3000
	Priority Volatile Organics	1 in 10	Method 624	Cool/4C	7 days	$215	$860
Groundwater Before and After Pump Test							
	Photovac	1 per well x 10	Region I USEPA	Cool/4C	2 days	$500/day rental	$3000
	Priority Volatile Organics	1 per well	Method 524.2	Cool/4C	7 days	$215	$12,000 — list of wells
Influent samples from Parella well	Photovac	2/day for 4 days	Region I USEPA	Cool/4C	2 days	$500/day rental	$2000
	Priority Volatile Organics	1/day for 3 days	Method 624	Cool/4C	7 days	$215	$645
Internal QA/QC for treatment plant:							
	Photovac	2/day	Region I USEPA	Cool/4C	2 days	included in rental	
Effluent samples	Photovac	2/day	Region I USEPA	Cool/4C	2 days	included in rental	
	Priority Volatile Organics	1/day for 3 days	Method 524.2	Cool/4C	7 days	$215	$645
Field Blank	Priority Volatile Organics	1/day for 3 days	Method 624	Cool/4C	7 days	$215	$645
Quality Control (QC). spiked sample/duplicate sample	Priority Volatile Organics	3 per batch	Method 624	Cool/4C	7 days	N/C	
Air							
Air samples of exhaust	Photovac	2/day	Region I USEPA	Cool/4C	2 days		
	Priority Volatile Organics	1/day	NIOSH Method 1003	Cool/4C	7 days	$230	$690
Electro-piezometer	Water levels	20/day	Terra 8 SOP	N/A	N/A	$1500/day	$10000
						Total	$33,485

Footnote

Analytical Methods o EPA Methods 624 Methods for Chemical Analysis of Water and Wastewater (EPA-600/4-79-020)

5.0. Applicable Laws and Regulations

Regulations under the the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), and the Federal Water Pollution Control Act (Clean Water Act or CWA), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) have the broadest applications to remedial actions.

5.1. Permits

Federal programs such as the Clean Water Act, the Clean Air Act and various Resource Conservation and Recovery Act programs have been authorized by the USEPA to be administered by New York State. Various State regulations may apply to the site cleanup operations.

New York State Permits and Regulations

For Federally supervised sites and for sites that produce plumes from hazardous waste disposal sites, NY State supervision is conducted by the Division of Hazardous Waste Remediation. The Regional Engineer for Environmental Quality, Harry Agarawal for the NY State DEC, has responsibility for administering both the Water and Hazardous Waste regulation and is the point of contact in obtaining a decision on the required State permits. Harry Agarawal reports to Al Klauss, the Regional Director of Environmental Quality Engineering. Ronald Pergardia, in Albany, has special responsibility for sites involving PRPs (Potentially Responsible Parties). The Regional Air Pollution Engineer, Neil Isabel, also reports to Al Klauss. The NYSDEC lawyer for this site is Lou Evans. Permits that may be required for this site include:

What is this?

- **NPDES Permits**

Discharge of pollutants or contaminants from a point source into U.S. waters requires a National Pollutant Discharge Elimination System (NPDES) permit pursuant to CWA section 402.

SPDES Permits?

- **Local Permission**

Discharge of pollutant contaminants into sewer on Highland Avenue belonging to the Wallkill publicly owned treatment works (POTW) will require permission of the POTW. This alternative will be used during the Pump Test. A verbal agreement was obtained in 1989 with Dennis Cosgrove, the recently retired Supervisor of Wallkill. A formal agreement needs to be obtained with the present Supervisor, Robert Brennan, and the POTW.

Discharge into local sewer: wh
is DEC Posit
?

- Groundwater Reinjection Permit, NYSDEC: Division of Water:

The injection of treated water from the Parella Well into an underground formation may require a Groundwater Reinjection Permit under the NPDES program administered by Caesar Manfredi of the NYSDEC, Division of Water. The reinjection of treated groundwater as a means of site cleanup is an acceptable policy of the NY State DEC detailed in two documents: Groundwater Policy Statements on the Reinjection of Groundwater. The Division of Hazardous Waste Remediation has the choice of administering NY State regulations either through a Division of Water Permit or through an Administrative Order.

According to Caesar Manfredi, because the site is being administered under CERCLA, the discharge of treated water into the ground may not require a permit but will have to meet the conditions of a permit (NYC Regulation Part 750). According to NY State regulations, under a permit, the discharge will meet the NY State Groundwater Quality Standard that is now 5 ppb for tetrachloroethylene, except in an area of containment such as a slurry wall or injection into a drawdown cone of recovery wells. In a decision on the appropriate groundwater requirements, the Division of Hazardous Waste Remediation will contact the Division of Water.

Caesar Manfredi has agreed to allow us to discharge the water to the ground during a pump test provided that we demonstrate to his satisfaction that the effluent criteria will be met. This demonstration may be in the form of a description of the air stripper operation in terms of discharge rate and time and anticipated effluent concentration. Whereupon Caesar Manfredi will issue a letter of temporary authorization to conduct the pump test.

- Clean Air Act Permits

Air Emissions: Regarding the air emission levels from site activity, General Switch has agreed to meet air emission levels permitted by existing permits granted by the State of New York. The air stripper will be located on the General Switch property and not at the Parella well. The water will be pumped out of the Parella well for treatment by the stripper on the General Switch site and the treated water discharged in the excavated holes formed during soil cleanup at the three hot spots.

According to the USEPA, a permit may not be required for such on-site remedial activity although the NY State air criteria will be observed.

It is upon the PRP's consult to identify, all ARAR's and demons trate that those ARARs will be met. Instead of this The Shakti associate is identifying the individu working in Regional offices, who are supposed responsible for these permits) Permission In this case the F.P.S. has the lea for DEC. and there five such discussions seems usele

Identify the criteria's. and demonstrate how these criteria's will be met.

According to Neil Isabel, NYSDEC Regional Air Pollution Engineer, emissions of pollutants to the air from the air stripper will require a New York State Air Permit (Air Resource Regulations 211.13 & 211-14). The criteria exhaust levels that will be permitted depend on the substance emitted, its quantity, and the air quality classification of the area. The NYSDEC will assess the impact of the exhaust. Based on past experience Neil Isabel does not envisage any problems in permitting the air stripper. The stripper must be separated from the exhaust from other manufacturing process operations.

Section 6 NYC RR 212 details the regulations for process and exhaust systems and the method of granting a permit to operate. An Air 100 Form will need to be completed that details the geographic location and chemical emissions from the site along with the emission rate potential (the emission rate without any controls) and the emission rate with controls. Neil Isabel stated on April 24, 1989 that we do not need a temporary air permit to conduct the pump test. We can conduct the pump test with the air stripper to provide hard data on the air emissions for the Air 100 Permit and he anticipates no problems in permitting the system. The regulations, according to Neil, specify the technology to be used (an air stripper) and as we propose to use the appropriate technology should not encounter a problem in applying for an operations permit supported by engineering drawings and data from the pump test. The engineering drawings will be certified by an engineer licensed to practice in New York State.

Soil Treatment

Neil Isabel requires an estimate of the rate of emission of solvent from the soil during soil treatment. New York State DEC reviewed hydrocarbon emissions from sites because of the ozone exceedences experienced in the State in the summer of 1989. It is noted that Orange County is in attainment for ambient ozone levels. John Davis of the Bureau of Source Control (518) 457-5618 is reviewing policy in regard to air strippers and will probably define the rate of emissions from a site above which controls are required. This policy may ask for an evaluation of the anticipated air emissions from the soil treatment and may either prevent the application of rotor tilling and evaporation of hydrocarbons as a remedial measure for spill sites without the control of these emissions

(I) Rotor tilling is unaccept
(II) uncontrol emission is unaccept able.
(III) Cleanup level?
(IV) Extent of excavat

Neil Isabel requires an estimate of the rate of emission of solvent from the soil during soil treatment by rotor tilling. He has informed Shakti Consultants that this rate will most likely be acceptable.

- RCRA Program Permits

Transportation of hazardous waste to an off-site treatment, storage, or disposal facility (TSDF) requires RCRA manifests and TSDF permits but will not be required for on-site treatment.

6.0. Schedule

We estimate that the well survey will take one month to complete, followed immediately by renovation of the necessary wells for water level recording and sampling. Renovation of the Parella well will take 5 days: that includes the uncovering of the well and installation of a new pump and digging a trench from the Parella (Cuison) property to the rear of the General Switch warehouse where the air stripper will be positioned. We have allowed an additional month to 6 weeks to renovate the observation wells needed for the pump test and to conduct the short-term pump tests. Several wells are below ground and will need to be excavated to gain access to the well. If the findings of the well survey reflect that there are no pumps to pull from the wells and the wells have easy access, the schedule will proceed to installing the required pumps and instrumentation into the wells. By that time the air stripper will be completed and deployed. Set up of the electro-piezometer will take 1 week and will include stringing the data wires over Highland Avenue. The pump test of the Parella well should take 3 days to obtain useful data. The completed laboratory analyses package with the attached Quality Control report from the laboratory will be available four weeks after the test. An integral part of the pump test is the qualified laboratory analysis results. The end of the pump test is when the quality control reviewed laboratory data is provided to the consultant. While we can prepare the findings on the hydrologic portion of the pump test during the month the laboratory is analyzing the samples, the pump test report will be delayed by the laboratory results and will be available to the client and USEPA twenty-one days after receipt by the consultant of the analysis package that marks the completion of the pump test.

TASKS	DURATION OF TEST							
	WEEKS							
	-3	1	4	8	12	16	20	24
APPROVAL FROM USEPA	X							
WELL SURVEY	XXXX							
OBTAIN PERMITS	XXXXXXXX							
SHORT-TERM PUMP TESTS		XXXXX						
RENOVATE WELLS			XXXXXX					
MOBILIZATION OF AIR STRIPPER				XXX				
SET UP DATA LOGGER					X			
INITIAL ROUND OF WATER LEVELS					X			
PUMP TEST					XX			
LABORATORY ANALYSIS						XXXXX		
REPORT WRITING							XXX	
FINAL REPORT SUBMISSION							X	
	-3	1	4	8	12	16	20	24

7.0. The Pump Test Report

The final Pump Test Report will include:

- Identification of the present ownership of the Parella well and provisions made to secure use of the well and any nearby land necessary for the operation of the Groundwater Remedy until such times as the USEPA determines, in accordance with Section X.F.3 of the Consent Decree, that groundwater treatment may be terminated.
- A summary of Pump Test procedures and results
- Graph of water level v time for each well instrumented and the computer data used in determining hydraulic conductivity, transmissivity and storativity
- Definition of the Parella Well's cone of influence and its hydrologic connection to other wells

  A groundwater contour map before and upon completion of the test
- Conclusions as to the Parella well's optimum pumping rate and measures necessary to maintain that optimum pumping rate.
- Conclusions as to whether the Pump Test demonstrated that the Parella well is a satisfactory for interception of the contaminant plume under or near the site.

Appendix:

Data Sheets, Field Notes and Equations, Calculations and Input data supporting the Pump Test Plan Conclusions

Technical References

Lab Analysis Results

Quality Assurance/Quality Control data package (1 copy)

References

1. Hydrogeologic Investigation of the General Switch Site, Fred C. Hart Associates, Inc, November 1984.

2. Soils Investigation to Determine the Extent of PCE Contamination at the General Switch Site, Fred C. Hart Associates, Inc, April 10, 1984.

3. Orange County Soil Survey

4. Frimpter, M.H. Groundwater Resources of Orange and Ulster Counties, NY, U.S. Geological Survey Paper - 1985.4.

5. Wallkill New York, Table: Summary of Water Level Measurements, November 1983 to February 1984. These water levels were taken by John Bee, a certified professional geologist, at that time employed as a geologist with the Technical Assistance Team, assisting the USEPA Emergency Response Branch Region II. The water levels were taken to obtain a fuller understanding of the water levels in the vicinity of General Switch.

6. New Jersey Geological Survey, Groundwater Report Series #1, Two Part Pump Test for Evaluating the Water Supply Capabilities of Domestic Wells.

7. Pumping Test Analysis for Low Yield Formations, Johnson Drillers Journal, Nov-Dec 1980.

8. Groundwater and Wells, Chapter 16 Collection and Analysis of Pumping Test Data, Johnson 1984.

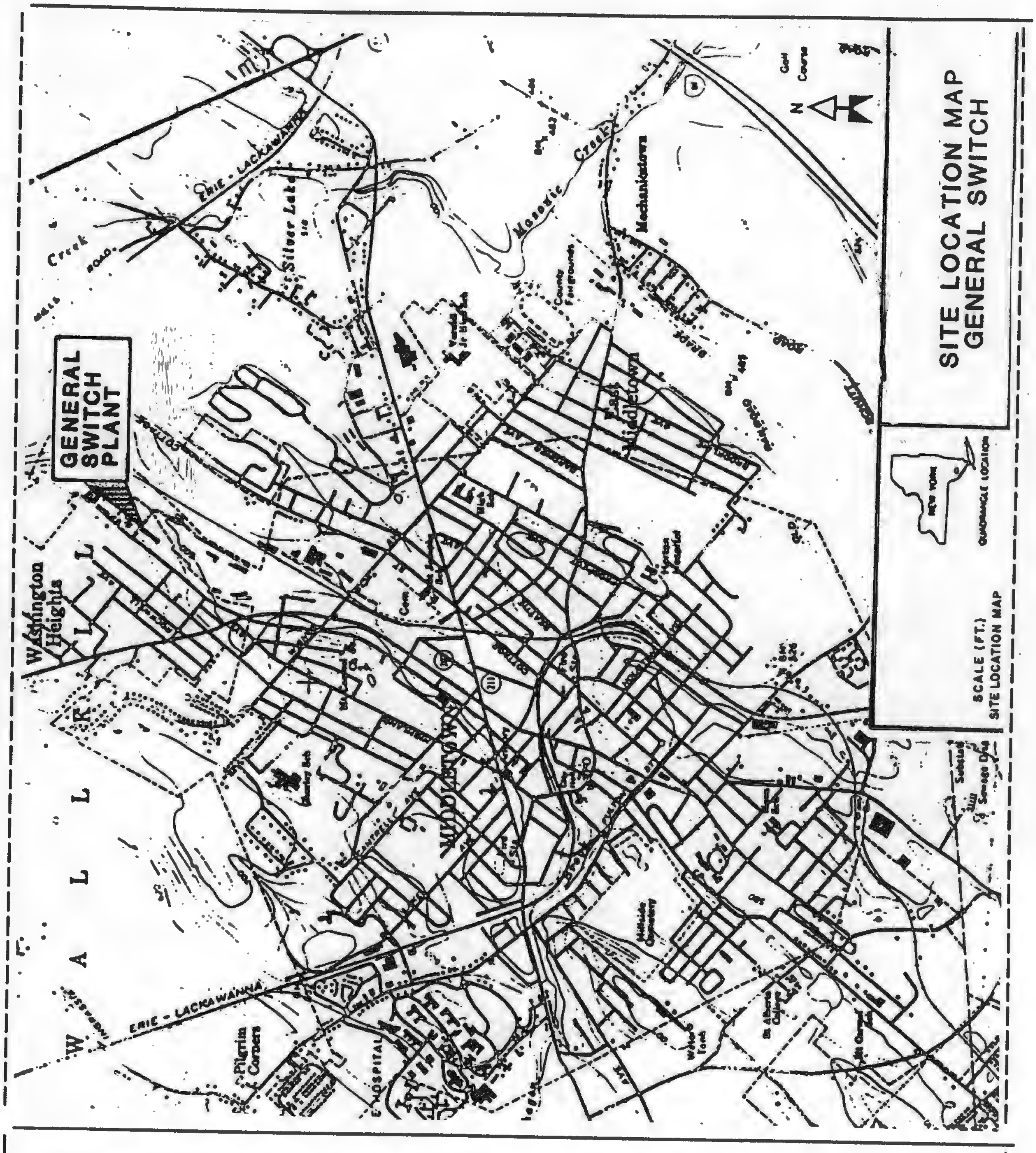


Figure 1. Site Location Map - General Switch

Shakti Consultants, Inc. Modified from Hydrogeologic Investigation
of General Switch Site,
Fred C. Hart Associates, Nov. 1984.

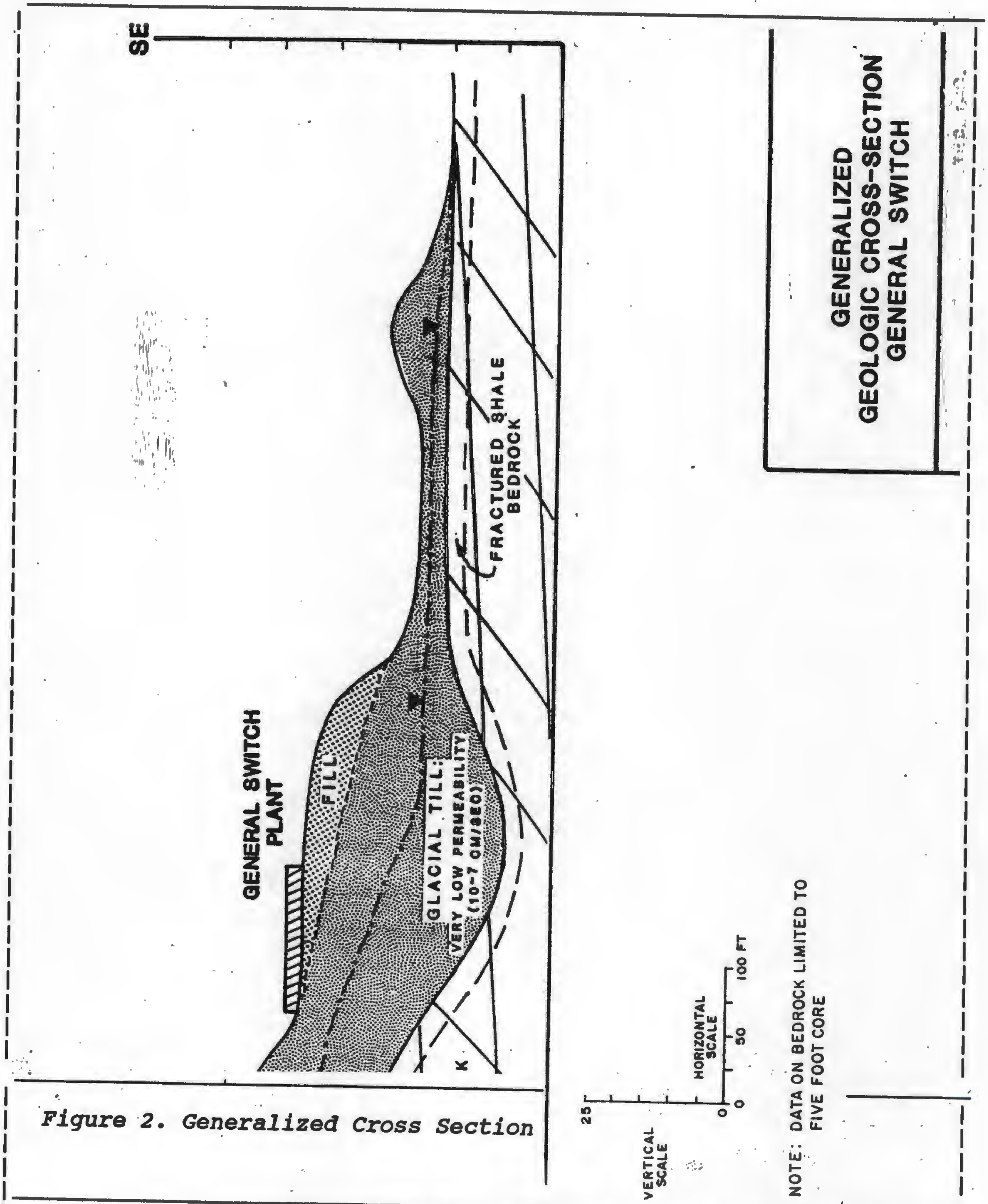


Figure 2. Generalized Cross Section

Shakti Consultants, Inc. Modified from Hydrogeologic Investigation of General Switch Site, Fred C. Hart Associates, Nov. 1984.

Figure 3. Water Table Elevations in the Glacial Till, Jan 1984

Shakti Consultants, Inc.

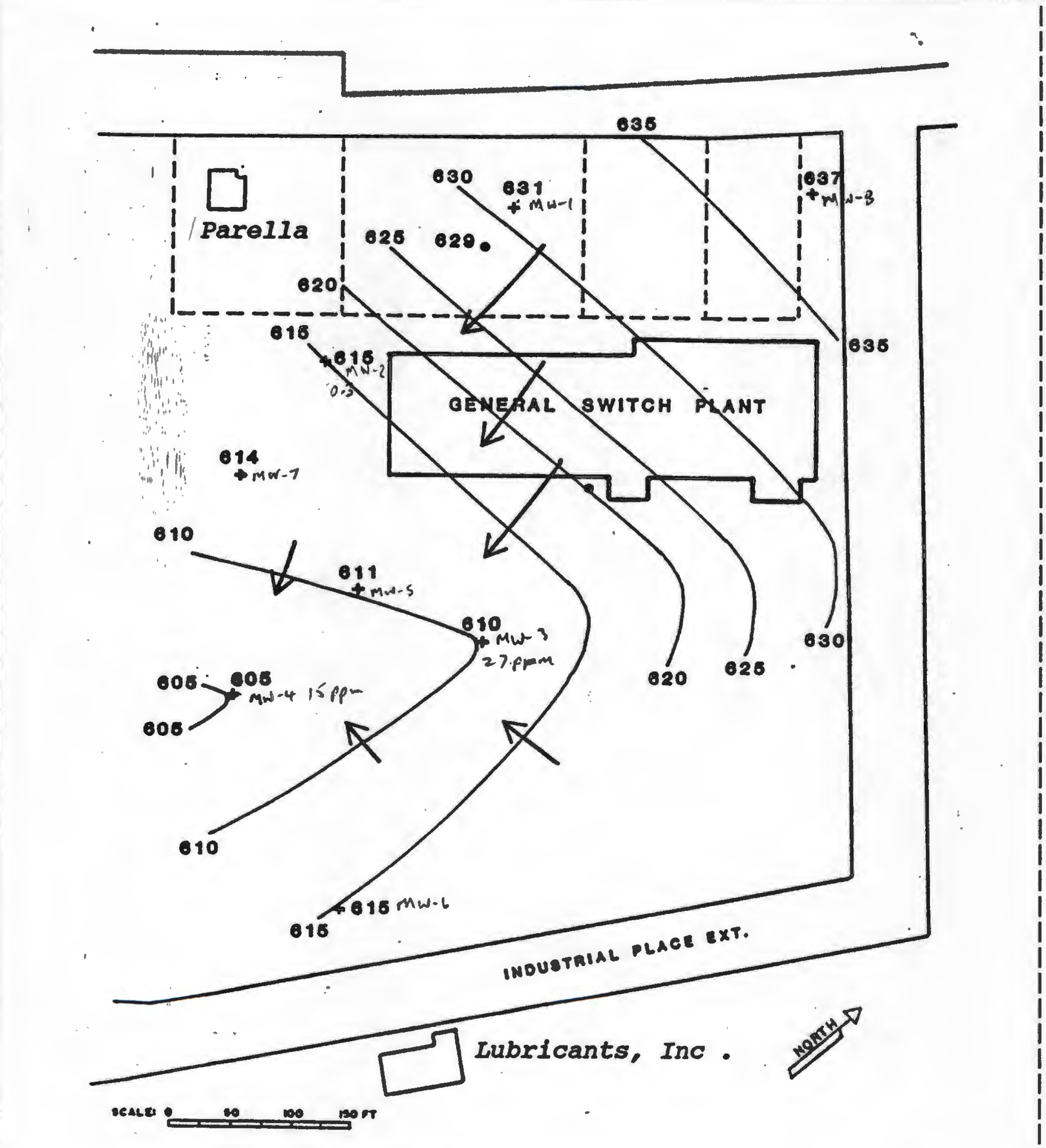
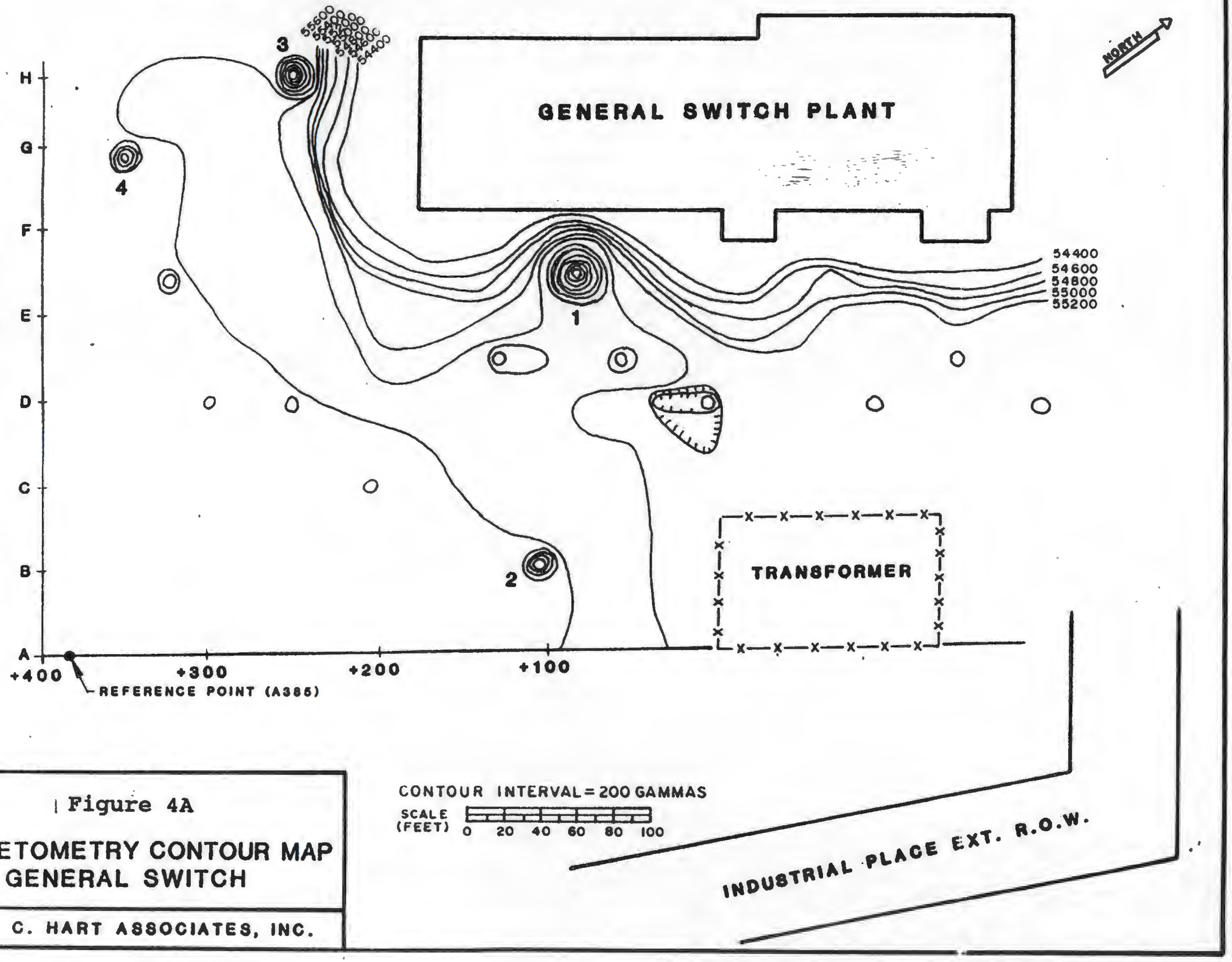


Figure 4. Contour Map of Water Levels - General Switch

Shakti Consultants, Inc.

Modified from Hydrogeologic Investigation
of General Switch Site,
Fred C. Hart Associates, Nov. 1984.

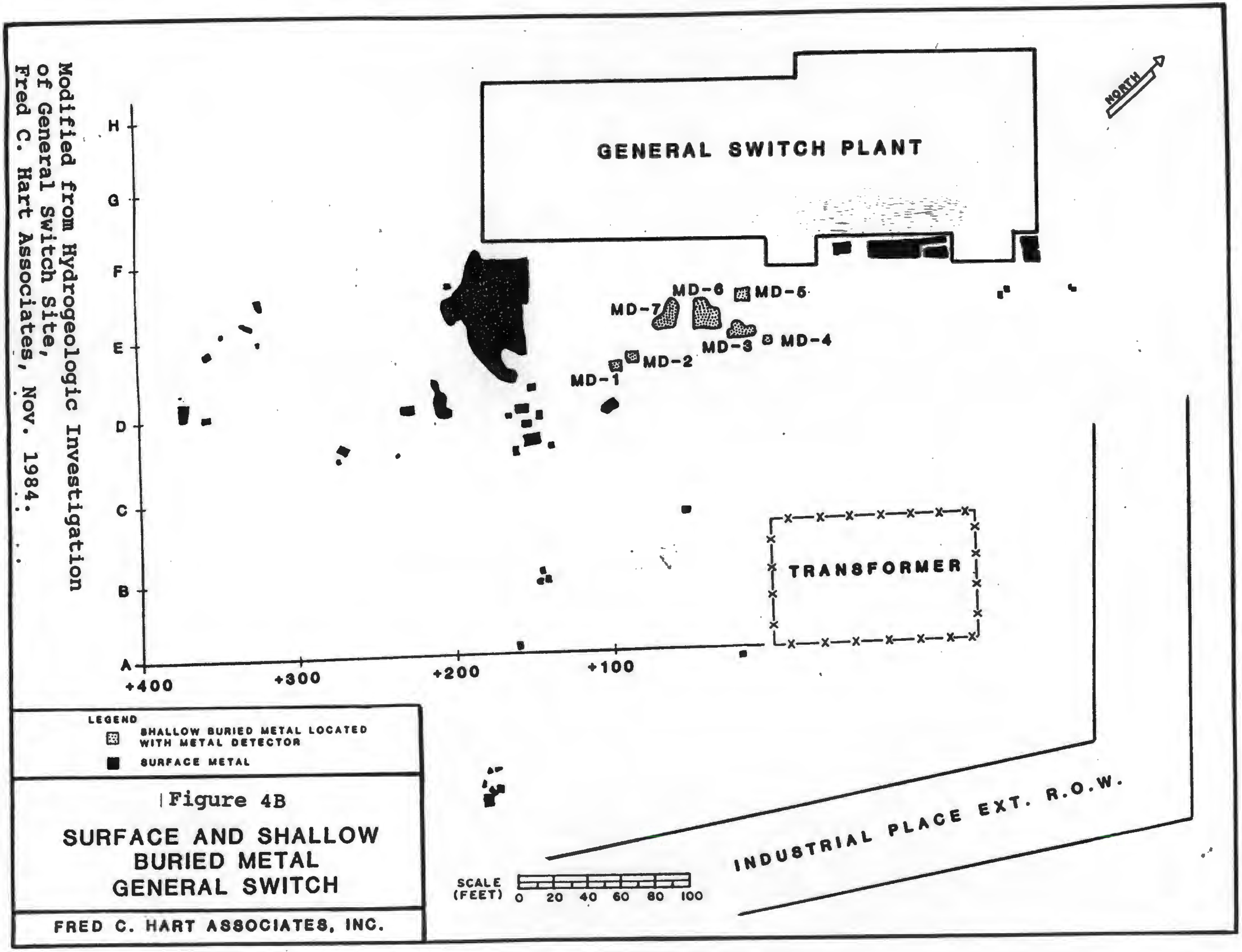


Modified from Hydrogeologic Investigation of General Switch Site, Fred C. Hart Associates, Nov. 1984.

Figure 4A

MAGNETOMETRY CONTOUR MAP
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.



Modified from Hydrogeologic Investigation of General Switch Site, Fred C. Hart Associates, Nov. 1984.

Figure 4B

SURFACE AND SHALLOW BURIED METAL GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

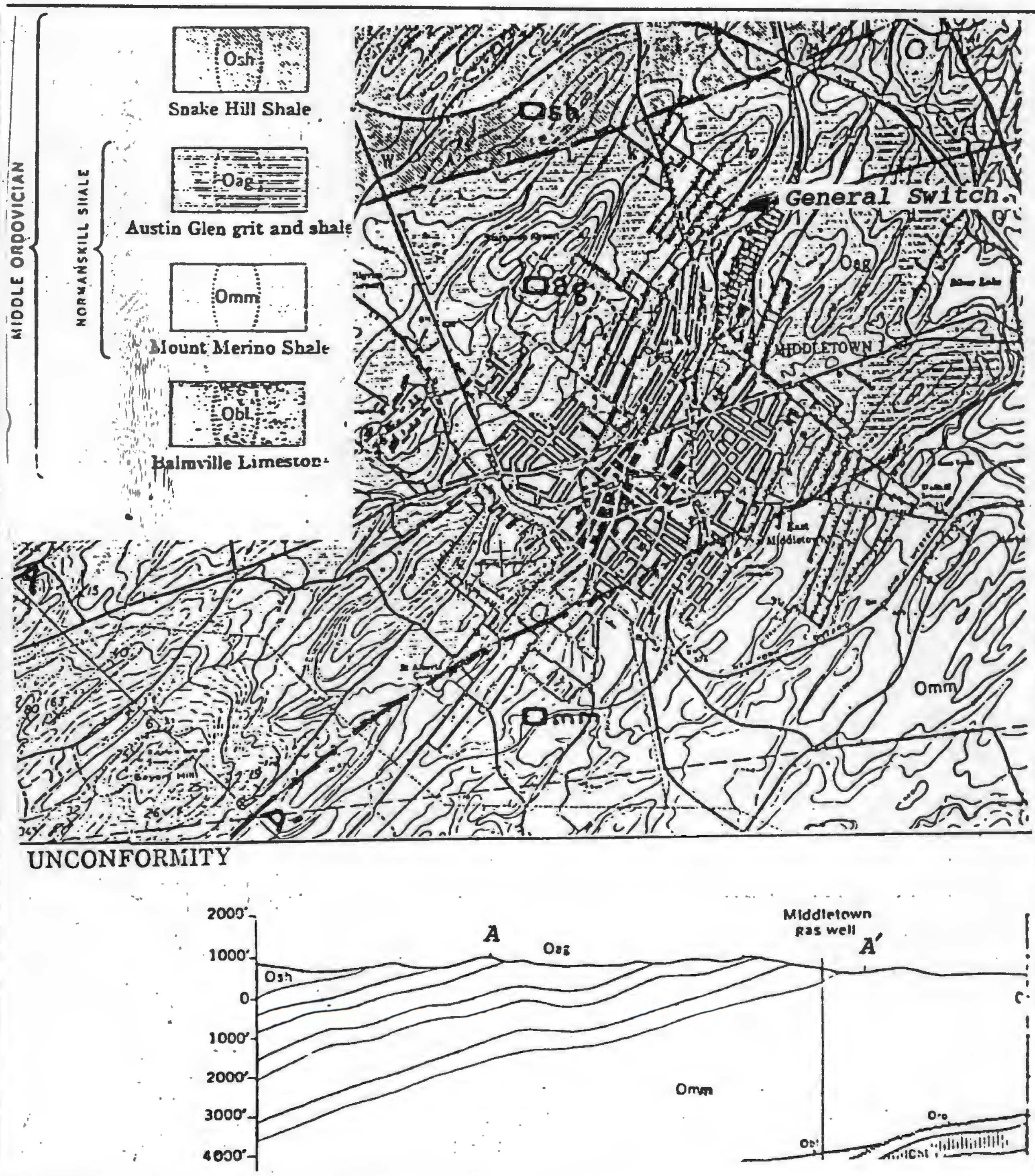


Figure 5. Geologic Map and Cross Section

Shakti Consultants, Inc.

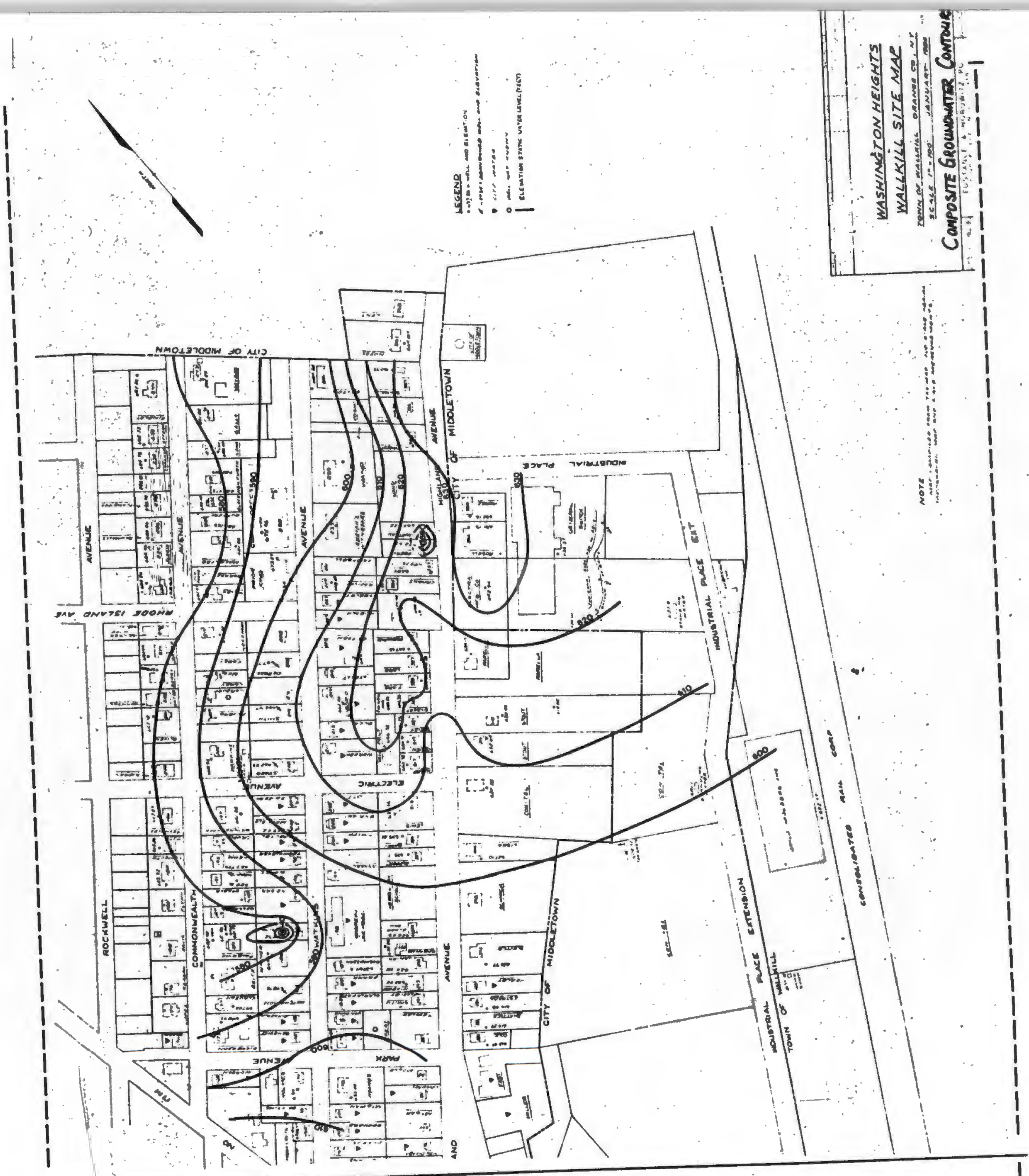


Figure 6. Composite Groundwater Contours - Washington Heights

Shakti Consultants, Inc.

Figure 1. Levels of Tetrachloroethylene (ppb) in the Parella Well during Pumping. Oct. 17-Dec. 26, 1983

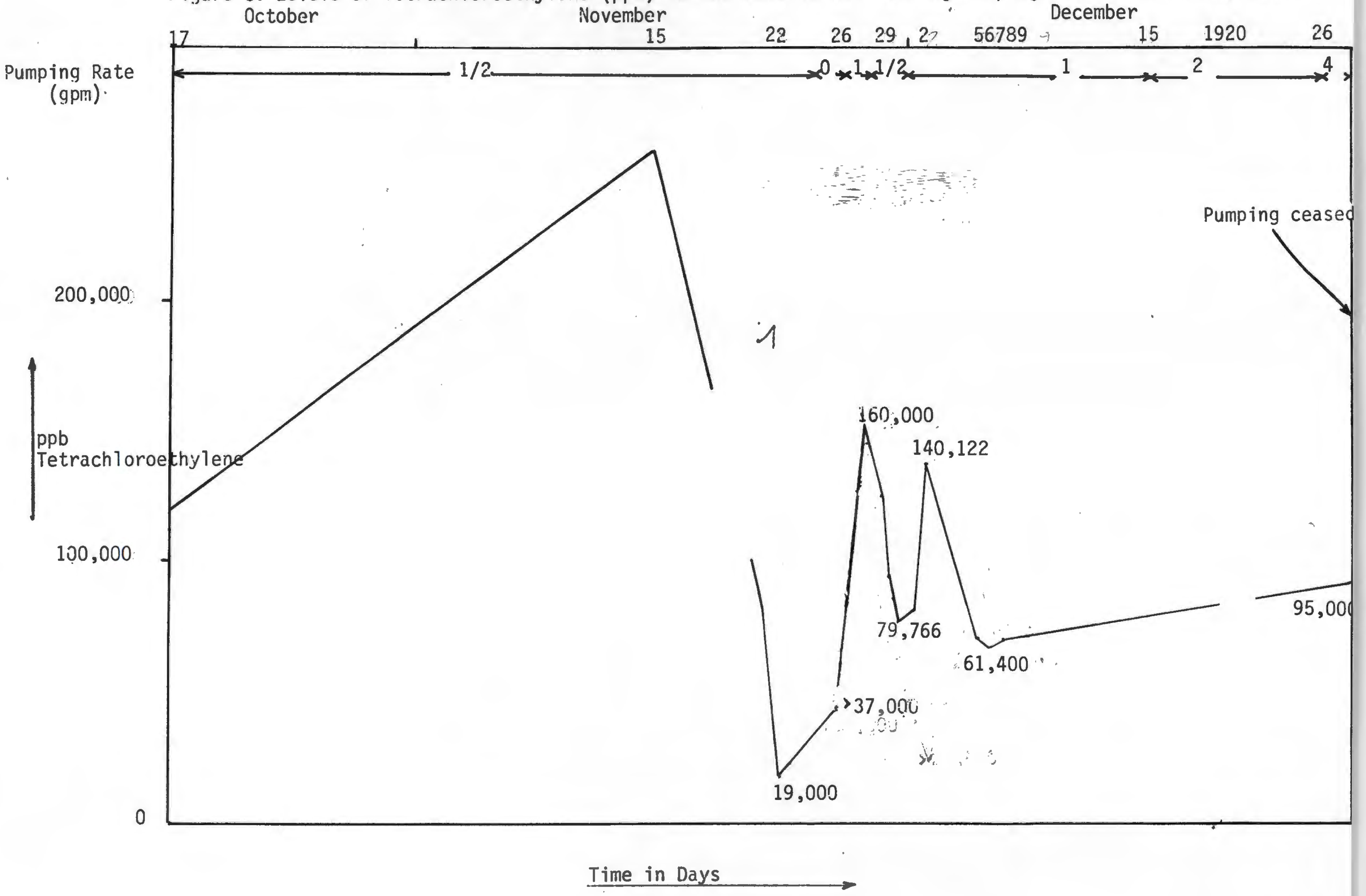


Figure 2. Plot of Data from Pump Test 1. Parella Well

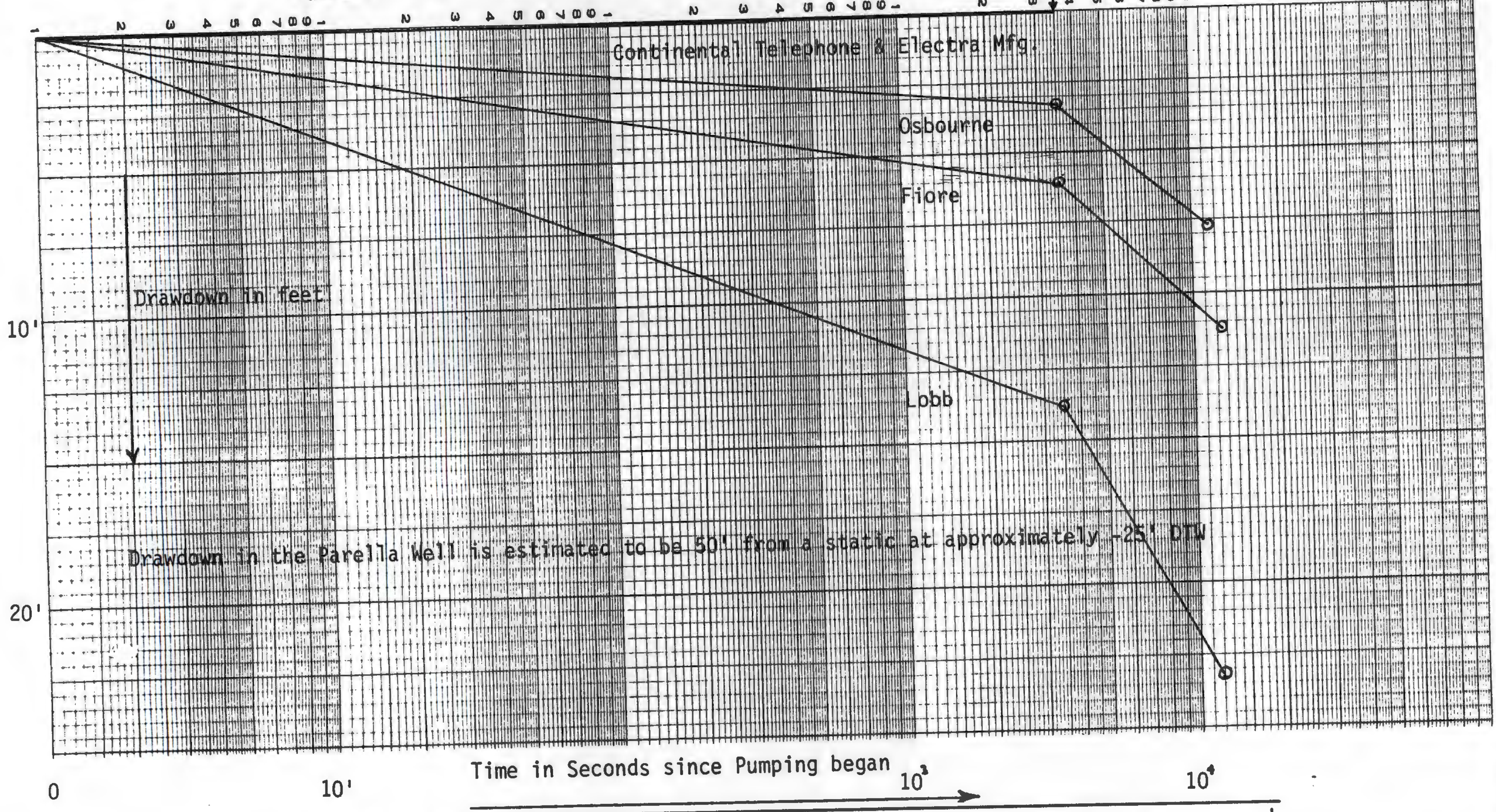


Figure 8. Plot of Data from the Pump Test 1. Parella Well

Shakti Consultants, Inc.

Table 1: Parella Pump Test #1

Time Of Reading Flow Rate		1455-1500 hr. Static	1610-1630 hr. 4 gpm	1656-1730 hr. 4 gpm	End Of Test
Residences/Well	Distance In Feet From Parella Well	Water Levels Measured In Ft. From Top Of Casing			Total Draw-Down
Parella Well		26.94'	30.33'	34.55'	50'* 7.61' = 34.55-26.94
Osbourne	185'	25.81'	39.68'	49.00'	23.19' = 49.00-25.81
Lobb	144'	22.28'	28.37'	33.45'	11.17' = 33.45-22.28
Fiore	150'	10.38'	10.36'	10.40'	.02 = 10.40-10.38
Electra Mfg.	194'	21.35'	21.37'	21.53'	.18 = 21.53-21.35
Continental Telephone	350'				

2/2/84

Table 2: General Switch Pump Test #1

Time Of Reading Flow Rate		Static $t_o = 12:13$ 2 gpm	13:53 - 14:21 2 gpm	16:26 - 16:40 2 gpm	End Of Test
Residences/Well	Distance In Feet from General Switch	Water Level In Feet From Top Of Casing			Total Draw-Down
General Switch	0	13.79'	>300'	>300'	>286'
Parella	370'	23.58'	23.92'	26.16'	-2.58
Osbourne	490'	32.61'	32.94'	34.56'	-1.95
Electra Mfg.	210'	13.70'	13.61'	13.59'	+ .11**
Perry	370'	65.72'	62.04'	59.13'	+6.59
Continental Telephone	670'	23.13'	23.1'	23.13'	0
Ward	650'	79.97'	79.15'	78.83'	+1.14
Pitt	580'	33.98'	33.98'	34.05'	-.07
Perez	260'	15.82'	15.80'	16.02'	-.2
Guild Molders	1040'	7.96'	7.94'	7.94'	+.02

*Estimated at the elevation of the pump when the Parella well lost suction.

**Positive values indicate a well that is recovering.

Table 3: Ruppert Pump Test #1

Time Of Reading		Static E0=11:15 11:05-11:15	12:00-12:35	13:46-14:18	End Of Test
Flow Rate			11 gpm-6gpm	2 gpm	
Residences/Well	Distance In Feet From Ruppert Well		Water Level In Feet From Top Of Casing		Total Draw-Down
Ruppert	0	Approx 33'	180'	180'	-147'
Barry	50'	32.78'	37.95'	42.05'	~~-42.05'~~ 9.27
Continental Telephone	290'	23.07'	23.55'	23.70'	-.63'
Knapp	250'	43.40'	42.32'	42.62'	+.78'
Van Pelt	310'	30.27'	29.2'	28.87'	+1.4'
Stout	400'	18.00'	18.00'	18.26'	-.26'
Robaina	270'	37.26'	37.55'	37.76'	-.5'
Estrada	480'	24.21'	24.21'	24.33'	-.12'
Morse	420'	111.13'	109.17'	107.94'	+3.19'
Rassmussen	360'	44.47'	44.50'	44.74'	-0.27'
Winner	480'	73.98'	70.16'	67.85'	+6.13'
Palermo	600'	81.53'	79.44'	77.94'	+3.59'

*Water levels at pump intake by assumption when pump broke suction: Well annulus blocked preventing direct water level measurement.

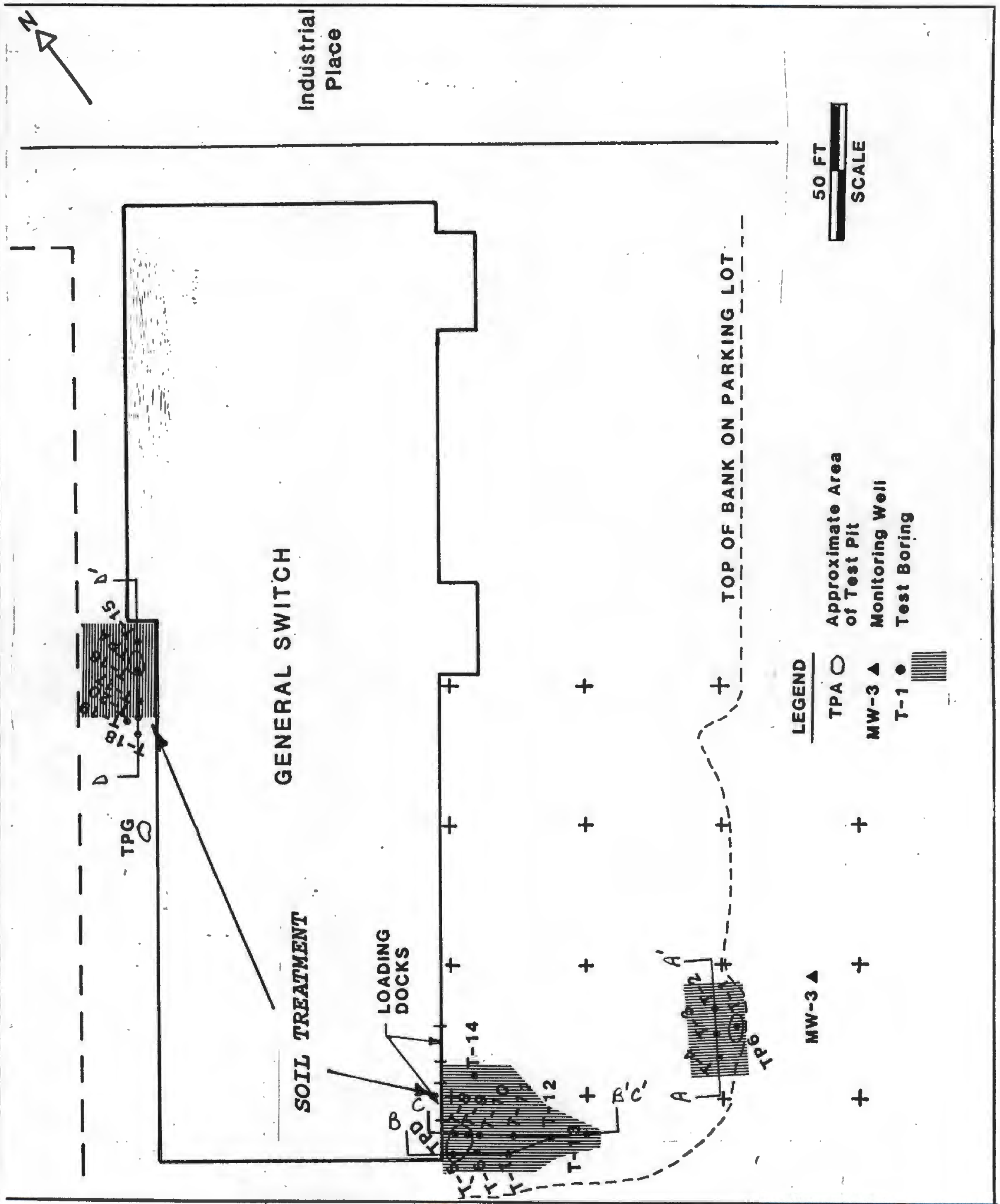
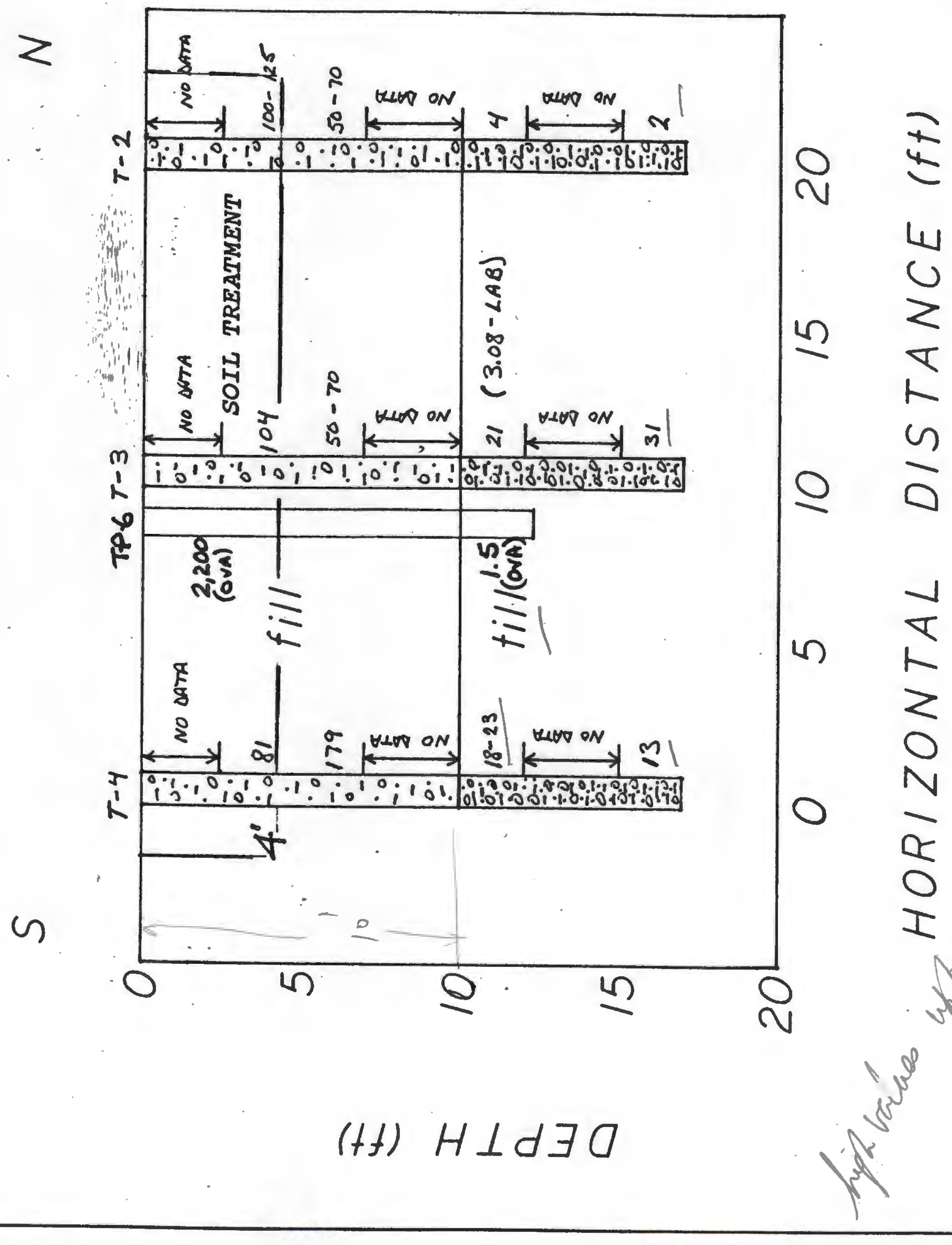
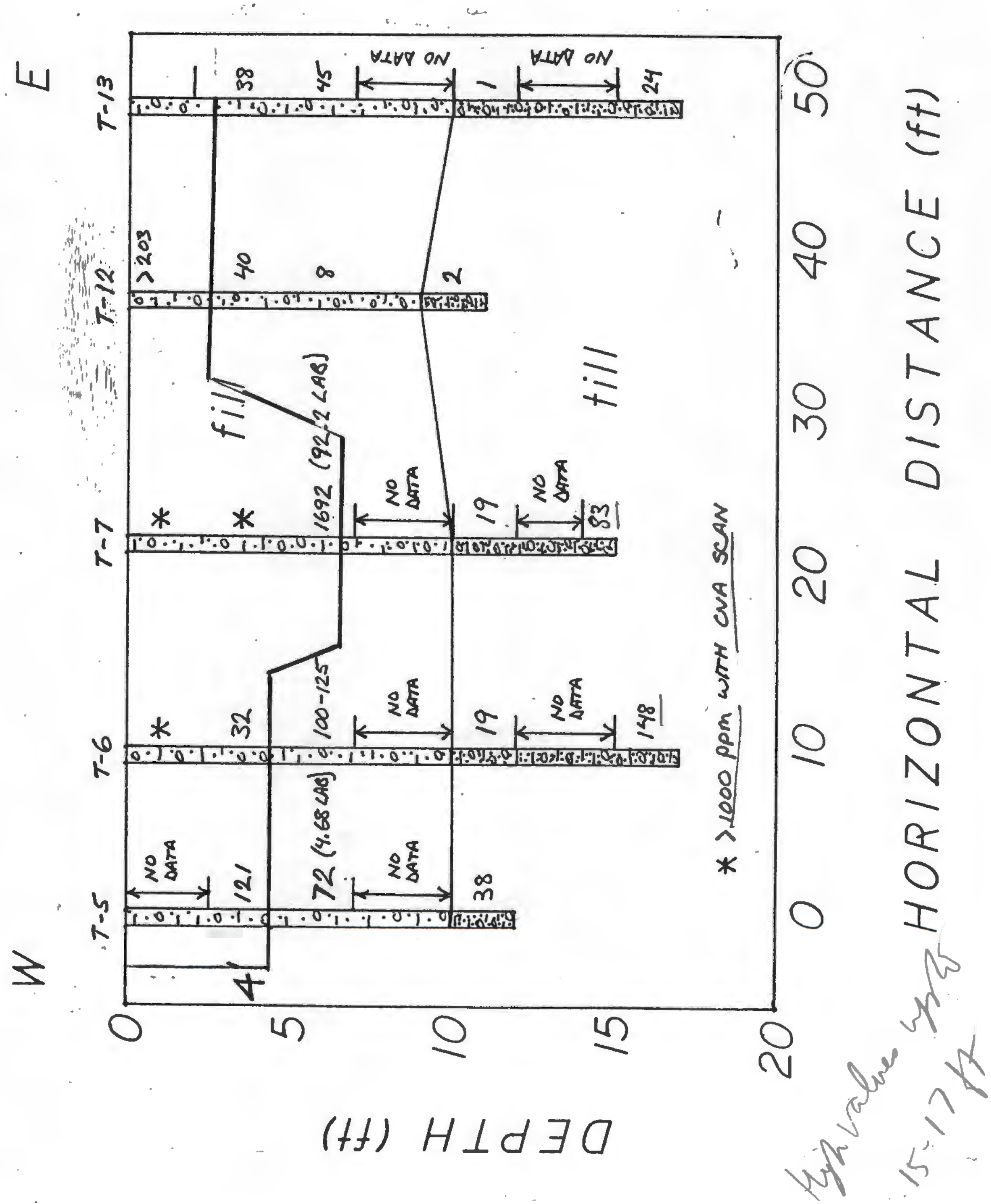


Figure 9. Location of Test Borings and Areas for Soil Treatment



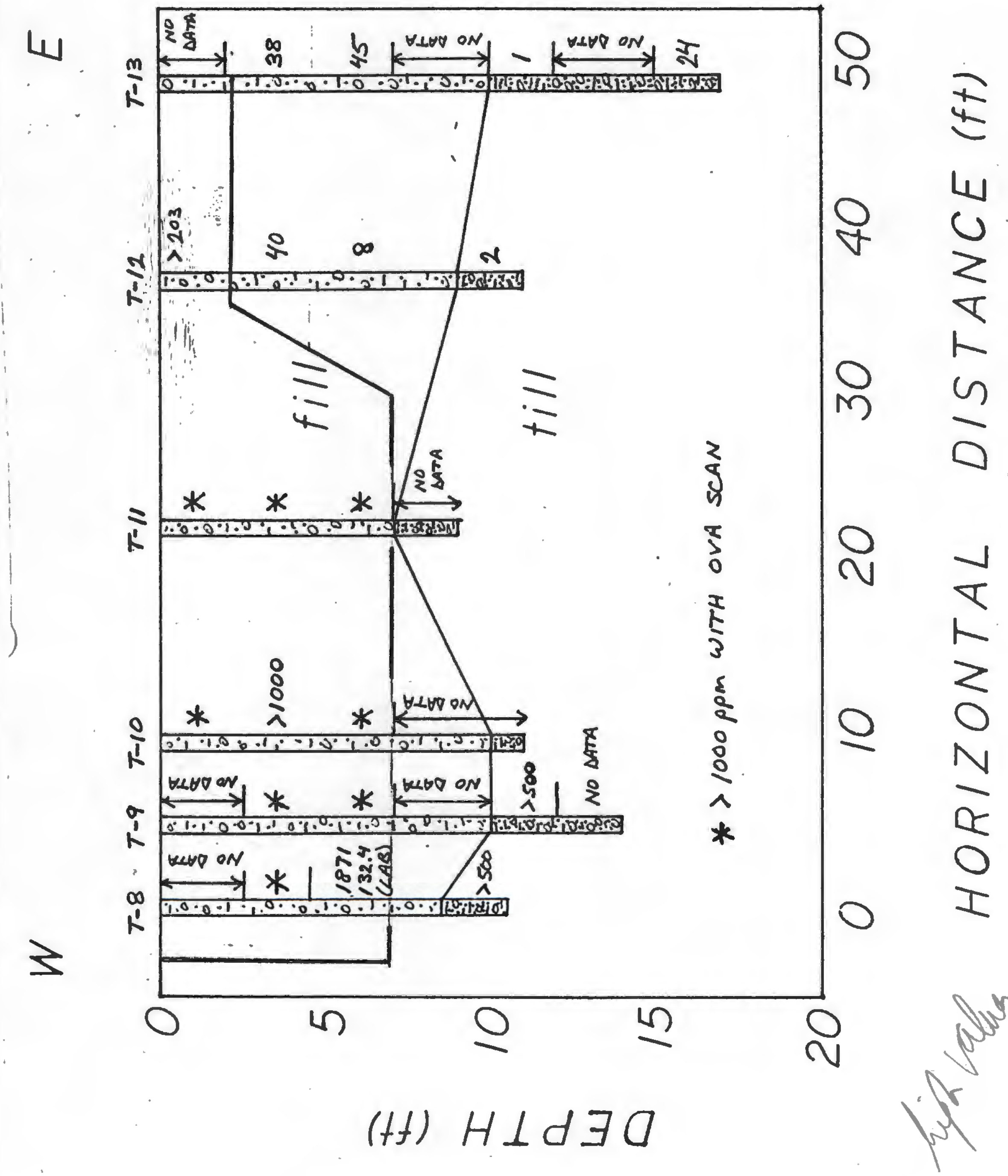
high values up to 15 ft

Figure 10. Cross-Section: Analytical Data & Depths for Soil Treatmen



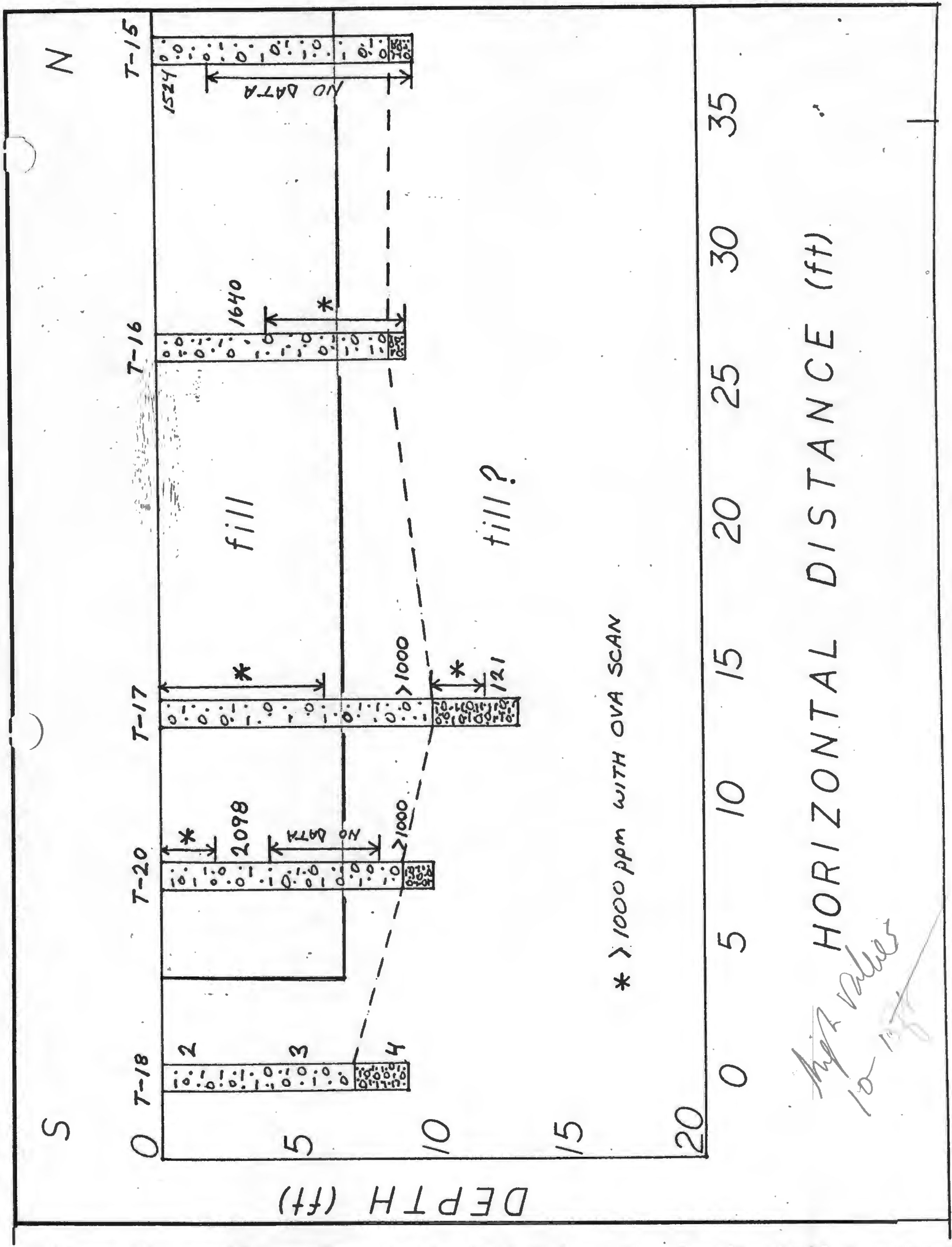
High values up to 15-17 ft

Figure 11. Cross-Section: Analytical Data & Depths for Soil Treatmen



high values upto 15-20 ft

Figure 12. Cross-Section: Analytical Data & Depths for Soil Treatment



high values 10-15'

Figure 13. Cross-Section: Analytical Data & Depths for Soil Treatment

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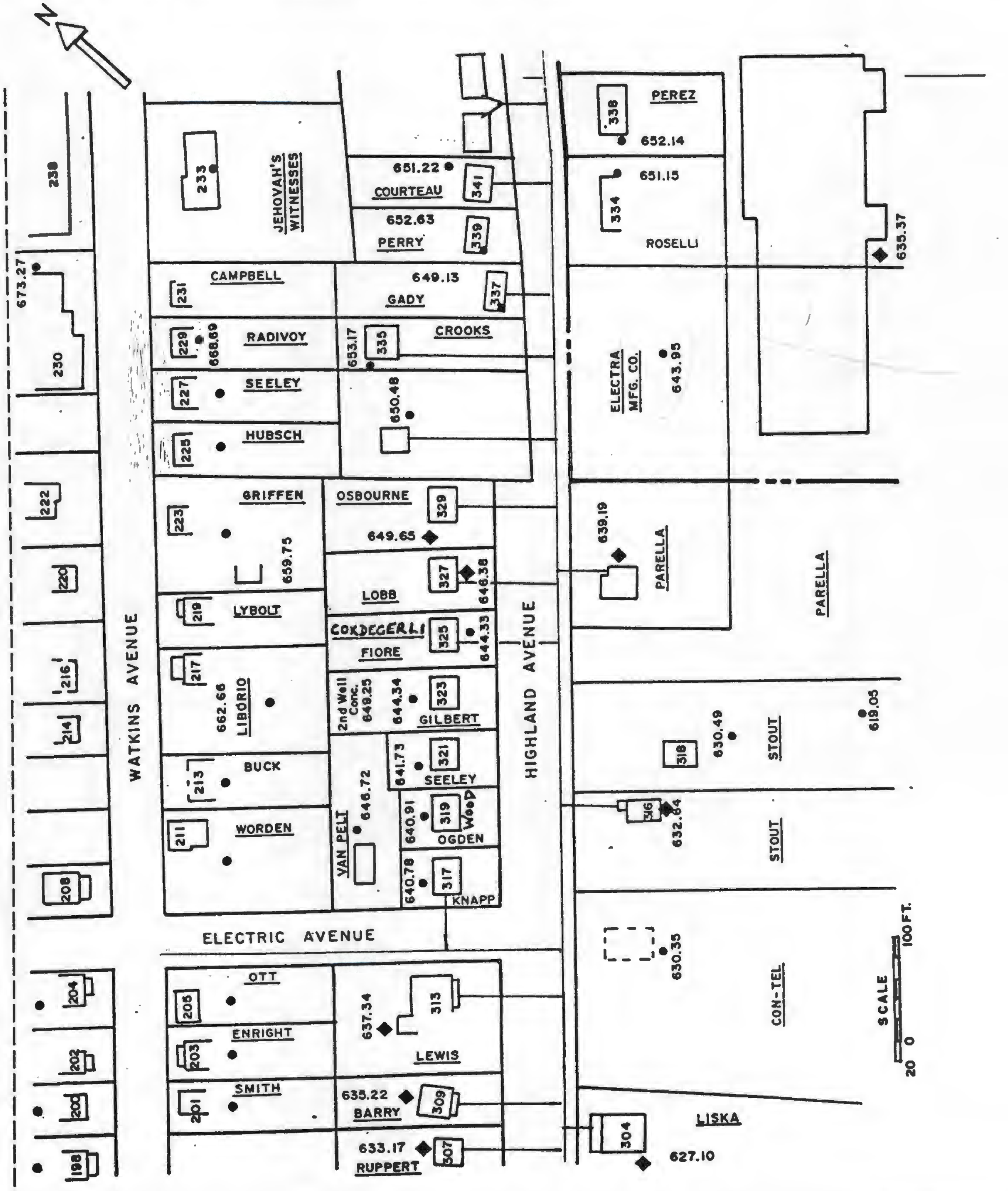

Figure 14. Location of Contaminated Wells & Water Supply Lines

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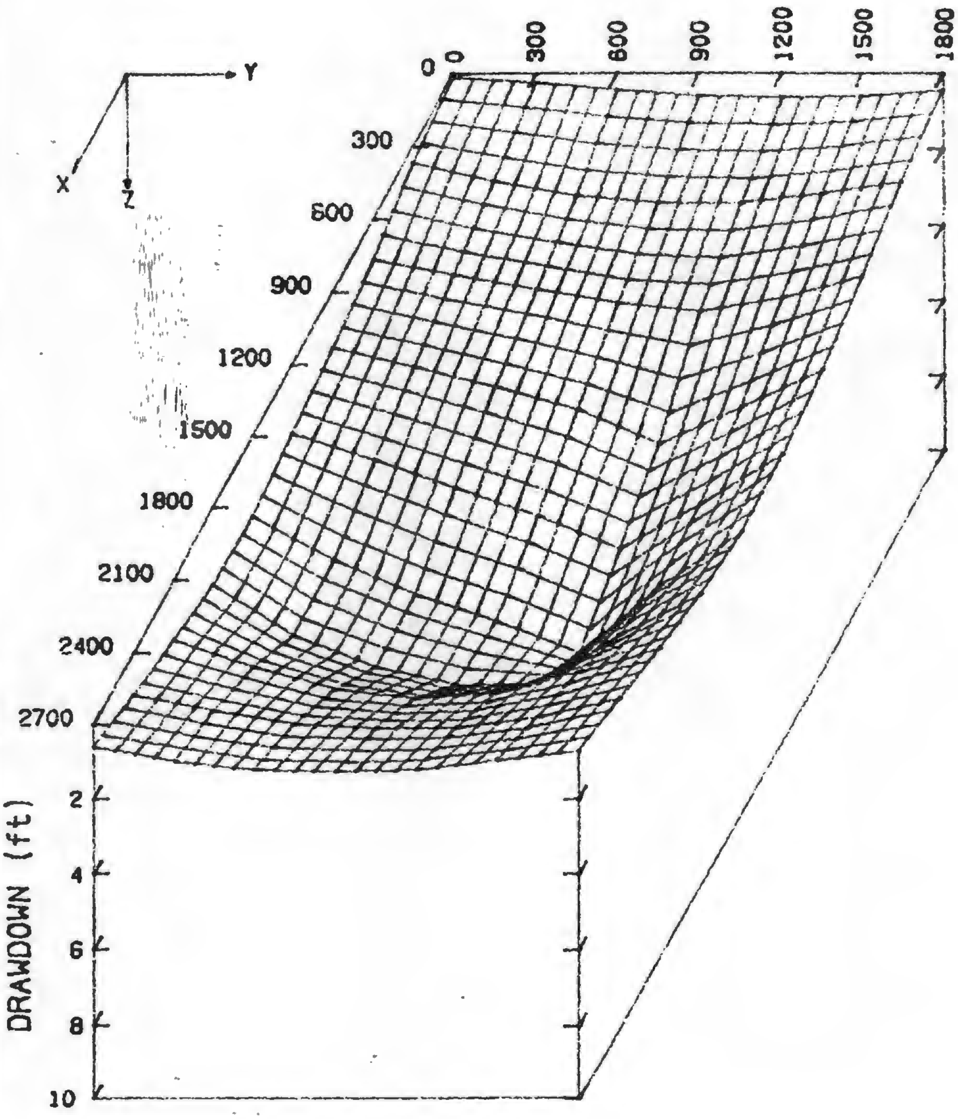
LEGEND

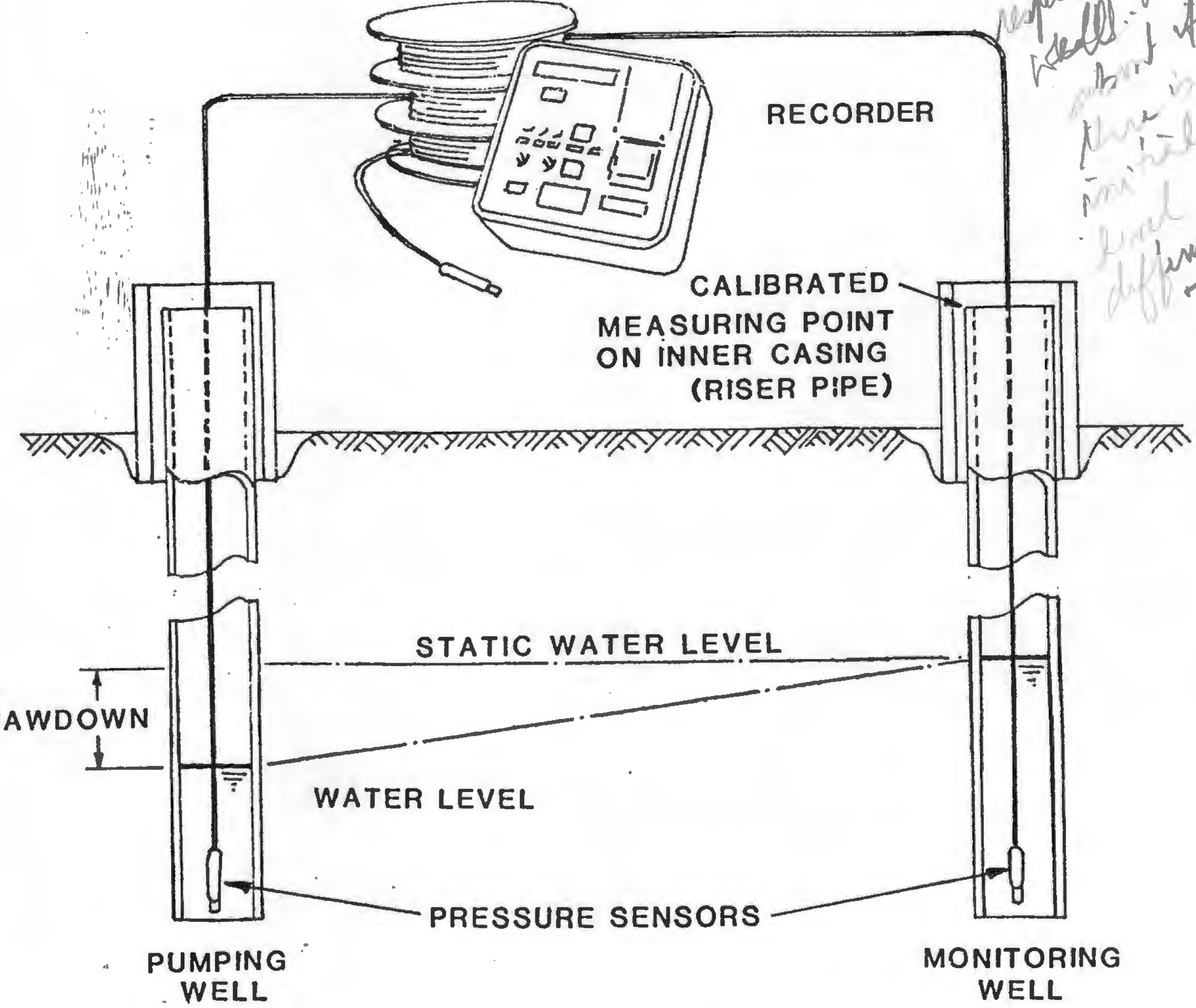
◆ WELLS CONTAINING GREATER THAN 50 PPB PCE
● UNCOMTAMINATED WELLS



GROUNDWATER LEVEL AFTER 5 YEARS OF PUMPING

NOTE: SCALE OF X AND Y AXES DIFFERS
FROM THAT OF Z AXIS

Figure 15. Zone of Influence of a Pumping Well



Question
Drawdown measured with respect to parella wells. what about if there is initial level differen

PRESSURE TRANSDUCERS

Figure 16. Pressure Transducer System

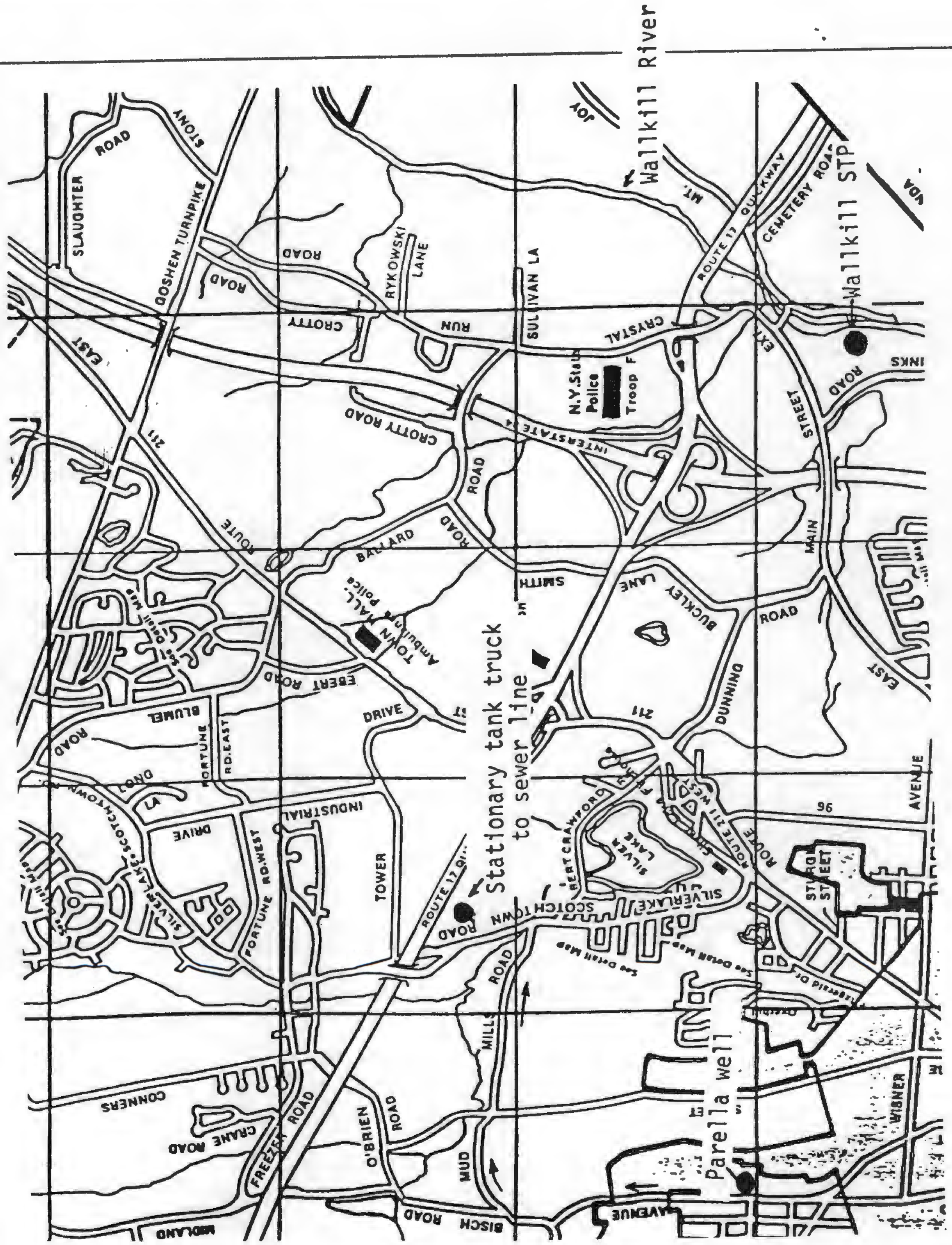
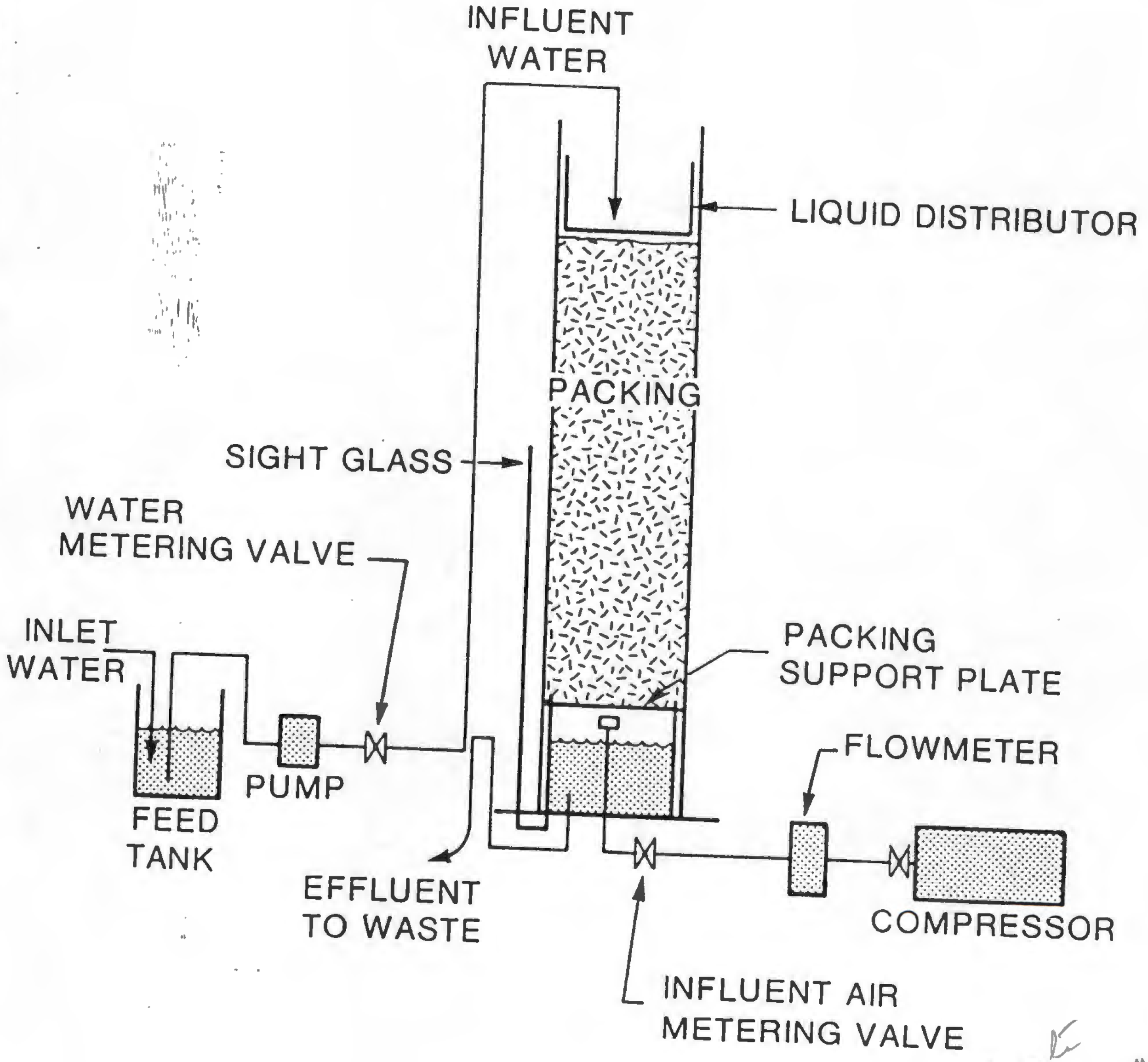


Figure 17. The Parella Well in Relation to the Wallkill STP

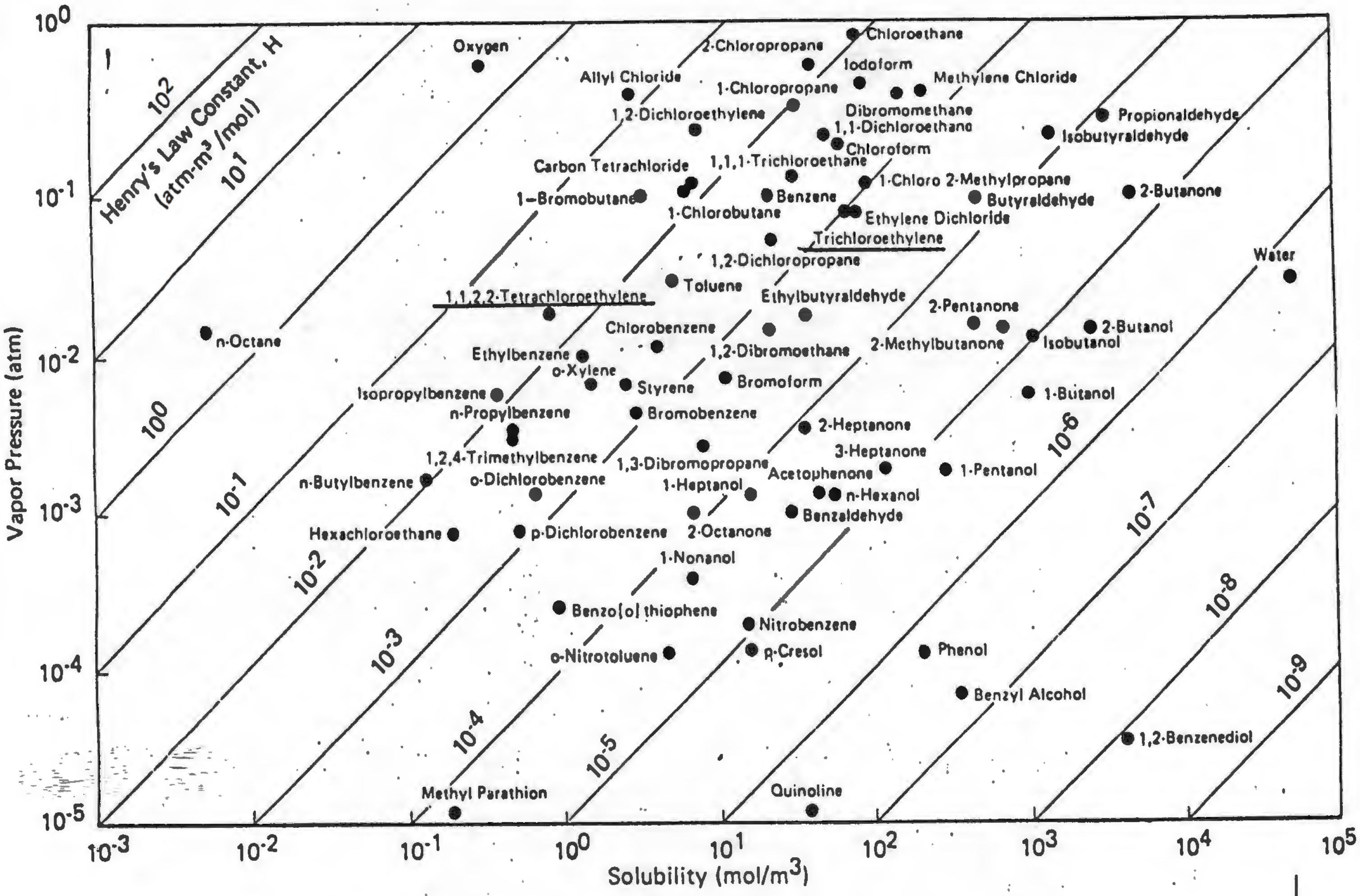


doesn't indicate collection of effluent air and treatment through AC

Figure 18. Packed Tower Air Stripper

Figure 19

Shakti Consultants, Inc.

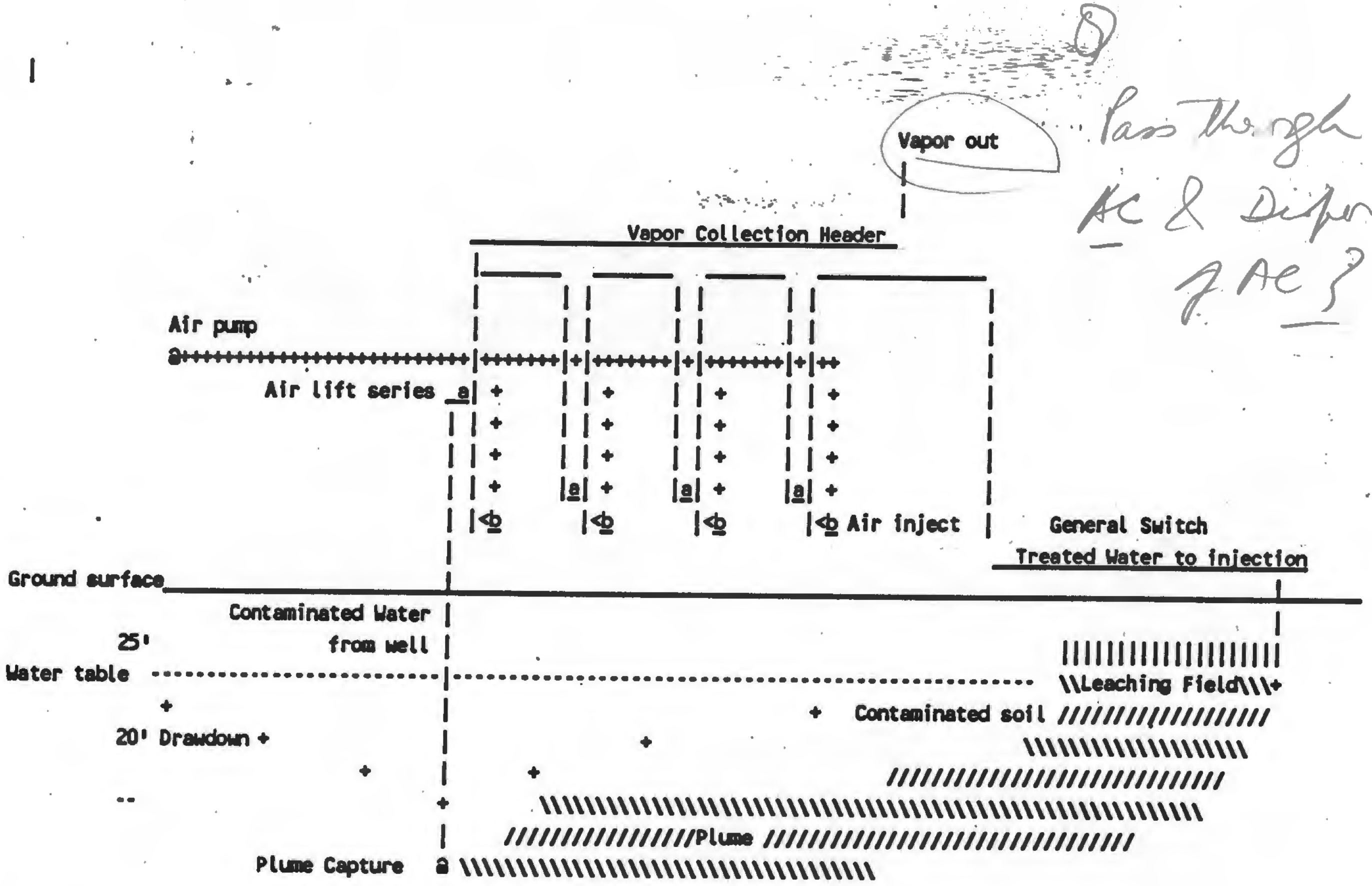


Source: Mackay and Yuen [15]. *(Reprinted with permission from the authors.)*

FIGURE 15–2 Solubility, Vapor Pressure and Henry's Law Constant for Selected Chemicals

Figure 20. Merry-Go-Round Air Stripper

Shakti Consultants, Inc.

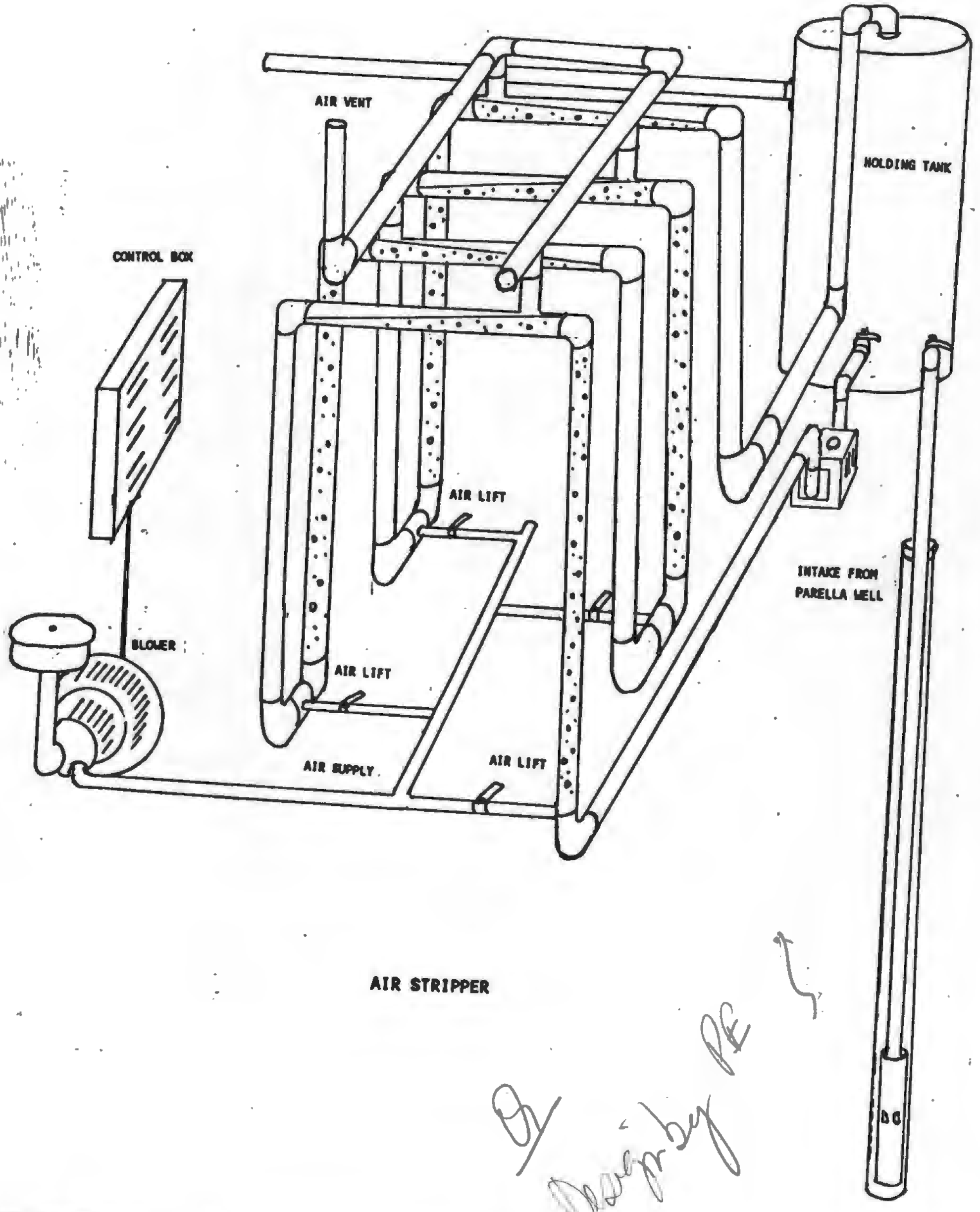


Pass through AC & Disposal of AC?

Pump 10'Submergence below Drawdown Cone for Turbine Pump

Yield is low?

Figure 20: Multistage Airlift System



OK Design by PE

Figure 21. Merry-Go-Round Air Stripper

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TYPICAL TRENCH LAYOUT

Figure 22. Trench Layout in Excavation

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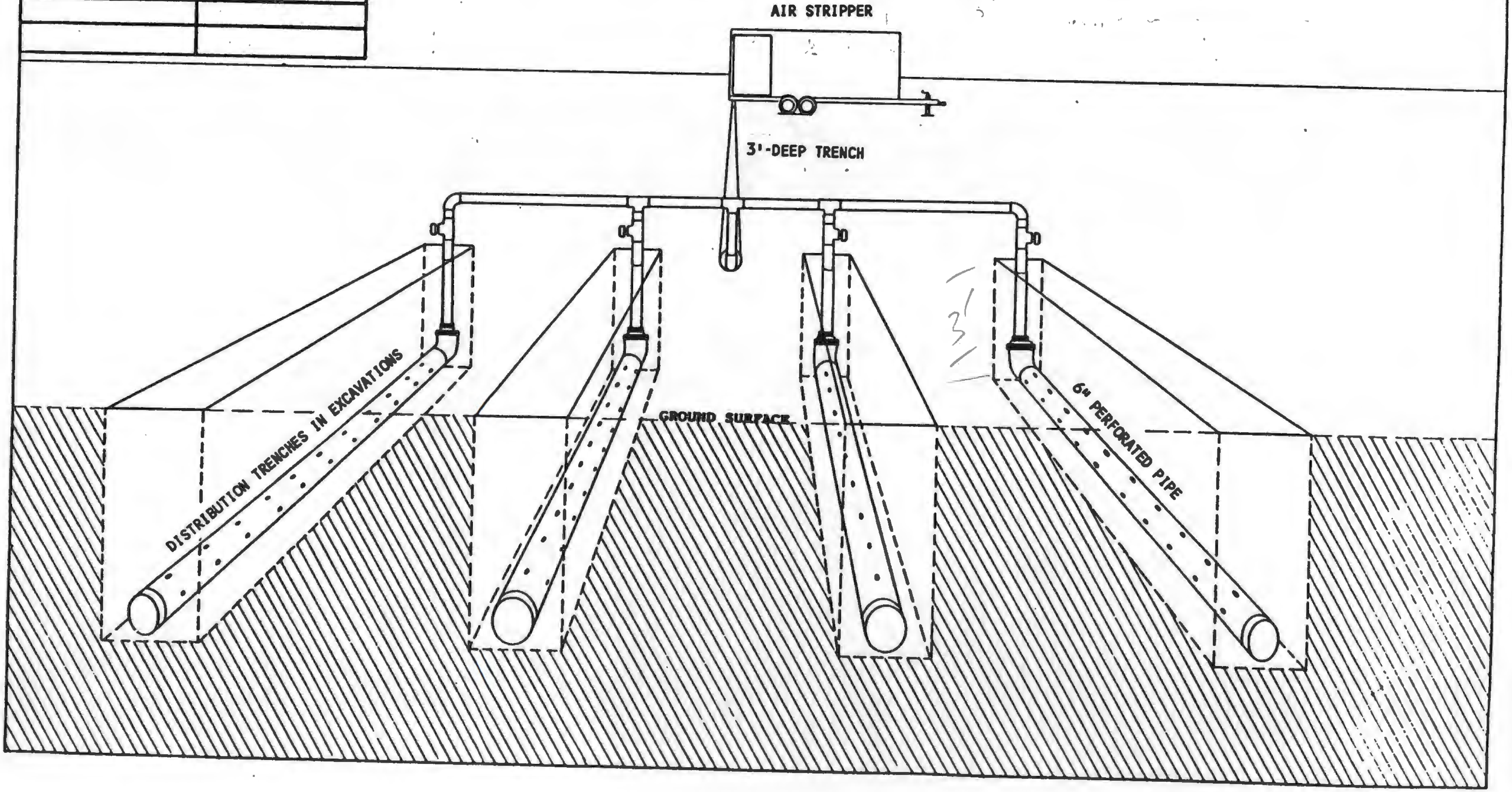

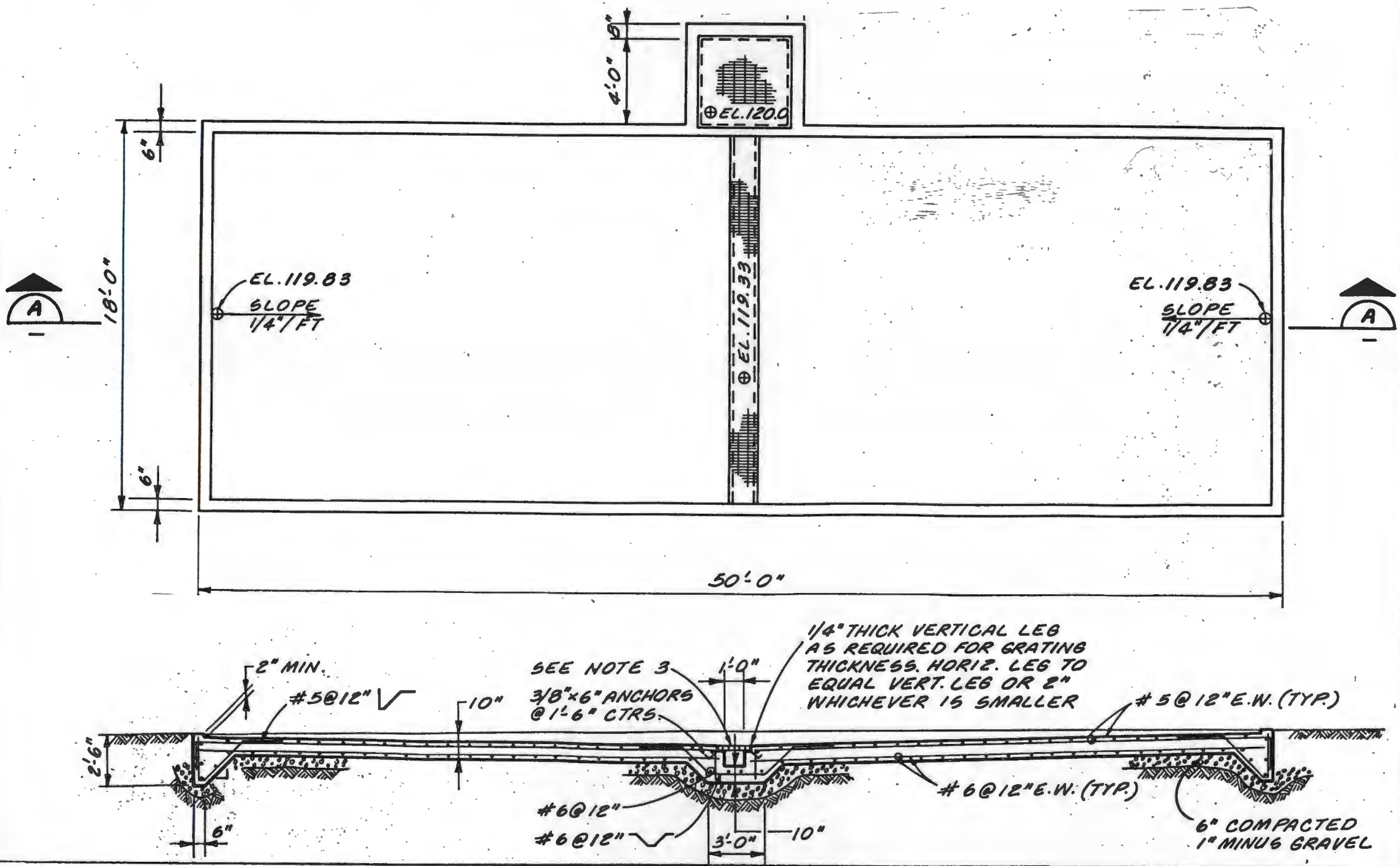

Figure 23. Soil Decontamination Pad

SECTION (A)
1/4" = 1'-0"

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Rotter tilling open to air for volatilization not acceptable.

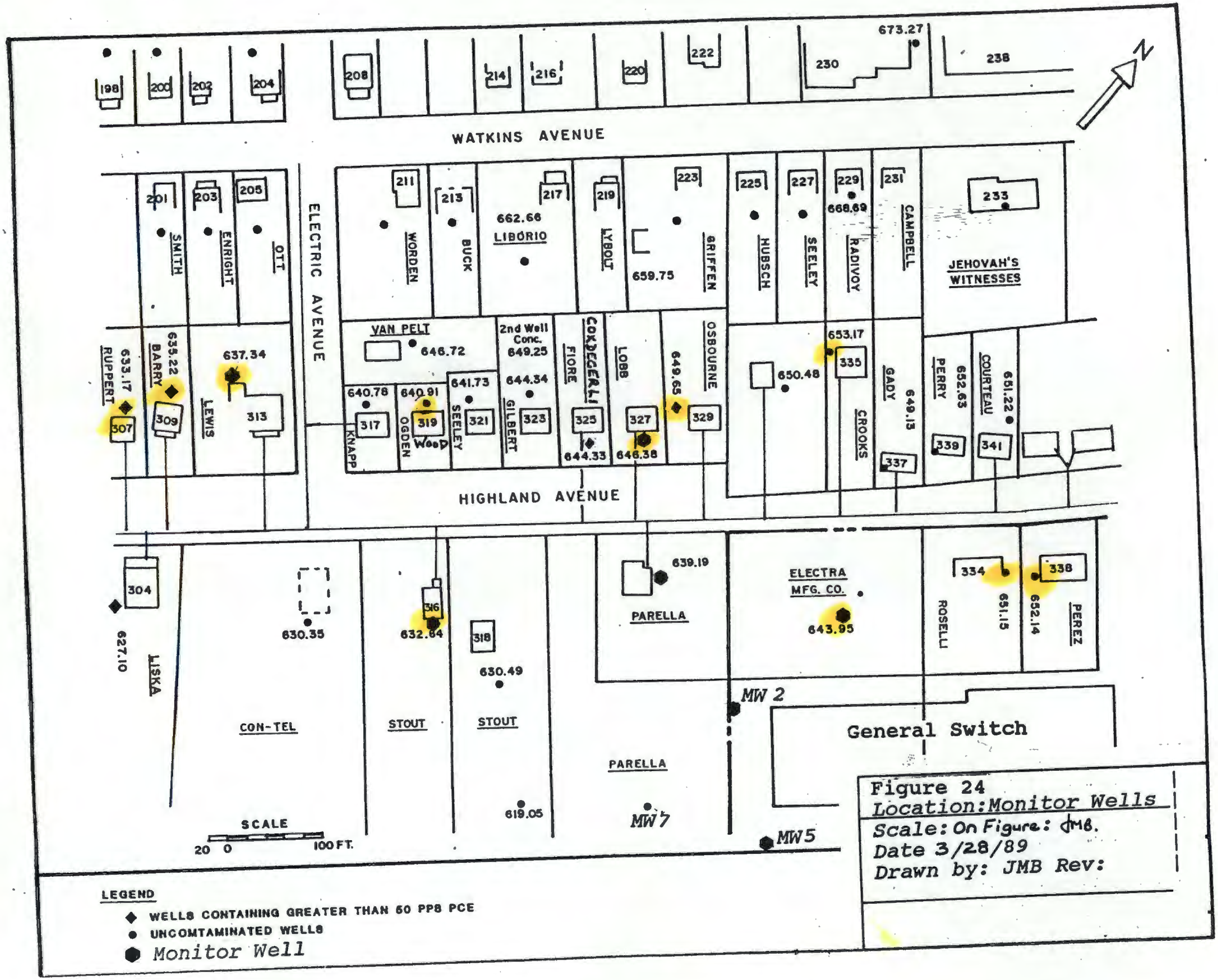


Figure 24
Location: Monitor Wells
Scale: On Figure: JMB.
Date 3/28/89
Drawn by: JMB Rev:

LEGEND
- ◆ WELLS CONTAINING GREATER THAN 50 PPB PCE
- • UNCOMTAMINATED WELLS
- ● Monitor Well

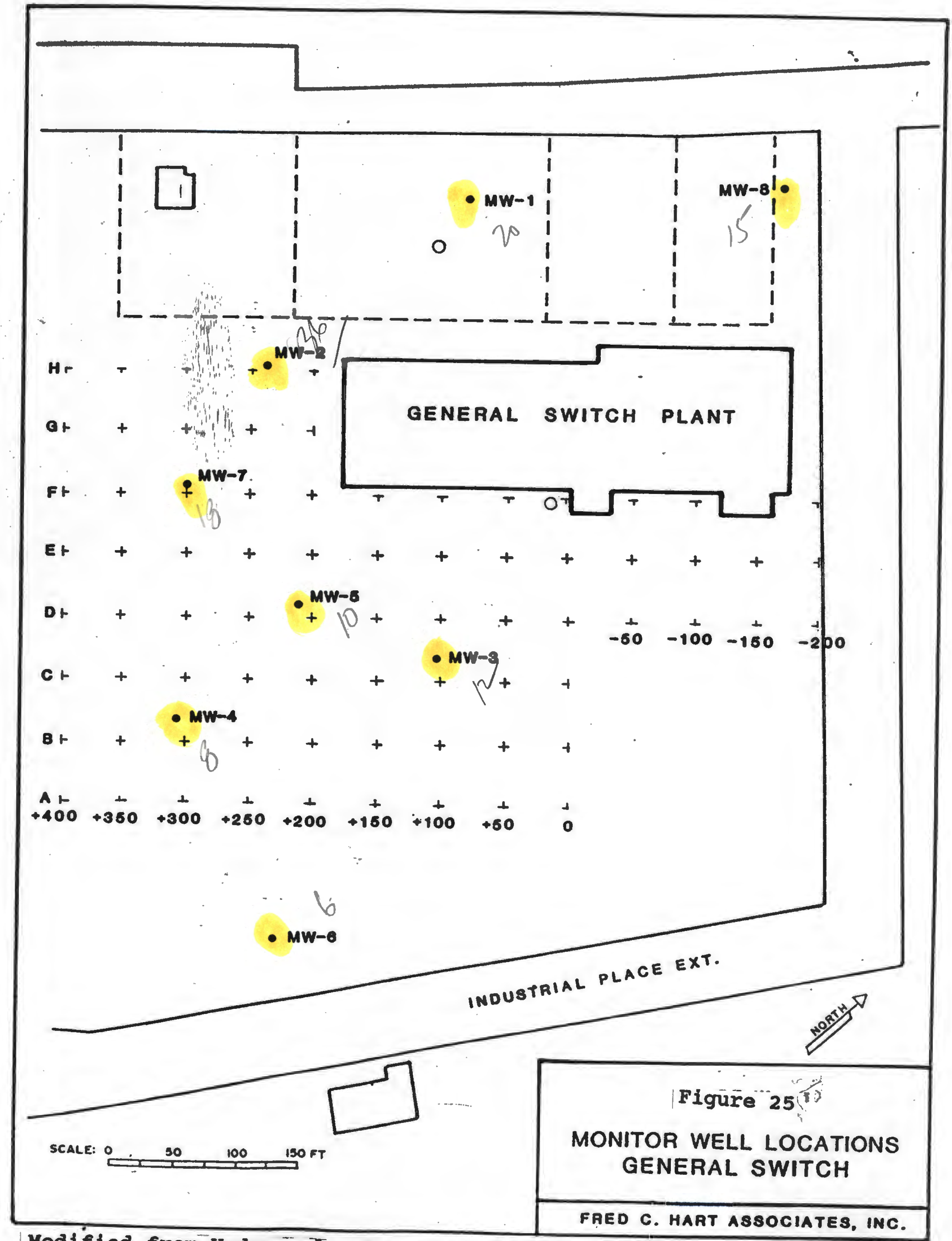


Figure 25

MONITOR WELL LOCATIONS
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

Modified from Hydrogeologic Investigation
of General Switch Site,
Fred C. Hart Associates, Nov. 1984.

Shakti Consultants, Inc.
Work Plan Appendix
Pump Test Plan
08/09/90

Well Logs, Fred.C Hart

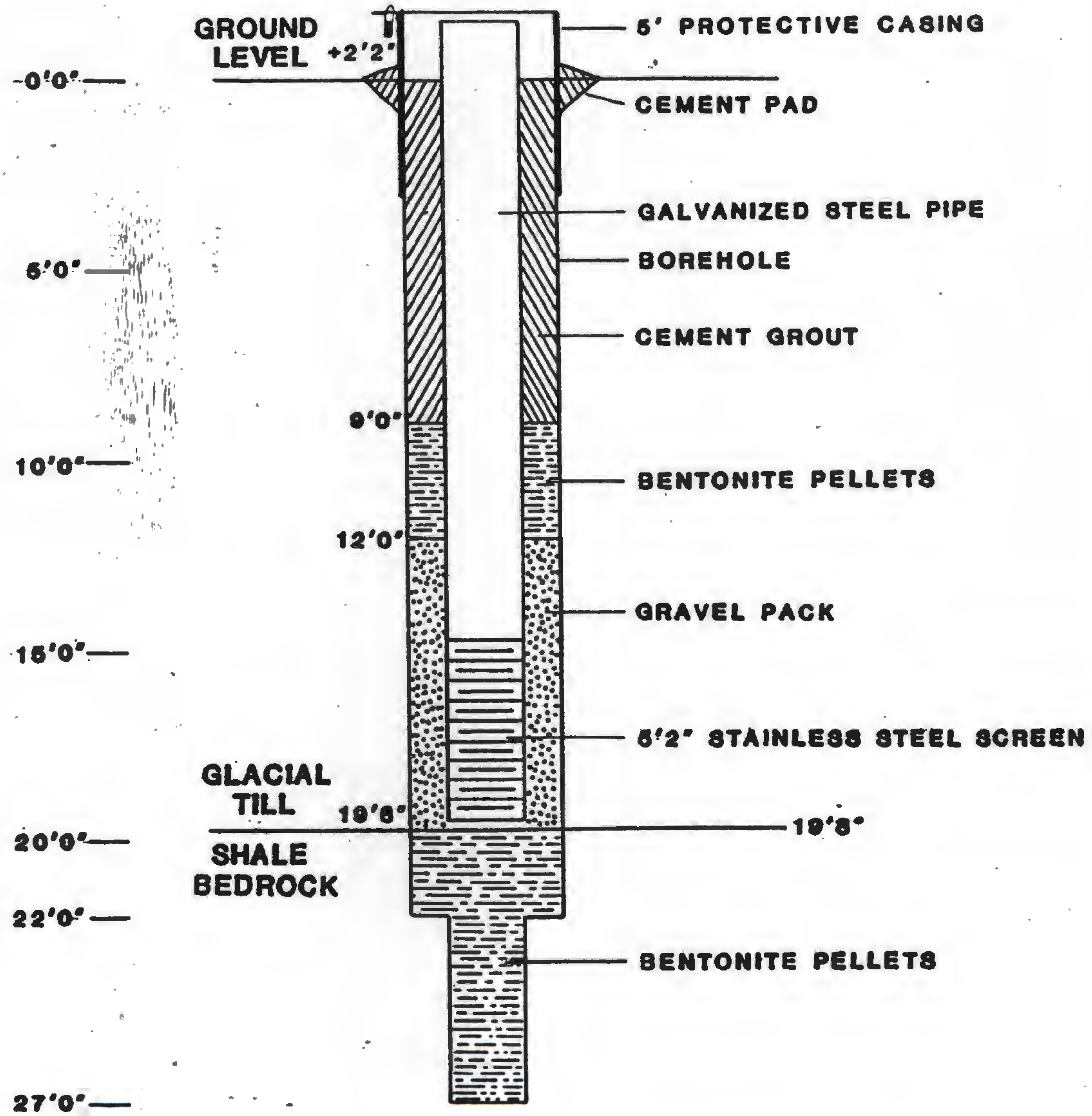


FIGURE III-11

WELL CONSTRUCTION
TEST BORING # 1
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

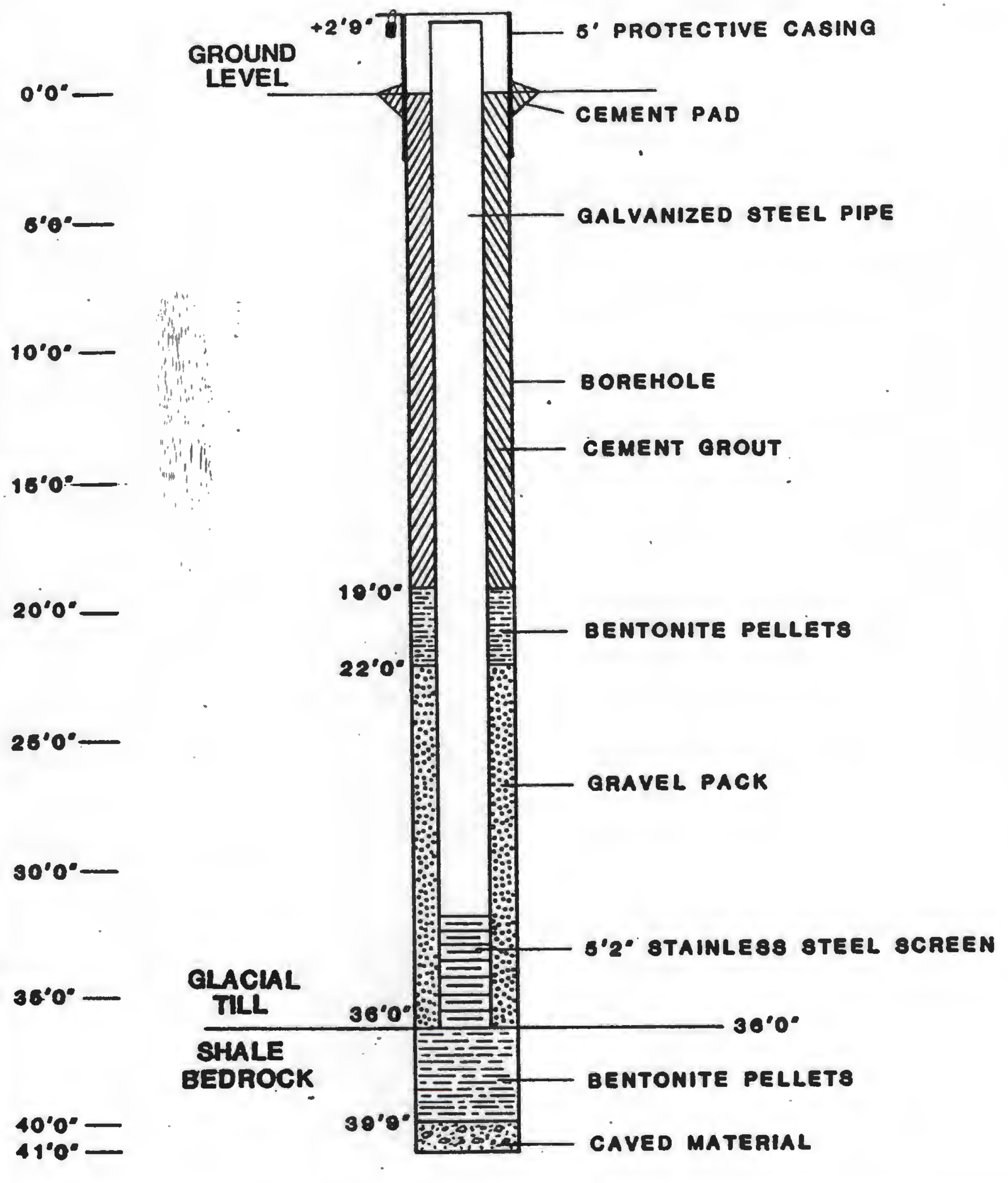


FIGURE III-12

WELL CONSTRUCTION
TEST BORING # 2
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

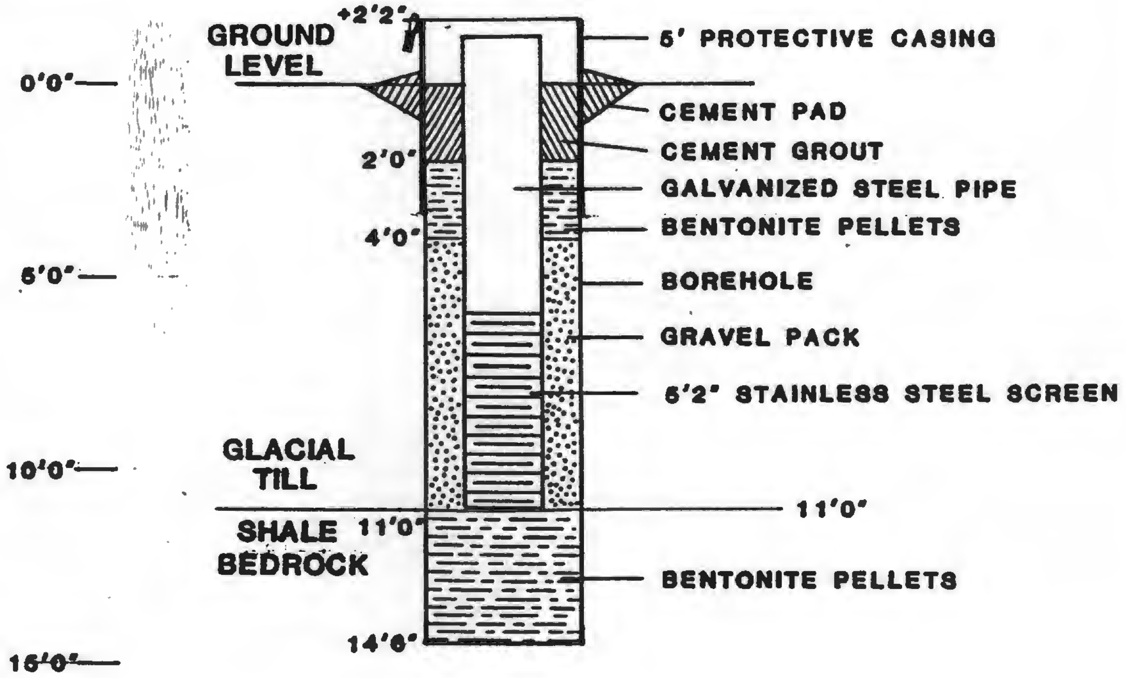


FIGURE III-13

WELL CONSTRUCTION
TEST BORING # 3
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

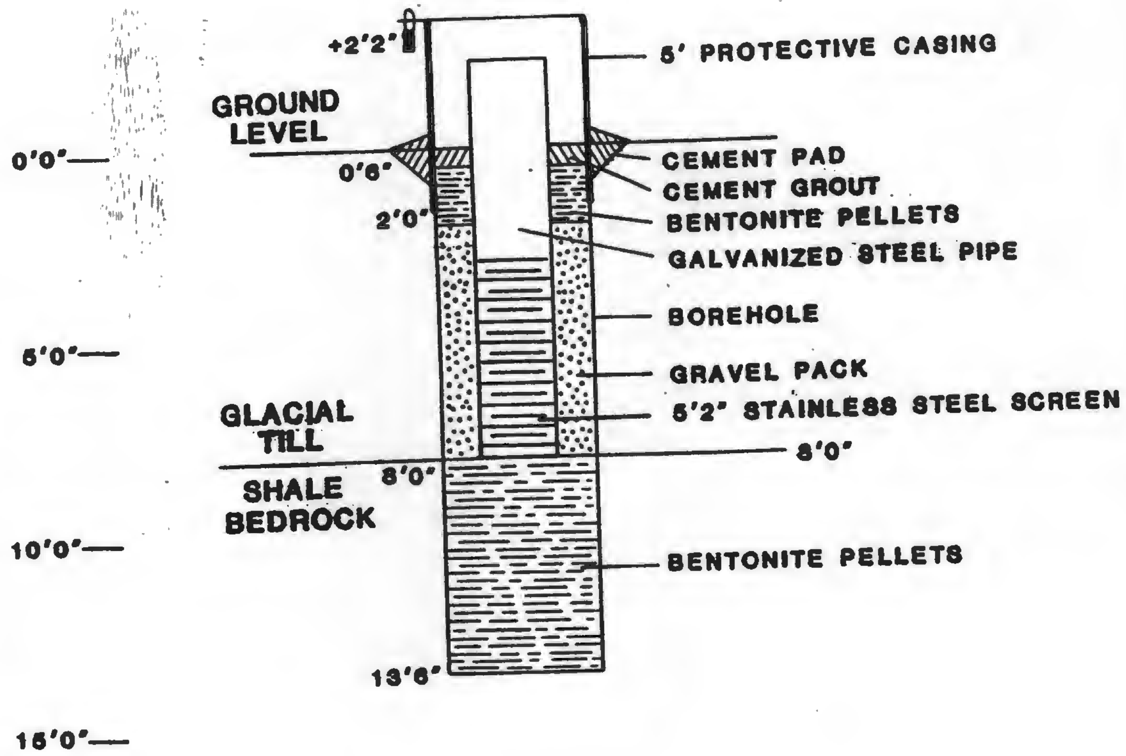


FIGURE III-14

WELL CONSTRUCTION
TEST BORING # 4
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

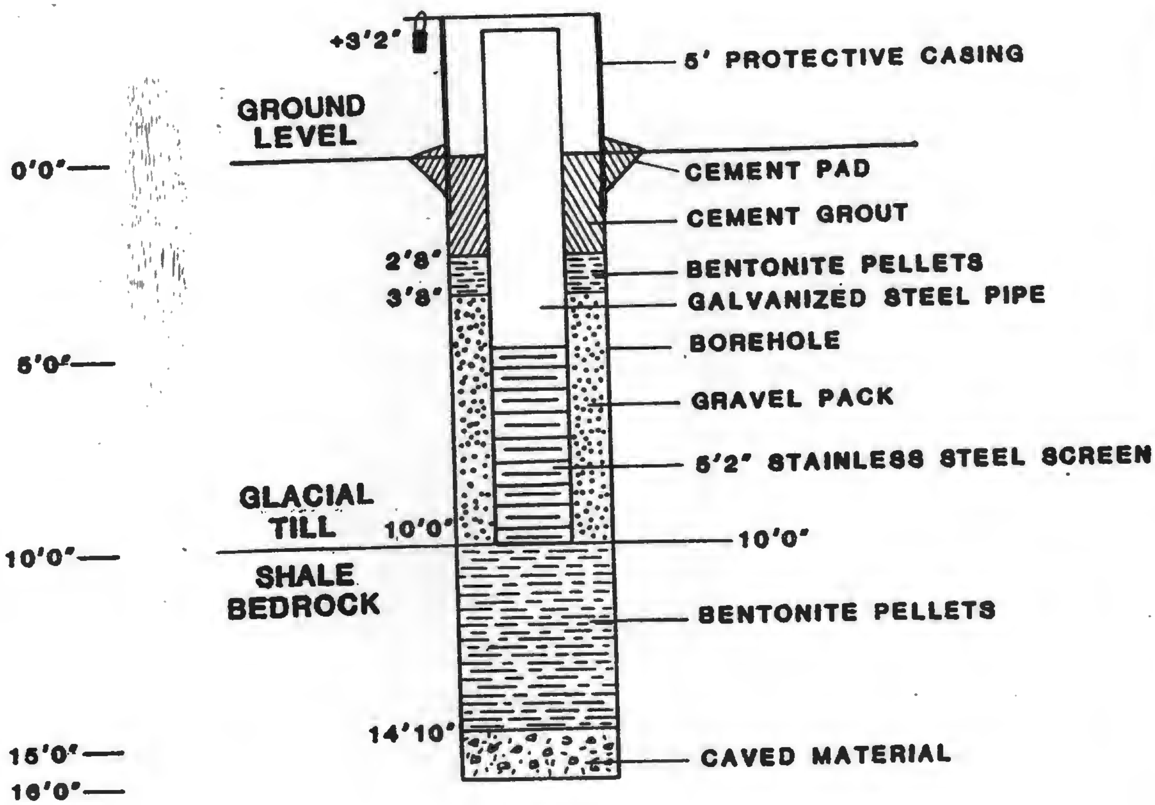


FIGURE III-15

WELL CONSTRUCTION
TEST BORING # 5
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

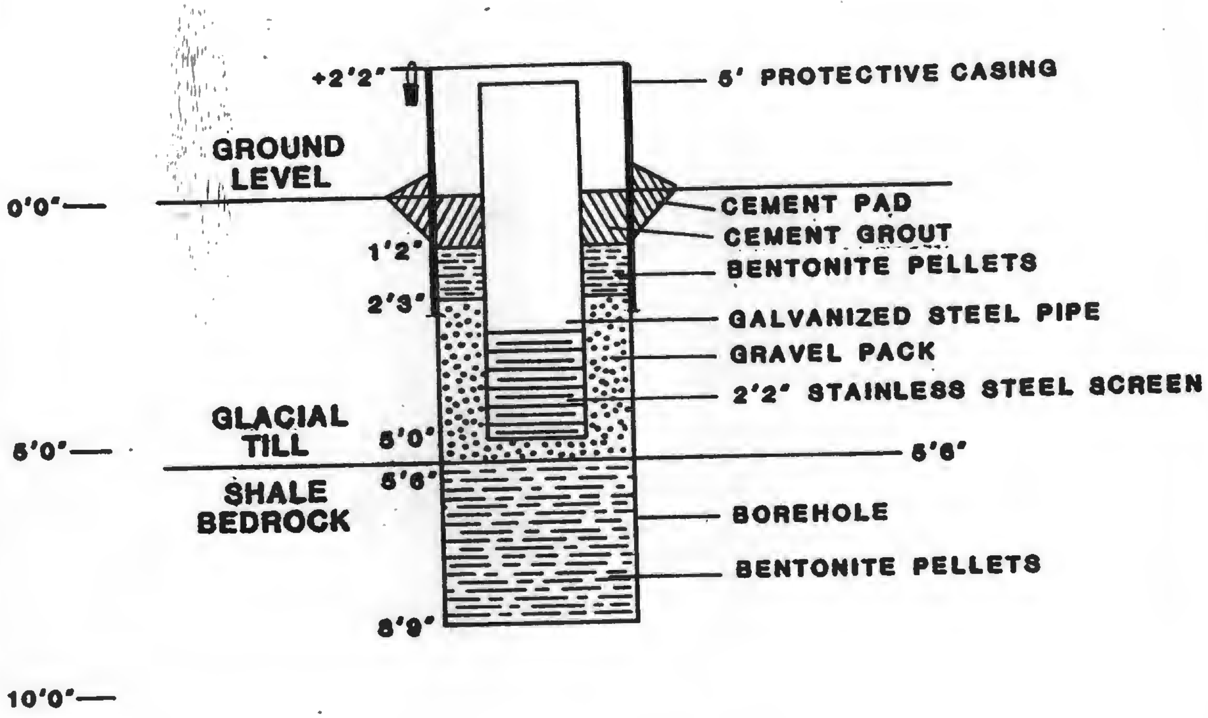


FIGURE III-16

WELL CONSTRUCTION
TEST BORING # 6
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

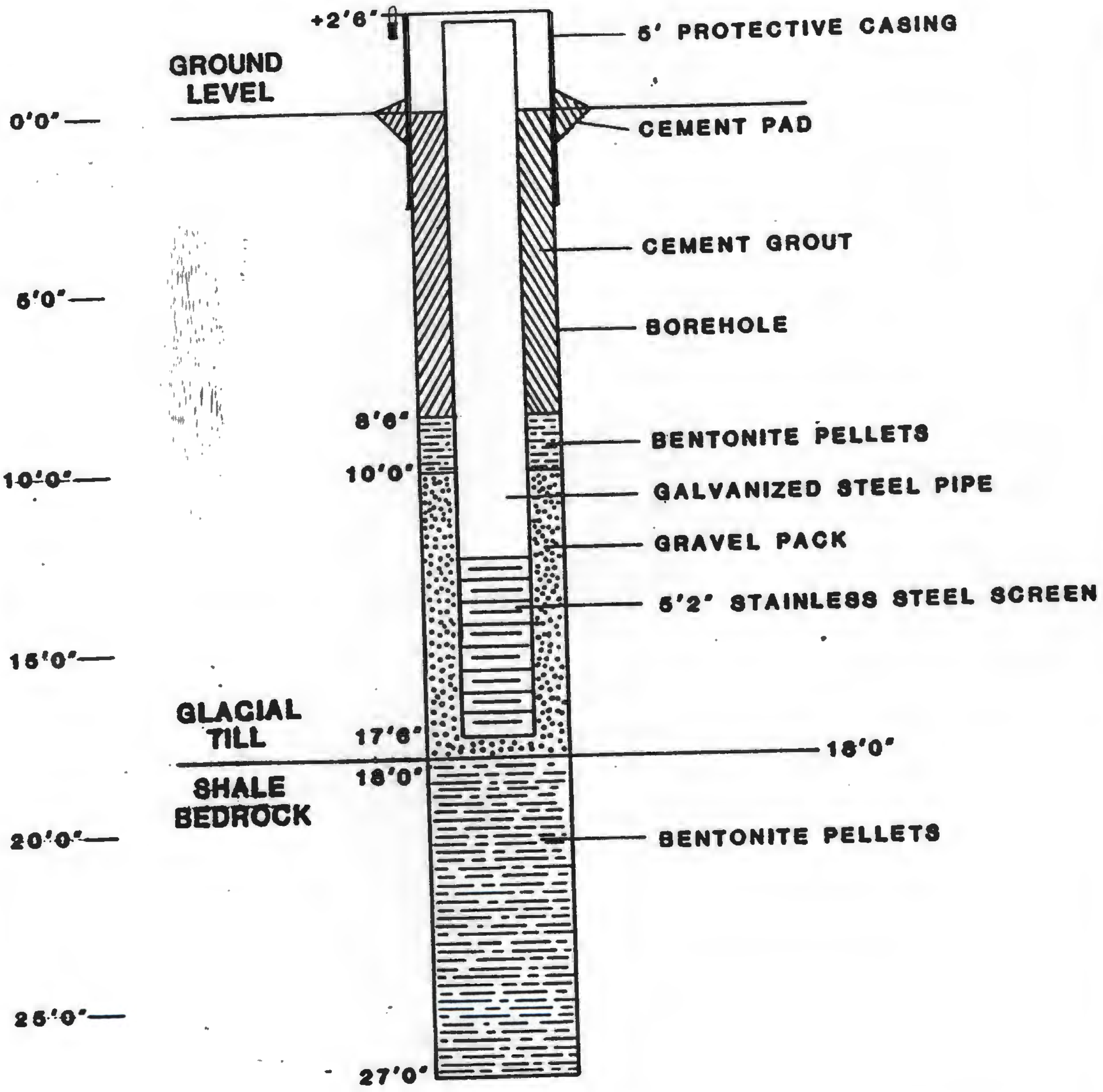


FIGURE III-17

WELL CONSTRUCTION
TEST BORING # 7
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

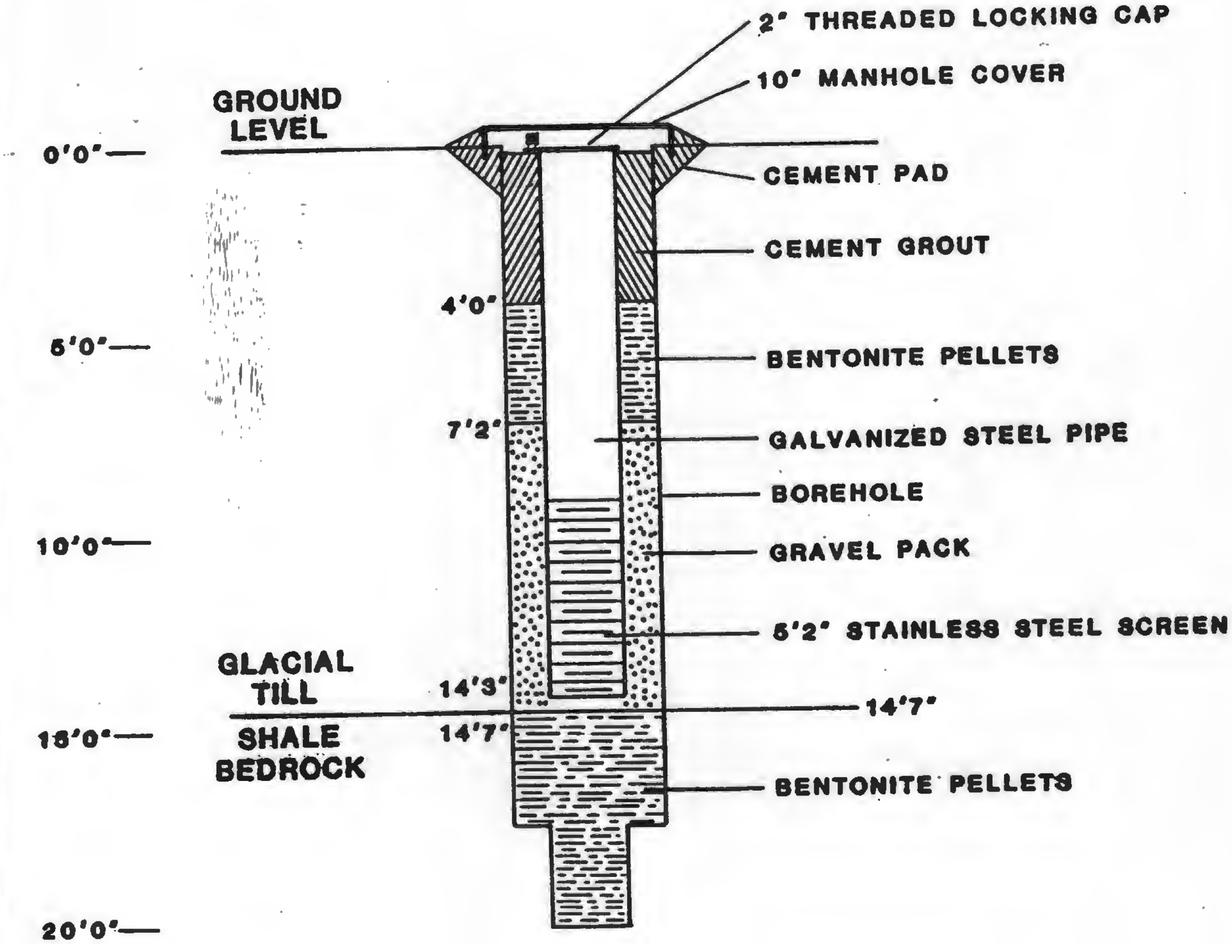
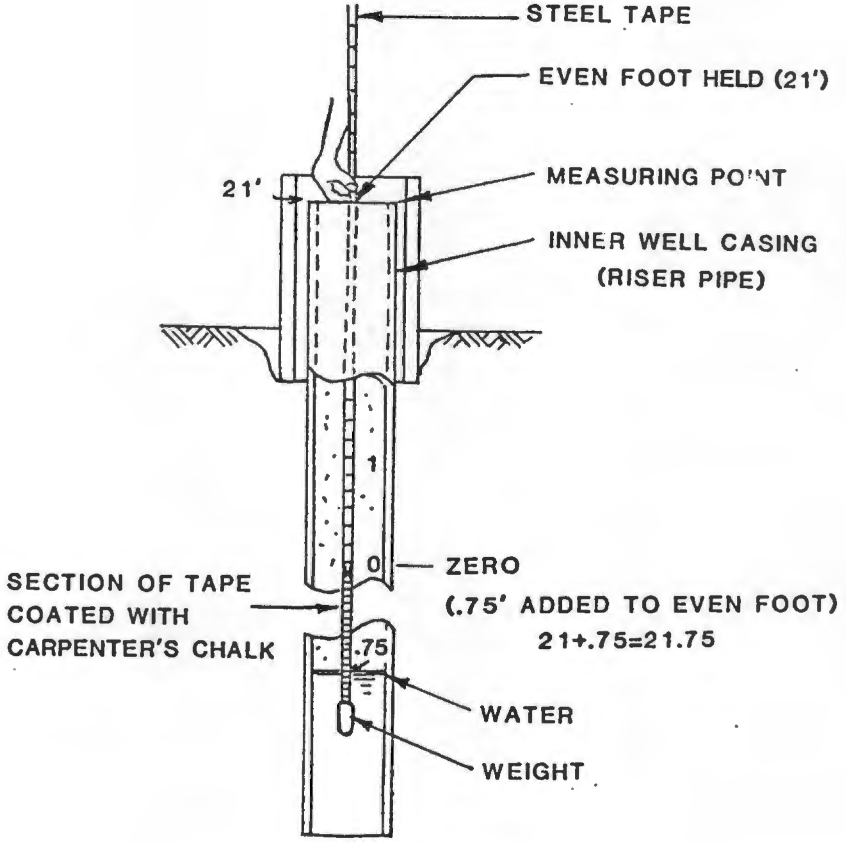


FIGURE III-18

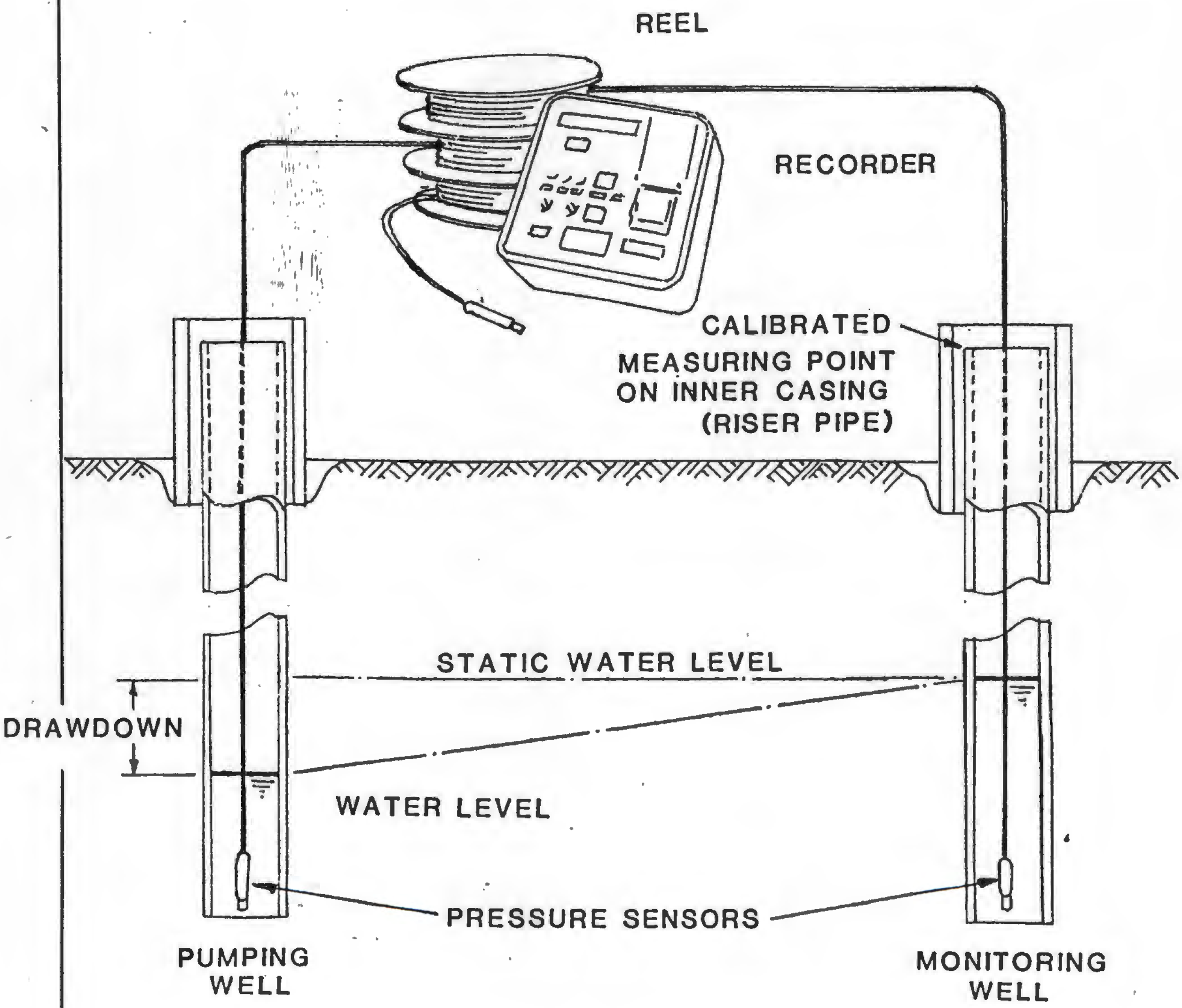
WELL CONSTRUCTION
TEST BORING #8
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.



WETTED TAPE

Shakti Consultants, Inc. 185 Gatzmer Avenue Jamesburg, NJ 08831	Figure 26 Example Water Level Measurement Scale: N/A : Date 3/3/89 Drawn by: JMB Rev:



PRESSURE TRANSDUCERS

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Figure 27 *Example*
Water Level Measurement
Scale: N/A : jmb.
Date 3/28/89
Drawn by: JMB Rev:

Shakti Consultants,Inc.

185 Gatzmer Ave
Jamesburg NJ 00831

52 Mountaineer Dr
Elkview, WV 25071

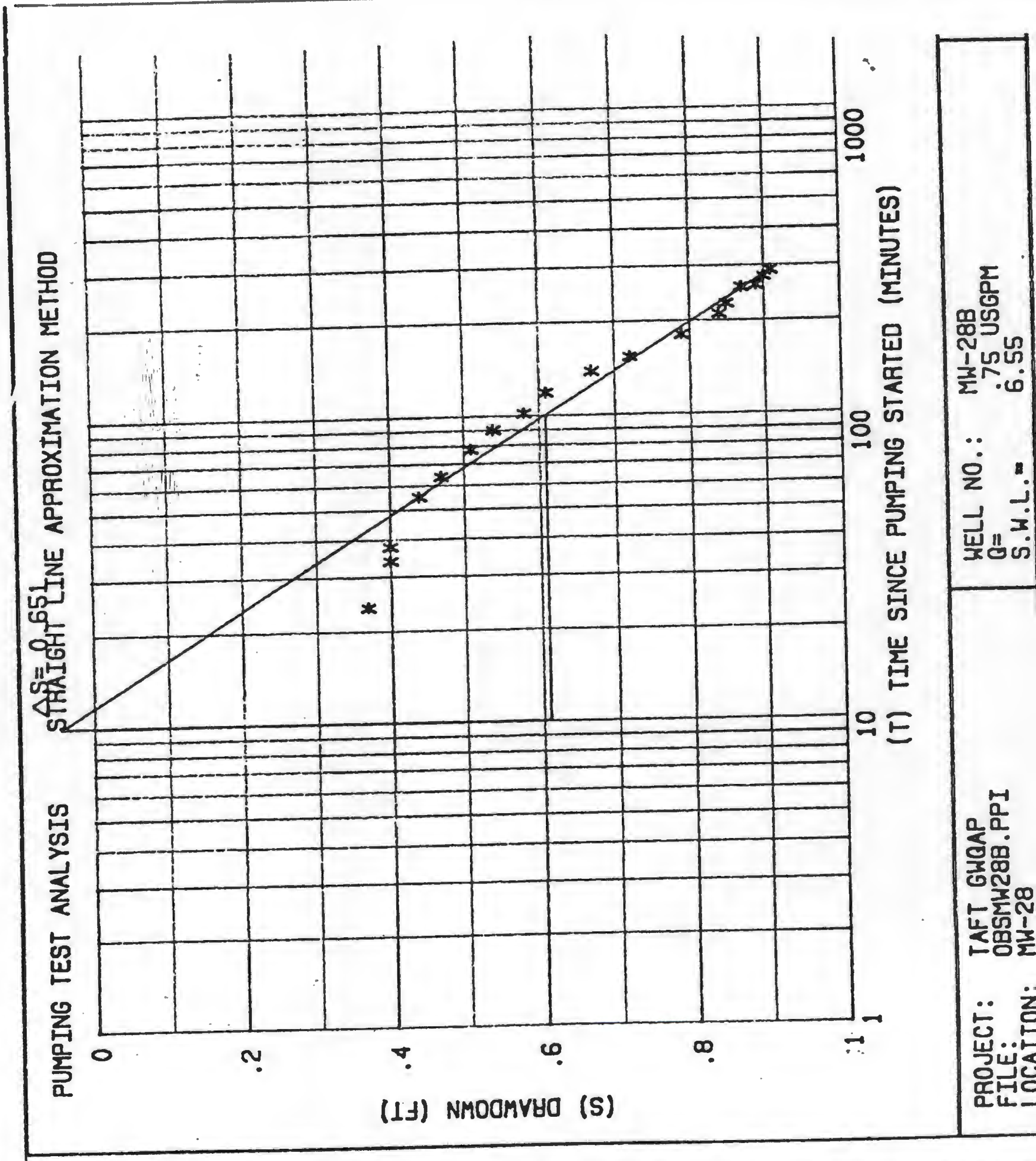
Water Level Record Sheet

Project
Location
Well #
Reference Pt Elev.(feet)
Land Surface Elev. (feet)
Well Depth (feet)
Perforated Interval
Aquifer

Well # Date	Time	Ground Elevn.	Depth of Water below TOC	Stick-up	Depth of Water below GL	Water Level Elevation

Shakti Consultants,Inc.
185 Gatzmer Avenue
Jamesburg, NJ 08831

Figure 28 Example
Water Level Records
Scale: N/A :
Date 3/ 3 /89
Drawn by: JMB Rev:



Shakti Consultants, Inc.
185 Gatzmer Avenue
Jamesburg, NJ 08831

Figure 29 Example
Time-Drawdown Graph
Scale: N/A :
Date 3 / 3 /89
Drawn by: JMB Rev:

JOB NO. 8-0072.

PROJECT NO. 2

CHAIN OF CUSTODY RECORD

ACCUTEST®
2235 ROUTE 130 • BLDG. B • DAYTON, NJ 08810 • (201) 329-0200

NAME OF CLIENT: DANA TRANSPORT.

ADDRESS: 12 FAIRFAX ST

CITY: AVENEL

STATE/ZIP: NJ 08831

ATTENTION: BILL SHERIDAN

SMPL ID	DATE SAMPLED	TIME SAMPLED	SMPLD BY	MATRIX	NO. CONT.	PRES.	pH	POINT OF COLLECTION	ANALYSES REQUESTED
008.2	11/11/88	1330	JMB	WATER	2 x 300	N/A	N/A.	T-2-N 7:0. DANA.	VOLATILE METHOD 624
009.1	11/11/88	1400	JMB	WATER	2x 300	N/A	N/A	T-4N. 8:0 DANA.	VOLATILE METHOD 624

Figure Example
Sample Documentation
Scale: N/A :
Date 3/28/89
Drawn by: JMB Rev:

1. RELINQUISHED BY:	DATE/TIME Terry Bowe 11/12/88	1. RECEIVED BY: Terry Bowe	3. RELINQUISHED BY:	DATE/TIME	3. RECEIVED BY:	SAMPLE LOCATION
2. RELINQUISHED BY:	DATE/TIME	2. RECEIVED BY:	4. RELINQUISHED BY:	DATE/TIME	4. RECEIVED BY:	

Appendix A

Standard Operating Procedures for Photovac Analysis

HEADSPACE ANALYSIS OF SOIL GAS AND WATER SAMPLES

Purpose

The concentration of VOC in soil and water may be determined by analysis of the headspace over a soil or water sample. During the survey the Photovac portable gas chromatograph and Laboratory analysis program is used as a basis for correlating the Photovac results to laboratory derived VOC analysis results for soil or water samples.

Method

Sampling Procedures - Headspace analysis

Samples of soil are obtained by subcoring soil from a split spoon sampler. The 30 cu mm of soil is are placed in a 40 ml vial such that the vial is three quarters full. The vials are than placed in a warm water bath held at 30 degrees C and heated for 20 minutes to drive the volatiles into the headspace of the vial. A 100 ul injection was then drawn from the headspace of the vial with an airtight syringe and introduced into the Photovac.

Dry soil samples are prepared for analysis by the addition of 10 ml of distilled water to the VOA vials.

Water samples are obtained either as grab samples or from a precleaned bailer. The 40 ml vial is filled 3/4 full leaving a headspace from which the sample is drawn.

The VOA vials are stored upside down on ice prior to the Photovac analysis, and prior to and during shipment for laboratory analysis.

Sample Analysis

The Photovac analysis is conducted using a Photovac Model 10S50 portable gas chromatograph (GC). The Photovac GC utilizes photoionization at a stable temperature maintained by the inboard GC column oven. The sample is injected through a model SA1020 encapsulated capillary column with a packing material of CPsil 19CB, nine feet in length.

The 10S50 gas chromatograph contains a built-in integrator and 4 libraries enabling the computer to interpret a chromatogram qualitatively and quantitatively when comparing the sample to a standard of known concentrations that is run and programmed into the Photovac library.

A 100 ul aliquot of the headspace from the sample is injected into the Photovac. The GC prints out the specific peaks for the compounds at the retention time for the VOC at the specific column temperature and carrier gas flow.

Chromatograms display the library listing and show the analysis conditions including the gain setting used. The data from this chromatogram is used to evaluate other chromatograms of the standards for the calibration range and to establish a lower detection limit. For example from experience, the detection limit for Benzene in water is 10 ppb.

QA/QC

Calibration

As part of the field analytical procedure, the Photovac is calibrated with a VOC standard. A standard is injected at the beginning and at the end of the daily analysis program to confirm positive identification.

Standards: The standards are composed of VOC in water that have high sensitivity and well defined peak separation, such as Benzene, Toluene, Ethylbenzene and Xylene (BTEX).

Preparation of Water Standards

The accuracy of the standards is dependent on the precautions taken in the transfers of liquids and care taken to prevent headspace loss. Cross contamination by using contaminated syringes must also be avoided.

Procedure

Standards may be made using analytical balances. The preferred method of making standards is to weigh small quantities of the volatile organic compounds in gas-tight syringes. These quantities are transferred to 20 ml of methanol and the whole reweighed (See Appendix A, Photovac Technical Bulletin #27 and Procedure For Weighing Liquids With A Syringe"). Concentration is then calculated directly on a wt/wt basis (ppm = ug/g).

Alternatively, the densities of the compounds are used to describe the weight of known volumes. The following is an example for making water standards at low ppb concentrations of Benzene and TCE. The procedure consists of 3 parts: a stock solution in methanol (approx. 1000-5000 ppm) is made, a serial dilation is made of 1/800 in water, followed by a further 1/500 dilution in water.

The standards are made up under controlled conditions by the testing laboratory from priority pollutant standards supplied and guaranteed by Supelco.

Results of Calibration Range Injections:

	LOWER LIMIT		CENTER LIMIT		UPPER LIMIT	
Chromatograms	#3	#4	#2		#1	
	calculated	actual	calculated	actual	calculated	actual
Benzene	.875	.624/.608	10.5	10.24	105	98.49
TCE	.666	.549/.549	8.0	7.56	80	71.76
Toluene	.875	.949/.906	10.5	9.69	105	105.8
PCE	.666	.718/.761	8.0	8.59	80	93.75

Injections: A 100 ul injection of the standard is introduced into the Photovac to obtain the retention time for the VOC at the specific column temperature and carrier gas flow.

The peaks derived from the standard is labelled by the inboard computer and integrated according to the peak size. The specific peak for a compound is then identified for the computer and assigned the known concentration of the standard. This chromatogram is then retained by the inboard computer and may be recalibrated at any time.

The computer identifies the sample peak with the retention time of the standard of the identified compound. All other peaks for the identified compound obtained during the Photovac analysis are thus assigned concentrations based on, and with respect to, the standard peak size.

A sample of the standard is included in the samples for Laboratory analysis to monitor any standard drift.

Duplicate Samples: Selected duplicate samples are retained in VOA vials from the split spoon samples. Equal volumes of soil are placed in the VOA vials so that a reasonable comparison of VOC contamination between samples could be made. Based on the results of the Photovac analysis, duplicate samples are identified for laboratory analysis. One in ten samples are chosen, placed in 950 ml amber glass jars with teflon sealed lids and sent to the Laboratory. The samples identified for laboratory analysis are chosen to cover a range of of VOC concentrations from approximately 100 ppb to 100 ppm. The laboratory analysis is conducted to provide quantitative data for the selected duplicate samples. This information is used as a basis for developing a correlation between the VOC concentration in the soil identified through Laboratory analysis and the Photovac data.

Interferences: The following precautions are taken to minimize the possibility of contamination influencing results:

A field blank of distilled water accompanies samples throughout the sampling effort and is analyzed at the time that field samples are analyzed. This field blank analysis protocol identifies inaccuracies introduced during soil gas and water sample collection and transport.

Syringes are screened for contamination by injecting ultra zero air into the GC after analyzing samples containing compounds of substantial concentrations. This screens for the possibility of contamination carry-over.

At the beginning of each day ultra zero air is injected into the gas chromatograph to determine if any internal contamination is present.

Background samples are taken on-site and analyzed periodically during the daily sampling effort. In addition, samples are taken daily from an area on or off-site that has been designated to be uncontaminated.

Duplicate samples are processed through the gas chromatograph for approximately 10% of the total samples analyzed.

Decontamination of Sampling Tool and Sample Container Cleaning Procedures:

The sampling tools used in a soils investigation, may include a drill rig and split-spoon components, stainless lab spatulas and a 3/8" diameter stainless steel rod. These tools are required to obtain the soil sample and transfer and tamp the contents of the split-spoon into the 40 ml amber glass, teflon-capped septum vials or the 250 ml amber glass bottles with teflon-lined caps.

Water samples are be collected using the VOA vial to grab a sample or a teflon bailer to obtain a water sample from a properly developed and evacuated well.

Hand tools are cleaned in the following manner:

- *Thorough washing with non phosphate detergent and tap water, utilizing a scrub brush*
- *Distilled water rinse (pressure-type sprayer)*
- *Acetone rinse (Reagent grade)*
- *Air dry*
- *Distilled water rinse (twice)*

Sample Containers: The sample containers used in this collection program are prepared by the analytical laboratory selected to perform all of the analysis.

Each VOA water sample is collected in three, 40 ml, teflon-lined, septum-capped glass vials. This protocol is written in accordance with the "Interim Analysis Guideline" for Total PHC, as contained in attachment 2,E. of the DRAFT Sampling Plan Guide of the NJDEP.

Bottles are prepared by the laboratory in accordance with current "organic-cleaned" protocol, as follows. The bottles are acetone rinsed, methylene chloride rinsed and oven-dried at 100 degrees C for one hour.

The containers for the Photovac analysis of VOC soil samples are identical to the water sample vials, and are provided with the same laboratory prep. The field blanks and trip blank (aqueous) samples are collected in four, 40 ml vials each, of the type and "preped" as previously described.

Documentation

Field notebooks are maintained by assigned field personnel. In addition, a printout of the analysis (chromatographic data) is maintained. This analysis protocol includes a listing of the certified gas standards of the compounds, a chromatogram, the time of analysis, a summary of analysis parameters, the retention times and concentrations of identified compounds, and a details of the sampling and precolumn/backflush analysis annotated on the computer printout.

Results

The results of the Photovac and laboratory analyses are displayed in a comparison table. A correlation between the laboratory data and the Photovac data is established.

Conclusion - Detection Limits;

Using the lower limit as the detection limit allows for adequate sensitivity for analysis of contaminants in groundwater and soil. A 100 ul injection of sample at an instrument gain of 100 will show 20 ppb as shown by chromatograms #3 and #4.

PHOTOVAC

Technical Bulletin

11

SOME OF THE COMPOUNDS THAT CAN BE DETECTED USING THE PHOTOVAC 10S SERIES OF PORTABLE GCs

Many of the chemicals mentioned herein are of a hazardous nature. Photovac expressly disclaims liability for any loss or injury arising out of the use of information, materials, equipment or practices described. Safe use of any procedure, equipment or material is the responsibility of the user.

For further information on contents of this bulletin or on Photovac products, please contact:

PHOTOVAC
incorporated

United States
PHOTOVAC INTERNATIONAL
INCORPORATED
741 Park Avenue
Huntington
New York 11743
USA
Telephone: 516-351-5809
Toll-free: 1-800-387-5700

Worldwide
PHOTOVAC INCORPORATED
134 Doncaster Avenue
Unit 2
Thornhill, Ontario
Canada
L3T 1L3
Telephone: 416-881-8225
Telex: 06-964634 PHOTOVAC TOR

	eV
Chlorobenzene	9.07
Chlorobromomethane	
1-chloro-2-bromoethane	10.63
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chlorobutanone	9.54
1-chloro-2,3 epoxy propane	10.60
Chloroethane (ethyl chloride)	10.97
Chloroethene	10.00
2-chloroethoxyethene	10.61
1-chloro-2-fluorobenzene	9.16
1-chloro-3-fluorobenzene	9.21
1-chloro-2-flouroethene(cis)	9.87
1-chloro-2-fluoroethene(trans)	9.87
Chloroform	11.37
o-chloroiodobenzene	8.35
1-chloro-2-methylbenzene	8.72
1-chloro-3-methylbenzene	8.61
1-chloro-4-methylbenzene	8.78
Chloromethylethyl ether	10.08
Chloromethylmethyl ether	10.25
1 chloro-2-methylpropane	10.66
Chloroprene	
1-chloropropane	10.82
2-chloropropane	10.78
3-chloropropene	10.04
p-chlorostyrene	
2-chlorothiophene	8.68
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
Cumene (i-propyl benzene)	8.75
Crotonaldehyde	9.73
Cyanoethene	10.91
Cyanogen bromide	10.91
3-cyanopropene	10.39
Cyclobutane	10.50
Cyclohexane	9.98
Cyclohexanone	9.14
Cyclohexene	8.95
Cyclo-octatetraene	7.99
Cyclopentadiene	8.55
Cyclopentane	10.52
Cyclopentanone	9.26
Cyclopentene	9.01
Cyclopropane	10.06
2-decanone	9.40
1,3-dibromobutane	
1,4-dibromobutane	
Dibromochloromethane	10.59
Dibromochloropropane	
1,1-dibromoethane	10.19
Dibromomethane	10.49
1,2-dibromopropane	10.26
2,2-dibromopropane	
1,2-dichlorobenzene	9.07
1,3-dichlorobenzene	9.12
1,4-dichlorobenzene	8.94
1,3-dichlorobutane	
1,4-dichlorobutane	
1,4-dichloro-2-butene(cis)	
2,2-dichlorobutane	
2,3-dichlorobutane	
3,4-dichlorobutene	
Dichlorodifluoromethane(Freon12)	11.75
1,1-dichloroethane	11.06
1,2-dichloroethane	11.04
cis-dichloroethene	9.65
trans-dichloroethene	9.66
Dichloroethyl ether	
Dichloromethane	11.35
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1,1-dichloropropanone	9.71
2,3 dichloropropene	9.82
Dicyclopentadiene	7.74
Dibutyl amine	7.69
Diethoxymethane	9.70
Diethyl amine	8.01
Diethyl ether	9.53
N-diethyl formamide	8.89
Diethyl Ketone	9.32
Diethyl Sulfide	8.43
1,2-difluorobenzene	9.31
1,4-difluorobenzene	9.15
Difluorodibromomethane	11.18
Difluoromethylbenzene	9.45
1,1-dimethoxyethane	9.65
Dimethoxymethane	10.00
Diiodomethane	9.34
Diisobutyl Ketone	9.04
Diisopropylamine	7.73
Dimethyl amine	8.24
2,3-dimethylbutadiene	8.72
2,2-dimethyl butane	10.06
2,2-dimethyl butane-3-one	9.18
2,3-dimethyl butane	10.02
2,3-dimethyl-2-butene	8.30
3,3-dimethyl butanone	9.17
Dimethyl disulfide	8.46
Dimethyl ether	10.00
Dimethylformamide	9.45
3,5-dimethyl-4-heptanone	9.04
2,2-dimethyl-3-pentanone	8.98
2,2-dimethyl propane	10.35
Dimethyl sulfide	8.69
Di-n-propyl disulfide	8.27
Di-n-propyl ether	9.27

	eV
Methyl cellosolve	
Methyl Chloroacetate	10.35
Methyl chloride	11.28
Methyl chloroform	11.25
Methylcyclohexane	9.85
4-methylcyclohexene	8.91
Methylcyclopropane	9.52
Methyl dichloroacetate	10.44
Methyl ethanoate	10.27
Methyl ethyl ketone	9.53
Methyl ethyl sulfide	8.55
2-methyl furan	8.39
Methyl iodide	9.54
Methyl isobutyl ketone	9.30
Methyl isobutyrate	9.98
1-methyl-4-isopropylbenzene	
Methyl isopropyl ketone	9.32
Methyl methacrylate	9.74
Methyl methanoate	10.82
Methyl mercaptan	9.44
2-methylpentane	10.12
3-methylpentane	10.08
2-methylpropane	10.56
2-methylpropanal	9.74
2-methyl-2-propanol	9.70
2-methylpropene	9.23
Methyl n-propyl ketone	9.39
Methyl styrene	8.35
Morpholine	8.88
Naphthalene	8.10
Nitric oxide	9.25
Nitrobenzene	9.92
Nitrotoluene	9.43
n-Nonane	
5-nonanone	9.10
n-Octane	
3-octanone	9.19
4-octanone	9.10
1-octene	9.52
n-Pentane	10.53
Pentachloroethane	11.28
1,3-pentadiene (cis)	8.59
1,3-pentadiene (trans)	8.56
Pentafluorobenzene	9.84
Pentamethylbenzene	7.92
n-pentanal	9.82
2,4-pentanedione	8.87
2-pentanone	9.39
3-pentanone	9.32
1-pentene	9.50
Perchloroethylene	9.32
Perfluoro-2-butene	11.25
Perfluoro-1-heptene	10.48
n-perfluoropropyl iodide	10.36

	eV
(n-perfluoropropyl-iodomethane)	9.96
(n-perfluoropropyl-methyl ketone)	10.58
Phenol	8.69
Phenyl ether	8.09
Phenyl isocyanate	8.77
Phosphine	9.96
Pinene	8.07
Propadiene	10.19
n-propanal	9.95
Propane	11.07
1-propanethiol	9.20
n-propanol	10.51
Propanone	9.69
Propenal (Acrolein)	10.10
Propene	9.73
Prop-1-ene-2-ol	8.2
Prop-2-ene-1-ol	9.67
Propionaldehyde	9.98
n-Propyl acetate	10.04
n-Propyl alcohol	10.20
n-Propyl amine	8.78
n-Propyl benzene	8.72
Propylene	9.73
Propylene dichloride	
Propylene oxide	10.22
n-Propyl ether	9.27
n-Propyl formate	10.54
Propyne	10.36
Pyridine	9.32
Styrene	8.47
Tetrabromoethane	
Tetrachloroethene	9.32
1,1,1,2-Tetrachloroethane	
1,1,2,2-Tetrachloroethane	
1,2,3,4-tetrafluorobenzene	9.61
1,2,3,5-tetrafluorobenzene	9.55
1,2,4,5-tetrafluorobenzene	9.39
Tetrafluoroethene	10.12
Tetrahydrofuran	9.54
Tetrahydropyran	9.26
1,2,4,5-tetramethylbenzene	8.03
2,2,4,4-tetramethyl-3-pentanone	8.65
1,1,1,2-tetrachloropropane	
1,2,2,3-tetrachloropropane	
Thioethanol	9.29
Thiomethanol	9.44
Thiophene	8.86
1-thiopropanol	9.20
Toluene	8.82
Tribromoethene	9.27
1,1,1-trichlorobutanone	9.54
1,1,1-trichloroethane	11.25
1,1,2-trichloroethane	
Trichloroethene	9.45

PHOTOVAC

Technical Bulletin

25

SOIL GAS SAMPLING PROCEDURE

For further information on contents of this bulletin or on Photovac products, please contact:

PHOTOVAC
incorporated

United States
PHOTOVAC INTERNATIONAL
INCORPORATED
741 Park Avenue
Huntington
New York 11743
USA
Telephone: 516-351-5809
Toll-free: 1-800-387-5700

Worldwide
PHOTOVAC INCORPORATED
134 Doncaster Avenue
Unit 2
Thornhill, Ontario
Canada
L3T 1L3
Telephone: 416-881-8225
Telex: 06-964634 PHOTOVAC TOR

PHOTOVAC TECHNICAL BULLETIN # 25

SOIL GAS SAMPLING PROCEDURE

INTRODUCTION

This procedure is based on an actual site investigation conducted with E.P.A. approval and is intended to provide a guide for similar investigations. Local site conditions and the type of compounds present will obviously be different and approval of the planned procedure will need local E.P.A. approval.

Many of the chemicals mentioned herein are of a hazardous nature. Photovac expressly disclaims liability for any loss or injury arising out of the use of information, materials, equipment or practices described. Safe use of any procedure, equipment or materials is the responsibility of the user.

A soil gas sampling and analysis program was conducted to delineate the area extent of subsurface contamination containing volatile organic compounds (VOC). Target VOC are benzene, toluene, trichloroethylene (TCE), and perchloroethylene (PCE). The following describes the field sampling methodology, the normal operation of the portable gas chromatograph, interferences and QA/QC.

METHOD

SAMPLING PROCEDURE

Prior to conducting the sampling effort, the project site area (approx. 40 acres) was delineated into a grid pattern of 100 by 100 ft. sampling stations.

A plunger bar was utilized to make a ½" diameter vertical hole approximately 5 ft. into the soil. The bar has a slide hammer enabling the operator to pound the bar out once the desired depth has been reached. Once the bar is removed a stainless steel tube (6' by ¼" OD) contained within a Teflon tube (1/8" OD) slightly longer than the stainless tube is inserted into the hole.

Attached to the end of the Teflon tube is a nail with its point just fitting into the Teflon tube, and the head of the nail just large enough to cover the end of the stainless steel tube. This arrangement is then inserted into the hole, nail-end first. When the tube has been inserted to maximum depth, withdraw the tube 3" from the bottom of the hole and release the nail by withdrawing the Teflon tube. The sample can either be taken through the Teflon tubing or the Teflon tube can be completely withdrawn and the sample taken through the stainless steel tube. Loose soil will then be packed around the tube to minimize infiltration of ambient air.

The probe of the TIP is attached either to the Teflon tube or stainless tube depending upon which of the above options is used to sample. The TIP is used to screen the soil gas to determine when the sampling tube has been purged. Once the TIP readings stabilize showing the highest reading, this value is recorded and the air bag sampling apparatus is connected. The TIP reading will be used by the G.C. operator to evaluate the injection size and gain setting in order to prevent the G.C. detector from being saturated with highly contaminated samples.

An air sampling bag is connected to the sampling tube within the desiccator. An air sampling pump is used to create a low pressure system within the desiccator causing air to be drawn up through the sample tube and filling the Tedlar Bag with soil gas. The bagged sample is now ready to be analyzed by the portable gas chromatograph.

INITIAL SCREENING

The following is the initial procedure used by the G.C. operator to evaluate injection size with respect to TIP readings. This may vary if G.C. data indicates larger or smaller injection sizes are required to stay within the working calibration range.

TIP READING (ppm)	INJECTION SIZE (µl)	GAIN SETTING
0-5	500	100
5-20	100-500	100
20-60	25-100	50
60-100	25-100	20
100-150	25-100	10

If TIP readings exceed 150 ppm the G.C. operator would make a syringe dilution using ultra zero (UZ) air as the diluter. Dilutions are made using a 1 ml syringe as follows:

1. 100 µl of sample taken from Tedlar bag
2. Using same syringe, 900 µl of UZ air taken
3. 5 min. allowed for equilibrium to be reached
4. Diluted sample within syringe is expelled to leave 100 µl of sample remaining. A 1:10 dilution is accomplished.

If dilutions are necessary, a minimum dilution of 1:2 and a maximum dilution of 1:10 would be used accordingly to TIP readings.

SAMPLE ANALYSIS

Two commercially prepared gas standards, certified to be ± 2 % of the listed concentrations would be used to calibrate the G.C:

1. Benzene (10.59 ppm) and Toluene (10.68 ppm) mixture

2. TCE (8.04 ppm) and PCE (8.28 ppm) mixture

A 12 µl injection of each standard would be made approximately after every 5 to 8 samples are run. Also, beginning daily, standards would be run before sample analysis.

The Gas Chromatograph contains a built-in integrator and 4 libraries enabling a chromatogram to be interpreted qualitatively and quantitatively when compared to known concentrations of standards.

CALIBRATION

The gas chromatograph is calibrated by injecting 12 µl of each standard mixture and programming the instrument's library. Attachment # 1 includes representative gas chromatograms, numbered 1 through 5, of the proposed standards. Chromatogram #1 includes the library listing and shows the gain setting used. The data from this chromatogram is used to evaluate other chromatograms of the standards for the calibration range and to establish a lower detection limit.

Calibration Range:

LOWER LIMIT: (Chromatogram #3 and #4) = 21 ppb Benzene and Toluene and 16 ppb TCE and PCE.

A 1 ml aliquot of each certified gas mixture was injected into a 500 ml glass dilution vessel. A 500 µl injection of this mixture is entered into the G.C. at a gain of 100. The library quantification for this injection should be (calculated concentrations):

Benzene & Toluene -- $21 \text{ ppb} \times \frac{500\mu\text{l}}{12\ \mu\text{l -(Library Injection)(LI)}} = .875 \text{ ppm}$

TCE & PCE -- $16 \text{ ppb} \times \frac{500\ \mu\text{l}}{12\ \mu\text{l (LI)}} = .666 \text{ ppm}$

CENTER LIMIT (Chromatograph #2): A 12µl injection was made at 100 gain of the 10.5 ppm Benzene & Toluene mix, and 8.0 ppm TCE & PCE mix.

Benzene & Toluene -- $10.5 \text{ ppm} \times \frac{12\ \text{ul}}{12\text{ul (LI)}} = 10.5 \text{ ppm}$

TCE & PCE -- $8 \text{ ppm} \times \frac{12\ \mu\text{l}}{12\mu\text{l (LI)}} = 8.0 \text{ ppm}$

UPPER LIMIT (Chromatogram #5); A 120 µl injection was made of the 10.5 ppm mix and 8 ppm mix. The gain being set at 10. Calculated concentration:

Benzene & Toluene -- $10.5 \text{ ppm} \times \frac{120\ \mu\text{l}}{12\ \mu\text{l (LI)}} = 105 \text{ ppm}$

TCE & PCE -- $8 \text{ ppm} \times \frac{120\ \mu\text{l}}{12\ \mu\text{l (LI)}} = 80 \text{ ppm}$

Results of Calibration range injections:

	LOWER LIMIT			CENTER LIMIT		UPPER LIMIT	
Chromatograms	#3	#4		#2		#1	
	calculated	actual		calculated	actual	calculated	actual
Benzene	.875	.624	.608	10.5	10.24	105	98.49
TCE	.666	.549	.549	8.0	7.56	80	71.76
Toluene	.875	.949	.906	10.5	9.69	105	105.8
PCE	.666	.718	.761	8.0	8.59	80	93.75

Detection Limits:

Using the lower limit as the detection limit will allow for adequate sensitivity. A 500 µl injection of sample at an instrument gain of 100 will show 20 ppb as shown by Chromatograms #3 and #4.

G.C. Conditions:

- 20 ml/min flow ratio
- 5% SE 30 on Chromosorb G packing
- 3 in. precolumn and 2 ft. analytical column
- gain set at 100, 50, 20 or 10
- Working Concentration Range:
  20 ppb (500 µl injection, gain 100) - 100 ppm (120 µl injection gain 10)

INTERFERENCES

The following precautions should be taken to minimize the possibility of contamination influencing results:

A field blank of ultra zero air within a Tedlar bag will accompany soil gas samples throughout the sampling effort and will be analyzed during the same time that field samples are analyzed. This field blank analysis protocol will establish if contamination by diffusion is detected subsequent to soil gas sampling analysis.

Syringes will be screened for contamination by injecting ultra zero air into the G.C. after analyzing samples containing compounds of substantial concentrations. This will minimize the possibility of contamination carry-over.

At the beginning of each day ultra zero air will be injected into the gas chromatograph to determine if any internal contamination is present.

QA/QC

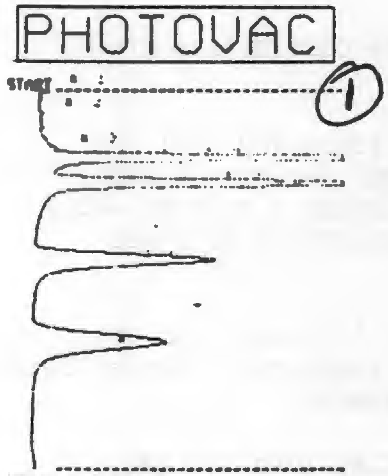
Background air samples would be taken on-site and analyzed periodically during the daily sampling effort. In addition, samples would be taken daily from an area on or off-site that has been designated to be noncontaminated. Duplicate samples would be processed through the gas chromatograph for approximately 10% of the total samples analyzed.

DECONTAMINATION

The sampling equipment would be decontaminated by purging the tubing with ambient air and then rescreening the equipment with the TIP. If contaminants are still present a soap wash, followed by high purity methanol and a distilled water rinse. Alternatively, the tubing may be discarded and replaced with new tubing.

DOCUMENTATION

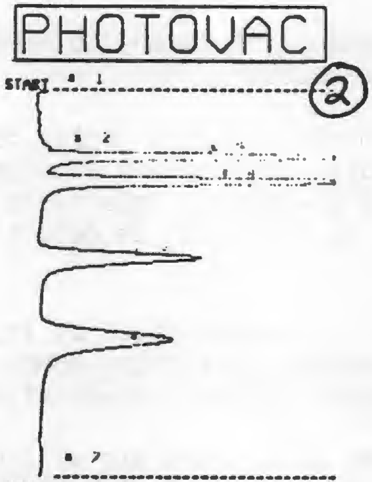
Field notebooks must be maintained by assigned field personnel. In addition, a printout of the analysis (chromatographic data) will be provided. This analysis will include a listing of the compounds (certified gas standards), a chromatogram, time of analysis, summary of analysis parameters, retention times and concentrations of identified compounds, and a program of sampling and precolumn/backflush analysis.



```
STOP @   583.5
SAMPLE RUN          AUG 11 1986  21:45
ANALYSIS #      3    12 UL. STD.
TEMPERATURE    20    10 PPM STD.
GAIN          100    20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.  AREA/PPM

UNKNOWN            3   33.7 432.9 AVG.
UNKNOWN            4  105.0  20.6  VS
UNKNOWN            5  146.3  23.0  VS
UNKNOWN            6  274.7  11.6  VS
UNKNOWN            7  407.1  12.5  VS
```



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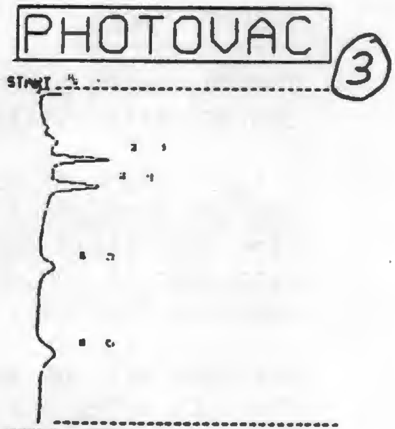
STOP @   600.0
SAMPLE RUN          AUG 11 1986  22: 0
ANALYSIS #     11    12 UL. STD.
TEMPERATURE    20    10 PPM STD.
GAIN          100    20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.  AREA/PPM

111 TCANE          2   93.3 0.834 PPM
BENZENE            3  104.9 10.74 PPM
TCE                4  143.1 7.557 PPM
TOLUENE            5  272.3 3.635 PPM
UNKNOWN            6  402.0  13.5  VS
```



```
STOP @   520.7
SAMPLE RUN          AUG 12 1986   3:23
ANALYSIS #     51   500 UL. STD.
TEMPERATURE    20    20 PPB STD.
GAIN          100    20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.  AREA/PPM

BENZENE            3  108.2 0.624 PPM
TCE                4  150.3 0.543 PPM
TOLUENE            5  270.3 0.945 PPM
UNKNOWN            6  413.3   1.2  VS
```

```
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 1   COMPOUND     ID #  R.T.    LIMIT

BENZENE            1  105.0 20.00 PPM
TCE                2  146.3 20.00 PPM
TOLUENE            3  274.7 20.00 PPM
PCE                4  407.1 20.00 PPM
111 TCANE          5   33.7 20.00 PPM
```

```
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CALIBRATED FOR  5.TOLUENE

SAMPLE RUN          AUG 11 1986  22: 3
ANALYSIS #     11    12 UL. STD.
TEMPERATURE    20    10 PPM STD.
GAIN          100    20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.  AREA/PPM

111 TCANE          2   93.3 0.834 PPM
BENZENE            3  104.9 10.74 PPM
TCE                4  143.1 7.557 PPM
TOLUENE            5  272.3 3.635 PPM
PCE                6  402.0 0.530 PPM
```

```
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CALIBRATED FOR  [illegible]

SAMPLE RUN          AUG 12 1986   3:30
ANALYSIS #     51   500 UL. STD.
TEMPERATURE    20    20 PPB STD.
GAIN          100    20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.  AREA/PPM

BENZENE            3  108.2 0.624 PPM
TCE                4  150.3 0.543 PPM
TOLUENE            5  270.3 0.343 PPM
PCe
                   6  413.3 0.710 PPM
```

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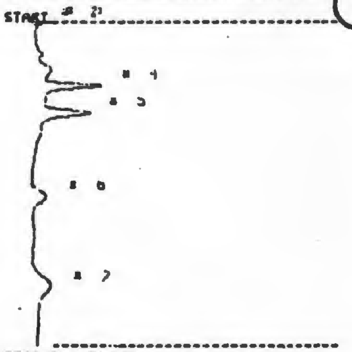
④



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STOP @   509.5
SAMPLE RUN          AUG 12 1986   9:40
ANALYSIS #    52   500 UL. STD.
TEMPERATURE   20   20 PPB STD.
GAIN         100   20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.   AREA/PPM

BENZENE            4  100.3 0.600 PPM
TCE                5  151.3 0.543 PPM
TOLUENE            6  291.0 0.500 PPM
UNKNOWN            7  420.1    1.3  VS
```

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```
CALIBRATED PEAK  6.TOLUENE

SAMPLE RUN          AUG 12 1986   9:41
ANALYSIS #    52   500 UL. STD.
TEMPERATURE   20   20 PPB STD.
GAIN         100   20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.   AREA/PPM

BENZENE            4  100.3 0.600 PPM
TCE                5  151.3 0.543 PPM
TOLUENE            6  291.0 0.300 PPM
PCE                7  420.1 0.701 PPM
```

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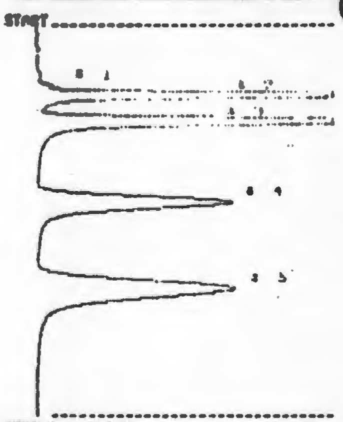
⑤



```
STOP @   802.9
SAMPLE RUN          AUG 12 1986  20:23
ANALYSIS #    87   120UL STD.
TEMPERATURE   23   10 PPM STD.
GAIN          10   20 ML-MIN FLOW.

COMPOUND NAME   PEAK  R.T.   AREA/PPM

BENZENE            2  100.5 30.43 PPM
TCE                3  148.1 71.76 PPM
TOLUENE            4  274.1 105.0 PPM
PCE                5  486.9 93.75 PPM
```

Shakti Consultants, Inc.
Work Plan Appendix
Pump Test Plan
08/09/90

Appendix B

Standard Operating Procedures for Groundwater Sampling

Shakti Consultants,Inc
1

52 Mountaineer Drive
Elkview, WV 25071

185 Gatzmer Avenue
Jamesburg, NJ 08831

sopgw

STANDARD OPERATING PROCEDURES FOR POTABLE AND MONITORING WELL SAMPLING

STANDARD OPERATING PROCEDURES POTABLE AND MONITOR WELL SAMPLING

Purpose. Representative groundwater samples can be collected from potable water supply wells or monitoring wells located within close proximity to a spill site. These wells are sampled to detect the presence and degree of contamination in the groundwater in the vicinity of each well at the time of sampling. If the results from this sampling campaign indicate groundwater contamination, then additional potable or monitoring wells located over a larger area may be sampled.

This standard operating procedure provides information on the following:

- Sample collection/preservation;
- Analytical requirements;
- Chain-of-custody control; and
- Summary Checklist
- Data sheets
- Calculation of saturated well volume
- Test procedures
- Equipment

Introduction

A detailed approach to well sampling is developed after complete review of the construction of the existing well and groundwater data.

The question of conducting interviews with home owners or public water supply officials and the extent of such interviews, is determined in the context of a public relations plan. Permission to enter property is obtained for all private well locations. For each sample location, a supplementary data sheet is completed

The information required prior to sampling of potable wells is as follows:

- *Precise location of well on property in relation to septic system or other contaminant sources*
- *Accessibility to well*
- *Name of driller and date installed*
- *Depth of well*
- *Well construction details*
- *Pump type and setting*
- *Access to the well*
- *Is water pumped into a holding tank before household distribution?*
- *Are any water treatment systems used?*
- *Well use data. Pumping rate, incidence and duration of use*

Once the well information is obtained, the precise location and method of sample collection is detailed.

In order for valid representative groundwater samples to be collected from monitor wells, it is very important to properly prepare the well prior to sample collection. This preparation entails developing groundwater flow to the well (well development), removing all the water which is standing in the casing (evacuation) and taking the sample from water which has recently been recharged from the aquifer.

If the wells can be accessed directly, an attempt is made to remove at least 3-5 well volumes prior to sample collection. If the wells cannot be reached, and the home or facility utilizes a holding tank or water treatment system, every attempt is made to grab a sample before it enters the holding tank or is treated. If this is not possible, then several holding tank volumes are evacuated prior to sample collection, and the collection method used is noted on the sample sheet. The samples are drawn directly from the tap or spigot into the sample bottles.

NOTE: A special case is when sampling for a floating layer, which requires procedures to minimize mixing and emulsification of the separate layer or in obtaining samples at discrete depth intervals in a well.

SAMPLING PROCEDURES

1. Water Height Measurement

After unlocking and removing the well cap, the position of the pump assembly is observed. If the pump is suspended at the top of the casing, it is lifted out of the casing. If it is submerged in the well, the pump is left in the well or measurement of the height of the water, or the static water level will be lowered and inaccurate. If the surface of the well water is below the top of a pump assembly which has been lowered into the well, the pump is partially removed and allowed to drain into the well. The pump is removed from the casing once it has drained completely. Time is allowed for the recovery of the static water level. Note this occurrence when recording the well water height.

The height of the water in the well is measured using a steel tape calibrated in decimal feet (See Water Level Measurement Section) or an equivalent method.

2. Removing Standing Water

The volume of well water to be evacuated prior to sampling is determined by subtracting the water surface measurement from the well depth. The difference is then multiplied by the appropriate gallons/foot of well volume

A bucket and stop watch or equivalent may be used to measure the rate of pumping from the well.

The method of evacuation should be pertinent to the goals of the sampling effort. In fractured rock or limestone or where the contaminant plume is at some distance or depth from the well intake, the evacuation of 3-5 well volumes may not duplicate the demands upon an aquifer caused by peak-load pumping. After extensive clothes washing, during sprinkling of gardens or extensive municipal supply pumping, the contaminant plume may temporarily be drawn upwards or sideways into the well resulting in higher health risks.

The pump location is critical to subsequent representative sampling and should be specified for each well. During evacuation, the pump should be located immediately below the water table or drawdown level in the well. Thus, all stagnant water in the borehole will be evacuated. If the pump is located at the well screen depth then stagnant water can remain in the well at the water table, and samples should only be taken at the well screen depth.

For product lighter than water, a protocol of well evacuation and 1 week of resting the well may be indicated so that floating product may again accumulate. In either case, the well screen should be located above and below the current water table to allow for seasonal fluctuations of the water table.

In cases where a well is emptied until dry and is very slow to recover, the volume required for evacuation may be reduced to two or three standing water volumes.

During the pumping of a groundwater well to take a sample, the drawdown with time may be noted to obtain the hydraulic characteristics of the aquifer involved.

Additional Considerations The nature of the pollutant parameter being monitored is the primary factor for specifying well evacuation and sampling methods. These specifications are most conveniently based on the general class of pollutant or parameter which requires monitoring in a particular program.

Physical properties include such parameters as conductance, color, pH, temperature, and turbidity. In general, most sampling methods are acceptable to monitor these parameters, provided they allow a thorough rinsing between sampling events. However, studies by Gibb, et al., (see reference below) have clearly shown that methods which affect gas composition of the sample will affect pH and volatiles concentration. Consequently, since gas lift pumping methods may leave water in the well in a disturbed and aerated condition, these methods are not suitable for well evacuation when volatiles or pH are a parameter of interest.

*Gibb, S.P.; R. M. Schuller; and R. A. Griffin. 1981. Procedures for the Collection of Representative Water Quality Data from Monitoring Wells. Illinois State Water Survey and Illinois State Geological Survey, Cooperative Groundwater Report, Champaign, Illinois.

Similarly, since concentration of metals can be significantly influenced by changes in pH, sampling for metals should not be allowed with gas lift or suction methods. The guidance provided above for well evacuation when pH is the parameter of interest also applies for metals. In addition, equipment used for monitoring metal concentrations should be metal free. Consequently, bailers and positive displacement pumps are most suitable for sampling metals provided they are constructed of appropriate materials. The methods acceptable for well evacuation are less restricted, but gas lift methods or equipment that alter the metal concentration of water remaining in the well through leaching or adsorption should be avoided.

Inorganic, non-metallic constitutent or parameters include acidity, alkalinity, bromide, chloride, fluoride, nitrate, etc. Most of the sampling and well evacuation methods described above are generally acceptable when considering the inorganic, non-metallic parameters. However, for parameters affected by pH or dissolved-gas changes, such as alkalinity, methods that minimize changes in dissolved gas composition are recommended for sampling. These methods include bailers, squeeze pumps, piston pumps; gas lift techniques are not recommended for well evacuation.

Generalized organic parameters include parmeters such as oil and grease, COD, TOC, TOX. Most sampling and well evacuation methods are suitable for these parameters, with the exception of the more sensitive parameters such as TOX. These sensitive parameters require methods suitable for sampling volatile organics.

It is appropriate that sampling for volatile organics be done with a glass or Teflon bailer after flushing with a non-aerating pump or bailer. Positive displacement pumps may be acceptable in sampling, provided they are constructed with suitable materals (Teflon or glass in most cases).

A well with a low yield may require a waiting period so that sufficient water reenters the well to provide a sample.

Once the required volume has been purged from the well, the sample to be analyzed may be collected.

3. Sample Collection, Preservation & Field Analyses

Wells may be sampled only after the water has been sufficiently recharged to obtain the needed amount of sample. All wells included in a given program are sampled within a one week time interval, weather permitting. Once the well is adequately evacuated, actual sampling may be performed using 1) steam cleaned bailers rinsed in distilled water, 2) dedicated bailers or 3) peristaltic pumps.

The bottom-loading bailers used are fitted with a teflon check valve at their base. Each bailer is fitted with a stainless steel wire leader and a new piece of nylon cord. A different pre-cleaned bailer is devoted to each well. If the bailer has not been used for well evacuation, the first 3 bails of water are wasted to rinse off any cleaning agents which might still be present on the bailer. The samples are poured directly from the bailer to sample jars. If filtering or chemical preservation of the samples is required these steps are followed immediately the water is removed from the well. For filtration, the use of a 0.45 micron filter is generally considered appropriate.

If dedicated bailers are not available, the bailers are steam cleaned and rinsed with distilled water. In addition, those wells which are suspected of being contaminated are sampled last in the sequence. It is prudent to avoid sampling highly contaminated wells on the same day as those wells anticipated to be clean.

For peristaltic pumps, suction tubing is dedicated to a particular well and is cleaned with distilled water between samplings.

Data relating to samples are recorded on a uniquely numbered sample documentation form. Each sample is defined with the following entries:

Date and time sample is collected
Sample I.D. number
Location of sampling point
Type of sample (e.g., soil, groundwater, surface water)
Field measurements

In addition, information regarding shipment of samples is recorded on the chain of custody forms.

Analyses of pH, temperature, and specific conductance are made in the field at the time of sampling because these parameters change rapidly and a laboratory analysis might not be representative of the true groundwater quality. Enough water from the well is removed to determine temperature of water, specific conductivity, and pH. Values for the parameters are recorded on field data sheets and the water discarded in a manner so as to avoid potential contamination.

All groundwater samples are carefully packed on ice for shipment to the R/D Lab. Proper chain-of-custody procedure is followed when transferring the samples from the field to the lab.

After each sample is obtained and placed in its container:

The sample bottle is capped and the bottle labelled. Labels show the sample number, date, sample source, preservative added, if any, and analysis to be performed.

All pertinent information is entered on field data sheets and chain-of-custody forms. Observations as to the odor or color of the water sample are included on the data sheets.

Samples are transferred to an ice chest for shipment to the laboratory.

All equipment is cleaned thoroughly between samples.

For VOA or VOX sampling:

The samples are collected in approximately 50 ml airtight, glass pharmaceutical vials with plastic caps lined by teflon septa. Each sample is clearly labeled as to location and number before the sample is collected.

Each sample consists of two 50 ml vials. Each vial is filled completely and checked to insure that no air is entrained once the cap is in place.

Each vial is wrapped to minimize the possibility of breakage during shipment.

For base neutrals/acid extractables:

Two liter jugs of water are taken and filled 2/3 full and the fill level marked on the outside of the bottle.

All analytical work is completed in compliance with standard USEPA requirements.

III. Chain of Custody Procedures

1. Sample Custody

The field sampler is personally responsible for the care and custody of unused, empty or sample filled containers until they are transferred or properly dispatched. Sample containers are kept under the custody of one designated person at any given time. A sample is under custody if:

a. It is in the samplers actual physical possession; or
b. It is in view, after being in the samplers physical possession; or
c. It is locked up to prevent tampering; or
d. It is in a designated secure area.

2. Field Log Book

Information pertinent to field sampling and measurements is recorded in a bound log book or a log book composed of the serially numbered data sheets filed in a three ring binder. The field sampling plan is appended to the log book as partial documentation of the sampling program. Specific entries that are included in the log book include at least, the following:

a. Each page dated and signed;
b. Date and time of sampling;
c. Sample identification number;
d. Location of sampling point;
e. Type of sample (e.g., grab, composite, groundwater, wastewater, sludge, soil, etc.)
f. Deviations from sampling plan;
g. Field measurements (e.g., pH, conductivity, temperature, etc.);
h. Field observations;
i. Photographs; and
j. Sample custody transfer and transport.

3. Sample Labels

Every sample container is uniquely labeled to prevent misidentification. Labels are attached to containers as they are generated in the field. The labels include the following:

a. Date and time sample collected;
b. Sample identification number;
c. Place of collection; and
d. Signature of collector.

4. Sample Seals

Sample seals are used to prevent unauthorized tampering from the time samples are collected until containers are opened in the laboratory. The seals may be attached over the sample container cap in such a way that the seal must be torn in order to open the container. The following information is recorded on each seal:

a. Date of sampling;
b. Signature of collector.

5. *Chain-of-Custody Record (Field Activities)*

Samples are accompanied by a Chain-of-Custody Record whenever possession of custody is transferred or relinquished. Each Chain-of-Custody Record sheet is filled out with a carbon paper duplicate before the field sample custodian relinquishes possession or arranges for shipment. The original record accompanies the samples relinquished. Each record sheet includes the following information

- *a. Signature of field sampler/sample custodian;*
- *b. Beginning date-time of possession;*
- *c. Final date-time of possession; and*
- *d. For each sample:*
- *e. Date-time of collection;*
- *f. Sample identification number;*
- *g. Location of sampling point; and sample type.*

6. *Transfer of Custody and Shipment*

The following are guidelines for shipping non-hazardous samples:

- *a. Samples are sealed in containers marked with name and address of laboratory;*
- *b. Samples are placed in a strong outside container such as a picnic cooler. Ice, dry ice or "blue ice" may be used inside plastic bags between the containers and box.*
- *c. The outer container is sealed completely with tape or glue and the sample dispatcher signs across the tape or glue joints at several locations on the package to serve as an "outer seal."*
- *d. The container is properly addressed and a shipping list affixed.*
- *e. Samples may be transported by rented or common carrier air, truck, bus, railroad, and entities such as Federal Express. If sent by mail, the package registered with return receipt requested. If sent by common carrier, a Bill of Lading is used. Receipts from post offices and Bills of Lading are retained as part of the permanent documentation. A convenience is to take the sample shipment to the nearest UCC shipping department.*

CLASSIFICATION SHEET

Sheet __ of __
Project: ______________ Job #: __________ Drill Hole: ____
Site Area: ______________
Contractor: ______________ Driller: ______________
Coordinates ______________ N/S: ______________ EW
Permit #: ______________ Agency ______________ State
Drill Method ______________ ______________
______________ ______________
Additions ______________ (Bentonite,etc. ______________
Date Drilled ______________

WELL CONSTRUCTION

See well construction diagram

WELL DEVELOPMENT

Distance ______________ to Water Submerge ______________ vol
Vol Pumped ______________ Rate ______________
Pump Used: ______________ ______________
Sp C ______________ initial ______________ stable
Temp ______________ initial ______________ stable
pH ______________ initial ______________ stable

SAMPLING

Elevation : ______________ Ground
Elevn ft Top of Casing ______________
Depth To water from TOC ______________
Stickup of the casing ______________
Elev of the Ground Calcltd ______________
Water from Top of Casing ______________
GW Elev ______________ 0 Hrs 24 Hrs.
Date: ______________ Comments ______________
See sample documentation sheet
Comments:

ACCUTEST®
2235 Route 130, Dayton, NJ 08810 201-329-0200

CHAIN OF COUSTODY

CLIENT

ADDRESS

CITY STATE / ZIP

ATTENTION TELEPHONE #

BILL TO:

JOB NO.:
PROJECT NO.:
FACILITY NAME:

REQUESTED TURN AROUND:
☐ 1 WEEK ☐ 2 WEEKS ☐ 3 WEEKS ☐ NORMAL

APPROVED:
☐ OTHER:

ACCUTEST ID	DATE SAMPLED	TIME SAMPLED	SMPL BY	MAT RIX	NO CONT	PRES	pH	FIELD ID / POINT OF COLLECTION	ANALYSES REQUESTED

1. RELINQUISHED BY:	**DATE/TIME:**	**1. RECEIVED BY:**	**3. RELINQUISHED BY:**	**DATE/TIME:**	**3. RECEIVED BY:**	**SAMPLE LOCATION:**
2. RELINQUISHED BY:	**DATE/TIME:**	**2. RECEIVED BY:**	**4. RELINQUISHED BY:**	**DATE/TIME:**	**4. RECEIVED BY:**	

DELIVERABLE PACKAGE (check one)
☐ ECRA TIER II ☐ NJPDES ☐ TIER I ☐ NORMAL QC ☐ OTHER

COMMENTS:

Acc-1/6-89

Shakti Consultants,Inc.

185 Gatzmer Ave
Jamesburg NJ 00831

52 Mountaineer Dr
Elkview, WV 25071

Water Level Record Sheet

Project

Location

Well #

Reference Pt Elev.(feet)

Land Surface Elev. (feet)

Well Depth (feet)

Perforated Interval

Aquifer zone

Date Time	Well	Well	Well	Well	Well	Well	Well

Comments

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185 Gatzmer Ave
Jamesburg NJ 00831

52 Mountaineer Dr
Elkview, WV 25071

Water Level Record Sheet

Project
Location
Well #
Reference Pt Elev.(feet)
Land Surface Elev. (feet)
Well Depth (feet)
Perforated Interval
Aquifer zone

Well # Date	Time	Ground Elevn.	Depth of Water below TOC	Stick-up	Depth of Water below GL	Water Level Elevation	Remarks

Comments

Shakti Consultants,Inc

Shakti Consultants,Inc.

185 Gatzmer Ave
Jamesburg NJ 00831

52 Mountaineer Dr
Elkview, WV 25071

Fracture/Joint Survey

Project
Location
Date Time

Diagram		Strike	Dip	Designation	Comments

Comments:

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185 Gatzmer Ave
Jamesburg NJ 00831
52 Mountaineer Dr
Elkview, WV 25071

Fracture/Joint Survey

Project
Location
Date Time

Diagram		Strike	Dip	Designation	Comments

Comments:

Formula for Calculation of Saturated Well Volume

The basic Formula is V = TT r^2h
V = Volume (ft^3)
TT = 3.14
r = Radius of monitoring well casing (ft.)
h = Height of standing water in well (ft.)

This formula is then modified to the following:

$$V = \frac{3.1416 \text{ x } r^2 \text{ x } h \text{ (inches}}{231}$$

So that the number of gallons of water per foot of pipe for any diameter can be obtained by:

No. 1. $V = \frac{3.146 \text{ x } (1/2 \text{ diameter})^2 \text{ x } 12}{231}$ or

No. 2. $V = \frac{0.7854 \text{ x } (1/2 \text{ diameter})^2 \text{ x } 12}{231}$ or

Consequently, if:

Pipe Size	Gal(s)/Ft.
2.0 in.	0.1632
3.0	0.3672
3 1/2	0.4998
4.0	0.6528
4 1/2	0.8262
5.0	1.0200
5 1/2	1.2342
6.0	1.4688

Note: 1 gallon of water = 231 cubic inches = 3.785 liters = 8.336 lbs. = 0.1337 cubic feet.

Shakti Consultants,Inc

CLASSIFICATION SHEET

Sheet __ of __
Project: ____________________
Job #: ____________________
Site Area: ____________________
Contractor: ____________________
Coordinates ____________________
____

Drill Method
Additions
Date Drilled

WELL CONSTRUCTION

See well construction diagram

WELL DEVELOPMENT

Well#					
Permit #:					
Distance to Water					
Submerge Volume					
Rate					
Vol Pumped					
Pump Used:					
Sp C initial					
stable					
Temp initial					
stable					
pH initial					
stable					

SAMPLING

Elevation Ground					
Elevn ft					
Top of Casing					
Depth To water from TOC					
Stickup of the casing					
Elev of the Ground					
Calcltd Water					
from Top of Casing					
GW Elev 0 Hrs					
24 Hrs.					
Date:					
Comments					

SAMPLE DOCUMENTATION

Shakti Consultants,Inc.

185 Gatzmer Ave
Jamesburg NJ 00831

52 Mountaineer Dr
Elkview, WV 25071

Sample # Site Designation Type Location Depth Other

Time Date
Site name Address

Sampled by Witness

Affiliation Address

Sampling Method

Decontamination

Type of Container Namber Volume

Field Preparation

Sample Preservation Time/Date

Preserved By

Custody Seal Volume Level on Container

Decontamination of Container

Stored In Time Date

Signature

Quality Assurance Samples (DR = Drilling Reagent,B = Backgrourd,
F = Field Blank, SS = Spiked Sample):
Air Monitoring - Calibration

TRANSPORTATION

See Chain of Custody

ANALYSIS

See Analysis Request Form

Comments:

PHOTOVAC
Technical Bulletin

27

PREPARATION OF AQUEOUS STANDARDS FOR GROUNDWATER ANALYSIS

For further information on contents of this bulletin or on Photovac products, please contact:

PHOTOVAC
incorporated

United States
PHOTOVAC INTERNATIONAL
INCORPORATED
741 Park Avenue
Huntington
New York 11743
USA
Telephone: 516-351-5809
Toll-free: 1-800-387-5700

Worldwide
PHOTOVAC INCORPORATED
134 Doncaster Avenue
Unit 2
Thornhill, Ontario
Canada
L3T 1L3
Telephone: 416-881-8225
Telex: 06-964634 PHOTOVAC TOR

PHOTOVAC TECHNICAL BULLETIN #27

PREPARATION OF AQUEOUS STANDARDS FOR GROUNDWATER ANALYSIS

This procedure is based on an actual site investigation conducted with E.P.A. approval and is intended to provide a guide for similar investigations. Local site conditions and the type of compounds present will obviously be different and approval of the planned procedure will need local E.P.A. approval.

PREPARATION OF WATER STANDARDS

This is a general guideline to be used when making water standards of volatile compounds. The example given is for Benzene and TCE, two compounds commonly found in groundwater contamination. The volumes used for generating the initial stock solution and subsequent dilutions are readily dispensable to allow the preparation of low concentration standards.

The accuracy of the standards is dependent on the precautions taken in the transfers of liquids and care taken to prevent headspace loss. Cross contamination by using contaminated syringes must also be avoided.

APPARATUS: The following apparatus is required, with care being taken to decontaminate the various items using only spectroscopic grade solvents:

1. 40 ml VOA bottles
2. Gas-tight syringes (50 ul to 100 ul).
3. Volumetric pipettes to measure 20 ml and 40 ml volumes. (Other glassware of compatible accuracy can be used as alternatives).
4. Analytical balance (and pan balance if available).

REAGENTS

1. 100 ml Methanol
2. Approximately 20 ml each of other desired reagents.
3. Organic-free water.

PROCEDURE

If analytical balances are available, then the preferred method of making standards is to weigh small quantities of the volatile organic compounds in gas-tight syringes. These quantities are transferred to 20 ml of Methanol and the whole reweighed (See Appendix A, "Procedure For Weighing Liquids With A Syringe"). Concentration is then calculated directly on a wt/wt basis (ppm = ug/g).

If analytical balances are not available, the densities of the compounds are used to describe the weight of known volumes. The following is an example for making water standards at low ppb concentrations of Benzene and TCE. The procedure consists of 3 parts: A) Making a stock solution in Methanol (approx. 1000-5000 ppm), B) 1/800 dilution in water, C) 1/500 dilution in water.

A) STOCK SOLUTION IN METHANOL

1. Using a 20 ml volumetric pipette, transfer 20 ml of Methanol to a 40 ml

VOA bottle. Cap the bottle immediately. The density of Methanol is $\frac{.7915\text{ g}}{\text{ml}}$ at 20°C, 20 ml should weigh:

$$\frac{.7915\text{ g}}{\text{ml}} \times 20\text{ ml} = 15.83\text{ g of Methanol}$$

2. Using a gas-tight 100 µl syringe, transfer 40 ul of TCE into the 20 ml of Methanol. The density of TCE is $\frac{1.465\text{ g}}{\text{ml}}$ at 20°C therefore 40 µl weighs

$$\frac{1.465\text{ g}}{\text{ml}} = \frac{1465\text{ mg}}{\text{ml}} = \frac{1465\text{ mg}}{1000\text{ µl}} = \frac{1.465\text{ mg}}{\text{µl}}$$

Therefore, $40\text{ µl} \times \frac{1.465\text{ mg}}{\text{µl}} = 58.6\text{ mg TCE}$

3. With a clean syringe, transfer 60 µl of Benzene to the TCE/Methanol mixture. The density of Benzene at 20°C is $\frac{.8794\text{ g}}{\text{ml}}$ therefore 60 µl =

$$\frac{0.8794\text{ g}}{\text{ml}} = \frac{0.8794\text{ mg}}{\text{µl}} \times 60\text{ µl} = 52.76\text{ mg Benzene}$$

Concentration of stock solution

$$\text{for Benzene - } \frac{52.76\text{ mg Benzene}}{52.76\text{ mg Benzene} = 58.6\text{ mg TCE} + 15.83\text{ g Methanol}} =$$

$$\frac{52.76\text{ mg Benzene}}{15.94\text{ g total}} = \frac{52{,}760\text{ µg}}{15.94\text{ g}} = \frac{3310\text{ µg}}{1\text{ g}} = 3310\text{ ppm}$$

$$\text{for TCE - } \frac{58.60\text{ mg TCE}}{58.60\text{ mg TCE} + 52.76\text{ mg Benzene} + 15.83\text{ g Methanol}} =$$

$$\frac{58.60\text{ mg TCE}}{15.94\text{ g total}} = \frac{3676\text{ µg}}{1\text{ g}} = 3676\text{ ppm}$$

This mixture is Solution A.

B) 1st Dilution of Stock:

Withdraw 50 µl of stock solution with a 100 µl syringe and transfer into 40 ml of organic-free water within a VOA bottle. Mix by shaking for a few minutes and let stand for 15 minutes.

$$\text{Concentration} = \frac{.050\text{ ml stock}}{40\text{ ml water}} = \frac{1}{800} = 4.6\text{ ppm TCE}$$

and 4.14 ppm Benzene (Solution B)

C) 2nd Dilution:

Using Solution B, withdraw 40 µl and expel into 20 ml water in a 40 ml VOA bottle. Invert the bottle and swirl a few minutes.

Let the solution sit 30 minutes to equilibrate before using.

Concentration: $\frac{40\ \mu l \text{ Solution B}}{20 \text{ ml water}} =$

$\frac{.40 \text{ ml}}{20 \text{ ml}} = \frac{1}{500}$ dilution = 9.2 ppb TCE + 8.3 ppb Benzene (Solution)

Solution C is the working Standard.

NOTE: Follow chemical manufacturer's recommended safety information for the reagents used.

Precautionary Notes

1. Care should be taken not to inject liquid into the G.C.
2. When using a 10S50 or 10S70 G.C. use a separate library for water standard data. By listing the headspace concentration as the liquid concentration, from the standards, the G.C. will then print results based on liquid concentration for field samples. This approach will prevent confusion with air calibration data and negates the need for using Henry's Law to calculate vapor concentrations with respect to liquid samples.
3. When working with samples in the parts-per-billion concentration range, freshly prepared aqueous standards should be used on a daily basis. The standards should be stored with the septum screw capped VOA vial inverted.
4. Depending upon the volume of headspace used for injection into the G.C., using a clean gas-tight syringe, transfer the same volume of UZ air to replenish the headspace. Allow the standard to equilibrate for approximately 1/2 hour.
5. Typically, injection volume of headspace range from 100-500 µl.

APPENDIX A

PROCEDURE FOR WEIGHING LIQUIDS WITH A SYRINGE

Cautions/Limitations:

1. The minimum amount of liquid to be weighed is 20 µl.
2. Use only about 50%-60% of the capacity of the syringe, therefore, the minimum size syringe that can be used is 50 µl.
3. Perform procedure as quickly as possible to avoid exposure and possible volatilization.
4. For liquids that are very volatile, it is necessary to draw total sample back into syringe barrel, before weighing, to prevent liquid volatilization during weighing procedure.

Procedure

1. Use a 50 µl syringe and withdraw at least 20 µl of liquid.
2. Carefully wipe the needle and syringe dry.
3. Place syringe on analytical balance and weigh. (Tare and sample).
4. Depress plunger to empty syringe into a suitable flask containing solvent. To prevent volatilization of liquid, be sure to empty contents of the syringe under the surface of the solvent.
5. Reweigh syringe (tare), and by difference calculate the weight of the liquid taken.

Shakti Consultants, Inc.
Work Plan Appendix
Pump Test Plan
08/09/90

Appendix C

Standard Operating Procedures for Air Sampling

Adsorbent Tubes

Photovac

Volatile Organic Air Pollutant Analysis

Introduction

Sampling for organics in air is performed by drawing air through a glass tube packed with activated charcoal, silica gel, porous polymer resin Tenax GC or other adsorbent. The traps and adsorbent must be thoroughly cleaned before use to minimize the trap background. Clean traps ready for field use must also be carefully packed in clean glass tubes to avoid contamination during handling.

Sample Trap Preparation

Materials

Glass sampling traps:	Pyrex glass traps constructed as shown in Figure 1.
Resin	Tenax GC, 35/60 mesh.
Glass wool	
Culture tubes	Pyrex glass screw cap tubes 25 mm x 110 mm
Pyrex	9825 or equivalent.
Teflon backed silicone septa	Pierce 12722 or equivalent.
Bakelite screw caps to fit culture tubes	Pierce 13219 or equivalent.
Dessicator	Glass dessicator with activated charcoal adsorbent.

Quart paint cans with pressure fit lids.

Resin Preparation

Extract new and used Tenax GC with methanol followed by pentane in a soxhlet extractor. Extract with each solvent at least 6 hours. Dry the resin under vacuum for at least 4 hours. Sieve the dried resin to the 35/60 mesh particle size range. Seal the cleaned and sieved resin in a glass jar capped with a teflon liner. Store in a dessicator containing activated carbon.

Trap and Container Cleanup

Wash new and used glass sampling traps and culture tubes with lab soap and hot tap water. Rinse at least three times with organics free water (Millipore or equivalent). Rinse with methanol and let air dry.

Bake the cleaned tubes in an oven at 220°C for at least 1 hour. Remove from the oven and store in a dessicator containing activated carbon. Wash glass wool with methanol, air dry and bake in an oven at 220°C for at least 1 hour. Remove from the oven and store in a dessicator containing activ#ated charcoal. Bake teflon backed septa in an oven at 80°C for 30 minutes. Remove from the oven and store in a dessicator containing activated charcoal. Bake paint cans in oven at 100°C for 1 hour.

Trap Preparation

Pack about a 1 cm plug of glass wool into the trap followed by 6 cm of cleaned Ten#x GC. Lightly tap the trap on the bench to pack the resin. Add another 1 cm glass wool plug to hold the resin in place. Condition each trap at 270°C with 20-30 ml/min helium flowrate for 30 minutes. Remove the hot trap and place into a culture tube with a glass wool plug to cushion the trap. Immediately cap the tube with a teflon lined septum cap. Store the tubes in batches of 7 traps in quart paint cans.

Quality Control

Prior to sending traps to the field, remove one trap from each paint can and analyze it for contaminants. If the traps are clean, the batch is acceptable for use. Mark the trap "Field blank - label and return" and replace it in the can.

Prior to sending traps to the field, remove one trap from each paint can and spike with known amounts of chemicals from: the permeation tube system. Mark the trap "Field spike - label and return" and replace it in the can.

Options

Traps with longer resin beds may be packed in order to increase the retention volumes of pollutants.

References

"Selection and Evaluation of Sorbant Resins for the Collection of Organic Coa'pounds", EPA-600/7-77-044, April 1977.

"Developement of Method for Carcinogenic Vapor Analysis in Ambient Atmospheres", EPA-650/2-74-121, July 1974.

Health and Safety Sampling

The following procedures and policies shall be followed to determine compliance with air quality standards ("Permissible Exposure Limits" or PELs).

Procedure: Personal Exposure

The determination of noncompliance with PELs requires measurement and documentation of an overexposure to at least one employee. For air contaminants having PELs, sampling must be conducted within the breathing zone. OSHA defines the breathing zone to be a sphere approximately two (2) feet in diameter surrounding the head.

In some instances (e.g., substances in 29 CFR 1910.10021014) personal sampling is not necessary to establish the presence of the material in order to substantiate a violation.

Procedure: Full-Shift Sampling.

Full-shift sampling is defined to be a minimum of the total time of the shift less one hour; i.e., 7 hours of an 8-hour workshift or 9 hours of a 10-hour workshift. Every attempt will be made to sample the greatest exposure periods. Such exposure may occur during set-up and take-down.

Pumps may be changed to avoid pump failure due to excessive sampling periods.

General Sampling Procedures

Calibrate the pumps in accordance with standard operating procedures with the collection device appropriate for the desired contaminant. Select the employee or location to be sampled and discuss the purpose of the sampling strategy. Advise the employees not to remove or tamper with the sampling equipment. Inform the employees when and where the equipment will be removed. Instruct the employee to notify the supervisor should the sampler require temporary removal. Place the sampling equipment on the employee or ina location so that it does not interfere with work performance.

To monitor the exposure of an individual: attach the collection device (filter cassette, charcoal tube, etc.) to the shirt collar or within the employee's breathing zone. The inlet orifice should generally be in a downward vertical position to avoid contamination. Position the excess tubing so as not to interfere with the work of the employee.

Turn on the pump; record the time. Adjust the flow rate to the calibrated mark. Observe the pump operation for a short time to check the flow rate. Record the information required by the Air Sampling Data form (OSHA-91). As a minimum, check the pump flow after approximately the first half-hour, hour, and every two hours thereafter. Ensure that the sampler is still assembled properly and that the hose has not become pinched or #etached from the cassette or the pump.

In order to determine of the desired flow rate is being maintained during sampling, one of the following two methods may be used.

1) The pump rotometer reading shall be observed and noted. On subsequent checks if the pump rotometer has changed, it should be adjusted back to the initial position.

2) The precision rotometer can be plugged into the cassette, and knowing the desired precision rotometer setting, the pump flow rate can be determined.
Adjustments shall be noted on the OSHA-91.

Take detailed notes concerning visible airborne contaminants and other conditions to assist in determining appropriate engineering controls.

Prepare a blank(s) during the sample period. Before removing the pump at the end of the sample period, check the flow rate to ensure that the rotometer ball is still at the calibrated mark. If the ball is no longer at the mark, record the pump or precision rotometer reading.

Turn the pump off and record the ending time. Remove the collection device from the pump and seal it as soon as possible. Prepare the samples for transport to the laboratory for analysis.

Pumps shall be recalibrated after each day of sampling (before charging) for the pump rotometer setting last used.

Sampling Method for Organic Vapors and Gases

Organic vapors and gases may be collected on activated charcoal, silica gel, or other adsorption tubes. Immediately before sampling, break off the ends of the charcoal tube so as to provide an opening approximately one-half the internal diameter of the tube. The charging inlet or the exhaust outlet of the pump shall not be used to break the ends of the charcoal tube. The smaller section of the charcoal is used as a backup and is positioned nearest the sampling pump. The charcoal tube shall be held or attached in an approximately vertical position with the inlet either up or down suring sampling.

The air to be sampled must be drawn directly into the inlet of the glass charcoal tube and not passed through any hose or tubing before entering the tubing to the pump. Cap the charcoal tube with the supplied plastic caps immediately after sampling and seal as soon as possible. For other adsorption tubes, follow the same procedures as those of the charcoal tube with the following exceptions:

1) Tubes may be furnished by the laboratory with either caps or flame-sealed glass ends. The capped version is simply uncapped during the sampling period and recapped at the end of the sampling period.

2) The ends of the flame-sealed glass tubes are broken at the beginning of the sampling period and capped at the end of the sampling period.

For organic vapors and gases, low flow pumps are preferable, except where measuring ceiling exposures.

Attachment to: Sample Trap Preparation

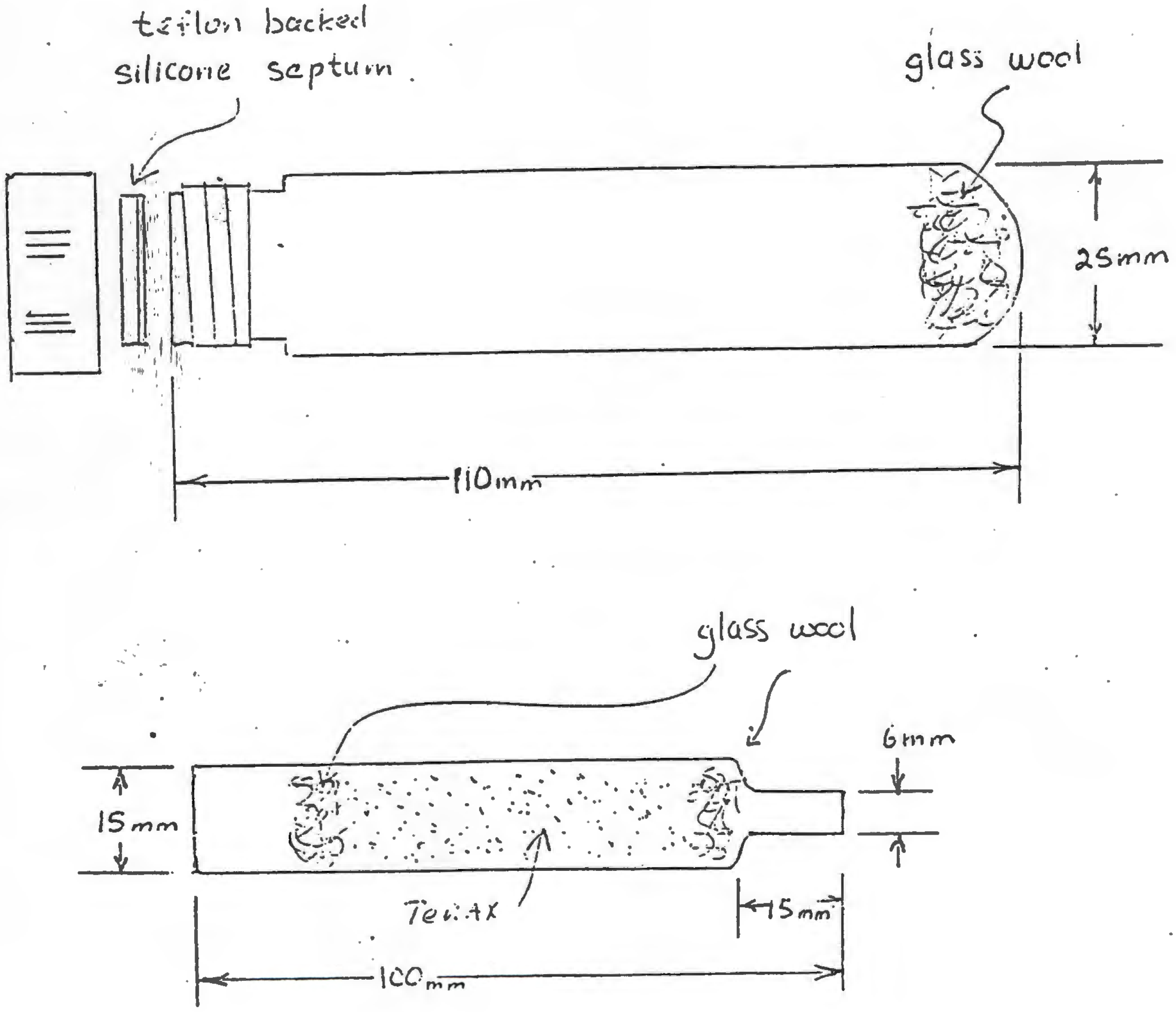
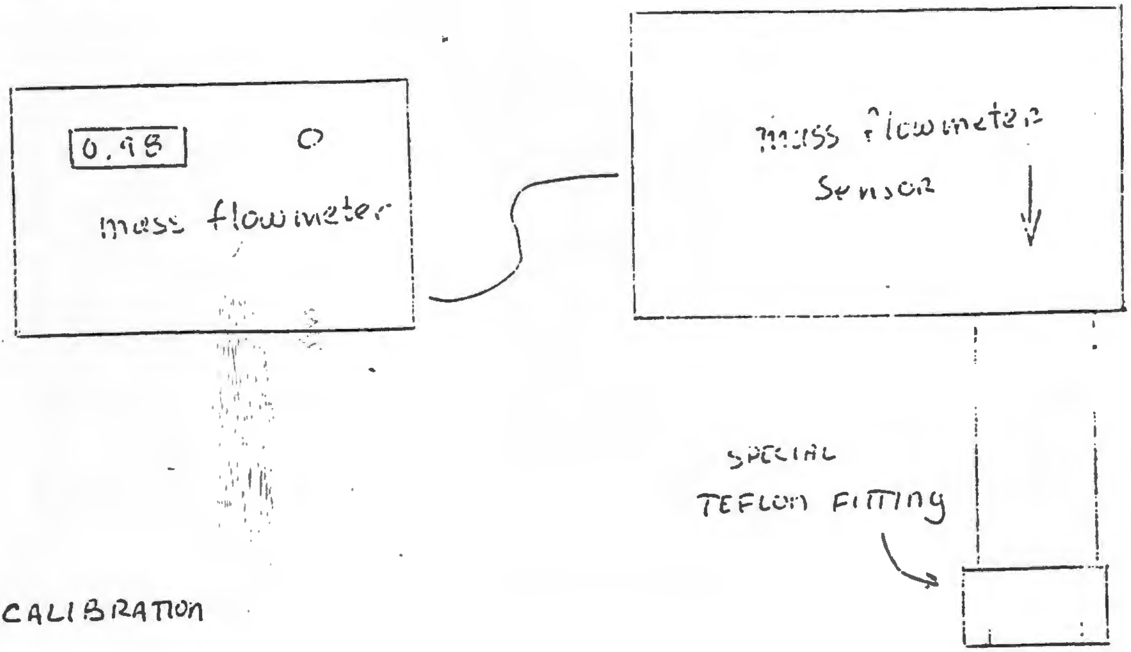


figure 1. Sampling trap and culture tube holder design.

Sample Collection



CALIBRATION

SAMPLING

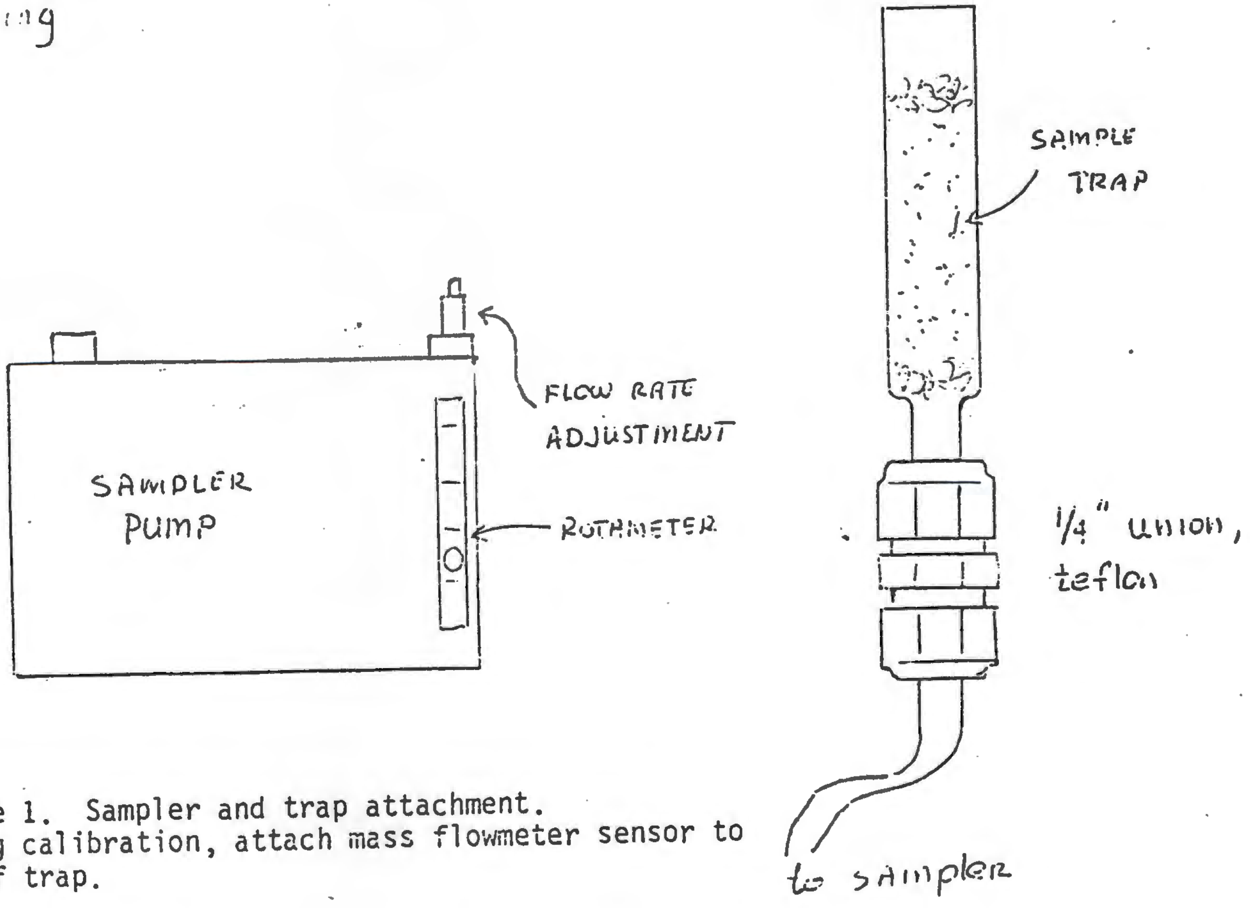


figure 1. Sampler and trap attachment.
During calibration, attach mass flowmeter sensor to top of trap.

FORMULA: Table 1

M.W.: Table 1

HYDROCARBONS, HALOGENATED

METHOD: 1003
ISSUED: 2/15/84
REVISION #1: 8/15/87

COMPOUNDS: (synonyms in Table 1)

benzyl chloride
bromoform
carbon tetrachloride
chlorobenzene
chlorobromomethane
chloroform
o-dichlorobenzene
p-dichlorobenzene
1,1-dichloroethane
1,2-dichloroethylene
ethylene dichloride
hexachloroethane
methylchloroform
tetrachloroethylene
1,1,2-trichloroethane
1,2,3-trichloropropane

SAMPLING

SAMPLER: SOLID SORBENT TUBE
(coconut shell charcoal, 100 mg/50 mg)

FLOW RATE: 0.01 to 0.2 L/min

VOL-MIN: Table 2
-MAX: Table 2

SHIPMENT: routine

SAMPLE STABILITY: not determined

FIELD BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: see EVALUATION OF METHOD [1]

BIAS: not significant [1]

OVERALL PRECISION (s_r): see EVALUATION OF METHOD [1]

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTE: compounds above

DESORPTION: 1 mL CS_2, stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURES: Table 3

CARRIER GAS: N_2 or He, 30 mL/min

COLUMN: Table 3; alternates are SP-2100, SP-2100 with 0.1% Carbowax 1500 or DB-1 fused silica capillary column

CALIBRATION: standard solutions of analyte in CS_2

RANGE: Table 3

ESTIMATED LOD: 0.01 mg per sample [2]

PRECISION (s_r): see EVALUATION OF METHOD [1]

APPLICABILITY: See Table 2 for working ranges. This method can be used for simultaneous determination of two or more substances suspected to be present by changing gas chromatographic conditions (i.e., temperature program). High humidity during sampling will prevent organic vapors from being trapped efficiently on the sorbent and greatly decreases breakthrough volume.

INTERFERENCES: None identified. The chromatographic column or separation conditions may be changed to circumvent interferences.

OTHER METHODS: This method combines and replaces P&CAM 127 [3], S101 [4], S110 [5], S113 [6], S114 [7], S115 [8], S122 [9], S123 [10], S126 [11], S133 [12], S134 [13], S135 [14], S281 [15], S314 [16], S328 [17], S335 [18], S351 [19], and Method 1003 (dated 2/15/84).

a. Remove and discard back sorbent section of a media blank sampler.
b. Inject a known amount (2 to 20 µL) of pure analyte, or calibration stock solution (see REAGENTS, 3.), directly onto front sorbent section with a microliter syringe.
c. Cap the tube. Allow to stand overnight.
d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11 and 12).
e. Prepare a graph of DE vs. mg analyte recovered.

10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1003-1 and in Table 3. Inject sample aliquot manually using solvent flush technique or with autosampler.
    NOTE: If peak area is above the linear range of the working standards, dilute with CS_2, reanalyze and apply the appropriate dilution factor in calculations.
12. Measure peak area.

CALCULATIONS:

13. Determine the mass, mg (corrected for DE), of analyte found in the sample front (W_f) and back (W_b) sorbent sections and in the average media blank front (B_f) and back (B_b) sorbent sections.
    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
14. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b)\cdot 10^3}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Laboratory testing was performed with spiked samples and generated atmospheres using SKC Lot 105 coconut shell charcoal [1]. Results were:

Compound	Range, mg/m³	Sample Size	Precision (s_r)		Desorption Efficiency	Ref.
			Overall	Measurement		
Benzyl chloride	2–8	10 L	0.096	0.031	0.90 @ 0.03–0.1 mg	[8]
Bromoform	3–10	10 L	0.071	0.043	0.80 @ 0.025 mg	[7]
Carbon tetrachloride	65–299	15 L	0.092	0.037	0.96 @ 1.3–4.8 mg	[16]
Chlorobenzene	183–736	10 L	0.056	0.025	0.91 @ 1.8–7.1 mg	[12]
Chlorobromomethane	640–2655	5 L	0.061	0.051	0.94 @ 3.3–13 mg	[6]
Chloroform	100–416	15 L	0.057	0.047	0.97 @ 1.8–7.4 mg	[19]
o-Dichlorobenzene	150–629	3 L	0.068	0.013	0.86 @ 0.5–1.9 mg	[14]
p-Dichlorobenzene	183–777	3 L	0.052	0.022	0.91 @ 0.7–2.7 mg	[15]
1,1-Dichloroethane	212–838	10 L	0.057	0.011	1.01 @ 1.9–8 mg	[10]
1,2-Dichloroethylene*	475–1915	3 L	0.052	0.017	1.00 @ 2.4–9.5 mg	[5]
Ethylene dichloride	195–819	3 L	0.079	0.012	0.96 @ 0.6–2.5 mg	[9]
Hexachloroethane	5–25	10 L	0.121	0.014	0.98 @ 0.05–0.2 mg	[4]
Methyl chloroform	904–3790	3 L	0.054	0.018	0.99 @ 2.9–11 mg	[17]
Tetrachloroethylene	655–2749	3 L	0.052	0.013	0.96 @ 2.1–8 mg	[18]
1,1,2-Trichloroethane	26–111	10 L	0.057	0.010	0.97 @ 0.3–1.2 mg	[13]
1,2,3-Trichloropropane	163–629	10 L	0.068	0.027	0.95 @ 1.5–6 mg	[11]

*isomer used (i.e., cis- or trans-) in evaluation unknown.

Table 1. General information.

Compound	M.W.	mg/m^3 = 1 ppm @ NTP	Synonyms	OSHA/NIOSH/ACGIH (ppm)
Benzyl chloride* ($C_6H_5CH_2Cl$)	126.58	5.17	(chloromethyl) benzene; α-chlorotoluene; CAS #100-44-7	1/—/1 [20,23]
Bromoform ($CHBr_3$)	252.75	10.33	tribromomethane; CAS #75-25-2	0.5/—/0.5 (skin) [20]
Carbon tetrachloride* (CCl_4)	153.84	6.29	tetrachloromethane; CAS #56-23-5	10, C 25/C 2/5 (skin) [20,24]
Chlorobenzene (C_6H_5Cl)	112.56	4.60	monochlorobenzene; phenyl chloride; CAS #108-90-7	75/—/75 [20]
Chlorobromomethane (CH_2BrCl)	129.39	5.29	bromochloromethane; Halon 1011; CAS #74-97-5	200/—/200, STEL 250 [20]
Chloroform* ($CHCl_3$)	119.39	4.88	trichloromethane; CAS #67-66-3	C 50/C 2/10 [20,25]
o-Dichlorobenzene (1,2-$C_6H_4Cl_2$)	147.00	6.01	1,2-dichlorobenzene; CAS #95-50-1	50/—/C 50 [20]
p-Dichlorobenzene (1,4-$C_6H_4Cl_2$)	147.00	6.01	1,4-dichlorobenzene; CAS #106-46-7	75/—/75, STEL 110 [20]
1,1-Dichloroethane (CH_3CHCl_2)	98.96	4.05	ethylidene chloride; CAS #75-34-3	100/100/200, STEL 250 [20,21]
1,2-Dichloroethylene ($ClCH{=}CHCl$)	96.94	3.96	acetylene dichloride; 1,2-dichloroethene; CAS #540-59-0	200/—/200, STEL 250 [20]
Ethylene dichloride* ($ClCH_2CH_2Cl$)	98.96	4.05	1,2-dichloroethane; CAS #107-06-2	50, C 100/5, C 15/10 [20,21,26]
Hexachloroethane* (CCl_3CCl_3)	236.74	9.68	perchloroethane; CAS #67-72-1	1 (skin)/—/10 [20,21]
Methylchloroform (CH_3CCl_3)	133.42	5.45	1,1,1-trichloroethane; CAS #71-55-6	350/C 350/350, STEL 450 [20,21,27]
Tetrachloroethylene ($Cl_2C{=}CCl_2$)	165.83	6.78	perchloroethylene; CAS #127-18-4	100, C 200, P 300/—/ 50, STEL 200 [20,28]
1,1,2-Trichloroethane (Cl_2CHCH_2Cl)	133.41	5.45	vinyl trichloride; CAS #79-00-5	10 (skin)/—/10 (skin) [20,21]
1,2,3-Trichloropropane ($CH_2ClCHClCH_2Cl$)	147.43	6.03	allyl trichloride; glycerol trichlorohydrin; CAS #96-18-4	50/—/50, STEL 75 [20]

*Suspect carcinogen [20,21,22].

CORRELATION BETWEEN FIELD GC MEASUREMENT OF VOLATILE ORGANICS AND LABORATORY CONFIRMATION OF COLLECTED FIELD SAMPLES USING THE GC/MS

Dr. Thomas M. Spittler, Richard J. Siscanaw,
Moira M. Lataille
U. S. EPA, Region I Laboratory
Lexington, MA 02173

Patricia A. Parks
University of Massachusetts, Amherst, MA

A procedure has been developed to monitor low levels of volatile organics in ambient air. On a given site, a two-phase monitoring program is established. The first phase involves field measurements using a sensitive portable gas chromatograph with a photoionization detector capable of determining most solvents in the 1-50 ppb range.

Once areas of concern are defined, a few lab samples are collected for GC and GC/MS analysis. Samples (1-30 liters) are adsorbed on precleaned activated charcoal. Lab analysis is performed using a Programmed Thermal Desorber (PTD) which desorbs the contents of the field sampler into a 300 cc stainless steel piston from which aliquots are withdrawn for GC or GC/MS analysis.

Based on first phase results, a detailed field study plan is formulated. In the second phase, field collection is again done on charcoal packed tubes. In the lab, analysis is by thermal desorption, GC and GC/MS. Correlation between field data and final GC/MS confirmation has been excellent. Vapor standards are used to calibrate lab instruments and to determine recovery efficiency.

The overall technique is relatively simple, inexpensive and produces answers in a rapid turnaround time. Several New England States are equipping to use this technique in investigations of hazardous waste sites and odor complaints. In addition, other regional laboratories within EPA are currently evaluating the procedures for ambient air investigations.

CORRELATION BETWEEN FIELD GC MEASUREMENT OF VOLATILE ORGANICS AND LABORATORY CONFIRMATION OF COLLECTED FIELD SAMPLES USING THE GC/MS

Introduction

Over the past five years, there has been a dramatic increase in methods development for measurement of volatile organics in ambient air. A wide range of solid adsorbents followed by solvent extraction and thermal desorption have been reported on.[1,2] Use of cryogenic trapping, cryogenic focussing of thermally desorbed vapors and many configurations of GC and GC/MS analysis have been reported.[3] Mobile vans have been outfitted with a wide range of GC equipment for direct field measurement[4] and a van containing a mass spectrometer is also employed for ambient air measurement.[5]

In all the above methodologies except the mobile vans, an important element of monitoring is missing, real time data - the ability to measure contamination on sites by direct sampling of the ambient air with no intervening concentration step. A second element often missing is the need to have a methodology which employs currently available tools even if the technique is not yet capable of answering all the questions surrounding analysis of volatile organics in ambient air. This paper reports on a technique for direct field measurement of volatile organics in ambient air in the 1-50 ppb range. For this purpose, a portable gas chromatograph with a sensitive PID detector is employed.[6] The field measurements are used to determine contamination qualitatively and semi-quantitatively. This provides the data needed to plan for and collect time integrated samples at appropriate locations for return to the lab. In the lab the analyst can confirm by GC/MS analysis his field identifications and quantitations.

Experimental Method

Figure 1 is a photograph of the Photovac portable gas chromatograph. Sampling is done with all-glass or gas-tight syringes. The air sample is immediately injected onto one of two columns. A short column (12" Carbowax) is used first to screen for the range of volatiles present. Figure 2 shows two mixtures run on the short and long columns. Separation of cis- and trans-1,1 DCE indicates how useful even short run data can be in making preliminary identifications by retention time (RT). When a determination has been made that no significant contaminants elute after a few minutes, the same sample can be injected on the 4' SE 30 column for better separation and RT determination.

Figure 3 is a typical field chromatogram showing the presence of aliphatic hydrocarbons in the C_2-C_6 range, as well as the commonest aromatics. Using a vapor mixture of Benzene and Toluene, the field analyst can readily identify and quantify these compounds. Where more complex chromatograms are encountered, it is a relatively simple matter to run two or three standard mixtures on both columns and then use two-column RT's to make a positive identification. Even interfering

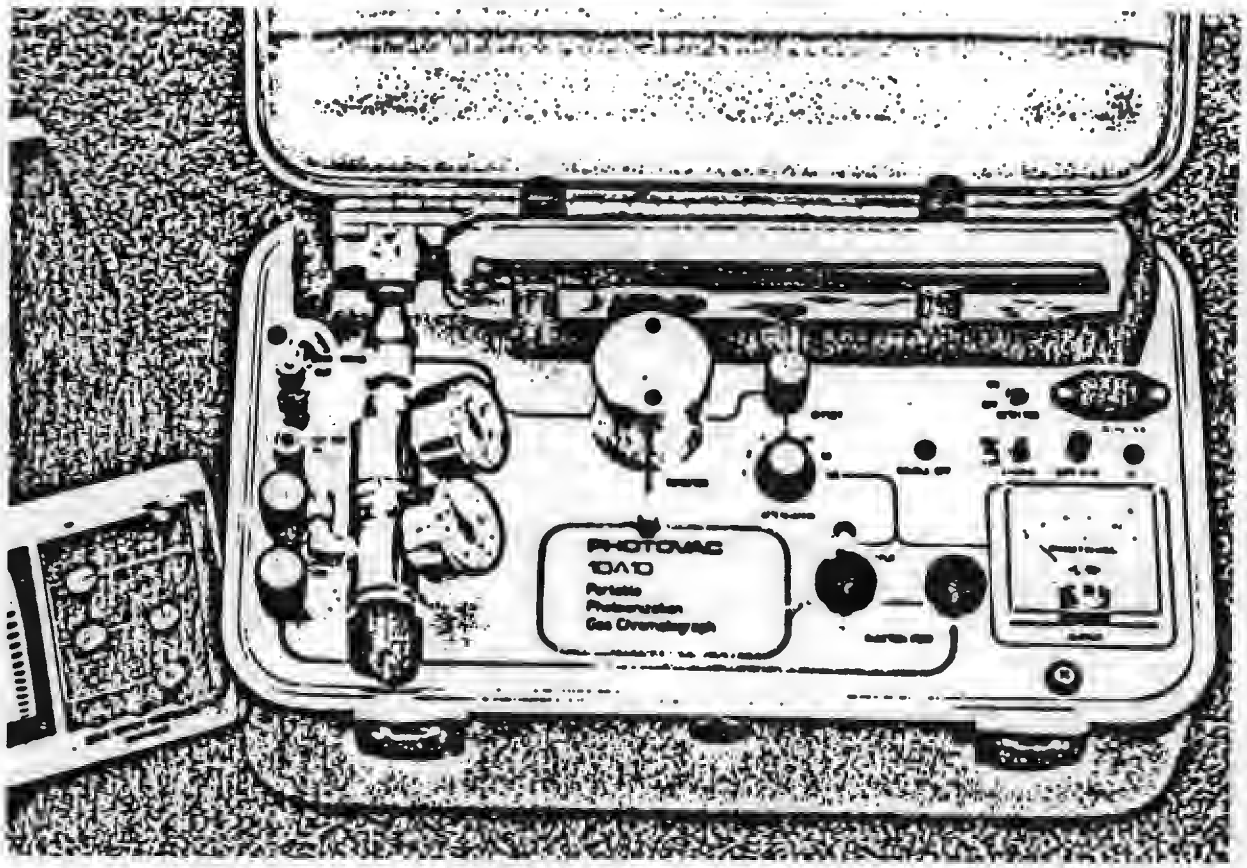


Figure 1 The Photovac 10A10 Portable Photoionization Gas Chromatograph

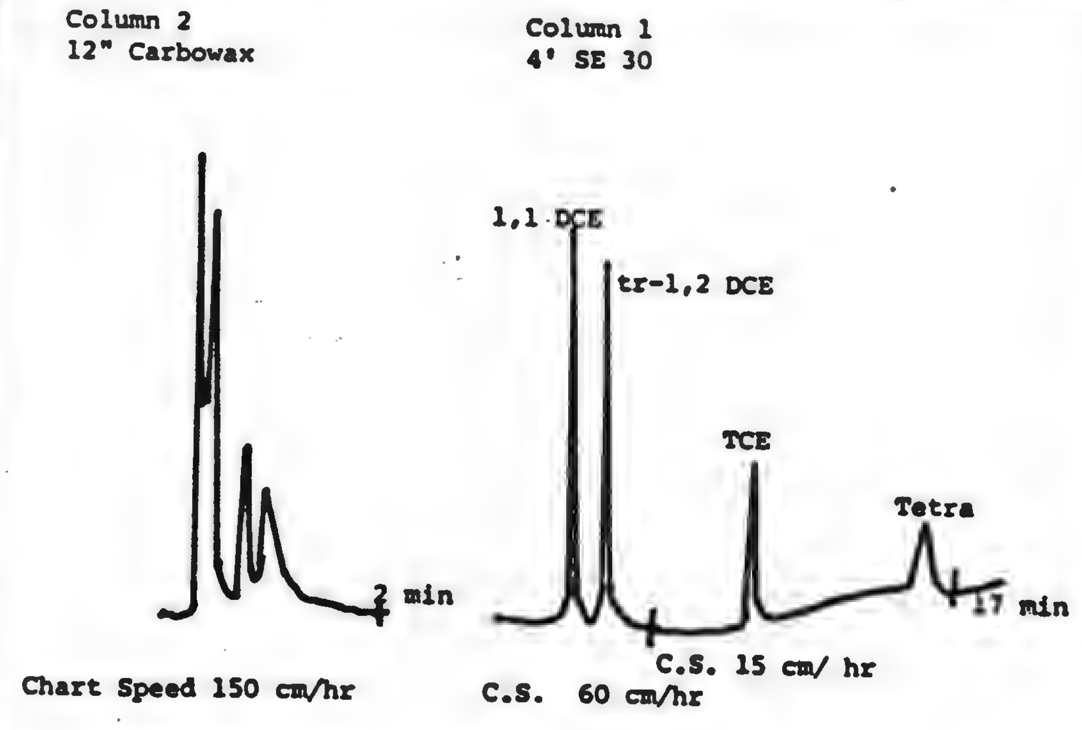


Figure 2 Chloroalkene Standard run on Both Columns of the 10A10 GC

and overlapping peaks can be tentatively identified in the field by this technique.

Organic vapor standards for field use are prepared in two ways. For qualitative identification, we often employ the headspace technique. This technique involves sampling the vapor headspace above a dilute aqueous solution of organic solvents. Such solutions are easily prepared and have amazing stability. The standards used in Figure 2 were prepared six months prior to these runs. Figure 4 shows the method used for preparation of aqueous and vapor standards. Standard B is prepared by injecting small amounts of the aqueous phases of stock samples C, D and E into a measured amount of organic free water. Stock samples C and D are simply equilibrium solutions of commonly encountered volatile solvents. In the case of very soluble solvents like acetone, a 5% solution is prepared and stored over a liquid mercury seal. The mercury prevents loss of solution strength by diffusion through the punctured septum. When an appropriate mixture has been prepared in vial B, the sample is kept in an inverted position. Again, liquid mercury prevents sample loss. The vial is only turned upright to withdraw a vapor headspace sample.

Vial A of Figure 4 indicates the method used for preparation of vapor standards. Typically 1 ul of organic liquid is injected into a stock vial and the concentration is calculated from density and vial volume. Dilutions into another vial can be made using a gas-tight syringe and careful gas handling technique. Once again, a liquid mercury seal is used to prevent loss of low level standards through septum punctures. Experience has shown that mercury sealed standards are stable for many days. Depletion is principally through withdrawal for analysis. Since stock standards are typically in the pph range (1 ul of 1,1 DCE/160cc contains 7,680 ppm) these standards can be used for months to prepare dilute standards without significant loss of strength.

Time integrated field sampling is done using 1/4" i.d. flared stainless steel tubes packed with activated charcoal. Tubes are prepared for field use by thermally desorbing at 250°C for 5 minutes into the holding chamber of a Foxboro Analytical Programmed Thermal Desorber (PTD). The chamber is a 300 cc polished stainless steel piston from which aliquots can be withdrawn for GC or GC/MS analysis. Tubes are precleaned to a background level corresponding to less than 1 ppb of volatile organics in a collected air sample. Depending on the volatile organic of interest and the volume of sampled air, detection to .01 ppb is possible with this system.

Precleaned sampling tubes are stored in individual septum sealed 40 cc vials for transport to and from the field. During field sampling, the tube is attached to a battery operated pump capable of flows from 50-500 cc/min. Sampling time and flow is adjusted to collect an adequate volume of ambient air and the exposed tube is replaced into its own sealed vial for return to the lab. Vials are stored in canisters containing activated charcoal and the sealed canisters are refrigerated during shipment and pre-analysis storage at the lab. Appropriate blanks, duplicates, backups and spikes are incorporated into

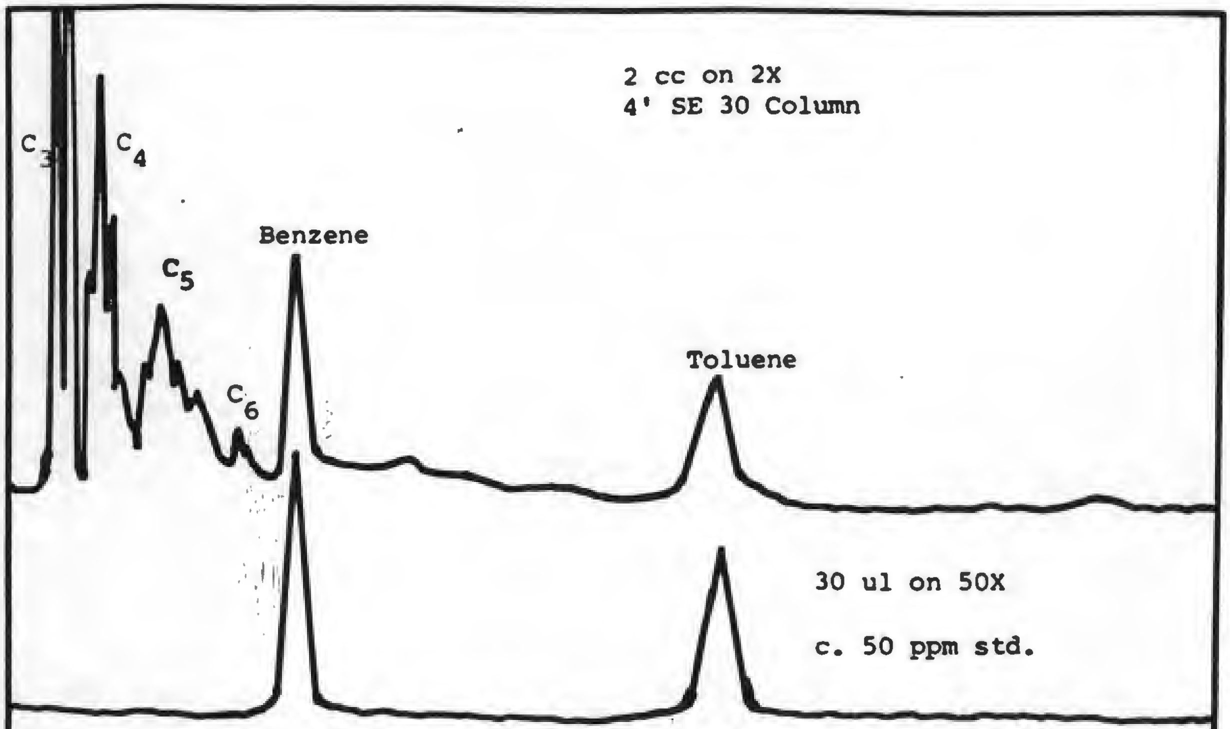


Figure 3 Field Chromatogram of Ambient Air Sample and Field Standard

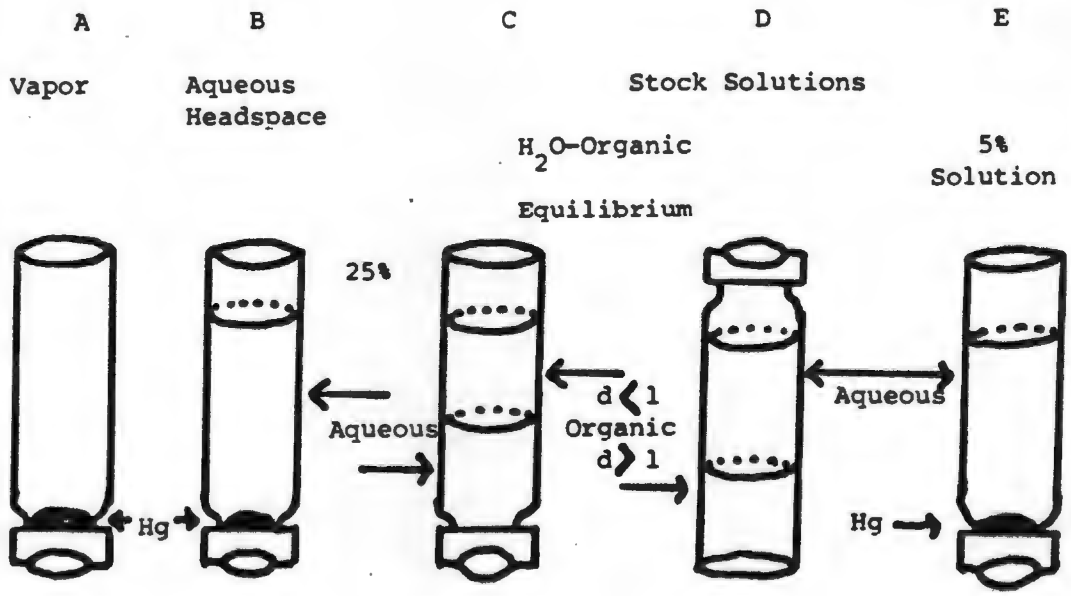


Figure 4 Standards for Lab and Field Calibration

the Quality Control program for any field study.

In the lab, analysis is carried out in two stages. The sample is thermally desorbed in the PTD at 200°C for five minutes. A first analysis is done by withdrawing a small sample (100-500 ul) and injecting into the same PID-GC that was used in the preliminary field study. Usually the pattern found in the field is repeated under the same conditions of column, flow, etc. Based on lab vapor standards (and experience), the analyst now knows the approximate composition and concentration of the field sample. Using this information, a second (much larger) vapor sample is now withdrawn from the PTD and introduced into the GC/MS for definitive qualitative and quantitative analysis.

Figure 5 shows the dry purge and trap (P&T) modification to the GC/MS for ambient air analysis. Through a Luer adapter, a large air sample can be injected onto the P&T trap. After sampling from the PTD and prior to injection into the GC/MS, a vapor spike of 100 ng of 2-chloro-propane is added to the large syringe. This serves as an internal standard for all GC/MS analyses. Vapor standards prepared as described above, are then injected <u>via</u> the dry P&T to calibrate the GC/MS system. The standards contain all identified volatiles above the GC/MS detection limit.

Finally, an adsorption-thermal desorption recovery study is run on any compounds found for which the lab has no prior recovery data. Recovery studies are performed in two ways. The first method employs a standard mixture such as the one used to calibrate the GC/MS. An appropriate sized aliquot is analyzed directly by GC or GC/MS. A second (larger) sample is loaded onto a charcoal tube using the apparatus shown in Figure 6. The spiked tube is then processed in the PTD and an aliquot is analyzed by GC or GC/MS which is exactly equivalent to the sample analyzed directly. Comparison of the two chromatograms by peak height measurements on the GC or integration on the GC/MS yields a direct recovery figure.

A second (more recent) approach is to spike a large air bag with several volatile solvents and wait a few days for equilibration with the walls. This artificial atmosphere is then sampled directly <u>via</u> syringe and analyzed by GC or GC/MS. Next a charcoal tube and pump is attached to the bag and it is sampled for 1-60 minutes at an appropriate flow rate. The collected sample is thermally desorbed and an appropriate aliquot from the PTD chamber is analyzed by the same analytical procedure. The two aliquots are sized to be exactly equivalent and % recovery is calculated by peak height or integration comparison.

<u>Results and Discussion</u>

Our field experience over the past four years has led us to conclude that in background air, only a few volatile organics are found above the 1 ppb level exclusive of aliphatic hydrocarbons. In most cases we find at upwind locations 1-10 ppb of benzene and 1-20 ppb of toluene along with 1-4 ppb of methyl and ethyl substituted benzenes. These aromatics are typical of automotive exhaust and/or widespread fugitive emissions from automotive fuel handling.

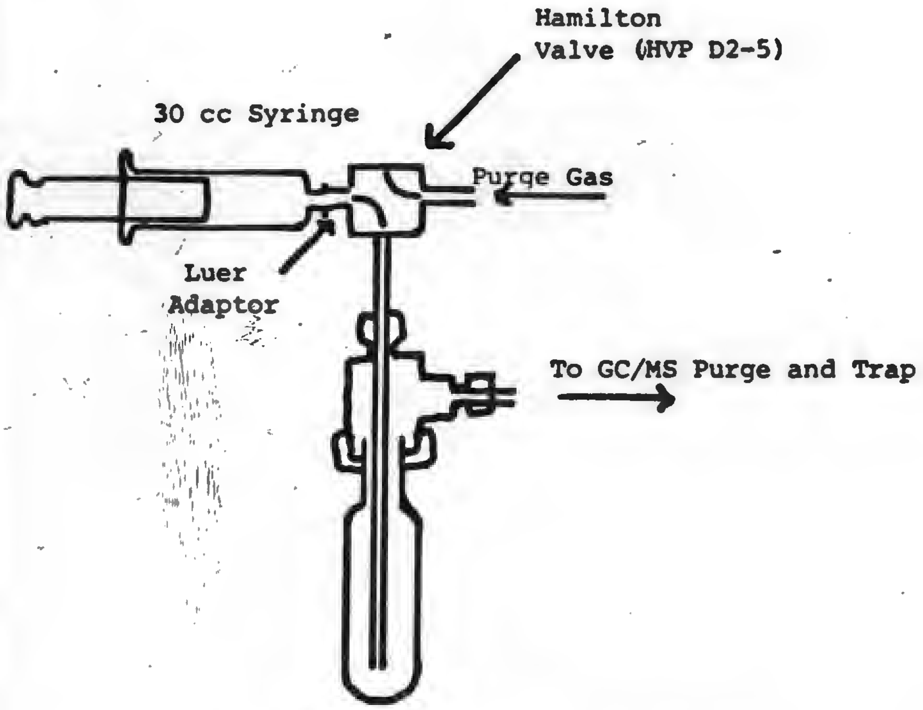


Figure 5 Dry Purge and Trap Adaptor for GC/MS

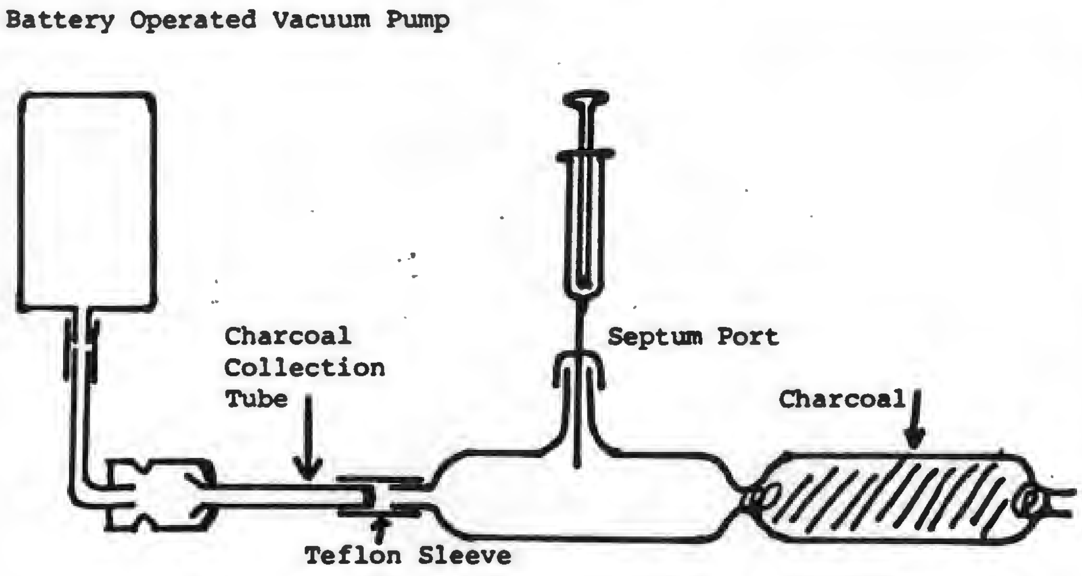
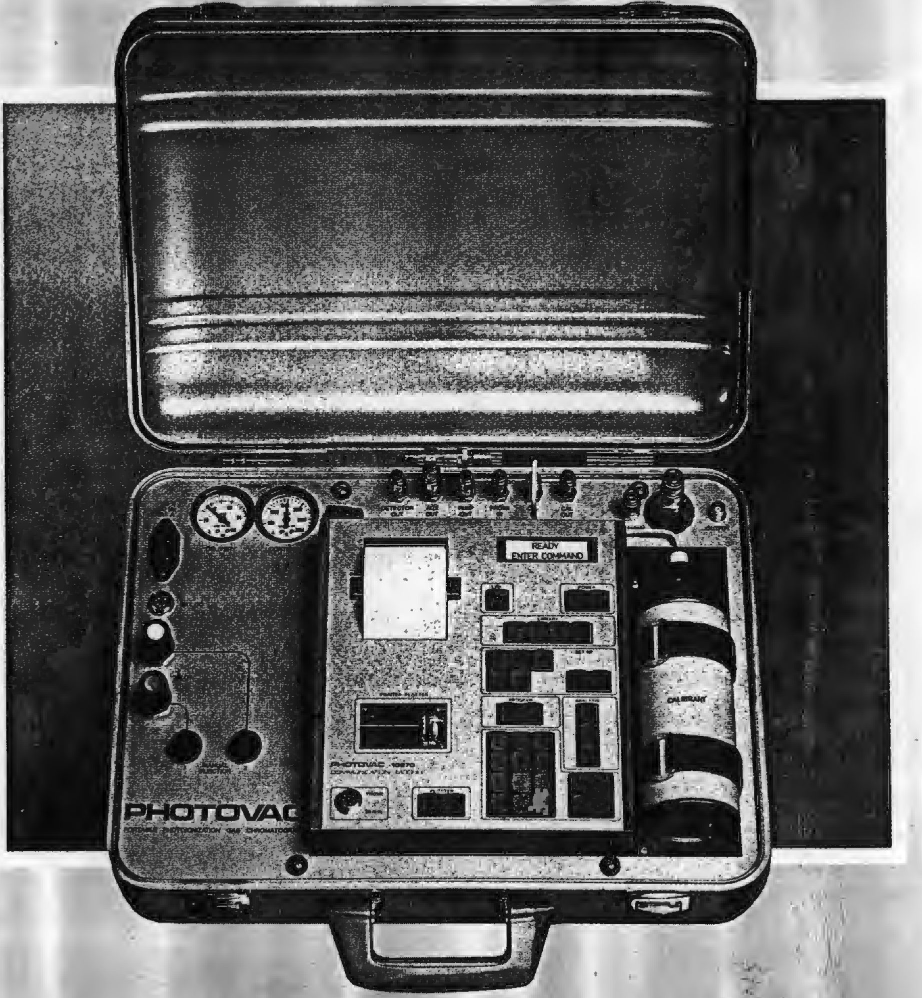


Figure 6 Spiking Device for Air Collection Tubes

CERCLA FASP ERT SARA EPA NIOSH SDWA NPL LUST OSHA

REM ATSDR DQ CERCLA FASP ERT SARA EPA NIOSH SDWA NPL LUST OSHA

PHOTOVAC 10S



The Ultra Sensitive Portable Air Analyzer

ERT SARA EPA NIOSH SDWA NPL LUST OSHA REM ATSDR

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NOW MORE POWERFUL TH

00 ppm 100ppm 10ppm 10p

PHOTOVAC'S PORTABLE GAS CHROMATOGRAPH

Sensitivity — Our exclusive photoionization detector leads all others in sensitivity and ruggedness. A range of five different energy lamps provides selectivity for different chemical groups — based on ionization potential.

Sensitivities of better than 0.1 ppb may be obtained for a 1 mL sample. No preconcentration is required!

Specificity — New 10S instruments offer a combination of FUSED QUARTZ CAPILLARY COLUMN CHROMATOGRAPHY with sophisticated ISOTHERMAL OVEN control. These features, combined with a NEW SELF-CLEANING 18-PORT VALVE SYSTEM, ensure superbly accurate chromatography, with a high degree of confidence in the identification of compounds.

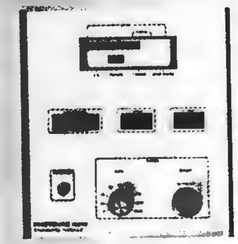
For added confidence, CONFIRMATIONAL MULTI-DIMENSIONAL CHROMATOGRAPHY, using two analytical columns in a single automated analysis, will be available FOR THE FIRST TIME in a portable instrument!

Reliability — The 10S line of chromatographs has become the tool of choice for a very wide range of different field-based operations. Reliability under these conditions has been of paramount importance and our success to date has depended upon a very reliable design. When making improvements, we have been careful not to compromise this reliability and have worked to enhance this vital aspect.

Speed — With the introduction of fused quartz capillary columns, an analysis which used to take ten minutes can now take LESS THAN TWO MINUTES.

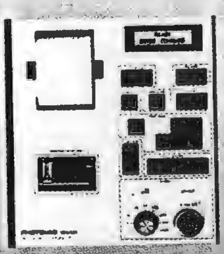
Portability — Despite improvements, such as fused quartz capillary columns, column oven, modem unit, improved valve usage, extended software and enhanced specificity, the Photovac 10S70 still weighs only 29.5 lbs (13.3 kg) and, with an optional battery pack weighing just 6 lbs (2.7 kg) lbs., provides the most weight-effective portable analysis system on the market.

The 10S Series — 4 Models Designed to Meet Your Particular Needs



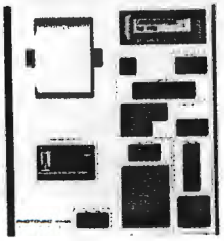
Model 10S10 - Manual

- Sample Injections are made manually
- Dual column configuration
- Calibrated by interspersing samples with injections of standard
- Portable external chart recorder required (available from Photovac)
- Liquid crystal display, with bar graph
- Rechargeable carrier gas reservoir (two days approximately)
- Rechargeable battery (8 hours approximately)
- Columns immediately accessible beneath hinged cover



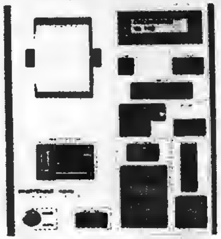
Model 10S30 - Automatic

- Contains all 10S10 features, plus:
- Computerized sample/analysis sequence with continuous monitoring
- Software selectable dual, triple or other column configurations
- Automatic backflush, using pre-column
- Chromatograms plotted for manual interpretation
- Built-in multi-color printer/plotter
- 32-character alpha-numeric liquid crystal display



Model 10S50 - Computer

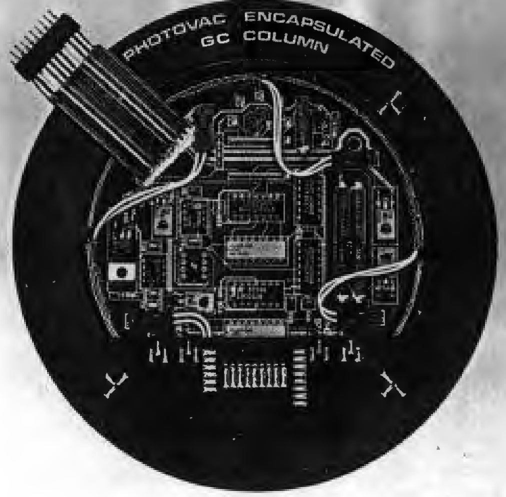
- Contains all the 10S30 features, plus:
- Computerized peak identification and quantitation
- Updates stored parameters through computerized auto-calibration
- Printout of compounds by name and with ppm or ppb concentrations
- Contains four libraries of 25 compounds each
- Provides variable period Time Weighted Averaging



Model 10S70 - Communications

- Contains all 10S50 features, plus:
- Serial/internal modem port for remote terminal or PC operation using PC DANDI*
- Fully automatic remote sensing capability
- Automatic call-in, in event of emergency
- Built-in audio alarm

PHOTOVAC 10S



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utomatic — Our AUTOMATED CHROMATOGRAPHY STEM has a sophistication that can only be found in laboratory nits costing four times as much. Features include precolumn kflush, multi-capillary column, isothermal control, direct omated sample introduction, on-board analysis and print-out of ata in plain language, automatic phone communication with a emote PC, alerting the user to impending changes in a situation er surveillance, continuous monitoring capability, Time ghted Averaging, auto-calibration.

PC Compatibility — While the computer power board our 10S50 and 10S70 instruments is truly phenomenal, is can be further extended through our PC DANDI* software ackage. This provides for direct connection of our 10S70 rument to a local or remote PC so that a wide range of different a reductions, abstractions and presentations can be performed. Up to 200 different chromatograms — together with their nalytical interpretation and set-up data — can be stored on disk. 10S70 can **automatically "call-in"** to a remote PC and ver data and actual reports, analyses and chromatograms,** henever a particular compound under surveillance passes a redetermined level of concentration.

Service — We provide on-line advice and assistance to customers. We are able, with the 10S70 model, to make a note connection to an instrument and check out problems hrough the telephone line**. When necessary, we can generally e an instrument back in our repair shop by the following rking day. We have **service centers in Huntington, NY, and in ronto, Canada** and, with our 1 year warranty and Extended Maintenance Plan, we are in a position to be able to give assistance h **minimum down-time.**

APPLICATIONS

Environmental — Evaluation of hazardous waste sites from such viewpoints as groundwater, soil and air contamination, the assessment of risk to nearby dwellings and wells, the safety of workers involved in on-site operations are all extremely viable applications for the 10S instruments.

Property line measurements of fugitive emissions — and the continuous in-place surveillance of these — are areas of increasing application.

Due to the 10S70's remote capability, it is possible for senior personnel to directly access a field instrument through a phone line and assess an unexpected turn of events.

Industrial Hygiene — In-plant air quality surveillance for single or multiple toxic gases or vapors has been an absolutely ideal application for the 10S analyzers. Our instruments are used for routine or emergency "grab" sampling as well as for continuous monitoring of areas of concern. TWAs are readily available on any time-base desired.

As a industrial hygienist, imagine the benefit of being able to instantly access a network of on-site monitors from a terminal based in your office; being able to obtain real time levels and the on-going TWA level; being able to remotely adjust the analytical parameters and examine a new and unexpected incident.

Specifications

Detectable compounds: Aliphatic/aromatic hydrocarbons, halohydrocarbons, alcohols, ketones, aldehydes, ethylene oxide, arsine, phosphine, TRS components (including hydrogen sulfide), glycol ether solvents.

Detector:
Photovac proprietary PhotoIonization detector.

Sensitivity:
Better than 0.1 ppb (benzene) for 1 mL air sample with 4:1 signal-to-noise ratio. Very low quench loss in air medium.

Chromatography:
Precolumn backflush fused quartz capillary column configuration with optional isothermal oven, software selectable sample volume, automated sampling using 6 three-port miniature valves, air or inert carrier gas. All instruments offer optional manual (syringe) sampling. 10S10 is exclusively for syringe sampling.

Multi-dimensional chromatography, using two dissimilar isothermal fused quartz capillary columns.

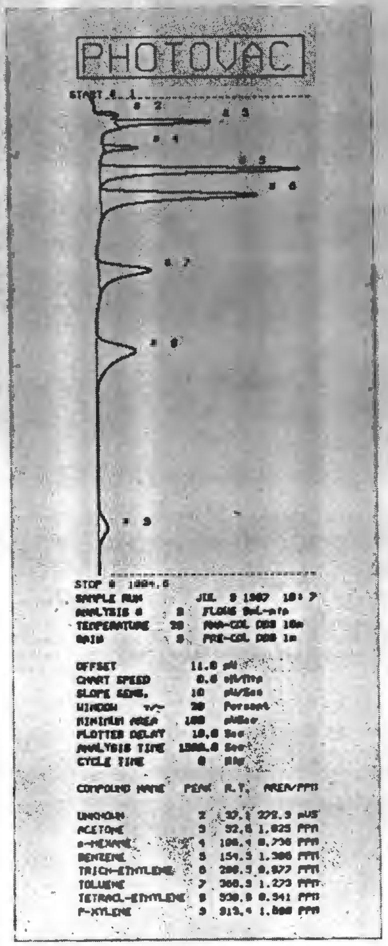
Power:
Internal batteries, external 12 V battery pack, 115 or 230 V ac mains (please specify choice). Isothermal oven requires external battery pack or mains adapter.

Calibration:
Automatic or manual, with new "peak locking" software.

Weight:
29.5 lbs (13.3 kg.)

Dimensions:
Width 18.25" (46 cm), Height 6.25" (16 cm), Depth 13.25" (34 cm).

Analysis Time:
Depends upon compounds required, almost always under 10 minutes.



10S70 PRINTOUT

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MODEL 10S70 DEPICTED

① Rugged Anodized Brushed Aluminum Case
② Carrier Gas Pressure Indicators
③ AC Power Input
④ External DC Power Input
⑤ Carrier Gas Flow Controls

⑥ Dual Injection Ports (for manual sampling)
⑦ 4-Color Printer/Plotter
⑧ Computer Controller Module
⑨ Gas Fittings for Auto-Sample and Calibrant Inlets etc.
10 Low Pressure External Carrier Gas Inlet

⑪ High Pressure Reservoir Fill
⑫ Signal Output (for external recorder etc.)
⑬ Alpha-numeric Liquid Crystal Display
⑭ Automatic Calibrant Container
⑮ Serial/Internal Modem Port

These data correlate well with the findings of Singh et al[7] in their investigations of major urban areas of the Southwest. Even in the vicinity of known organic sources, such as chemical companies, spills and hazardous waste dumps or storage facilities, the levels of volatile solvents detectable at downwind sites (500-1000 ft from point sources) is usually in the 1-50 ppb range. Table I is a listing of such solvents found in 14 different field studies in the New England area over the past three years.

TABLE I

Organic Compounds Found In Field Studies

Site: Compound	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Benzene	+	+	+	+	+	+	+	+		+				
Toluene	+	+	+	+	+	+	+	+	+	+	+	+		+
Tetra	+	+	+	+		+	+	+			+	+		+
Acetone			+											+
Freon			+			+			+	+				
VCM			+								+			
Ethylbenzene			+			+								
Xylenes			+			+						+		
1,1 DCE			+											+
1,2 DCE		+	+						+					
1,1,1 TCE		+	+					+						+
CH_2Cl_2			+						+					
TCE					+			+						
THF									+					+
$CHCl_3$		+												
Nitrobenzene													+	
Ethyl Ether														+

At the present time most of the work in methods development centers around recovery efficiency for solid adsorbents. Our experience with spiking of adsorbent tubes (Method I described above) has produced useful recovery data for most of our field studies. Table II gives data for an eight-component mixture spiked onto activated charcoal using the equipment shown in Figure 6.

Table II

Adsorption-Desorption Efficiency on Activated Charcoal

Compound	% Recovery					
1,1 DCE	64	68	64	71	70	22
Benzene	>100	>100	*	106	100	100
Tetra	36	64	85	70	60	45
Chlorobenzene	78	55	70	60	52	36
Ethylbenzene	40	28	41	39	35	22
o-xylene	42	39	35	30	25	22
TCE	12	17	3	5	19	5
Toluene	76	65	86	73	50	47

* Improper recorder attenuation setting

Standard injections contain 4-8 ng of solvent. Charcoal tubes were spiked with 400-800 ng of the same standard vapor mix. When thermally desorbed, an aliquot from the PTD chamber contained 4-8 ng and was injected into the PID-GC under identical conditions. Aside from obvious fluctuations attributable to wall losses in the syringe and spiking equipment, the data on TCE are the most difficult to interpret.

A second set of recoveries was run using the same basic technique, but with fewer components in the mixture. These data are shown in Table III.

Table III

Adsorption-Desorption Efficiency on 3M Activated Charcoal

Compound	% Recovery					
Benzene	81	104	118	87	100	82
TCE	76	97	133	102	105	100
Toluene	63	100	135	82	80	88
Tetra	71	100	92	92	85	94

A modified form of activated charcoal supplied by 3M Corporation was used in this study. There is an obvious improvement in recovery of all compounds except Benzene, but precision is still rather poor.

An ongoing study of VCM on activated charcoal using the artificial bag atmosphere described above yielded more consistent recovery data (Table IV).

Table IV

Vinyl Chloride Recovery Using Freshly Packed Charcoal Tubes

Tube #	105	125	103	108	111	127	126	122	120	124	123	121
% Recovery	109	100	105	111	98	101	107	102	94	76	87	100

x = 99 sigma = 9.8

In this study, twelve tubes were packed with fresh coconut charcoal. It is not possible to determine at the present time whether improved precision and accuracy (% recovery) is due to the bag method of spiking or to the use of fresh adsorbent. This point is presently under investigation.

One example of field use of the PID-GC to investigate a PVC manufacturing facility is shown in Figure 7. The unit was operated in a station wagon parked upwind of the property. Background was extremely low at this site owing to its proximity to the ocean. Thirty-one field samples were analysed in a two-hour period and yielded a complete profile of upwind, downwind and even in-plant VCM levels. Chromatograms of selected samples taken at locations shown on Figure 7 are shown in Figure 8 together with calibration data. Because of the extremely low background, sub ppb detection limits were attainable here. A second field and lab study of a PVC facility is currently in progress and will be reported on at the March meeting.

The methodology described here has several advantages: 1) It is relatively inexpensive; 2) It employs commercially available components; 3) Use of the field GC alone is a feasible first step to ambient air investigations; 4) Real time data are generated, leading to a saving of time and expense by identifying early in a study the areas deserving of more intensive and costly investigation. 5) Where adequate laboratory support is available, complete confirming analytical data and standardization for quantification can be easily supplied.

It should be noted that sensitive chromatographic equipment cannot be placed in the hands of untrained investigators if one hopes to obtain maximum usefulness from the type of study described here.

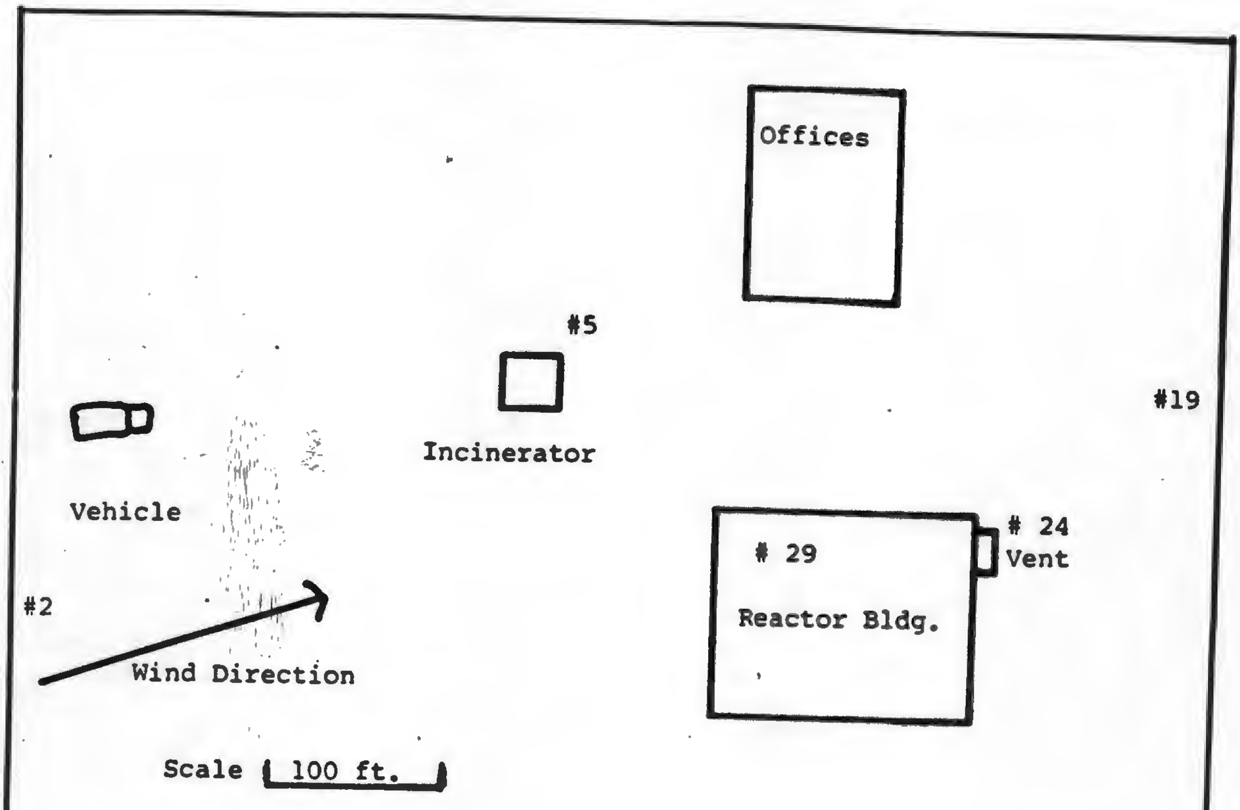
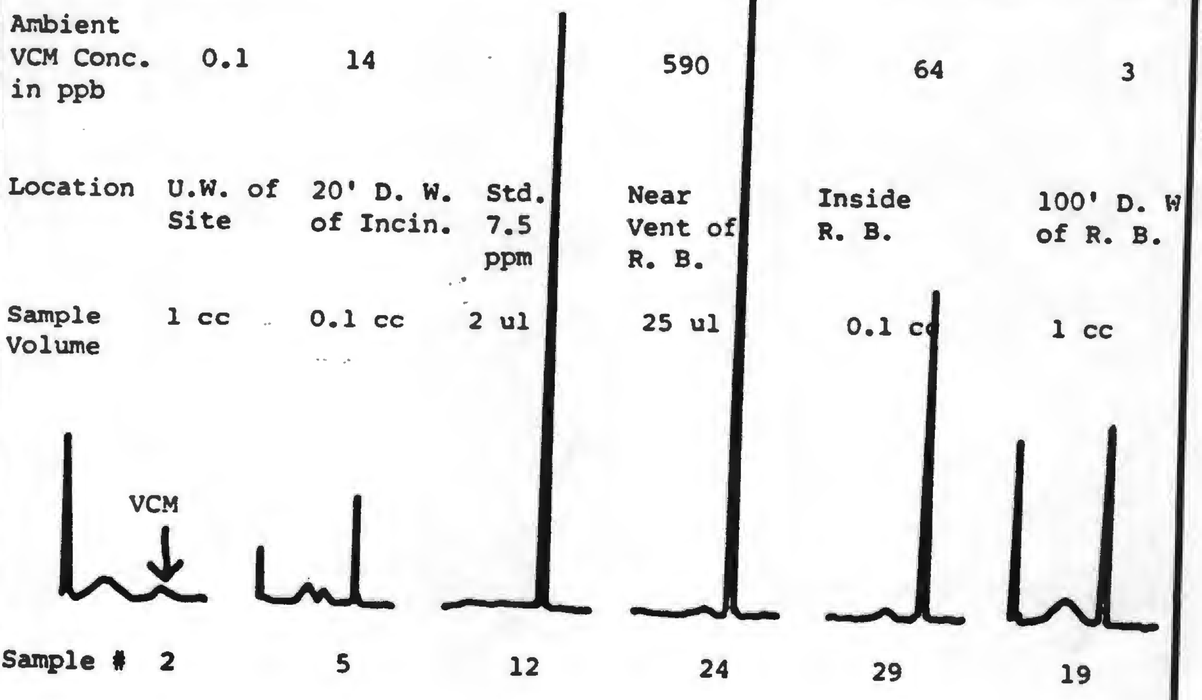


Figure 7 Field Study of a PVC Manufacturing Facility



Ambient VCM Conc. in ppb	Location	Sample Volume	Sample #
0.1	U.W. of Site	1 cc	2
14	20' D. W. of Incin.	0.1 cc	5
	Std. 7.5 ppm	2 ul	12
590	Near Vent of R. B.	25 ul	24
64	Inside R. B.	0.1 cc	29
3	100' D. W of R. B.	1 cc	19

Figure 8 Field GC data at a PVC Manufacturing Facility

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RECORD OF AIR SAMPLING

Field Data Sheet Lab #60472 - Air Sample #2

The following information was recorded for the following sampling location:

Hicksville MEK Spill Site #246-82. Borehole A1 following water sampling.

a) Name of Person(s) Conducting Sample - John Bee.

Witness - Jerry Naples

b) EPA Property Number of Pump - Sample Pump #3 (No EPA #)
MSA Part #466118

c) Weather Conditions

- Ambient Temperature - 80°F.
- Wind Speed/Direction - 3 mph, from N.W.
- Barometric Pressure
- Relative Humidity
- Cloud Cover - 50%.
- Precipitation - None During Sampling.

d) Time and Date - September 9, 1982 - 1407-1507 Hr.

e) Location - Through 60 ft. of tygon tubing, the intake of which was set at 57'11" depth, one ft. above water table.

f) Sample Time - 1 Hour.

g) Calibration

- Sample Pump #3 (No EPA #)*
- Mass Flow Meter Number - 142070
- Mass Flow Meter Flow Rate (before and after use of MSA pumps; the calibration and recalibration readings.) 50cc/min & 50cc/min.

*In addition to calibrating the MSA pump a sample of calibration gas for the HNU was connected at 100 psi to the intake of the tygon - the HNU, sampling the exhaust ~~gas~~ of the pump deflected after 29 seconds, and returned to background 1 ppm after 13 minutes when the calibrating gas was disconnected. The deflection calibrated at 85 ppm with 75 ppm calibration gas (span setting #5). Without any gas pressure forcing air through the tube, deflection occurred after 24.8 seconds.

AIR MONITORING DATA SHEET

te: ____________ Site Identification: ____________

Person Sampling: ____________ Qualified By: __ Other__

Meteorological Conditions

Temperature: ____________ °C/°F Wind Speed: ____________ Direction: ____________

Barometric Pressure: ____________ Relative Humidity: ____________

loud Cover – Type: ____________ Amount: ____________

recipitation – Type: ____________ Amount: ____________

Instrument Data

Number: ____________ Calibration/Service Date: ____________

erson Calibrating: ____________ Qualified By: __

Calibration Data: ____________

NU: Type of Probe(s) [illegible] e)

Date Lens Cleaned: ____________

VA/GC Mode Used: ____________

Type & Number of Column: ____________

Type of Probe: ____________

Filters: ____________

____

____

tector Tubes: Type of Unit: ____________ (Bendix, Draeger, etc.)

Specific Tube(s): ____________

Tube Lot Number: ____________

Tube Expiration Date: ____________

Number of Pump Strokes/Sample Volume: ____________

____

____

Page __ of __

Data Sheet

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
mical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Exact Location: ______________________________
Chemical Monitored: ______________ Amount Measured: ______________
Time Started: ______________ Time Finished: ______________

Appendix D

Obtained by the Technical Assistance Team, in support of the USEPA Removal Action of 1983-1984.

- Wallkill New York: Summary of Water Level Measurements, 1983-84
- Wallkill Well Data
- Wallkill, New York, Tetrachloroethylene Sample Results

WALLKILL NEW YORK
TABLE
SUMMARY OF WATER LEVEL MEASUREMENTS

#	Residents	Top of Casing Elevation (ft)	Water Level Elevations In Feet Above Mean Sea Level 11/15/83	12/1/83	12/14/83	12/15/83	12/16/83	12/21/83	1/12/84	1/13/84	2/2/84	2/3/84
Industrial Place												
#	General Switch	635.37			624.77				621.74			
	Wooden Sump Opp. Contel	600.15										
2	Guild Molders	602.77							595.02		594.81	
Highland Avenue Extn.												
420	Orange Handling	628.63				616.70						
400	Kuhl Restaurant	638.84				603.31						
409	R. C. Prior	636.58										
406	F. Kuhl	628.81				622.76						
Highland Avenue												
355	Pitt	664.54				630.91				630.89		
339	Perry	654. approx.									588.28	
338	Perez	652.14	652.14									
328-332	Electra Mfg.	643.95	624.37			634.23	633.88	633.57	631.31		630.25	
330	Cornelius Merle	650.48	606.17				640.41		613.76			
329	Osbourne	649.65	602.72			604.13	622.71		619.01		617.04	
327	Lobb	646.38	606.58			596.41	606.70	620.57	617.99			
325	Fiore	644.33	607.82				622.05 607.50	622.05	617.26			
323	Gilbert	649.25	620.44				630.07					
321	Seeley	641.73	606.62					606.04	608.60			
320	Parella	639.19									615.61	

WALLKILL NEW YORK
TABLE
SUMMARY OF WATER LEVEL MEASUREMENTS

#	Residents	Top of Casing Elevation (ft)	Water Level Elevations In Feet Above Mean Sea Level 12/21/83	1/13/84	1/16/84	2/3/84
186	Gerald Winner	649.19				575.21
175	J. M. Holmes (Shallow)	633.09	623.00			
168	Wegenroth	639.47		611.59		
	Commonwealth					
196	Reynolds	667.27			580.27	
193	Kehm (Shallow)	657.77			652.83	
183	Palermo (New)	654.90			564.77	573.37
	(Dug)	651.96				
	(Old)	651.79				
177	Claussen (Shallow)	647.65			642.60	
173	Dickerson	648.97			590.35	
243	Meyers	695.59		585.31		
229	Rumert	683.26		576.68		
210	Berry	679.82		<579.82		

WALLKILL NEW YORK
TABLE
SUMMARY OF WATER LEVEL MEASUREMENTS

#	Residents	Top of Casing Elevation (ft)	Water Level Elevations In Feet Above Mean Sea Level 11/15/83	12/15/83	12/16/83	12/21/83	12/22/83	1/13/84	1/12/84	2/2/84	2/3/84
316	Stout	632.64									614.64
306-314	Continental Telephone	630.35	605.76			609.00			607.43	607.22	607.28
309	Barry	635.22			604.18				603.49		
297	Robaina	630.06							593.51		592.80
295	Janiak	623.38			589.50						
286	Estrada	616.45			595.65				592.75		
Electric											
31	Van Pelt	646.72			619.20			621.70			616.00
Watkins Avenue											
251	Saxton	684.35					601.65	595.08			
239	Ward	676.07								569.10	
238	Cosmo Optics (New)	675.96					593.34	600.17			
228	Prior King Press	673.27									
220	De Rose (Shallow)	667.77						658.65			
217	Robert Libario (Shallow)	662.66					658.53	656.25			
190	Morse	651.46						481.55			540.33
197	Rasmussen	639.64						592.79			595.17

WALLKILL NEW YORK
TABLE
SUMMARY OF WATER LEVEL MEASUREMENTS

#	Residents	Top of Casing Elevation (ft)	Water Level Elevations In Feet Above Mean Sea Level							
			11/15/83	12/1/83	12/14/83	12/15/83	12/16/83	1/12/84	1/13/84	2/3/84
319	Ogden	640.91	609.63				605.67	612.16		
	Stout Lot #4									
	Dug Well #1 (Shallow)	619.05					617.96	617.86		
	Dug Well #2 (Shallow)	630.49					629.44	629.18		
317	Knapp	640.78	592.87				600.63	599.08		597.38

WALLKILL WELL DATA

Industrial Avenue
Highland Avenue Extension

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
Industrial Place										
General Switch	City+ Abandoned Well	635.37	6" x 480"	Submersible 460'	2 gpm	None	537	268 mins @ 2 gpm	Well contaminated Well pumps dry in 20 mins. unless throttled back. Easy access, above ground	1981 Tonkins
17 Lubricants Inc. Packaging	City	No Well							Resident for 10 yrs. Use varsol, lubricants, trichloroethylene. Poor housekeeping	
2 Guild Molders (342 5701)	City (Drinking)	602.77	6" Centering guide @ 90'	Submersible 11 stage 11 HP		None	4		Plastic molding. Solvents used in decorating bottles	1975 Sullivan
Orange County Corrugated	No well City Used to be DSW Railroad	No well								

*Time required in minutes that well pumped @ selected gpm to obtain evacuation of 3 well volumes.

WALLKILL WELL DATA

Highland Avenue Extension, Sands, Electric & Watkins Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
275 Neldham (343-3378)	City No well						No Well			
Sands										
24 Miller Realty (342-3974)	City No well						No Well			
Sam E. Fast										
Electric										
31 Van Pelt (342-0176)	Well	646.72	6" x 230"	Submersible 1/2 HP		None			Well above ground. Easy access.	1973
Watkins										
165 Sherman R. Stephens (342-1709)	City	618.13			None				Dug well. Easily accessible.	-
168 Alice Wegenroth (342-1479)	Well	636.47	6" x 70'	Submersible 60' 1/3 HP	Never ran dry				Well in sump under slab. Previous owner Perrello (361-3611)	-
170 Mrs. Brittings (342-3367)	City No well						City - No Well			
171 J.M. McEwan (343-8743)	City No well						City - No Well			

WALLKILL WELL DATA

Highland Avenue Extension

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
295 Vicent Janiak (342-1610)	Well	623.38	6' x 200'+	Jet 1 HP		Softener	245 gal.	93 min @ 8 gpm Softener	Some sulfur. Contaminated. Kitchen sink 2 gpm+bath 4 gpm+ + bath sink 2 gpm= 8 gpm	1950
293 Wayne Nixdorf	Well	623.45								
292 George Sleiter	Well	620.97								
291 Donna Smith (342-1157)	Well	621.87	4' x 17'	Jet 1/2 HP		Filter	25 gal	25 min @ 3 gpm. Filter	Hand dug	<1940
288 Seymour Healy (342-2998)	City					City - No Well				
286 Antonio Estrada (343-9824)	Well	616.45	6" x 170'	Submersible 1/2 HP						1976
287 Issy Tessler (342-2947)	Well		6" x 135'	Submersible 120' x 1/2 HP					Resident estimated Max pump rate 47 gpm	
282 Frank Shattuck	Well	614.29								
281 Arthur Condadi (343-2044)	City (McGawline)					No Well				
280 James Cole	Well	613.49								

WALLKILL WELL DATA

Highland Avenue Extension

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
316 Stout (Janice) (343-4626)	Well Temp City	632.64	6" x	Jet		Yes			Contaminated	
306-314 Continental Telephone	No resident	630.35	6" x 192'	None					Obstruction. No resident. Above ground. Casing open/cut off	
313 Chris Lewis (342-0139)		637.34							Contaminated	
309 Robert Barry (342-0714)	Well	635.22	6" x 203'	Submersible 6 stage, 180'		None			Contaminated. Temporary city water	1977 Davis
307 George Ruppert (342-0009)	Well	633.17	6" x 205'	Submersible 1/2 HP		10 gpm			Contaminated. Temporary city water. Rock @ 90' (5' into rock)	1979 Davis
304 Edward Liska	Well	627.10	6" x 137'	1/3 HP					Well TOC 3' underground 6' from house	1959 Davis
299 Hilton Eckerson	Well	626.53								
298 Schmick	Well									
297 Francisco Robaina (343-0360)	Well	630.06	6" x 200'	Submersible		None	245 gal.		Contaminated. Temporary city water.	

WALLKILL WELL DATA

Highland Avenue Extension

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
325 Dominick Fiore (343-2994)	Well	644.33	6" x 172'	Submersible 160', 1/4 HP	11 gpm	None			Water cooler for drinking. Contaminated. Well above ground. Easy access.	1974 Davis
323 Gilbert	Well	649.25	6" x 180'	Submersible 160'					Sounding 116' centering guide? Contaminated. In concrete sump	
321 Seeley	Well	641.73	6" x 220'	Submersible 200'		None			Above ground. Easy access.	
320 Charles Parella (342-2385 Wo) (286-1666 Ho)	Well Temp City	639.19	6" x 100'	Jet 80'	2 gpm or will loose suction	None			Below ground. Extraction well. Contaminated. Temporary city water.	
319 Gary Ogden (343-2960)	Well	640.91	6" x 215	Submersible 1/2 HP					Above ground. Contaminated.	
318 Stout Lot #4 (Ruins)	No Resident Dug Wells	#1 619.05 #2 630.49	3' x 16' 3' x 11'	None None	– –	None None			No resident. No resident.	
317 Oscar Knapp (342-5310)	Well	640.78	6" x 220'	Submersible 200', 1/2 HP	–	None			Little sulfur. above ground - easily accessible. Contaminated.	1973 Davis

WALLKILL WELL DATA

Highland Avenue Extension

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
337 Olive Gady (342 1741)	Well	649.73	6" x 87'	Jet 3/4 HP	-	None			Well under house	1948
335 Janet Crooks (343 8452)	Well	653.17	6" x 106'	Jet 1/2 HP					Well below grade (4-5'). Contaminated	1960 Davis
334 William Roselli (342 1744)	Well Temp City	651.15	6" x 108'	Jet 1/2 HP		None			City water 1983 from General Switch. Well below grade. Contaminated	1953 Davis
328-332 Electra Mfg.	Well	643.95	6" x 100'+	None		None			Pulled hand pump. Well open.	
330 Cornelius Merle (813 343 0698) Local:Homer Carlisle (342-3126)	Well	650.48	6" x 265'	Submersible	-	None			Residents in Florida. Well above ground. Easy access.	1977 Davis
329 D. Osbourne (343-6745)	Well Temp City	649.65	6" x 200'	Submersible 180'					Well above ground. Easy access. Temp city water. Contaminated.	1980 Davis
327 Mrs. Lobb (342-2159)	Well Temp City	646.38	6" x 170'	Submersible 150'	4-5 pgm	None			Above ground-easy access. Contaminated.	1973 Davis

Highland Avenue Extension

WALLKILL WELL DATA

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
357 Chas Schmall (Dght. 342 3528 343-3529)	Well	663.93	6" x 212'	Submersible 200' 1/2 HP	15 gpm	None			Wellhead under water 12/15/83. Please call daughter	1966 Davis
355 William Pitt (343 3717)	Well	664.54	6" x 110'	Jet 99' 3/4 HP	1 gpm	None			Well pumps dry @ 4 gpm in 40 mins. V. poor yielding well. Contaminated.	1940 -
353 Ken Ernest (343 4831) Katherine Ward	Well	Well inside house Empty lot	6" x 115'	Jet 90 3/4 HP	Supplies family of 2	None			Well under house	1960
341 Chas Courteau (342 2787)	Well		6" x 165'		-		-	-	Well below grade	-
339 Ray Perry (343 3820)	Well	652.63	6" x 210'	Submersible		Sediment Filter			Well below grade (2'). Dug up.	1955
338 Raymond Perez (343 0645)	Well Temp City	652.14	6" x 60'	Jet		None			Well used for garden only during summer. Temp. water from General Switch. Contaminated.	-

WALLKILL WELL DATA

Watkins Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
186 Gerald/Eva Winner (343-5406 Ofc.) (343-8100 Ho.)	Well	649.19	6" x 280"	Submersible 250' 3/4 HP	3 gpm	None	352 gal.	100 min @ 3.5 gpm	Well TOC below grade	1966 Davis
187 Peter H. Rasmussen (342-2329)	Well	639.64	6" x 146'	Submersible 135' 1/2 HP	7 gpm	Yes	156	44 min @ 3.5 gpm	Obstruction-centering guide at 80? Contaminated	1935
190 Louis W. Morse	Well	651.46	6" x 314'	Submersible 200 1/2 HP		Culligan			Had water supply problems with well since Palermo sunk wel. Contaminated	1970 Tompkins
194 Dianne Regan	City						City – No Well			
195 Hebrew Day School (343-8588)	City						City – No Well			
196 Wontz	City						City – No Well			
198 Floyd Terwilleger (343-7150)	City						City – No Well		Dug well filled	
201 M. Smith (343-0319)	City						City – No Well		Authority on McGaw Line Water supply	

WALLKILL WELL DATA

Watkins Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
219 Fred Lybolt (343-7886)	City Aband. Well	659.75	3' x 40'	None		Charcoal			Well is on #217 (common well)	1960
220 Dennis De Rose (342-4110)	City Aband. Well	667.77		None		None			Jet pump in basement. Shallow dug well under cement slab.	–
221 Janice Panella (342-2506)	City						City – No Well			
222 Frank Currier (343-1498)	City						City – No Well			
223 Ronald Griffin (343-1191)	City						City – No Well			
225 Mr. Hubsch (342-1191)	City						City – No Well			
227 Chester Seeley (343-1074)	City						City – No Well			
228 Prior King Press (343-3318)	Well	673.27	6" x 200'	Submersible 180' 1/2 HP		None	235 gal.	78 min. @3.5 gpm	Well 6" below grade Chronic pressure loss.	1957

Industrial Avenue
Highland Avenue Extension

WALLKILL WELL DATA

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
Continental Telephone Offices	No well City Used to be D&W Railroad						No well			
Wooden clad sump opposite Continental telephone		600.15								
International Diesel Electric (Midland Avenue Ext.)	City no wells								Frank Cizek w/historical society of D&W confirmed no wells.	
409 R. C. Prior	Well	636.58	6" x 480'	Submersible 2 HP	3 gpm	None			Above ground. Slow recovery	1983 W. Roacke
409 Federal Cabinet	Well	-	6" x 200'	Submersible 2 HP					Well under bldg. slab	1955 -

*Time required in minutes that well pumped @ selected gpm to obtain evacuation of 3 well volumes

WALLKILL WELL DATA

Watkins Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
229 Joseph Radivoy (342-0735)	Well	668.69					221 gal assumed	63 min @ 3.5 gpm	Contaminated. TOC below ground.	
231 Clarence Campbell (342-0194)	Well	Prior King Press Well								
233 Jehovahs Witness	Well									
238 Cosmo Optics (343-2105)	Old Well#1 (Under house)	-	6" x 190'	Submersible 3/4 HP	8-10 gpm	None	280 gal.	80 min @ 3.5 min	Under house. Contaminated	1960 Davis
	New Well#2	675.96	6" x 290'	Submersible 3/4 HP	5-6 gpm	None	368 gal.	105 min. @ 3.5 gpm	Well under heavy concert slab. Contaminated	1980 Davis
239 Sal & Kay Ward (343-6643)	Well	676.07	6" x 214"	Submersible 168' 3/4 HP	8 gpm	None	256 gal	73 min @ 3.5 gpm	Contaminated. Centering guide @ 22'. Removed to water-table.	1958 Davis
251 Saxton (343-8748)	Well	684.35	6" x 250'	Submersible 200' x 1/2 HP	10 gpm	None	308 gal.	88 min. @ 3.5 gpm		

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
208 Hollis E. Johnson (342-2400)	Well	667.08	180' x 6"	Submersible 175' 1/2 HP	3 1/2 gpm	No			Slight bacteria contamination. Nauseous, boils, cleared up last week.	1974 Davis
209 Panero (342-2193)	Well		255' x 6"	Submersible 240' 1 1/2 or 2 HP	6-7 gpm	No			Well in front of house 4' out from left kitchen window (well 190' original). 1955 went dry, drilled to 255' in 1969.	1955
210 Harold C. Berry (343-8711)	Well	679.82	160' x 6"	Submersible 1/3 HP	40 gpm	No				
211 Bob Norbury (342-3962)	Well		212' x 6"	Submersible		Yes				
213 Letha Carey (342-2295)	Well	675.46	139' x 6"	Submersible		No			Sediment in water. Well covered by driveway. Do not like taste.	1950 Davis
214 Jay Mader (342-2850)	Well	680.44	170' x 6"	Jet 1 HP		No			Well covered by layer concrete slab, but hole in center. Sore throats, skin rashes.	

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
195 John Crudo, Jr. (342-4385)	Well	-	150' x 6"	Submersible 140'		Yes				
196 R.J. & Louise Reynolds (342-4355)	Well	667.27	240' x 6"	Submersible 200'	6 gpm	Yes			Hard water/occasional sulfur-well located in backyard in a U-shaped arrangement of concrete blocks-easy access.	1977 Davis
197 Allan J. Brincherhoff (343-2303)	Well	661.34	270' x 6"	Submersible 200' 1/2 HP	5 gpm	No			Hard water/sulfur. Well in corner of pump. Pulled yearly. Located near driveway near reflector. Plenty of water	1975 Davis
200 James Kieran (342-1152)	Well	671.56	189' x 6"	Submersible 160'		Yes. Caligan				1964
205 James Hawkins (343-5919)	Well	668.92	190' x 6"	180'	4 gpm	Softner			Pumps dry in 1 hr. very hard. Easy access through house -acess from outside.	1930
206 Wallace K. Bliven (342-0662)	Well	667.18	165' x 6"	Submersible 155'	2 gpm					

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
186 Flynn	Well									
187 Gessner	Well									
188 Norma Derouth (342-0862)	Well	663.32	296' x 6"	Submersible 1.5 HP		None			Well on left side of house under orange bucket.	DeRossi
189 Michael Steels (343-5656)	Well		110' x 6"	Submersible 1 HP		Softner			Well between front door step and blue post to the right.	
191 Bertha Krawiec (343-8688)	Well	654.76	240' x 6"	Submersible	3 1/2 gpm	Softner			In backyard. Hard water and sulfur.	1968 Davis
192 Hite (342-0260)	Well	665.26	177' x 6"	Submersible		Softner			Drilled well on back-yard path under round slab-abandoned dug well in shed that is partially filled in. Explosive charge see data sheet.	1961 Davis
193 Theresa Kehm (342-0595)	Well	657.77	25-30' x 3'	Jet		None			Dug well. Pump in basement-well, rear of house near drive-covered with concrete slab.	

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
183 John & Evelyn Palermo (342-3071)	Well +	654.90	276' x 6"	Submersible	5 gpm	None			Old well dry May. 1983 was 365' and have a dug well-both in left side yard, slight sulfur odor-use new well in front.	
	Abandoned Well +	651.79	365' x 6"							
	Dug well	651.96	10' x 3'							

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
173 Norman P. Dickerson (343-1569)	Well	648.97	6" x 250'	Submersible 200' 1/2 HP	12-15 gpm	Filter for sulfur			Some sulfur-located left side yard. Green casing. Easy access.	1972 Davis
174 Miguel Lopez (343-5928)	Well	Well under house		Jet Pump 1/2 HP	Enough for a family of 5 (accept dry spells)	None			Wife-kidney infections Well under addition in back of house. Accessed through basement.	
176 Reagan	Well	Well under house								
177 Ira S. Clauson (343-4443)	Well	647.65	13'	None					Dug well-under round slab in backyard-easy access.	1925
179 Jeff & Dale Rieck (342-6383)	Well	Well under house	-	Submersible		For sulfur			Enters house by basement window near porch in back-exact location underground.	1960
182 Mrs. Harry Davis (343-4439) (343-1061 Wo)	Well + Abandoned Well		-	Submersible		None			Abandoned well under garage. Floor-opening available.	1975 Davis

WALLKILL WELL DATA

Commonwealth Avenue

# Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
232 Linda Caffery (342-3533)	Well	695.73								
233 Paul Heilfurth (343-0310)	Well Dug well	683.84 686.47	155' x 6" 30' x 3'	Submersible 146' 1/2 HP	8 gpm	No			Reported rash-never goes dry 7/16/82 replaced pump and pipe dug well 30' no pump easy access.	
237 Bill Noha (343-6043)	Well	688.44							Malignant melanoma	
241 Hazel Gallo (343-0746)	Well	691.82	95' x 6"	Jet 1/2 HP		No			Gallo pump repaired 12/83.	
243 Shares Well with well #245 Meyers	Well	-								
244 Patrick Finlay (343-4929)	Well	697.32	163' x 6"	Submersible 135'	8 gpm	No				
245 M. Meyers (342-1895)	Well	695.59	256' x 8"	Submersible		Yes			Well turned cloudy for short time when 320 Highland Ave. started pumping.	

WALLKILL WELL DATA

Commonwealth Avenue

#	Resident (Telephone #)	Type of Water Supply	Elevation Top of Casing (Ft.)	Diameter Depth (Ft.)	Pump Type Depth (Ft.) H.P.	Max Pump Rate (Gal)	Water Filter	Submerged Well Volume (Gal)	Sample Protocol*	Comments	Year Drilled Driller
227	Charles J. & Alice MacEntee (342-1331) (343-7107 Work)	Well	681.50	280' x 6"	Submersible 275'	5 gpm	No			Hard/sulfur-well above ground directly to rear of house. Behind Cosmo Optics.	1977 Davis
228	W. Plantenga (342-1125)	Well	693.75		Submersible		No			Well water checked in Nov. 1 abandoned. well hard to access. Contact owner Mr. Mielke, Middletown	
229	David Ruppert (343-1753)	Well	683.26	265' x 8"	Submersible 220' 1/2 HP	5 gpm	No			2 residents w/rash 90' to bedrock 100' casing-bedrock @ 95'.	1975 Davis
230	C. Thacker (343-2155) (343-1580 Work)	Well	694.72	200' x 6"	Submersible 190'	5-6 gpm	No			Hard/sulfur. Facial rash/headaches/nausea.	1960 Davis
231	Eugene & Shirley Block (342-4220)	Well	690.15	152' x 6"	Submersible		Softner			Well under front porch. Pump repaired in October. Galvanized pipe eaten away.	1955

3/28/84

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LOCATION

GENERAL NOTES:

1) Unless otherwise noted, sampling was performed by EPA or EPA in concert with State or County.

2) Unless otherwise noted, samples were collected after running the tap for 15 minutes.

3) Laboratories:

   a) Envirotest is a commercial laboratory located at 717 Broadway, Newburgh, New York. It is certified by the New York State Department of Health for Drinking Water Analysis. Sample analysis was performed using EPA Method 601.

   b) Clayton is a commercial laboratory located at 160 Fieldcrest Avenue, Raritan Center, Edison, New Jersey. It has received interim certification from the State of New Jersey for Water Quality Analysis. Sample analysis was performed using EPA Method 624.

   c) TAT/Photovac indicates on-site analysis by the EPA Technical Assistance Team (TAT) Contractor, Roy F. Weston. Sample analysis was conducted on a Photovac Model 10A10 portable ionization gas chromatograph equipped with a photoionization detector and an SE-30 Chromosorb 100/120 column. The system was operated at room temperature. Sample headspace was analyzed.

   d) NYSDEC/DSHW/GC indicates on-site analysis by the New York State Department of Environmental Conservation, Division of Solid and Hazardous Wastes. Sample analysis was conducted using a Hewlett-Packard gas chromatograph (GC) Model 5710A equipped with an electron capture detector and a 3% SP2100 Supelcoport 100/120 column. The GC was run isothermally at 35°C. Sample headspace was analyzed.

   e) USEPA/ESD is the EPA Region II Environmental Services Division Laboratory located in Edison, New Jersey. Sample analysis was performed using the EPA Method 624.

   f) USEPA/ERT is the EPA Environmental Response Team Laboratory located in Edison, New Jersey. Sample analysis was performed using the EPA 624 Method.

   g) NYSDHCLR - is the New York State Department of Health Center for Laboratory Research located in Albany, New York. Sample analysis was performed using EPA Method 503.1 and EPA Method 601.

4) Quality Assurance/Quality Control (QA/QC)

   a) All data reported by Envirotest and the TAT/Photovac field lab was reviewed for QA/QC by TAT II.

   b) Data reported by Clayton and the USEPA/ERT were reviewed for QA/QC by the ERT.

   c) Data reported by USEPA/ESD was reviewed for QA/QC by the ESD.

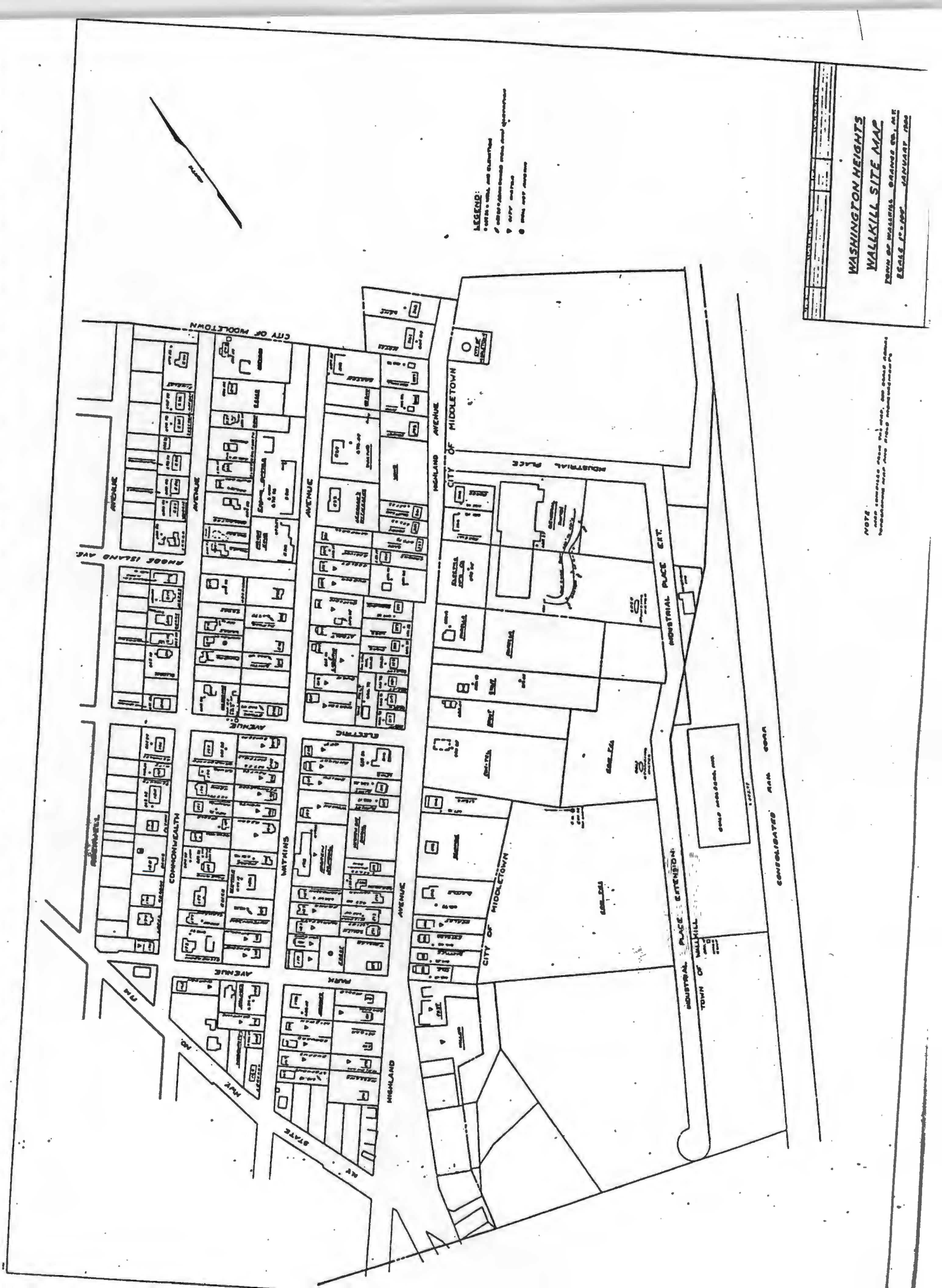
   d) Data reported by the NYSDEC/DHSW/GC was reviewed for QA/QC by the NYSDEC/DHSW.

   e) Data reported by the NYSDHCLR was reviewed for QA/QC by the NYSDHCLR.

   f) Data reported by the Orange County Health Department (OCHD) was reviewed for QA/QC by the OCHD.

5) All samples analyzed at commercial laboratories were under EPA control unless otherwise noted.

6) All sample analysis results are reported in parts per billion (ppb) unless otherwise noted. (ug/g = microgram per gram)


WASHINGTON HEIGHTS
WALLKILL SITE MAP
TOWN OF WALLKILL ORANGE CO., N.Y.
SCALE 1"=100' JANUARY
LEGEND:
CITY OF MIDDLETOWN
RHODE ISLAND AVE.
AVENUE
COMMONWEALTH
WATKINS
AVENUE
HIGHLAND AVENUE
ELECTRIC AVENUE
PARK AVENUE
HIGHLAND
N.Y. STATE HWY. NO.
INDUSTRIAL PLACE
INDUSTRIAL PLACE EXT.
INDUSTRIAL PLACE EXTENSION
TOWN OF WALLKILL
CONSOLIDATED RAIL CORP.
NOTE

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* BLANK					
12/20/83		<1	01/05/84	ENVIROTEST	
01/06/84	68569	ND	01/13/84	USEPA/ESD	
01/27/84	68577	ND	02/01/84	USEPA/ESD	
02/22/84	66256	ND	02/22/84	NYSDEC/DSHW/GC	
03/07/84	66289	<1	03/08/84	NYSDEC/DSHW/GC	
* 173 COMMONWEALTH AVE, DICKERSON					
12/19/83	69171	<1	12/21/83	ENVIROTEST	
02/15/84	68874	<1	02/16/84	NYSDEC/DSHW/GC	
* 174 COMMONWEALTH AVE, LOPEZ					
12/19/83	69191	<1	12/21/83	ENVIROTEST	
02/15/84	68875	<1	02/16/84	NYSDEC/DSHW/GC	
* 176 COMMONWEALTH AVE, REAGAN					
12/19/83	69172	<1	12/21/83	ENVIROTEST	
* 177 COMMONWEALTH AVE, CLAUSON					
12/19/83	69187	<1	12/21/83	ENVIROTEST	
* 179 COMMONWEALTH AVE, RIECK					
12/20/83	68960	<1	01/03/84	ENVIROTEST	
* 182 COMMONWEALTH AVE, DAVIS					
12/19/83	69175	<1	12/21/83	ENVIROTEST	
12/20/83	69195	<1	01/05/84	ENVIROTEST	
03/07/84	66295	ND	03/08/84	NYSDEC/DSHW/GC	
* 183 COMMONWEALTH AVE, PALERMO					
12/19/83	69188	<1	12/21/83	ENVIROTEST	
02/15/84	66226	<1	02/16/84	NYSDEC/DSHW/GC	
* 186 COMMONWEALTH AVE, FLYNN					
12/19/83	68976	<1	01/05/84	ENVIROTEST	
02/15/84	66227	<1	02/16/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 188 COMMONWEALTH AVE, DEMOUTH					
12/19/83	69174	<1	12/21/83	ENVIROTEST	
02/15/84	66228	<1	02/16/84	NYSDEC/DSHW/GC	
* 191 COMMONWEALTH AVE, KRAWIEC					
12/19/83	68951	<1	01/05/84	ENVIROTEST	
02/15/84	66229	<1	02/16/84	NYSDEC/DSHW/GC	
* 192 COMMONWEALTH AVE, HITE					
12/19/83	69173	<1	12/21/83	ENVIROTEST	
02/15/84	66230	<1	02/16/84	NYSDEC/DSHW/GC	
* 193 COMMONWEALTH AVE, KEHM					
12/19/83	68952	<1	01/05/84	ENVIROTEST	
03/07/84	66285	ND	03/08/84	NYSDEC/DSHW/GC	
* 195 COMMONWEALTH AVE, CRUDO					
12/20/83	68958	<1	01/03/84	ENVIROTEST	
03/07/84	66294	ND	03/08/84	NYSDEC/DSHW/GC	
* 196 COMMONWEALTH AVE, REYNOLDS					
12/19/83	68977	<1	01/05/84	ENVIROTEST	
03/06/84	66268	ND	03/06/84	NYSDEC/DSHW/GC	
* 197 COMMONWEALTH AVE, BRINCKERHOFF					
12/19/83	69189	<1	12/21/83	ENVIROTEST	
02/15/84	66231	<1	02/16/84	NYSDEC/DSHW/GC	
* 200 COMMONWEALTH AVE, STEELE					
12/19/83	69200	<1	01/05/84	ENVIROTEST	
* 206 COMMONWEALTH AVE, BLIVEN					
02/15/84	66232	<1	02/16/84	NYSDEC/DSHW/GC	
* 208 COMMONWEALTH AVE, JOHNSON					
12/19/83	69192	<1	12/21/83	ENVIROTEST	
03/06/84	66269	ND	03/06/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 210 COMMONWEALTH AVE, BERRY					
12/19/83	69193	<1	12/21/83	ENVIROTEST	
02/15/84	66233	<1	02/16/84	NYSDEC/DSHW/GC	
* 211 COMMONWEALTH AVE, NORBURY					
12/19/83	69190	<1	12/21/83	ENVIROTEST	
03/07/84	66284	ND	03/08/84	NYSDEC/DSHW/GC	
* 213 COMMONWEALTH AVE, CAREY					
12/19/83	69196	<1	12/21/83	ENVIROTEST	
03/06/84	66270	ND	03/06/84	NYSDEC/DSHW/GC	
* 214 COMMONWEALTH AVE, MADER					
12/19/83	69194	<1	12/21/83	ENVIROTEST	
02/16/84	66235	ND	02/16/84	NYSDEC/DSHW/GC	
* 217 COMMONWEALTH AVE, HOFFMANN					
12/20/83	68953	<1	01/05/84	ENVIROTEST	
02/16/84	66236	ND	02/16/84	NYSDEC/DSHW/GC	
* 220 COMMONWEALTH AVE, VARSA					
12/20/83	68979	<1	01/05/84	ENVIROTEST	
* 221 COMMONWEALTH AVE, MUELLER					
12/19/83	69197	<1	12/21/83	ENVIROTEST	
02/16/84	66237	ND	02/16/84	NYSDEC/DSHW/GC	
* 224 COMMONWEALTH AVE, MORRIS					
12/20/83	68980	<1	01/05/84	ENVIROTEST	
02/16/84	66238	ND	02/16/84	NYSDEC/DSHW/GC	
* 226 COMMONWEALTH AVE, RUNNALLS					
12/20/83	68981	<1	01/05/84	ENVIROTEST	
02/16/84	66239	ND	02/16/84	NYSDEC/DSHW/GC	
* 227 COMMONWEALTH AVE, MACENTEE					
12/20/83	68959	<1	01/03/84	ENVIROTEST	
03/07/84	66297	ND	03/08/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 228 COMMONWEALTH AVE, PLANTEGA					
12/20/83	68985	<1	01/03/84	ENVIROTEST	
03/06/84	66271	ND	03/06/84	NYSDEC/DSHW/GC	
* 229 COMMONWEALTH AVE, RUPPERT					
12/19/83	69198	<1	12/21/83	ENVIROTEST	
02/16/84	66240	ND	02/16/84	NYSDEC/DSHW/GC	
* 230 COMMONWEALTH AVE, THACHER					
12/20/83	68984	<1	01/03/84	ENVIROTEST	
03/06/84	66275	ND	03/06/84	NYSDEC/DSHW/GC	
* 231 COMMONWEALTH AVE, BROCK					
12/19/83	69199	<1	12/21/83	ENVIROTEST	
03/06/84	66272	ND	03/06/84	NYSDEC/DSHW/GC	
* 232 COMMONWEALTH AVE, CAFFERY					
12/20/83	68983	<1	01/03/84	ENVIROTEST	
* 233 COMMONWEALTH AVE, HEILFURTH					
12/20/83	68954	<1	01/05/84	ENVIROTEST	
02/08/84	03907	<1	02/08/84	NYSDEC/DSHW/GC	
* 237 COMMONWEALTH AVE, NOHA					
12/20/83	68955	<1	01/05/84	ENVIROTEST	
03/06/84	66273	ND	03/06/84	NYSDEC/DSHW/GC	
* 241 COMMONWEALTH AVE, GAZZO					
12/20/83	68956	<1	01/05/84	ENVIROTEST	
* 244 COMMONWEALTH AVE, FINLEY					
12/20/83	68982	<1	01/05/84	ENVIROTEST	
03/06/84	66274	ND	03/06/84	NYSDEC/DSHW/GC	
* 245 COMMONWEALTH AVE, MEYERS					
12/20/83	68957	<1	01/05/84	ENVIROTEST	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 31 ELECTRIC AVE, VAN PELT					
12/19/83	69170	<1	12/21/83	ENVIROTEST	
03/06/84	66276	ND	03/06/84	NYSDEC/DSHW/GC	
* 277 HIGHLAND AVE, PULUCH					
11/29/83	68523	ND	12/06/83	CLAYTON	CITY WATER
* 282 HIGHLAND AVE, SHATTUCK					
02/16/84	66234	ND	02/16/84	NYSDEC/DSHW/GC	
* 286 HIGHLAND AVE, ESTRADA					
11/28/83	69122	ND	12/06/83	CLAYTON	
01/05/84	68558	ND	01/10/84	USEPA/ESD	
* 287 HIGHLAND AVE, TESSELER					
11/28/83	69115	ND	12/06/83	CLAYTON	
03/06/84	66292	ND	03/06/84	NYSDEC/DSHW/GC	
* 291 HIGHLAND AVE, SMITH					
11/07/83		<1	11/09/93	ENVIROTEST/OCHD	
11/28/83	69121	ND	12/06/83	CLAYTON	
11/28/83	69121	<1	12/06/83	USEPA/ERT	
02/23/84	66267	ND	02/23/84	NYSDEC/DSHW/GC	
* 292 HIGHLAND AVE, PETRIZZO					
11/22/83	68503	ND	12/02/83	USEPA/ERT	
01/06/84	68565	ND	01/06/84	USEPA/ESD	
03/07/84	66286	ND	03/08/84	NYSDEC/DSHW/GC	
* 293 HIGHLAND AVE, NIXDORF					
11/29/83	69151	ND	12/06/83	CLAYTON	
01/05/84	68895	ND	01/13/84	USEPA/ESD	
01/05/84	68897	ND	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68899	ND	01/11/84	TAT/PHOTOVAC	75 MINUTES
02/22/84	66257	ND	02/22/84	NYSDEC/DSHW/GC	
* 295 HIGHLAND AVE, JANIAK					
10/17/83	34289	ND	11/15/83	NYSDHCLR	
11/28/83	69120	17	12/06/83	CLAYTON	CONTAMINATION DETECT
12/09/83	69179	ND	12/10/83	USEPA/ESD	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 295 HIGHLAND AVE, JANIAK					
01/05/84	68894	ND	01/11/84	USEPA/ESD	
01/05/84	68898	ND	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68896	ND	01/11/84	TAT/PHOTOVAC	75 MINUTES
01/23/84		ND	01/24/84	ENVIROTEST/OCHD	
* 297 HIGHLAND AVE, ROBAINA					
12/09/83	69180	37	12/10/83	USEPA/ESD	CONTAMINATION DETECTE
01/05/84	68900	40	01/13/84	USEPA/ESD	CONTAMINATION DETECTE
01/23/84		65	01/24/84	ENVIROTEST/OCHD	> NYSDOH 50 PPB LIMIT
01/25/84	02510	46	01/25/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
01/25/84	02511	78	01/25/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
01/25/84	02512	76	01/25/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 90 MINUTES
02/14/84	68869	24	02/15/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 30 MINUTES
02/14/84	68868	10	02/15/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/14/84	68871	40	02/15/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 60 MINUTES
03/20/84	66299	5	03/20/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* 299 HIGHLAND AVE, ECKERSON					
11/28/83	69118	ND	12/06/83	CLAYTON	
01/05/84	68562	ND	01/11/84	USEPA/ESD	
02/23/84	66265	ND	02/23/84	NYSDEC/DSHW/GC	
* 304 HIGHLAND AVE, LISKA					
10/14/83	24020	<1	10/17/83	ENVIROTEST/OCHD	
11/30/83		<1	12/02/83	ENVIROTEST/OCHD	
12/02/83	24888	<1	12/05/83	ENVIROTEST/OCHD	
01/05/84	68563	ND	01/13/84	USEPA/ESD	
02/21/84	66245	ND	02/21/84	NYSDEC/DSHW/GC	
02/21/84	66245	ND	02/21/84	NYSDEC/DSHW/GC	
* 307 HIGHLAND AVE, RUPERT					
11/25/83	69101	7000	12/06/83	CLAYTON	> NYSDOH 50 PPB LIMIT
02/03/84	03401	5517	02/03/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 30 MINUTES
02/03/84	03402	12112	02/03/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
2/03/84	03403	13985	02/03/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 180 MINUTES

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 309 HIGHLAND AVE, BARRY					
11/23/83	68544	100	12/06/83	CLAYTON	> NYSDOH 50 PPB LIMIT
12/09/83	69166	730	12/09/83	ENVIROTEST/OCHD	> NYSDOH 50 PPB LIMIT
02/07/84	03801	39	02/07/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
03/20/84	66212	118	03/20/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* 313 HIGHLAND AVE, LEWIS					
12/06/83	69156	ND	12/19/83	USEPA/ERT	
01/05/84	68886	ND	01/10/84	USEPA/ESD	
01/05/84	68890	<.5	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68888	<.5	01/11/84	TAT PHOTOVAC	90 MINUTES
02/21/84	66244	16	02/21/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/22/84	66249	8	02/22/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/22/84	66250	3	02/22/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 30 MINUTES
02/22/84	66252	2	02/22/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 60 MINUTES
02/23/84	66259	5	02/23/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/23/84	66261	2	02/23/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 30 MINUTES
03/20/84	66298	27	03/20/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* 316 HIGHLAND AVE, STOUT					
11/08/83	68805	3500	11/11/83	USEPA/ESD	> NYSDOH 50 PPB LIMIT
11/15/83	63941	ND	12/16/83	USEPA/ESD	
02/08/84	03909	2341	02/08/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
02/08/84	03910	2536	02/08/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 30 MINUTES
02/08/84	03911	2909	02/08/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
03/21/84	66220	2700	03/21/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* 317 HIGHLAND AVE, KNAPP					
11/23/83	68807	ND	11/23/83	USEPA/ERT	
11/23/83	68543	ND	12/06/83	CLAYTON	
01/05/84	68557	ND	01/10/84	USEPA/ESD	
02/22/84	66253	11	02/22/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/23/84	66260	9	02/23/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/23/84	66262	10	02/23/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 30 MINUTES
03/20/84	66300	9	03/20/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 319 HIGHLAND AVE, OGDEN					
11/08/83	68806	ND	11/08/83	USEPA/ERT	
11/23/83	68542	ND	12/06/83	CLAYTON	
01/05/84	68885	ND	01/10/84	USEPA/ESD	
01/05/84	68887	ND	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68889	.2	01/11/84	TAT/PHOTOVAC	90 MINUTES
02/22/84	66251	<1	02/22/84	NYSDEC/DSHW/GC	
* 320 HIGHLAND AVE, PARELLA					
10/17/83	34292	120000	11/15/83	NYSDHCLR	> NYSDOH 50 PPB LIMI
11/15/83	63940	260000	11/17/83	USEPA/ESD	> NYSDOH 50 PPB LIMI
11/22/83	68501	76000	12/02/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
11/23/83	68535	1900	12/06/83	CLAYTON	> NYSDOH 50 PPB LIMI
11/26/83	69105	>37000	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
11/28/83	69114	160000	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
11/29/83	68548	126000	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
11/29/83		87000	12/06/83	NYSDHCLR	> NYSDOH 50 PPB LIMI
11/30/83	69138	96480	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMI
12/01/83	69124	79766	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMI
12/02/83	69142	83000	12/08/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
12/03/83	69146	140122	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMI
12/06/83	69150	73000	12/29/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
12/07/83	69157	70300	12/08/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
12/07/83	34205	72000	12/08/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI
12/08/83		72000	12/15/83	NYSDHCLR	> NYSDOH 50 PPB LIMI
12/09/83	69165	61400	12/29/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
12/29/83	69152	95000	12/29/83	USEPA/ERT	> NYSDOH 50 PPB LIMI
01/06/84	68568	56000	01/12/84	USEPA/ESD	> NYSDOH 50 PPB LIMI
01/12/84		65805	01/13/84	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMI
01/25/84	02507	64000	01/25/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI
01/27/84	68576	53000	02/01/84	USEPA/ESD	> NYSDOH 50 PPB LIMI
02/07/84	03802	65796	02/07/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI
02/07/84	03803	62007	02/07/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI 30 MINUTES
02/07/84	03804	58718	02/07/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI 60 MINUTES
03/22/84	64221	44500	03/22/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMI
* 321 HIGHLAND AVE, SEELY					
10/14/83	24040	ND	10/17/83	ENVIROTEST/OCHD	
11/08/83	68804	ND	11/11/83	USEPA/ERT	
11/23/83	68541	ND	12/02/83	USEPA/ERT	
01/05/84	68561	ND	01/11/84	USEPA/ESD	
03/07/84	66283	<1	03/08/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 323 HIGHLAND AVE, GILBERT					
11/07/83		<1	11/09/83	ENVIROTEST/OCHD	
11/08/83	68803	ND	11/11/83	USEPA/ERT	
11/23/83	68540	ND	12/06/83	CLAYTON	
11/30/83		<1	12/02/83	ENVIROTEST/OCHD	
12/01/83	24888	<1	12/05/83	ENVIROTEST/OCHD	
01/05/84	68556	ND	01/11/84	USEPA/ESD	
03/07/84	66282	ND	03/08/84	NYSDEC/DSHW/GC	
* 325 HIGHLAND AVE, FIORE					
10/14/83	24020	<1	10/17/83	ENVIROTEST/OCHD	
11/08/83	68801	<1	11/11/83	USEPA/ERT	
11/23/83	68516	ND	12/02/83	USEPA/ERT	
11/30/83		<1	12/02/83	ENVIROTEST/OCHD	
12/01/83	24888	<1	12/05/83	ENVIROTEST/OCHD	
01/05/84	68876	ND	01/13/84	USEPA/ESD	
01/05/84	68879	.2	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68884	.3	01/11/84	TAT/PHOTOVAC	75 MINUTES
02/22/84	66258	<1	02/22/84	NYSDEC/DSHW/GC	
* 327 HIGHLAND AVE, LOBB					
10/14/83	24020	1800	10/17/83	ENVIROTEST/OCHD	> NYSDOH 50 PPB LIMIT
10/17/83	34288	2500	11/15/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT
11/08/83	68802	1600	11/11/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/22/83	68512	720	12/02/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/26/83	69107	410	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/27/83	69109	880	12/02/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/28/83	69112	1700	12/02/83	CLAYTON	> NYSDOH 50 PPB LIMIT
02/14/84	68870	42	02/15/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/14/84	68872	70	02/15/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 30 MINUTES
02/14/84	68873	77	02/15/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
03/20/84	66213	39	03/20/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* 329 HIGHLAND AVE, OSBORNE					
11/07/83		900	11/08/83	ENVIROTEST/OCHD	> NYSDOH 50 PPB LIMIT
11/08/83	68814	2400	11/11/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
02/06/84	03701	207	02/06/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
02/06/84	03702	92	02/06/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 30 MINUTES
02/06/84	03703	52	02/06/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
03/20/84	66211	41	03/20/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 335 HIGHLAND AVE, CROOKS					
11/07/83		<1	11/08/83	ENVIROTEST	
11/23/83	68518	28	12/06/83	CLAYTON	CONTAMINATION DETECTE
11/08/83	68808	ND	11/11/83	USEPA/ERT	
12/09/83	69177	ND	12/10/83	USEPA/ESD	
01/05/84	68878	ND	01/13/84	USEPA/ESD	
01/05/84	68881	ND	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68883	ND	01/11/84	TAT/PHOTOVAC	75 MINUTES
02/21/84	66242	ND	02/21/84	NYSDEC/DSHW/GC	
* 337 HIGHLAND AVE, GADY					
11/08/83	68809	ND	11/11/83	USEPA/ERT	
11/30/83	-	<1	12/02/83	ENVIROTEST/OCHD	
12/01/83	24888	<1	12/05/83	ENVIROTEST/OCHD	
01/05/84	68877	ND	01/13/84	USEPA/ESD	
01/05/84	68880	ND	01/11/84	TAT/PHOTOVAC	30 MINUTES
01/05/84	68882	ND	01/11/84	TAT/PHOTOVAC	50 MINUTES
02/21/84	66243	ND	02/21/84	NYSDEC/DSHW/GC	
* 338 HIGHLAND AVE, PEREZ					
10/17/83	34293	7	11/15/83	NYSDHCLR	CONTAMINATION DETECTE
11/08/83	68813	ND	11/11/83	USEPA/ERT	
11/28/83	69123	2	12/06/83	CLAYTON	CONTAMINATION DETECTE
01/05/84	68891	ND	01/10/84	USEPA/ESD	
01/05/84	68892	2.6	01/11/84	TAT/PHOTOVAC	CONTAMINATION DETECTE 30 MINUTES
01/05/84	68893	1	01/11/84	TAT/PHOTOVAC	CONTAMINATION DETECTE 45 MINUTES
* 339 HIGHLAND AVE, PERRY					
11/08/83	68810	ND	11/11/83	USEPA/ERT	
11/22/83	68510	ND	12/02/83	USEPA/ERT	
01/05/84	68560	ND	01/11/84	USEPA/ESD	
03/07/84	66281	ND	03/08/84	NYSDEC/DSHW/GC	
* 341 HIGHLAND AVE, COURTEAU					
11/08/83	68811	ND	11/11/83	USEPA/ERT	
11/22/83	68509	ND	12/02/83	USEPA/ERT	
01/05/84	68555	ND	01/10/84	USEPA/ESD	
03/07/84	66290	ND	03/08/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 344 HIGHLAND AVE, ROSELLI					
10/14/83	24020	<1	10/17/83	ENVIROTEST/OCHD	CITY WATER
11/07/83		<1	11/09/83	ENVIROTEST/OCHD	CITY WATER
11/08/83	68812	ND	11/11/83	USEPA/ERT	CITY WATER
* 353 HIGHLAND AVE, ERNEST					
11/22/83	68505	ND	12/02/83	USEPA/ERT	
01/05/84	68554	ND	01/09/84	USEPA/ESD	
03/07/84	66280	ND	03/08/84	NYSDEC/DSHW/GC	
* 355 HIGHLAND AVE, PITT					
11/28/83	69117	165	12/06/83	CLAYTON	> NYSDOH 50 PPB LIMI
12/09/83	69167	<1	12/10/83	ENVIROTEST/OCHD	
01/05/84	68559	ND	01/11/84	USEPA/ESD	
03/07/84	66296	ND	03/08/84	NYSDEC/DSHW/GC	
* 357 HIGHLAND AVE, SCHMALL					
11/22/83	68507	ND	12/02/83	USEPA/ERT	
01/05/84	68551	<2	01/09/84	USEPA/ESD	
03/06/84	66279	ND	03/06/84	NYSDEC/DSHW/GC	
* 361 HIGHLAND AVE, NOYES					
11/22/83	68506	ND	12/02/83	USEPA/ERT	
01/05/84	68553	ND	01/09/84	USEPA/ESD	
03/06/84	66278	ND	03/06/84	NYSDEC/DSHW/GC	
* 363 HIGHLAND AVE, LENT					
11/28/83	69116	ND	12/06/83	CLAYTON	
01/05/84	68551	ND	01/09/84	USEPA/ESD	
03/06/84	66293	ND	03/06/84	NYSDEC/DSHW/GC	
* 400 HIGHLAND AVE, KUHL					
11/22/83	68504	ND	12/02/83	USEPA/ERT	
03/06/84	66277	ND	03/06/84	NYSDEC/DSHW/GC	
* 408 HIGHLAND AVE, KUHL					
11/22/83	68505	ND	12/02/83	USEPA/ERT	
01/05/84	68564	<2	01/13/84	USEPA/ESD	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 409 HIGHLAND AVE, FEDERAL CABINET					
01/06/84	68567	ND	01/12/84	USEPA/ESD	
02/23/84	66263	ND	02/23/84	NYSDEC/DSHW/GC	
* 409A HIGHLAND AVE, R.C. PRYOR					
01/06/84	68566	ND	01/11/84	USEPA/ESD	
02/23/84	66264	ND	02/23/84	NYSDEC/DSHW/GC	
* LOT NO.4 HIGHLAND AVE, STOUT					
11/15/83	63941	ND	12/16/83	USEPA/ESD	
* SEWER MANHOLE ON HIGHLAND AND PARK AVE					
12/07/83	34206	<2	12/08/83	NYSDEC/DSHW/GC	
01/26/84	02607	11	01/26/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* INDUSTRIAL PLACE - MANHOLE AT STREET END					
1/26/84	02606	23.5	01/26/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
01/26/84	02605	1250	01/26/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* INDUSTRIAL PLACE SECOND MANHOLE					
12/07/83	34208	720	12/08/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* INDUSTRIAL PLACE, GENERAL SWITCH					
10/17/83	34621	1100	11/29/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT
12/22/83	68991	1294	12/22/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
12/22/83	68992	2156	12/22/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT 30 MINUTES
12/22/83	68993	3877	12/22/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT 45 MINUTES
12/29/83	68999	2051	12/29/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
12/29/83	69000	1772	12/29/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
02/02/84	03304	1320	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 120 MINUTES
02/02/84	03305	1760	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 180 MINUTES
02/02/84	03306	1660	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 240 MINUTES
02/02/84	03301	1440	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 30 MINUTES
2/02/84	03302	1480	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 60 MINUTES
02/02/84	03303	1340	02/02/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 90 MINUTES

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* INDUSTRIAL PLACE, GENERAL SWITCH - SEWER LINE					
01/26/84	02603	667	01/26/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* INDUSTRIAL PLACE, GENERAL SWITCH - SOIL					
10/18/83	34412	UG/G 450	10/20/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT
10/18/83	34413	UG/G 1.2	10/20/83	NYSDHCLR	CONTAMINATION DETECTE
12/07/83	34103	<1	12/07/83	NYSDEC/DSHW/GC	SURFACE
12/07/83	34101	UG/G 126	12/07/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 1 FOOT DEEP
12/07/83	34101	UG/G 17.5	12/07/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE SURFACE
12/07/83	34101	UG/G 115	12/07/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT 2 FEET DEEP
12/08/83	34102	UG/G 4.7	12/08/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 2 1/2 FEET DEEP
* INDUSTRIAL PLACE, GENERAL SWITCH COOLING WATER					
12/07/83	34209	20	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* INDUSTRIAL PLACE, GUILD MOLDERS					
01/12/84	68571	ND	01/13/84	TAT/ PHOTOVAC	
* INDUSTRIAL PLACE, GUILD MOLDERS - PROCESS WATER					
12/21/83	68962	<1	01/03/84	ENVIROTEST	
* INDUSTRIAL PLACE, HERTZBURG BRUSH - 1ST MANHOLE					
12/21/83	68961	280	01/03/84	ENVIROTEST	> NYSDOH 50 PPB LIMIT
01/26/84	02601	32	01/26/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* INDUSTRIAL PLACE, HERTZBURG BRUSH - 3RD MANHOLE					
01/26/84	02602	46	01/26/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* INDUSTRIAL PLACE, JUNKYARD - MANHOLE IN MIDDLE					
01/26/84	02606	608	01/26/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
01/26/84	02609	168	01/26/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* INDUSTRIAL PLACE, LUBE PACKING - MANHOLE					
2/07/83	34207	2400	12/08/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
01/26/84	02604	1400	01/26/84	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* INDUSTRIAL PLACE, LUBE PACKING - SOIL					
12/08/83	34203	UG/G <1	12/08/83	NYSDEC/DSHW/GC	1 FOOT DEEP
12/08/83	34204	UG/G 2.7	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 6 INCHES DEEP
12/08/83	34201	UG/G 4.5	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 1 FOOT DEEP
12/08/83	34201	UG/G 3.5	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE 3 FEET DEEP
12/08/83	34202	UG/G 3.2	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE SURFACE
12/08/83	34202	UG/G <1	12/08/83	NYSDEC/DSHW/GC	1 FOOT DEEP
12/08/83	34203	UG/G <1	12/08/83	NYSDEC/DSHW/GC	1 FOOT DEEP
* INDUSTRIAL PLACE, STREAM SAMPLE					
12/29/83	68998	0.6	12/29/83	TAT/PHOTOVAC	
* 29 PARK AVE, EBERT					
2/21/84	66246	ND	02/21/84	NYSDEC/DSHW/GC	
* 34 PARK AVE, DUCO					
11/23/83	68550	ND	12/06/83	CLAYTON	
02/23/84	66266	ND	02/23/84	NYSDEC/DSHW/GC	
* RD3 BISCH RD, GOODRICH					
12/21/83	68963	<1	01/03/84	ENVIROTEST	
02/22/84	66254	ND	02/22/84	NYSDEC/DSHW/GC	
* RD3 MAPLE RD, HOFFMAN					
12/21/83	68964	<1	01/03/84	ENVIROTEST	
02/22/84	66255	ND	02/22/84	NYSDEC/DSHW/GC	
* 103 ROCKWELL AVE, PENNINGTON					
02/21/83	68986	<1	01/03/84	ENVIROTEST	
* 167 ROCKWELL AVE, BILA					
02/21/84	66241	ND	02/21/84	NYSDEC/DSHW/GC	

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* 172 ROCKWELL AVE, BROWN					
02/08/84	03907	<1	02/08/84	NYSDEC/DSHW/GC	
* SPIKE					
12/20/83	68978	93	12/28/83	ENVIROTEST	
12/20/83	68978	92	01/05/84	ENVIROTEST	
* MIDDLETOWN STP EFFLUENT					
12/07/83	34214	4	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
01/18/84	01813	<1	01/24/84	NYSDEC/DSHW/GC	
01/19/84	01906	<1	01/24/84	NYSDEC/DSHW/GC	
02/08/84	03904	1	02/08/84	NYSDEC/SDHW/GC	CONTAMINATION DETECTE
02/09/84	04002	1	02/09/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* MIDDLETOWN STP INFLUENT					
10/18/83	34414	260	10/20/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT
12/07/83	34213	30	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
1/19/84	01907	3	01/24/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/08/84	03803	9	02/08/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/09/84	04001	6	02/09/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* MONHAGEN BROOK - DOWNSTREAM OF MIDDLETOWN STP					
12/07/83	34211	4	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
01/18/84	01814	<1	01/24/84	NYSDEC/DSHW/GC	
01/19/84	01905	<1	01/24/84	NYSDEC/DSHW/GC	
02/08/84	03906	1	02/08/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
02/09/84	04004	1	02/09/84	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
* MONHAGEN BROOK - UPSTREAM OF MIDDLETOWN STP					
12/07/83	34212	ND	12/08/83	NYSDEC/DSHW/GC	
01/18/84	01812	<1	01/24/84	NYSDEC/DSHW/GC	
01/19/84	01904	<1	01/24/84	NYSDEC/DSHW/GC	
02/08/84	03905	<1	02/04/84	NYSDEC/DSHW/GC	
02/09/84	04003	<1	02/09/84	NYSDEC/DSHW/GC	
* TANK TO SEWER					
11/23/83	68545	>12000	12/06/83	CLAYTON	> NYSDOH 50 PPB LIMIT
11/26/83	69108	38900	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/27/83	69110	16300	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
1/28/83	69113	7000	12/06/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
11/29/83	68549	5300	12/06/83	USPEPA/ERT	> NYSDOH 50 PPB LIMIT
11/29/83		2300	12/03/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

COLLECTION DATE	LAB NUMBER	TETRACHLOROETHYLENE CONCENTRATION (PPB)	ANALYSIS DATE	LABORATORY	COMMENTS
* TANK TO SEWER					
12/01/83	69125	29023	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
12/01/83	69141	44798	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
12/03/83	69145	25979	12/15/83	TAT/PHOTOVAC	> NYSDOH 50 PPB LIMIT
12/05/83	69153	53000	12/16/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
12/06/83	69176	48000	12/19/83	USEPA/ERT	> NYSDOH 50 PPB LIMIT
12/07/83		33000	12/19/83	NYSDHCLR	> NYSDOH 50 PPB LIMIT
11/25/83	69103	34000	12/30/84	USEPA/ERT	> NYSDOH 50 PPB LIMIT
* TANK TO SEWER BOTTOM					
12/07/83	34105	25000	12/08/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* TANK TO SEWER TOP					
12/07/83	34104	33000	12/08/83	NYSDEC/DSHW/GC	> NYSDOH 50 PPB LIMIT
* WALKILL RIVER AT COUNTY ROAD #53					
01/19/84	01902	<1	01/24/84	NYSDEC/DSHW/GC	
* WALLKILL RIVER - DOWNSTREAM OF WALLKILL STP					
12/07/83	69164	ND	12/20/83	USEPA/ERT	
12/07/83	34109	<2	12/08/83	NYSDEC/DSHW/GC	
* WALLKILL RIVER - UPSTREAM OF WALLKILL STP					
11/23/83	68537	ND	12/06/83	USEPA/ERT	
12/07/83	69163	ND	12/20/83	USEPA/ERT	
12/07/83	34108	10	12/08/83	NYSDEC/DSHW/GC	CONTAMINATION DETECTE
01/19/84	01910	<1	01/24/84	NYSDEC/DSHW/GC	
* WALLKILL RIVER AT MIDWAY ROAD					
01/19/84	01901	<1	01/24/84	NYSDEC/DSHW/GC	
* WALLKILL RIVER AT ROUTE 17M					
01/19/84	01903	<1	01/24/84	NYSDEC/DSHW/GC	
* WALLKILL STP EFFLUENT					
11/23/83	68520	FAILED QC	12/06/83	CLAYTON	
11/24/83	68547	11	12/06/83	CLAYTON	CONTAMINATION DETECTE
1/29/83		10	12/03/83	NYSDHCLR	CONTAMINATION DETECTE
12/01/83	69140	1	12/15/83	TAT/PHOTOVAC	CONTAMINATION DETECTE
12/02/83	69144	2	12/06/83	USEPA/ERT	CONTAMINATION DETECTE

TABLE III-9

POTABLE WELL SAMPLING DATA
(PCE values in ug/liter)

Owner	Street	EPA/NYSDOH** 10-17-83-4-19-84	FCHA Potable Well Sampling Trips 6-4-84-6-5-84	7-17-84-7-18-84	9-19-84-8-28-84	9-20-84
Knapp	Highland	ND-12	24	15		7
Van Pelt	Electric	ND-LT1	ND		ND	
Ogden	Highland	ND-LT1	ND		ND	ND/0.1*
Seeley	Highland	ND-LT1	ND			ND
Gilbert	Highland	ND-LT1	ND		ND	0.2
Cornelius	Highland	NAR	ND/ND*			
Crooks	Highland	ND-28	LT 0.1	ND		
Tessler	Highland	ND	ND			
Petrizzo	Highland	ND	ND			
Fiore	Highland	ND-LT1	0.1	ND		
Heilfurth	Commonwealth	LT1	ND		ND	
McEntee	Commonwealth	ND-LT1	ND			
Ruppert	Commonwealth	ND-LT1	ND			
Caspe	Highland	NAR	ND			
Pitt	Highland	ND-165	ND			
Wegenroth	Watkins	NAR	ND			
Brinkerhoff	Commonwealth	LT1	ND		ND	
Palermo	Commonwealth	LT1	ND			
Berry	Commonwealth	LT1	ND			
Varga	Commonwealth	LT1	ND			
Prior King Press	Watkins	ND-2,3	1/ND*	2		
Holmes	Watkins	ND	ND			

TABLE III-9 (CONTINUED)

POTABLE WELL SAMPLING DATA
(PCE values in ug/liter)

Owner	Street	EPA/NYSDOH**	FCHA Potable Well Sampling Trips			
		10-17-83- 4-19-84	6-4-84- 6-5-84	7-17-84- 7-18-84	9-19-84- 8-28-84	9-20-84
Eckerson	Highland	ND	ND	ND		
Lopez	Commonwealth	LT1	ND			
Rasmussen	Watkins	ND-12	ND			
Liska	Highland	LT1-12		130	850/810*	
Nixdorf	Highland	ND		ND		
Barry	Highland	39-730		250		
Osborne	Highland	41-2400		34		
Bliven	Commonwealth	ND-LT1		ND		
Hoffman	Commonwealth	ND-LT1		ND		
Winner	Watkins	ND-1.1		ND		
Stout	Highland	2341-3500		3,500		
Lobb	Highland	39-2500		46		
Janiak	Highland	ND-17		ND		
Parella	Highland	1900-260,000		68,000/47,000*		
General Switch	Highland	1100-3877		1,400		
Lewis	Highland	ND-49		107	120	
Robanna	Highland	5-78		4		13
Radivoy	Highland	ND-4.5		2		
Muller	Commonwealth	ND-LT1		ND		
CosmoOptics New Well	Watkins	ND		2		

TABLE III-9 (CONTINUED)

POTABLE WELL SAMPLING DATA
(PCE values in ug/liter)

Owner	Street	EPA/NYSDOH** 10-17-83-4-19-84	FCHA Potable Well Sampling Trips 6-4-84-6-5-84	7-17-84-7-18-84	9-19-84-8-28-84	9-20-84
CosmoOptics Old Well	Watkins	ND-6 failed QC		ND		
Smith	Highland	ND-LT1			ND	ND
Courteau	Highland	ND			ND	
Perry	Highland	ND			ND	
Reynolds	Commonwealth	ND-LT1			ND	ND
Kieran	Commonwealth	ND-LT1			ND	
Hawkins	Commonwealth	ND			ND	
Shattuck	Highland	ND				LT 0.1
Estrada	Highland	ND				ND
Gady	Highland	ND-LT1				0.1
Ward	Wilkins	ND-2				ND
Ebert	Park	ND				LT 0.1
Duco	Park	ND				LT 0.1
Ruppert	Highland	7,000-13,985		14,000/18,000*		
Trip Blanks		ND	ND		ND	
Field Blanks		ND	ND		ND	

* Represents replicate analysis.

**Column represents range in PCE values from EPA/NYSDOH sampling program.

LT = Less than.

NAR = No available range.

Appendix D

Permits

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-3505

Henry G. Williams
Commissioner

April 1, 1987

MEMORANDUM

TO: Regional Water Engineers, Bureau Directors, Section Chiefs

SUBJECT: Division of Water Technical and Operational Guidance Series (2.1.1)
GROUNDWATER CONTAMINATION REMEDIATION STRATEGY
(Originator: Mr. Halton)

I. PURPOSE

To establish strategies for source control and remediation of groundwater contamination.

II. DISCUSSION

This document applies to chronic groundwater contamination incidents for which the Division of Water (DOW) has lead responsibility for source control and groundwater remediation. These cases are identified in the August 14, 1984 MOU between DOW and the Division of Solid and Hazardous Waste (DSHW). The MOU says that DOW has lead responsibility if the source of the groundwater contamination is:

1. Any recurring point source discharge.
2. Petroleum or chemical products which, if leaked or spilled, would not constitute a hazardous waste under RCRA/Part 370.
3. Leaks or spills of waste materials other than hazardous wastes.
4. Unknown.

This document does not apply to immediate or short-term response to spills, or to cases for which DSHW has lead responsibility.

DOW is responsible for the site investigation, at least until the source is identified. However, this document assumes that a site investigation has already taken place. It considers two issues; the control of continuing sources of contamination and the remediation of contaminated groundwater plumes (see figure 1).

III. GUIDANCE

1. Step I deals with on-going sources of contamination (see figure 2). "Source Control"(1) will be required if there is a violation of water quality standards (ground or surface). A source control program must eliminate the violation if technologically feasible. If not, the program must accomplish all that is technologically feasible. Cost will not be considered.

Responsibilities

1. The RWE, in consultation with BSPR, has the following responsibilities:

   a. Final selection/approval of source control and plume management programs.

   b. To determine when an impairment exists.

   c. To decide if termination of a plume management program can be considered, or, if not, to decide if there are any acceptable alternatives to continuing.

   d. To provide overall supervision and coordination for all site investigations, monitoring, negotiations with the owner, assemblage of case reports, and liaison with the Regional Attorney on enforcement cases.

2. BSPR, in consultation with the RWE, has the following responsibilities:

   a. To conduct detailed hydrogeologic evaluations of the site at the request of the RWE and to identify sources of contamination where possible.

   b. To advise on all hydrogeologic technical issues, including site monitoring, evaluation of consultant reports, and options for plume management and source control. Review of cost/benefit data.

   c. To render the decision on when a plume management effort has reached a technical "dead end".

3. BWFD/BMA, in consultation with the RWE, are responsible for the regulation of any point source discharge from the site to ground or surface waters.

4. NYSDOH shall be consulted by the RWE regarding:

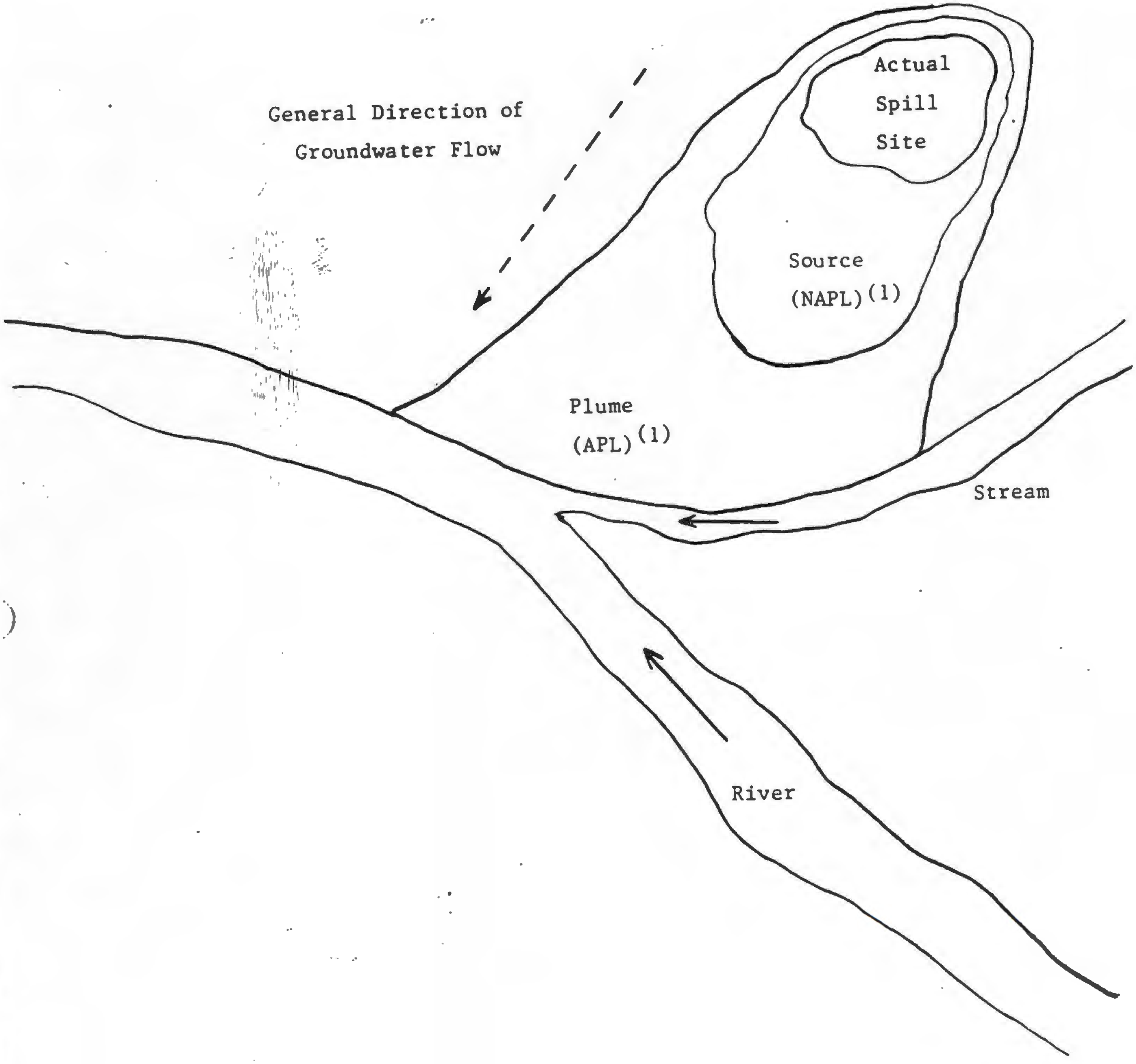
   a. Acceptable levels of chemicals in drinking water, if not covered by existing water quality standards.

   b. Acceptability of public water supplies.

   c. Risk assessment regarding residual contamination.

Figure 1

Groundwater Contamination by Past Chemical Spill



(1) - See Glossary

Figure 2

Step I - Source Control

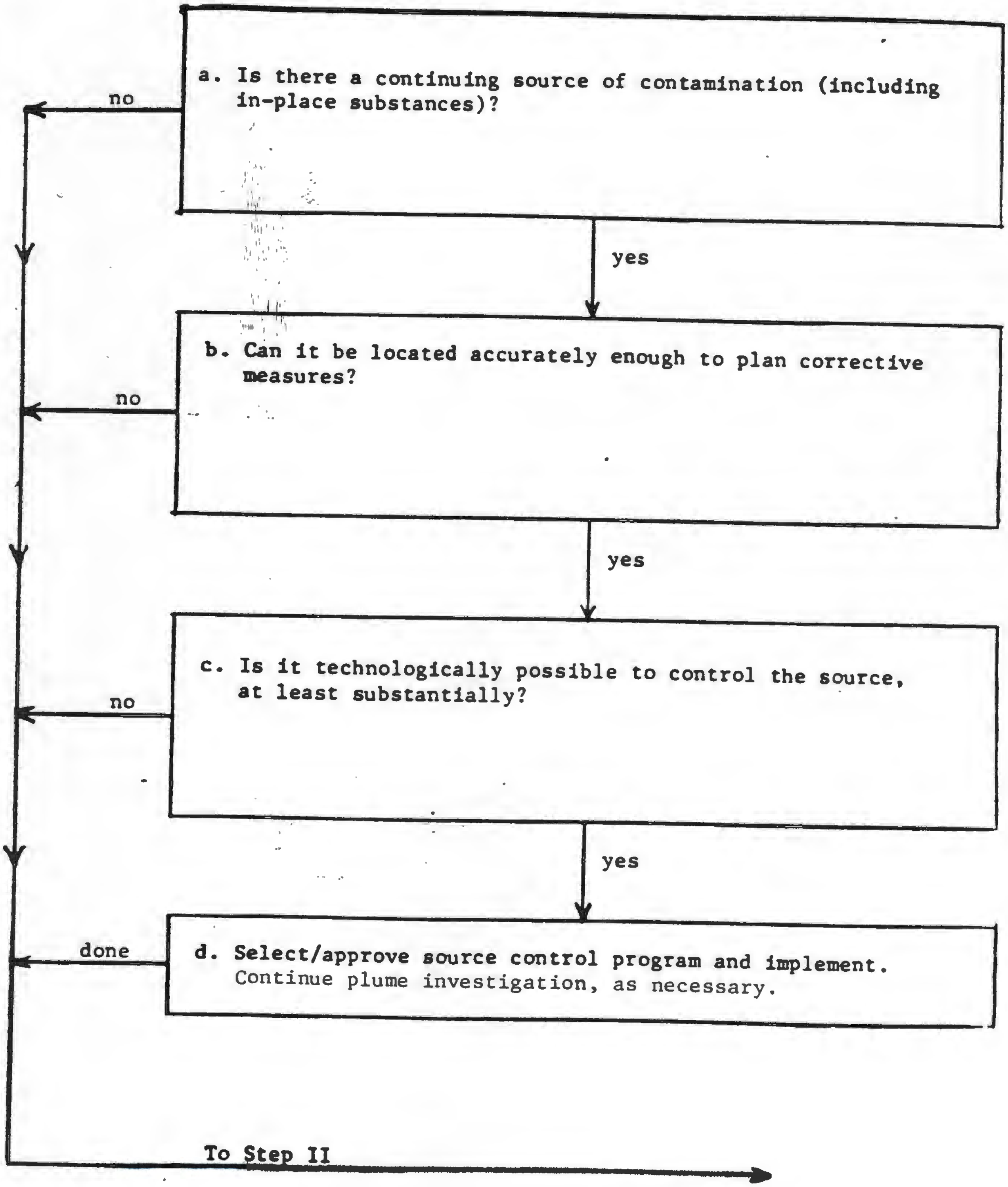
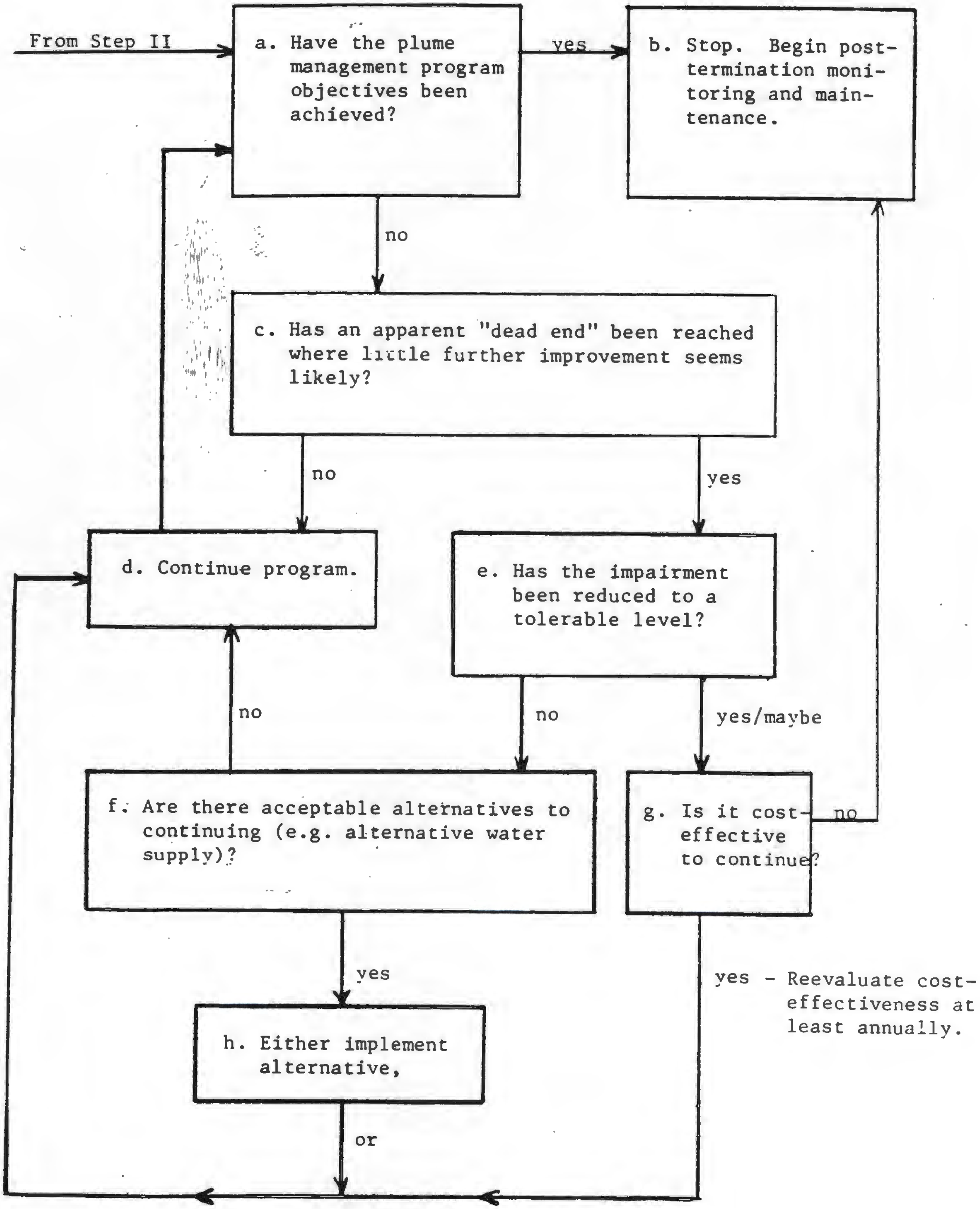


Figure 4

Step III - Termination



SUMMARY OF CODE REVISION

STANDARDS

General MCLs

The **New York State Department of Health** has adopted standards to limit organic chemical contamination of public drinking water supplies. The code revision (to Part 5 of the State Sanitary Code) establishes maximum contaminant levels (MCLs) or standards for:

Principal Organic Contaminant (POC) - 0.005 mg/l (5 ug/l)
Unspecified Organic Contaminant (UOC) - 0.050 mg/l (50 ug/l)
Total of POCs and UOCs - 0.10 mg/l (100 ug/l)

POCs would be defined as any organic chemical belonging to any of six general chemicals classes:

Halogenated Alkanes
Halogenated Ethers
Halobenzenes and Substituted Halobenzenes
Benzene and Alkyl- or Nitrogen-Substituted Benzenes
Substituted, Unsaturated Aliphatic Hydrocarbons
Halogenated Non-aromatic Cyclic Hydrocarbons

POCs, by definition, exclude trihalomethanes and other organic chemicals with a specific MCL of their own.

UOCs would be defined as any organic chemical not covered by another MCL.

The Department recognizes the possible need for exceptions from the proposed MCLs for POCs and UOCs if the presence of a specific organic chemical does not represent contamination and sufficient, valid scientific information demonstrates that they do not pose an unreasonable risk to human health. When justified, the regulation contains provisions to allow for the establishment of a more lenient (higher) MCL.

The regulation also allows a water supplier to submit justification for a higher MCL for up to 60 days following application of a paint or lining to a potable water appurtenance. The Commissioner may allow the higher MCL if he determines that no unreasonable risk to human health would result.

The Department recognizes the need to use a stricter (lower) interim guideline value for a contaminant which lacks a chemical-specific MCL but for which the available toxicological data are judged sufficient to warrant more stringent control. The regulation allows for consideration of lower interim guidelines when justified. The Department believes that, from a public health perspective, the benefits associated with the broad nature of the general MCLs outweigh the fact that interim guidelines may have to be used in some cases. For example, the existing guidelines for PCBs - 1 ug/l; aldicarb - 7 ug/l; carbofuran - 15 ug/l; atrazine - 25 ug/l will be retained until a specific MCL for each chemical is developed.

Initial Sampling

The initial monitoring requirement for each source depends on the type and size of the system as scheduled below:

System Type/Size	Required Samples per source
Community serving 10,000 or more persons	One per quarter for one year by 12/31/88
Community serving 3,300-9,999 persons	One per quarter for one year by 12/31/89
Community serving fewer than 3,300 persons and more than 149 service connections	One per quarter for one year by 12/31/90
Community serving fewer than 150 service connections	One by 6/30/91
Nontransient, Noncommunity	One by 6/30/92
Noncommunity	State Discretion

Systems serving over 10,000 persons were notified by mail in October 1987 to perform the required sampling under existing Code, Section 5-1.75, and EPA regulations.

As with other contaminants, the State may use Section 5-1.51(e) to require a system to monitor sooner or more frequently whenever the potential exists for an MCL violation. Consequently, systems with sources that have been shown by previous monitoring to be contaminated may be required to monitor before the above schedule.

Vulnerability to Contamination

The State will assess the vulnerability to contamination of all sources of water supply based on:

a. previous monitoring results

b. number of persons served by the public water system

c. proximity of the system to a larger system

d. proximity to commercial or industrial use, disposal or storage of volatile synthetic organic chemicals; and

e. the degree of protection afforded the source of water supply.

Detailed guidance in determining vulnerability will be developed similar to EPA's as presented in the Federal Register, November 13, 1985, Volume 50, No. 219.

For systems serving fewer than 150 service connections, more than one sample will be required for those sources that are determined to be vulnerable. Following a determination of nonvulnerability, the State may reduce initial and some of the repeat sampling described below for intermediate sized systems (more than 150 service connections, but population less than 3,300 persons). It is unlikely that systems serving 3,300 or more persons would have monitoring reduced since EPA's guidance considers all systems this large to be vulnerable to contamination. Statewide surveys show that volatile organic chemicals are more than twice as likely to be found in sources of these larger systems.

Repeat Monitoring

At those sources where contaminants are detected, (at 0.0005 mg/l or above) monitoring would be required to continue on quarterly intervals. Systems with 150 or more service connections for which contaminants are not detected would be required to repeat monitoring every three years. Systems with fewer than 150 service connections would not be required to repeat monitoring unless they are determined to be vulnerable.

DETERMINATION OF COMPLIANCE

If the results of a sample exceed the MCLs, the supplier of water would be required to collect one to three confirmation samples as soon as practical but no later than 30 days. If the average of all samples (monitoring sample plus confirmation sample(s)) exceeds the MCL, a MCL violation occurs. Those systems with sources that exceed the MCLs after the effective date will be put on a compliance schedule and required to provide public notification. Both short and long-term compliance strategies will be developed. The long-term strategy in most cases, would be to develop alternative sources or provide treatment. Potential short-term strategies include an alternative water source, minimal use of a contaminated source, such as stand-by for peak demand, conservation measures, temporary treatment, and consumer advisories.

Persistent violators of MCLs, or monitoring and reporting requirements will be subject to enforcement actions as for other contaminants regulated in the code.

NOTIFICATION

The supplier of water must make State, consumer and public notification for MCL or other violations according to requirements similar to those existing for other contaminants.

The regulations also require systems to notify its consumers as to the availability of monitoring results for volatile organic chemicals. Notification will be included in the first set of water bills issued by the system after the receipt of the result or by other written notice within three months. The State would accept as written notice, a one-time publication in a daily newspaper of general circulation in the area served by your system. The notice should:

1. identify a person and supply the telephone number to contact for information on the monitoring results, and
2. where appropriate, state that quarterly monitoring will continue for the remainder of the year.

A legal notice is acceptable provided it is conspicuous and does not contain unduly technical language, unduly small print or similar problems that frustrate the purpose of the notice.

TABLE 1
ORGANIC CHEMICALS IN REQUIRED MONITORING
VINYL CHLORIDE AND 52 PRINCIPAL ORGANIC CONTAMINANTS
(AS PER ENVIRONMENTAL LABORATORY APPROVAL PROGRAM)

CHEMICAL NAME ELAP NOMENCLATURE	CHEMICAL NAME USED PREVIOUSLY IN PROPOSAL
benzene	
bromobenzene	
bromochloromethane	
bromomethane	
n-butylbenzene	
sec-butylbenzene	
tert-butylbenzene	
carbon tetrachloride	
chlorobenzene	
chloroethane	
chloromethane	
2-chlorotoluene	(o-chlorotoluene)
4-chlorotoluene	(p-chlorotoluene)
dibromomethane	
1,2-dichlorobenzene	(o-dichlorobenzene)
1,3-dichlorobenzene	(m-dichlorobenzene)
1,4-dichlorobenzene	(p-dichlorobenzene)
dichlorodifluoromethane	
1,1-dichloroethane	
1,2-dichloroethane	
1,1-dichloroethene	(1,1-dichloroethylene)
cis-1,2-dichloroethene	(cis-1,2-dichloroethylene)
trans-1,2-dichloroethene	(trans-1,2-dichloroethylene)
1,2-dichloropropane	
1,3-dichloropropane	
2,2-dichloropropane	
1,1-dichloropropene	
cis-1,3-dichloropropene	
trans-1,3-dichloropropene	
ethylbenzene	
hexachlorobutadiene	
isopropylbenzene	
p-isopropyltoluene	(p-cymene)
methylene chloride	(dichloromethane)
n-propylbenzene	
styrene	
1,1,1,2-tetrachloroethane	
1,1,2,2-tetrachloroethane	
tetrachloroethene	(1,1,2,2-tetrachloroethylene)
toluene	
1,2,3-trichlorobenzene	
1,2,4-trichlorobenzene	
1,1,1-trichloroethane	
1,1,2-trichloroethane	
trichloroethene	(1,1,2-trichloroethylene)
trichlorofluoromethane	(fluorotrichloromethane)
1,2,3-trichloropropane	
1,2,4-trimethylbenzene	
1,3,5-trimethylbenzene	
m-xylene	
o-xylene	
p-xylene	

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OP | LOCATION | FACILITY | EMISSION POINT | I

A ADD
C CHANGE
D DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-12 BEFORE ANSWERING ANY QUESTION

PROCESS, EXHAUST OR VENTILATION SYSTEM

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

NAME OF OWNER/FIRM		9 NAME OF AUTHORIZED AGENT	10 TELEPHONE	19 FACILITY NAME (IF DIFFERENT FROM OWNER/FIRM)	
2 NUMBER AND STREET ADDRESS		11 NUMBER AND STREET ADDRESS		20. FACILITY LOCATION (NUMBER AND STREET ADDRESS)	
CITY - TOWN - VILLAGE	4. STATE	5 ZIP	12. CITY - TOWN - VILLAGE	13. STATE	14. ZIP
				21 CITY - TOWN - VILLAGE	22 ZIP
				23 BUILDING NAME OR NUMBER	24 FLOOR NAME OR NUMBER
OWNER CLASSIFICATION		15. NAME OF P.E. OR ARCHITECT PREPARING APPLICATION	16. N.Y.S. P.E OR ARCHITECT LICENSE NO.	17. TELEPHONE	
				25 START UP DATE ___ / ___ MO YR	26 DRAWING NUMBERS OF PLANS SUBMITTED
7 NAME & TITLE OF OWNERS REPRESENTATIVE	8 TELEPHONE	18 SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT		27 PERMIT TO CONSTRUCT A ☐ NEW SOURCE B ☐ MODIFICATION	28 CERTIFICATE TO OPERATE A. ☐ NEW SOURCE C. ☐ EXISTING SOURCE B ☐ MODIFICATION

OWNER CLASSIFICATION
☐ COMMERCIAL C ☐ UTILITY E ☐ STATE F ☐ MUNICIPAL H ☐ HOSPITAL I. ☐ RESIDENTIAL
B ☐ INDUSTRIAL D ☐ FEDERAL G ☐ EDUC. INST J ☐ OTHER

SECTION B

29 EMISSION POINT ID	30. GROUND ELEVATION (FT)	31 HEIGHT ABOVE STRUCTURES (FT)	32 STACK HEIGHT (FT)	33 INSIDE DIMENSIONS (IN)	34 EXIT TEMP (°F)	35 EXIT VELOCITY (FT/SEC)	36. EXIT FLOW RATE (ACFM)	37 SOURCE CODE	38 HRS/DAY	39 DAYS/YR	40 % OPERATION BY SEASON Winter Spring Summer Fall

SECTION C

41 DESCRIBE PROCESS OR UNIT	1	2
	3	4.
	5	6.
	7	8

SECTION

EMISSION CONTROL EQUIPMENT I D	CONTROL TYPE	MANUFACTURER'S NAME AND MODEL NUMBER	DISPOSAL METHOD	DATE INSTALLED MONTH / YEAR	USEFUL LIFE
42	43	44	45	46 /	47
48	49	50	51	52 /	53

CALCULATIONS

SECTION F

CONTAMINANT NAME	CAS NUMBER	INPUT OR PRODUCTION	UNIT	ENV RATING	EMISSIONS ACTUAL	UNIT	HOW DET	PERMISSIBLE	% CONTROL EFFIC'CY	HOURLY EMISSIONS (LBS/HR) ERP	ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	10^x	PERMISSIBLE
54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142	143

SEC. G

SOLID FUEL TYPE	SOLID FUEL TONS/YR	%S	LIQUID FUEL TYPE	LIQUID FUEL THOUSANDS OF GALLONS / YR	%S	GAS TYPE	GAS THOUSANDS OF CF/YR	BTU/CF	APPLICABLE RULE	APPLICABLE RULE
144	145	146	147	148	149	150	151	152	153	154

Upon completion of construction sign the statement listed below and forward to the appropriate field representative
THE PROCESS, EXHAUST OR VENTILATION SYSTEM HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED SPECIFICATIONS AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS.

155 SIGNATURE OF AUTHORIZED REPRESENTATIVE OR AGENT | DATE

AGENCY USE ONLY

156 LOCATION CODE	157 FACILITY ID. NO.	158 U.T.M. (E)	159 U.T.M. (N)	160 SIC NUMBER	161 DATE APPL. RECEIVED	162 DATE APPL. REVIEWED	163 REVIEWED BY:
					/ /	/ /	

PERMIT TO CONSTRUCT

164 DATE ISSUED	165 EXPIRATION DATE	166 SIGNATURE OF APPROVAL	167 FEE
/ /	/ /		

168.
1. DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2. THIS IS NOT A CERTIFICATE TO OPERATE
3. TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

CERTIFICATE TO OPERATE

169 DATE ISSUED	170 EXPIRATION DATE	171 SIGNATURE OF APPROVAL	172 FEE
/ /	/ /		

173.
1. ☐ INSPECTED BY__________ DATE__________
2. ☐ INSPECTION DISCLOSED DIFFERENCES AS BUILT VS. PERMIT, CHANGES INDICATED ON FORM
3. ☐ ISSUE CERTIFICATE TO OPERATE FOR SOURCE AS BUILT
4. ☐ APPLICATION FOR C.O. DENIED ________ DATE ________ INITIALED

174. SPECIAL CONDITIONS:

1.	2.
3.	4.
5.	6.
7.	8.

Appendix E

Technical References

The Johnson
Drillers
Journal

November-December 1980 *Vol. 52. No. 6*

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Geophysical Equipment

Minnesota, St. Paul	
Charles Howe	612-636-3900

About the cover: R. J. Strasser rigs at the Marmes site on the Snake River, north of Walla Walla, Wash. Article begins on page 7.

Pumping Test Analyses for Low Yield Formations

The driller can determine aquifer characteristics that help him to discover ground water flow patterns, the effects of dewatering or the migration of pollution plumes.

BY DAVID C. SCHAFER

OCCASIONALLY IT IS necessary to determi aquifer characteristics of very low yieldi formations — those with transmissivities l than 500 gallons per day per foot. Though terest in these aquifers is certainly not becaus their productive capability, it may be desira to determine ground water flow characterist even in these low yield formations in order determine such things as regional ground wa flow patterns, effect of dewatering or migrat of pollution plumes near point sources contamination.

Different Approach Is Required

Conventional pumping test analysis using standard time drawdown graph often does work effectively in low T (transmissivity) for tions for two reasons. First, the pumped w low specific capacity (gallons per minute per of drawdown) may cause the pump to break tion during the test and it may be impractic throttle back the pumping rate sufficientl prevent this. Second, even if a constant pum rate can be maintained without breaking tion, most of the data obtained will prob

---

Mr. Schafer is a hydrologist and a regional manage headquarters office of Johnson Division, UOP In reflect casing storage effects rather than true aquifer parameters (see "Casing Storage Can Affect Pumping Test Data," Jan-Feb. 1978. *Johnson Drillers Journal)*. Thus a different approach is required.

The best method for analyzing these formations is to pump a substantial portion of the casing empty, then shut the pump off and measure water levels as they recover. In ordinary pumping tests these measurements correspond to the non-pumping portion of the test. However, in low T formations this "recovery period" is actually the "pumping period!"

After pump shut-off, the casing slowly begins filling with water. This water comes from the aquifer and actually represents the water pumped during this so called "pumping period." The pumping rate is determined by measuring the volume of casing filled in a given length of time.

During the test, careful measurements are made of time since pumping began (t) along with drawdown (s) at each of these times. Then a calculation is made to determine Q for each time t and finally the ratio s/Q is computed for each measured drawdown value. The ratio is simply the reciprocal of the specific capacity.

A graph is then constructed showing t versus the ratio s/Q plotted as usual on semi-logarithmic graph paper with t on the log scale. A straight line of best fit is drawn through the data points and T is calculated as follows:

$$T = \frac{264}{\Delta(s/Q)}$$

where $\Delta(s/Q)$ is the change in s/Q over one log cycle of graph paper.

This graph has the unique advantage that it will accurately reflect aquifer transmissivity independent of casing storage effects. In addition it will be sensitive to nearby recharge and/or negative boundaries and will reveal these conditions like any ordinary time drawdown graph.

To see how this technique works it is best to work an example. Table 1 shows data obtained from a 6-inch well pumped at 10 gpm for 15 minutes. Drawdown after 15 minutes of pumping measured 90 feet.

The next data point was recorded two minutes following pump shut-off or 17 minutes since pumping started. At this time the pumping water level was 85.66 feet, indicating that 4.34 feet of casing had filled during the two minute interval.

The annulus between the 6-inch casing and 1¼" drop pipe holds 1.4 gallons per foot so that the volume of casing filled is 1.4 times 4.34, or 6.08 gallons in two minutes. Thus,

$$Q = 6.08 \text{ gallons/2 minutes} = 3.04 \text{ gpm}$$

finally,

$$s/Q = 85.66 \text{ ft/3.04 gpm} = 28.2 \text{ ft/gpm}$$

which is plotted at a time of 17 minutes on the

TABLE 1

Pumping rate = 10 gpm
Pumping period = 15 minutes
Drawdown at pump shut off = 90 ft
Casing — 6" I.D.
Drop pipe — 1¼" I.D.

Time in minutes since pumping started (t)	Drawdown in feet (s)	Number of feet of casing filled	Time in minutes required to fill	Volume filled divided by time required in gallons per minute (Q)	s/Q in feet per gallon per minute
15 (pump shut off)	90				
17	85.66	4.34	2	3.04	28.2
20	79.7	5.96	3	2.78	28.6
30	64.2	15.5	10	2.17	29.5
40	51.9	12.3	10	1.72	30.2
60	35.6	13.3	20	1.14	31.1
80	24.6	11.0	20	.77	31.8

graph shown in Figure 1.

This analysis is repeated for each drawdown measurement. The resultant calculated s/Q values are shown in Table 1 and plotted in Figure 1. The formation T value from the graph is

$$T = \frac{264}{\Delta(s/Q)} = 264/5.3 = 49 \text{ gpd/ft}$$

Conventional Analysis Not Effective

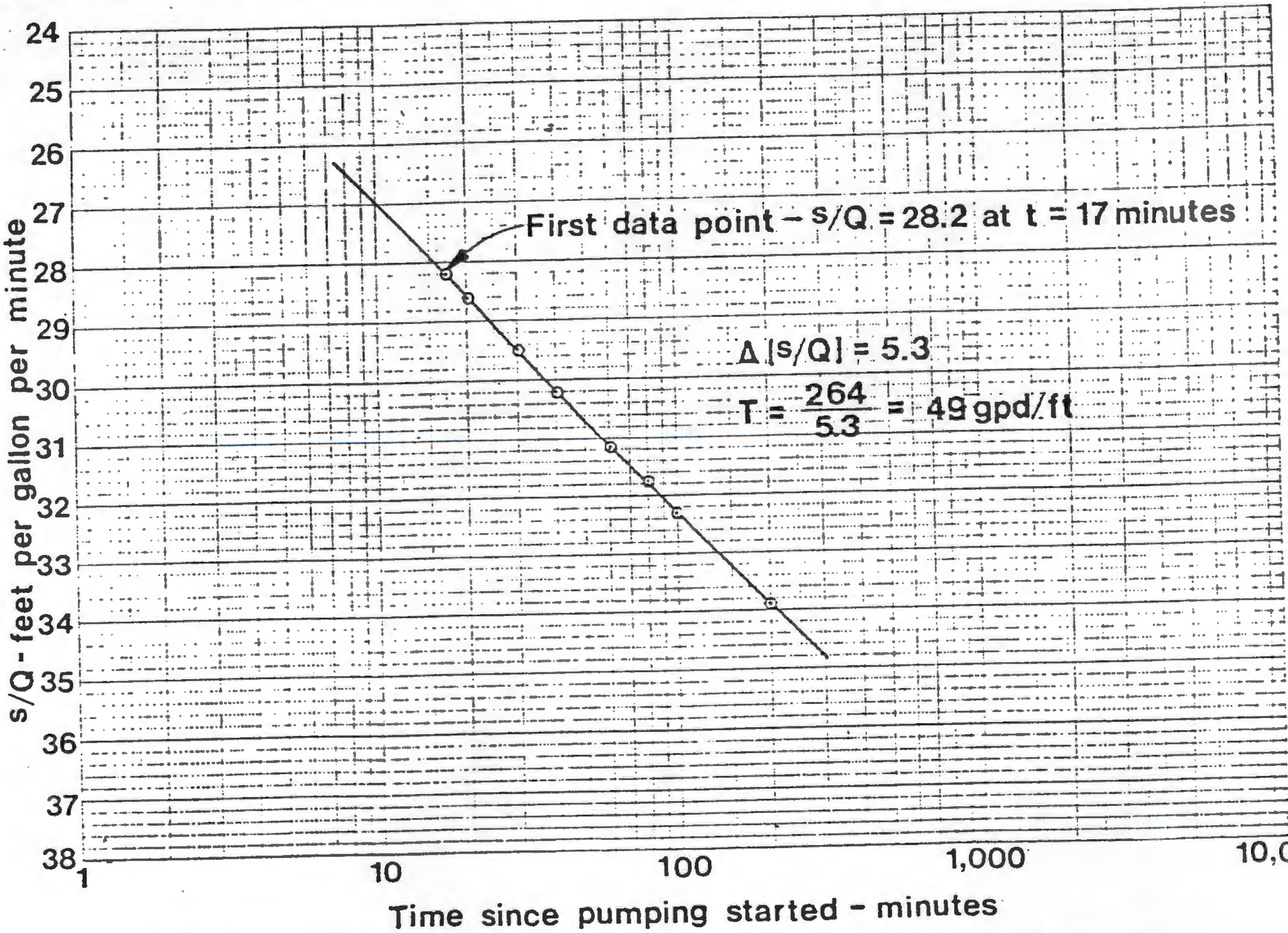
Examination of the hydraulic characteristics of this well (not included here) shows that if a conventional time drawdown graph had been used, casing storage effects would have lasted for approximately twelve hours. This means that data recorded in the first twelve hours of pumping would have been useless and longer pumping than this would have been required to obtain any usable data at all. However, data collected after twelve hours of pumping probably would be more influenced by boundary conditions than by aquifer transmissivity. Thus, in practice, it actually might have been impossible to determine the T value using conventional analysis techniques regardless of the length of the test. The value of the method described above becomes very clear: it may be the only way to determine T values in certain low yielding aquifers.

In order to maximize the accuracy of this method, it is best to unload (empty) the casing as rapidly as possible. Thus it is actually better to use a high capacity pump than a low capacity pump in analyzing extremely low-yielding wells!

Another good idea is to unload the casing with compressed air since this can typically be done ir one minute or less.

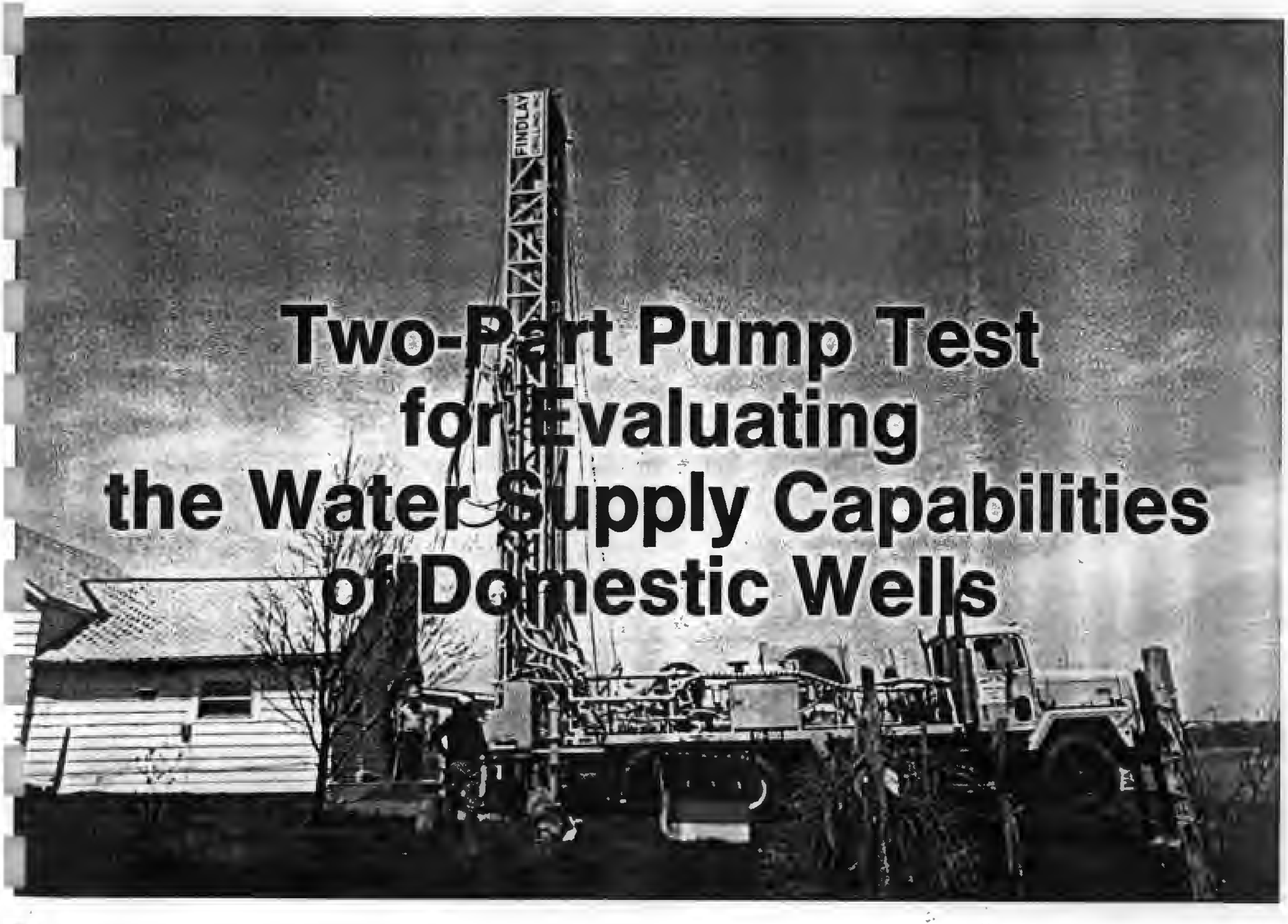
Recorded Data Must Be Accurate

An additional important consideration is tha all data recorded for this type of analysis must b absolutely accurate. Small errors in the recorde values of time and/or drawdown can result i large errors in the calculated values of s/Q. Fo best results, drawdown should be recorded to th nearest hundredth of a foot and timed to th nearest second or two.



In low transmissivity situations, readings are taken after pump shut-off. In this method, s/Q is the reciprocal of the specific capacity and t is time measured after shut-off as water begins to enter the casing.

New Jersey Geological Survey
Ground-Water Report Series No. 1



Two-Part Pump Test for Evaluating the Water Supply Capabilities of Domestic Wells

N.J. Department of Environmental Protection ■ Division of Water Resources

Thomas H. Kean, *Governor*
Richard T. Dewling, Ph.D., P.E., *Commissioner*

TWO-PART PUMP TEST FOR EVALUATING THE WATER-SUPPLY CAPABILITIES OF DOMESTIC WELLS

New Jersey Geological Survey
Ground-Water Report Series No. 1

by
Jeffrey L. Hoffman and Robert Canace

Department of Environmental Protection
Division of Water Resources
CN029
Trenton, NJ 08625

John W. Gaston, Jr., P.E., Director
Haig F. Kasabach, State Geologist

1986

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TWO-PART PUMP TEST FOR EVALUATING THE WATER-SUPPLY CAPABILITIES OF DOMESTIC WELLS

by
Jeffrey L. Hoffman and Robert Canace

Key terms: aquifer test, water yield, well construction, constant head test
New terms: peak demand rate, peak demand test

ABSTRACT

An evaluation of the capability of a well drilled in rock to supply domestic needs can be based on predicted household water use patterns and characteristics of the well. Household water demand is estimated using a residency rate of two per bedroom and a usage rate of 100 gallons per capita daily. Water use is assumed to be split between equal morning and evening periods of peak demand. Rate of usage during peak periods is estimated at 3 gallons per minute per bathroom. Duration of the peak demand periods is estimated by dividing total usage during peak demand periods by the average rate of usage during peaks.

Capability of the well to meet peak demand and total daily demand is evaluated through a two-part pump test. The first part, a peak demand test, is a drawdown test to determine whether or not the combined well storage and aquifer contribution to well flow can meet peak needs. The second part, a constant head test, is to determine whether or not flow from the aquifer is sufficient to meet total daily needs. If so it is assumed that the aquifer can meet long-term household needs. Measurements of drawdown during the pump test are used in determining the depth at which the pump should be placed in the well and the necessary depth if the well needs to be deepened to provide additional storage.

The method does not take into account extreme droughts, interfering stresses on the aquifer from other pumping or decreasing efficiency of the well and pump due to aging.

INTRODUCTION

In response to inquiries by local health agencies and the public concerning domestic well failures, the New Jersey Geological Survey has developed a method to estimate the water supply needs of private homes and to evaluate the adequacy of wells drilled to supply those households. The method consists of a calculation to estimate total daily needs and peak demand needs of a household and a two-part pumping test to determine whether or not a well can meet these needs. The procedure is intended primarily for use in areas of consolidated bedrock (Regions 2 and 3 of the New Jersey water well construction regulations (NJAC 7:10-35), shown in figure 1).

The yield of a well is usually established by pumping the well and measuring the discharge (well flow), in gallons per minute, from the well head. Unfortunately, pump test requirements for domestic water wells have not been standardized. The New Jersey Department of Environmental Protection requires only that "each well be tested for yield and drawdown" (NJAC 7:10-3.58). No testing procedures are stipulated under the code. A variety of local ordinances regulate well testing. Most of these have been established on the basis of experience in the field or other local ordinances. Most have fixed minimum yield requirements regardless of household size for issuance of the certificate of occupancy.

The method outlined in this report is modified from a procedure developed by the Connecticut Well Drillers Association (Hunt, 1978). It supplements the Connecticut approach by providing a systematic method based on anticipated peak and long-term demand to design, perform and evaluate a pump test.

The pump test is divided into two parts. The first part, the **peak demand test,** is to see if the well can meet the predicted water demand of the house during twice-daily periods of peak use. The second part, the **constant head test,** is to measure the aquifer's ability to transmit sufficient water to the well for the total daily water demand of the household.

The pump test identifies satisfactory wells and, for wells that are not satisfactory, whether the problem lies with insufficient storage or with inability of the aquifer to transmit sufficient water to the well. Insufficient storage can be corrected by deepening the well to provide additional storage within the borehole, redrilling to a greater diameter or constructing a surface storage tank. The necessary depth to which the well must be deepened can be estimated using measurements of aquifer yield and drawdown taken during the constant head

Figure 1. Geologic regions of New Jersey as defined in water well construction regulations. (NJAC 7:10-35)

test. Insufficient aquifer yield may, in some instances, be corrected by developing the well or deepening it to encounter additional water-bearing zones.

Equations, tables and worksheets are provided to assist in the recording and analysis of pump test data. A flow diagram is also provided which shows the evaluation procedures and options should the well fail. Hypothetical examples have been included to demonstrate the method.

It must be recognized that this method is a simplified mathematical approach that cannot take into account many of the physical factors that can influence long-term well performance. These include seasonal fluctuations in ground water availability, extreme drought, permanent dewatering of fracture zones, stresses on the aquifer from nearby wells and reduction of well and pump efficiency due to clogging or wear. These factors may result in failure of wells which were rated as satisfactory at the time of testing.

BASIS AND BACKGROUND

A method for estimating the water needs of individual households and evaluating domestic wells was developed by the Connecticut Well Drillers Association (Hunt, 1978). The impetus for the development of the **Connecticut minimum well formula** was an objection to a requirement by the Federal Housing Authority that a home have a well with a yield of 5 gpm (gallons per minute) or more to qualify for loan assistance. The Well Drillers Association, convinced that 5 gpm was an unreasonable across-the-board requirement, demonstrated that smaller yields could be certified as adequate for domestic needs if household demand were taken into account. The Connecticut minimum well formula:

1. estimates **peak load** (household water demand, in gallons, within each of two daily peak use periods);
2. estimates **peak time** (the length of peak use periods in minutes);
3. evaluates the capability of the well to meet the peak demand of the household, and;
4. establishes a minimum pump capacity and pump installation depth to assure an adequate supply.

In the Connecticut method, if the well can deliver the peak load within the peak time it is considered to be satisfactory. This determines whether or not the well can supply peak needs. But like many domestic well tests, it does not evaluate the long-term ability of the aquifer to supply the well. Also, for a well which fails the pump test, the Connecticut method does not determine whether the cause of failure is inadequate storage or inability of the aquifer to transmit sufficient water. The two-part pump test presented here uses a peak demand test followed by a constant head test. The constant head test measures the rate at which water can move from the aquifer to the well. This test determines whether or not the aquifer can transmit sufficient water for long-term needs. If the well fails either test, the constant head test provides guidance as to how the well might be modified to meet the household demand. For instance, if the well can meet the total daily demand but not the peak demand, the constant head test results can be used to estimate the depth to which the well would have to be drilled to provide sufficient storage in the bore-hole to meet the peak demand. If flow from the aquifer falls short of total daily demand, then the well must be deepened to encounter additional water-bearing zones or redrilled at another location, but the test cannot provide an estimate of the required well depth.

ASSUMPTIONS

In order to calculate peak load and peak time, the Connecticut formula and the modification presented here rely on four assumptions concerning water use. The assumptions are conservative. While one or more of the assumptions may not be met by a particular household, there is a sufficient margin of safety that water use estimates will be valid for determining the adequacy of wells for most peak periods for most families. Orndorff (1966) reported that on days when intensive chores are performed the peak demand may be several times the average demand. The assumptions are not valid for these days. The assumptions are:

1. Each person uses 100 gpd (gallons per day).

   Comments: The use of 100 gpd per capita is consistent with *Standards for the Construction of Public Non-Community and Non-Public Water Supplies* (NJAC 7:10-3.32), in which this value is applied as a planning criterion. This is a conservative figure which exceeds most measured values for water consumption. Reported average per capita consumption is approximately half this volume, or about 50 gpd (U. S. Environmental Protection Agency, 1978; Orndorff, 1966, p. 30, table 7). Average per capita consumptions of up to 80 gpd have been reported (Linaweaver and others, 1967, p. 2). In addition, in a detailed study of domestic water use Orndorff (1966) found that though total usage increases with family size, per capita usage decreases. This provides an additional margin of safety for larger families.

2. Two people occupy each bedroom.

   Comments: The average residency rate in the United States in 1980 was reported to be 2.75 residents per dwelling (U.S. Department of Commerce, 1981, table 10). Inasmuch as most new dwellings have two or more bedrooms, an estimate of two people per bedroom is conservative and allows for later addition of bedrooms or higher-than-average occupancy rates.

3. Most daily water usage occurs during two peak periods.

   Comments: In his study of domestic water use Orndorff (1966, p. 23) concluded that "peak demands tend to occur during two particular times of the day." One of these is in the morning and the other in the evening. While most water use occurs during these peaks, there is additional use at other times. Because of water use during off-peak times, it is reasonable that no more than half the total daily water use will occur during a single peak demand period. Differences in habitual water use patterns among families will thus seldom be such that peak water use will be underestimated.

4. Water flows through fixtures at the rate of three gallons per minute per bathroom during peak periods.

   Comments: This is the key assumption in estimating peak time (the duration of peak demand periods). In the Connecticut formula it is assumed that water use during peak time is in large part bathroom use. Orndorff (1966) points out that, although a normal daily peak demand can be determined statistically, water demand of particular households is established by habitual patterns. Bathroom use would be the prime example.

   New Jersey's *Standards for the Construction of Public Non-Community and Non-Public Water Systems* (NJAC 7:10- 3.10, et seq., 1978) require that water systems provide a minimum flow rate of 2 gpm at each plumbing fixture. Orndorff reported average peak demand rates of 1.60 gpm for a subdivision served by onsite wells and 2.29 gpm in homes served by an external water source. The use of 3 gpm provides a margin of safety above measured rates of water usage and the requirements established for domestic water supply systems.

For making calculations, it is assumed that water flows through the fixtures of a half bath at 1.5 gpm.

THEORY

Calculation of Household Water Demand

In order to establish conditions for a pump test, it is necessary to quantify the total daily demand and peak demand which will be placed on the well. Total daily demand is a function of the number of residents and per capita usage. Peak demand can be quantified in terms of volume, time and rate. The total volume of water the household will require during each of two daily periods of peak demand is the **peak load.** The average rate of use during peak demand times is the **peak demand rate.** The length of time within which the peak load demand for water will be exerted is the **peak time.**

To quantify the concepts of peak load, peak time and peak demand rate the following assumptions, discussed above, are applied:

1. each person uses 100 gallons per day.
2. two people occupy a bedroom.
3. most daily water usage occurs during two peak periods.
4. water flows through fixtures at the rate of three gallons per minute per bathroom during peak periods.

Under these assumptions equations for peak load, peak time and peak demand rate can be expressed as:

$$\text{peak load (gallons)} = \frac{\text{(no. of bedrooms) (persons/bedroom) (gallons/person/day)}}{\text{peak periods/day}}$$

$$= \frac{\text{(no. of bedrooms) (2) (100)}}{2} = \text{(no. of bedrooms) (100)} \qquad (1)$$

$$\text{peak demand rate (gpm)} = \text{(gpm/bathroom) (no. of bathrooms)}$$

$$= \text{(3) (no. of bathrooms)} \qquad (2)$$

$$\text{peak time (minutes)} = \frac{\text{peak load (gallons)}}{\text{peak demand rate (gpm)}} \qquad (3)$$

As an example, a three bedroom house with two bathrooms will have:

peak load = 3 bedrooms X 100 gallons/bedroom
= 300 gallons

peak demand rate = 3 gpm/bathroom X 2 bathrooms
= 6 gpm

peak time = 300 gallons/6 gpm
= 50.0 minutes

Pump Test Design

Well flow (discharge) is a combination of water pumped from the standing column of water in a well (the **well storage contribution**) and water flowing into the well from the aquifer (the **aquifer contribution**). In any well evaluation it is necessary to recognize that the well acts as a water storage area. Water is taken from well storage during peak demand times and gradually replenished from the aquifer during off-peak times.

At the beginning of the two-part pump test, the water in a well is at the static level: the water in the well and aquifer are at the same pressure and there is no net flow into or out of the well. As soon as the pump goes on for the peak demand test, water is removed from the casing and the water level drops. Because the pressure is now lower in the well than in the aquifer, water will flow from the aquifer into the well. Until the water level stops dropping, the discharge pumped from the well includes well storage and aquifer contribution components. In general, though certainly not always, the aquifer contribution will increase as the water level in the well drops.

For the constant head test the water level must be stable or nearly stable, neither dropping nor rising rapidly. The water level may stabilize during the peak demand test due to increase in aquifer contribution, or it may be stabilized by decreasing the pumping rate. When the water level and pumping rate are stable the well is said to be at equilibrium, the pumping to be at a constant head pumping rate and the water to be at a constant head level.

Peak Demand Test

The peak demand part of the two-part test determines whether or not the volume of water stored in the well plus the volume which will flow from the aquifer to the well during peak time will be sufficient for peak needs. The well is allowed to come to its static level, then is pumped at the peak demand rate for the peak time. A well for which the combined well storage and aquifer contributions are insufficient will fail before the expiration of the peak time.

Constant Head Test

The constant head test determines whether or not the aquifer contribution will meet long-term needs. An accurate measurement of the aquifer contribution can be made when the well is being pumped under constant head conditions. If a well is being pumped but the water level is not changing, the volume of water stored in the well is not changing. The well storage contribution is therefore zero and all water flowing from the well is coming from the aquifer; the aquifer contribution is equal to the measured pumping rate. If the aquifer contribution rate is less than the flow required for total daily needs (see tables 3 and 4), the well fails this portion of the test.

Test Results

If the well passes the constant head test but fails the peak demand test, the aquifer can supply enough water on a daily basis, but additional storage is required for peak demand needs. Storage may be provided in either the well or a surface storage tank.

If a well fails the constant head test it will not supply enough water on a daily average to meet household needs regardless of whether or not it passed the peak demand test. Aquifer contribution must be increased by developing, deepening or relocating the well.

Depth Required for Adequate Storage

If, for a well which has passed the constant head test but failed the peak demand test, storage is to be provided by deepening the well, the necessary well depth can be calculated from results of the constant head test. Two assumptions are necessary. The first is that there is no aquifer contribution until the drawdown in the well reaches the level measured tion. There is indeed aquifer contribution before the water level falls this far, but the rate is not measured during the test and is thus unknown. The second assumption is that as soon as the drawdown in the well reaches the level measured during the constant head test, the aquifer contribution begins at the rate measured at the conclusion of the constant head test and does not increase as the drawdown increases. This, also, is a conservative assumption, but is reasonable in that in a bedrock aquifer the most significant water-bearing zones are commonly associated with weathered fractures within several tens of feet of the soil/rock interface. Additional drawdown below the fractured or weathered zone may not induce much more water to flow into the well.

The volume of water which will enter the well from the aquifer during peak demand periods can be estimated using these assumptions. Subtracting this volume from the peak load gives the total volume of storage needed. Conversion of storage volume to additional depth required for drawdown is discussed under *Additional Drawdown for Wells Without Adequate Storage* in the *Implementation* section, below.

Surface Storage Tanks

The effect of surface storage of water on the well depth required for reliable peak supply can be taken into account by subtracting the available volume in the storage vessel from the peak demand. This gives the volume which must come from the well during each peak demand period. Dividing this lower volume by the peak demand rate gives the length of time the pump must operate during the peak demand period. The calculation of the necessary volume of well storage then proceeds as discussed above. The peak demand test should be carried out using the lower value for pumping time. The surface storage tank must, of course, be refilled, but if the well has passed the constant head test it should be possible to fill between peak demand periods.

Normally a domestic water supply system includes a hydropneumatic tank. A conventional hydropneumatic tank is intended primarily for maintenance of water pressure and contributes little to available water storage. Only that volume of water which drains from the tank before declining pressure causes the well pump to switch on contributes to available storage. This can be referred to as the available storage volume of the tank. An additional tank, dedicated to water storage and equipped as necessary to deliver water to the plumbing system of the house at the required pressure, could conceivably be installed.

Total Well Depth and Pump Placement

The pump must be placed in a well so as to allow for the maximum drawdown measured during the peak demand test. Pump size must be based on the required water pressure in the plumbing and the anticipated drawdown. Too deep of a pump setting can be as undesirable as too shallow a setting if the pump cannot deliver water at the required pressure. A balance must be struck between obtaining the storage advantage of maximum drawdown and ensuring adequate water pressure. This report attempts to prevent well failure caused by setting the pump at too shallow a depth.

IMPLEMENTATION

Testing of domestic wells is not usually conducted in a manner that establishes long-term performance capability. In fact, estimates of well yield are frequently made during drilling. In particular this is true with air rotary drilling when estimates of yield are based on the quantity of water lifted from the well with an air compressor. For an accurate test a pump with a discharge rate control is necessary; this might include the use of valves or a throttle on a generator used to power a pump.

An effective pump test must determine whether the well can supply both peak needs and total daily needs. In the method presented here, this is done using a two-part pumping test. The first part is the peak demand test and the second is the constant head test. Both of these must be performed in one continuous testing session. *It is important to note that the well is not considered to be satisfactory until it passes both tests during one continuous session.*

Peak Demand Test

The peak demand test is a drawdown pumping test to determine if the well can supply the water needed by the household during times of peak water demand. In this test the well is pumped at the peak demand rate estimated for the household for a time equal to or greater than the estimated peak time. If pumping can be maintained at this rate for the peak time, then the well should be able to support the peak needs of the household. If this pumping cannot be maintained, storage in the well is insufficient. The constant head test will provide further information as to the nature of the difficulty.

Constant Head Test

The constant head test is to determine if flow from the aquifer to the well can replenish water removed from the well during peak demand periods. In this test the pumping rate is adjusted so that the drawdown stabilizes. When the water in the well is at a constant level, one is certain that all of the discharge is coming from the aquifer, none from well storage. If under this constant head pumping condition the aquifer can supply the total daily household needs, then long-term needs can most probably be met. For the purposes of this report a constant head condition exists when the pumping rate is held steady and the water level changes at a rate of less than 6 inches per hour.

Outline of Testing Procedure

Planning of a pump test and evaluation of the results (figure 2) can be summarized as follows:

1. The well is constructed in accordance with state and local requirements.
2. The **peak demand rate** and **peak time** are calculated from the number of bedrooms and bathrooms using equations 2 and 3 or tables 1 and 2. Unless surface storage is to be taken into account, these are the required discharge rate and duration of the peak demand pump test.
3. The peak demand test is performed. For this test the pump should be positioned so as to take full advantage of the available drawdown in the well. The static water level in the well is measured prior to pumping. Then the well is pumped at the peak demand rate for the peak demand time. If pumping cannot be sustained at this rate the well fails the peak demand pump test. The water level at the completion of the peak demand test must be measured accurately for it is used to measure drawdown during the constant head test and, later, used to establish the pump setting.
4. The **constant head test** is undertaken *immediately* upon completion of the peak demand test regardless of whether or not the well passed the peak demand test.

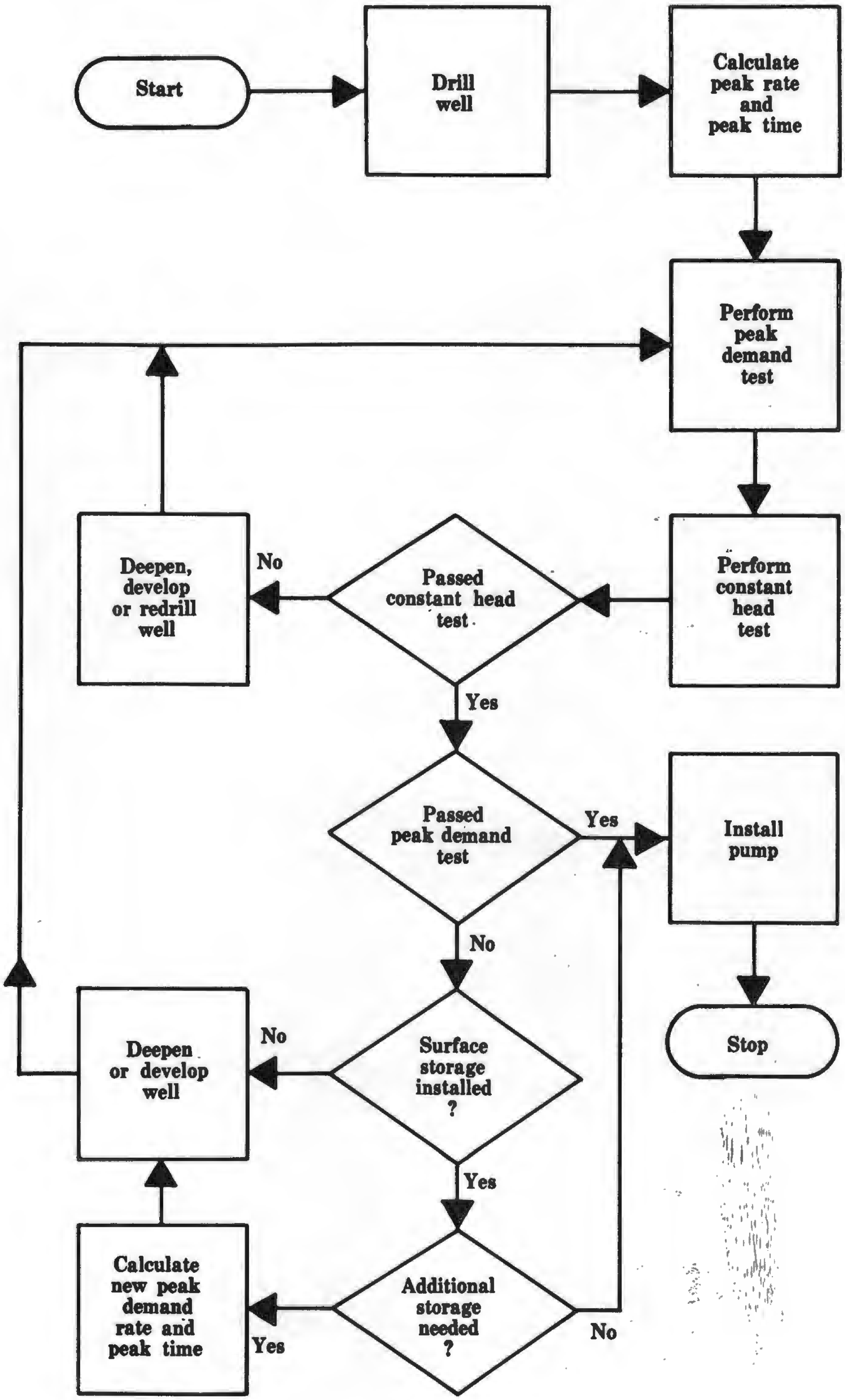

Figure 2. Flow chart of performance and evaluation of pump test.

The well is not allowed to recover from the peak demand test. In the constant head test the pumping rate is lessened, if necessary, to a rate at which the drawdown shows insignificant change with time. A **constant head condition** exists if the head changes at a rate of less than 0.5 feet (6 inches) per hour under a constant pumping rate. The pumping rate which maintains this condition is termed a **constant head pumping rate.** The water level at the constant head pumping rate must be measured accurately. The difference between this level and the static water level is the **constant head drawdown.** The constant head pumping rate should be as close as possible to the peak demand pumping rate, but the main objective is to achieve a stable water level while pumping. Too low a discharge rate will result in underestimation of the capabilities of the aquifer and may lead to overdeepening of the well.

5. The constant head pumping rate is converted to gallons per day (table 3) and compared to the total daily demand of the household. If the discharge rate during the constant head test will provide the total daily water demand, the well passes the constant head test. If not, it fails.

6. The results of the two tests are evaluated. The four possible outcomes are:

    a. Peak demand test—Pass
    Constant head test—Pass

    This well can supply the home with enough water. The pump should be installed as discussed under *Total Well Depth and Pump Placement* below.

    b. Peak demand test—Pass
    Constant head test—Fail

    This well, when full, can supply peak demand needs. However, more water will be withdrawn each day than can be replaced by the aquifer. This well will prove inadequate sooner or later. It must be deepened, developed or redrilled at a new location to provide a larger aquifer contribution. In bedrock aquifers the well may not encounter additional water-bearing zones at greater depth. The aquifer may not provide sufficient supply for domestic needs. If the well is redrilled, developed or deepened it must be retested.

    c. Peak demand test—Fail
    Constant head test—Pass

    This well lacks sufficient water from combined well storage and aquifer flow to meet peak needs. The aquifer contribution is, however, sufficient to meet total daily needs. More storage must be supplied to satisfy short-term peak demands. This can be accomplished by deepening the well and lowering the pump, redrilling to a greater diameter or adding a water storage tank. If the well is to be deepened, a method for calculating additional required depth is described in *Additional Drawdown for Wells Without Adequate Storage,* below. If a water storage tank is installed see *Surface Storage Tanks,* above. If the well is redrilled or developed it must be retested.

    d. Peak demand test—Fail
    Constant head test—Fail

    This well has neither sufficient storage nor sufficient aquifer contribution to ensure an adequate household supply. It must be deepened to encounter additional water-bearing zones, developed to increase flow to the well or a new well drilled elsewhere. Depending on the success of efforts to increase flow from the aquifer, storage may have to be increased. The well must be retested when any of the above procedures are completed.

Additional Drawdown for Wells Without Adequate Storage

A well that fails the peak demand test but passes the constant head test can be made satisfactory by providing additional storage. If additional storage is created by deepening the well, the necessary additional volume of storage and corresponding necessary available drawdown are found by calculating as follows:

A. *Assured volume:* The assured volume of water in the well is the volume in the well between the static water level and the constant head pumping level. Calculate this volume by multiplying the constant head drawdown by the storage capacity per foot of well casing (1.4 gallons per foot for a 6-inch well).

B. *Assured time:* This is the time it will take to pump the assured volume from the well. It is calculated by dividing the assured volume by the peak demand rate.

C. *Shortfall volume:* This is the volume of water which must be supplied after the assured volume has been withdrawn from the well. It is calculated by subtracting the assured volume from the peak load.

D. *Shortfall time:* This is the time within which the well must supply the shortfall volume. It is calculated by subtracting the assured time from the peak time.

E. *Aquifer contribution volume:* This is the volume of water the aquifer is predicted to supply to the well during the shortfall time. During the shortfall time water is assumed to be moving from the aquifer to the well at the aquifer contribution rate measured during the constant head test. Aquifer contribution volume is calculated by multiplying the aquifer contribution rate by the shortfall time.

F. *Additional well storage volume:* This is the volume of water which must be withdrawn from well storage after the assured volume has been pumped. It is calculated by subtracting the aquifer contribution volume from the shortfall volume.

G. *Additional well drawdown:* This is the additional drawdown required beyond the constant head drawdown. It is calculated by dividing the required additional well storage volume by the storage capacity per foot of well casing (1.4 gallons per foot for a 6-inch well).

Equations for this sequence of calculations are:

A. assured volume
= constant head drawdown X storage capacity per foot of well casing

B. assured time = assured volume/peak demand rate

C. shortfall volume = peak load – assured volume

D. shortfall time = peak time - assured time

E. aquifer contribution volume
= shortfall time X aquifer contribution rate

F. additional well storage volume
= shortfall volume - aquifer contribution volume

G. additional well drawdown
= additional well storage volume/storage capacity per foot of well casing of well

The additional well drawdown is the predicted drawdown below the constant head level at the end of peak time. It is used to calculate the required well depth as shown in *Total Well Depth and Pump Placement*, below. After deepening or redrilling, both parts of the pump test must be redone during a single testing session.

Total Well Depth and Pump Placement

It is recommended that the pump be placed at least 10 feet below the depth to water measured at the end of a successful peak demand pump test. Also, in order to prevent siltation problems, the pump should be placed at least 10 feet above the bottom of the well. An equation for minimum pump depth is:

minimum pump depth
= depth to water at end of successful peak demand pump test + 10 feet

As an additional safety precaution the pump depth can be increased beyond that suggested here, thus allowing for more drawdown than measured during testing. This will require a well deeper than the minimum shown above and may necessitate a more powerful pump.

EXAMPLES

Example 1: Well passes both parts of test

A builder proposes a 3 bedroom, 2 bathroom house. From table 1 the pump test should last for at least 50 minutes. From table 2, the pumping rate should be at least 6 gpm.

A well was drilled, allowed to stand for 12 hours to come to its static water level, then was pumped at 8 gpm for 1 hour. After 1 hour of pumping the drawdown was 22.0 feet. In being pumped at 8 gpm for 1 hour, the well more than met the peak demand requirements and passed the peak demand test.

The constant head test was begun without pause in a second hour of pumping, also at 8 gpm. At the end of the second hour the drawdown was 22.2 feet. Because of this small change in the drawdown the well was properly considered to be at a constant head level. 8 gpm is equvalent to more than 11,000 gallons per day (table 3). A 3 bedroom house will require 600 gallons per day (table 4). The well thus passed the constant head test.

Because the well passed both parts of the pump test the production pump can be set according to the minimum safety allowance at 10 feet lower than the drawdown measured during the peak demand pump test; this is 32 feet below the static water level. Setting the pump deeper would provide an additional margin of safety. The pump should be placed at least 10 feet above the bottom of the well as a precaution against siltation.

Example 2: Well fails peak demand test

A 5 bedroom, 3 bathroom house is proposed. A 6-inch well 250 feet deep has been drilled and allowed to stand for 12 hours to come to its static water level.

From table 4, the daily household water demand will be 1000 gallons and the peak load 500 gallons. From tables 1 and 2 the peak demand pump test should last at least 55.5 minutes and the discharge rate should be at least 9 gpm.

Before pumping, the static water level was measured at 25 feet below the ground surface. At a pumping rate of 9 gpm the well failed after 33 minutes. The driller therefore proceeded directly to the constant head test. After some trial and error, the driller determined that 2 gpm was the maximum rate at which a constant head could be maintained. At the end of the constant head test the water level in the well was 230 feet below the top of the casing.

An aquifer contribution of 2 gpm is equivalent to 2,880 gallons per day (table 3) and will satisfy long-term needs. The well passed the constant head test. It failed, however, the peak demand test. The problem therefore lies in an inadequate volume of storage. The driller decided to deepen the well to provide additional storage in the borehole and calculated the additional required drawdown as outlined in *Depth Required For Adequate Storage* and below:

The constant head drawdown at a 2 gpm pumping rate is the constant head pumping level of 230 feet minus the static water level of 25 feet. This comes to 205 feet.

The assured volume (the volume of water stored in the well between the static water level and the level measured in the constant head test) is 205 feet of drawdown times 1.4 gallons per foot of casing. This comes to 287 gallons.

The assured time (the time it will take to pump out the assured volume) is 287 gallons divided by the peak demand rate of 9 gpm, or 31.9 minutes.

The shortfall time is 55.5 minutes (the peak time) minus 31.9 minutes (the assured time), or 23.6 minutes.

The shortfall volume is 500 gallons (the peak load) minus 287 gallons (the assured volume), or 213 gallons.

During the shortfall time the aquifer contribution is constant at 2 gpm. The total aquifer contribution volume is thus 2 gpm times 23.6 minutes, or 47.2 gallons.

The volume of water which must be stored in the well below the constant head level is 213 gallons (the shortfall volume) minus 47.2 gallons (the aquifer contribution volume during peak time). This comes to 165 gallons.

The additional required drawdown is calculated by dividing the shortfall volume of 165 gallons by the storage capacity of 1.4 gallons per foot of well casing. This comes to 118 feet.

The maximum predicted drawdown is 205 feet (the maximum drawdown during the constant head test) plus 118 feet (the additional drawdown for peak needs calculated above) plus 10 feet (the minimum safety allowance). This comes to 323 feet below the static water level.

The total well depth then should be at least 25 feet (the static water level) plus 323 feet (the maximum predicted drawdown below the static level) plus 10 feet (pump placement above well bottom). This comes to a total of 368 feet.

The well must therefore be deepened to a minimum depth of 368 feet, then retested.

ADDITIONAL CONSIDERATIONS

The two-part pump test is a means of evaluating the capability of a well to supply domestic needs. The interpretation of test results is mathematical and may not take into account all the physical factors that affect a particular well. Some additional considerations are listed below:

1. *Seasonal recharge variations:* Pump tests performed during times of seasonally high ground water may not accurately predict performance during times of reduced water availability. A well that passes a pumping test in the spring, during high water-table conditions, may not be able to provide an adequate supply in summer or during drought periods when the water table is lower. Tests performed between June and October are more reliable than those performed in the rest of the year in determining if a well will satisfy household water demands.

2. *Low aquifer contribution:* The aquifer contribution as defined in this report is the volume of water that flows from the aquifer to the well during pumping. Table 4 shows that a one-bedroom house requires 200 gallons per day, which is equivalent to 0.14 gallons per minute. This is an extremely low aquifer contribution value. Experience has shown that a well with an aquifer contribution of less than 0.5 gpm (720 gpd) is a marginally dependable source of water for domestic use. It is recommended that a minimum cut-off of 0.5 gpm be established for the aquifer contribution.

3. *Addition or withdrawal of water during drilling:* During drilling water may be added to the aquifer or withdrawn depending upon the drilling method used. Immediately after completion of drilling the heads in the aquifer near the well may not be at static (unstressed) levels. The pump test should be conducted after any stresses induced by the drilling process have dissipated. A 12-hour recovery period is recommended between completion of drilling and performance of the pump test.

4. *Storage capacity:* Chapter 199 of NJAC 7:10-3.85 specifies minimum hydropneumatic tank sizes. These tanks maintain pressure in household water systems. They provide some storage, but this is not their primary purpose. They never empty completely, so the available storage in these tanks is less than their total volume. The presence of tanks specified in the regulations, or larger tanks dedicated solely to water storage, may be taken into account when calculating peak demand volumes.

5. *Large households:* The assumptions that relate dwelling size to household water demand may not be applicable to large dwellings that are not fully occupied. For homes with more than 5 bedrooms or 3 bathrooms it may prove advisable to use a different method to predict peak demand time, peak load and peak demand rate.

6. *Pump discharge:* In areas of vertical fracturing and thin or permeable overburden, water discharged at the surface may quickly infiltrate to the water table. If a pump test is conducted at such a site and the water pumped from the well is discharged at the well head, the water may return to the well as artificial recharge. Because this recharge will not be present during normal operation of the well, aquifer contribution will be overestimated. Water should be discharged at a distance from the well head in order to minimize this possibility.

7. *Drawdown safety factor:* A drawdown safety factor of 10 feet was recommended above. That is, the pump is to be set 10 feet below the drawdown level measured during the peak demand pump test. This level may be increased if a well is drilled in an aquifer known for large water level fluctuations.

8. *Well diameter:* Normally, domestic wells drilled in rock aquifers have a diameter of 6 inches. This provides approximately 1.4 gallons of storage per foot of drawdown in the casing. Increasing the well diameter will increase the storage per foot of well depth. The increased storage can be accounted for by using the appropriate value for the storage capacity per foot of drawdown.

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TABLES

Table 1: Duration of **peak time** in minutes as a function of the numbers of bedrooms and bathrooms in a dwelling.

		Number of Bathrooms				
		1	1½	2	2½	3
Number of Bedrooms	1	33.3	22.2	16.7	13.3	11.1
	2	66.7	44.4	33.3	26.7	22.2
	3	100.0	66.7	50.0	40.0	33.3
	4	133.3	88.8	66.7	53.3	44.4
	5	166.7	111.1	83.3	66.7	55.5

Table 2: **Peak demand rate** as a function of the number of bathrooms in a dwelling.

Number of Bathrooms	Peak Demand Rate (gpm)
1	3
1½	4.5
2	6
2½	7.5
3	9

Table 3: **Flow volumes** in gallons per minute corresponding to flow volumes in gallons per day.

Flow Volume (gpm)	Flow Volume (gpd)
0.01	14.4
0.02	28.8
0.05	72.0
0.1	144.0
0.2	288.0
0.3	432.0
0.4	576.0
0.5	720.0
0.6	864.0
0.7	1,008.0
0.8	1,152.0
0.9	1,296.0
1.0	1,440.0
2.0	2,880.0
5.0	7,200.0
10.0	14,400.0

Table 4: **Daily demand volume** and **peak load** as a function of the number of bedrooms in a dwelling.

Number of Bedrooms	Daily Demand Volume (gallons)	Peak Load (gallons)
1	200	100
2	400	200
3	600	300
4	800	400
5	1,000	500

DOMESTIC WELL WORKSHEET FOR TWO-PART PUMP TEST

(sheet 1 of 2)

PUMP TEST

Test Design

Preliminary Well Summary

1. Depth of well .... ______ feet
2. Static water level (depth to water from top of casing) .... ______ feet
3. Number of hours between well completion and measurement of static water level .... ______ hours

Dwelling Summary

4. Number of bedrooms .... ______
5. Number of bathrooms .... ______

Peak Demand Test Requirements

6. Peak time (required minimum duration of test, from table 1) .. ______ minutes
7. Peak demand rate (required minimum discharge rate from pump during test, from table 2) .... ______ gpm
8. Peak load (from table 4) .... ______ gallons

Test Measurements

Peak Demand Test

9. Depth to water at beginning of test (static water level) .... ______ feet
10. Depth to pump at end of test ...... ______ feet
11. Discharge rate measured during test (use minimum observed) .... ______ gpm
12. Duration of test .... ______ minutes
13. Depth to water at end of test ...... ______ feet
14. Drawdown at end of peak demand test .... line 13—line 9 = ______ feet

Constant Head Test

15. Constant head pumping rate .... ______ gpm
16. Duration of pumping at constant head rate .... ______ minutes
17. Depth to water at end of test ...... ______ feet
18. Drawdown at end of constant head test .... line 17—line 9 = ______ feet

Evaluation of Results

19. Peak demand test duration. If line 12 is less than line 6 then well fails peak demand test ...... ______ pass or fail
20. Peak demand pump test rate. If line 11 is less than line 7 then well fails peak demand test ...... ______ pass or fail
21. Calculate aquifer contribution (multiply line 15 by 1440 or use table 3) .... ______ gpd
22. Daily home water demand (from table 4) .... ______ gpd
23. Aquifer contribution rate. If line 21 is less than line 22 then well fails constant head pump test ... ______ pass or fail

DOMESTIC WELL WORKSHEET FOR TWO-PART PUMP TEST

(sheet 2 of 2)

Actions Based on Test Results

Peak demand test	Constant head test	Action
24. pass	pass	Go to *Pump Placement and Minimum Well Depth* (lines 35-37).
25. fail	pass	The well must be developed to increase yield, deepened to increase storage or surface storage installed. If the well is deepened or developed, it must be retested. Go to lines 28-34 (*Additional Drawdown for a 6-inch Well With Insufficient Storage*)
26. pass	fail	The well must be developed, deepened or redrilled at a new location to increase yield. It must then be retested.
27. fail	fail	

ADDITIONAL DRAWDOWN FOR A 6-INCH DIAMETER WELL WITH INSUFFICIENT STORAGE

28. Assured volume .... line 18 X 1.4 gallons/foot = ______ gallons

29. Assured time .... line 28/line 7 = ______ minutes

30. Shortfall volume .... line 8 – line 28 = ______ gallons

31. Shortfall time .... line 6 – line 29 = ______ minute

32. Aquifer contribution volume .... line 15 X line 31 = ______ gallons

33. Required additional storage .... line 30 – line 32 = ______ gallons

34. Additional drawdown needed in well .... line 33/1.4 gal/ft. = ______ feet

TOTAL WELL DEPTH AND PUMP PLACEMENT

35. Minimum total drawdown needed .... line 14 + 10 feet = ______ feet

36. Depth below top of casing to place pump .... line 9 + line 35 = ______ feet

37. Minimum total depth of well .... line 36 + 10 feet = ______ feet

GLOSSARY

Aquifer contribution: the proportion of the well flow at any given time which comes directly from the aquifer.

Aquifer contribution rate: the maximum rate at which water can flow from an aquifer to a well. Here assumed to equal the pumping rate measured in the constant head test.

Aquifer contribution volume: the total volume of water which flows from the aquifer to the well during the shortfall time.

Assured time: the time it will take to pump the assured volume from the well at the peak demand rate.

Assured volume: the volume of water in a well below the static level and above the constant head level.

Constant head: a stable water level attained under a constant pumping rate. For this report a rate of change of less than 0.5 feet (6 inches) per hour is taken as stable.

Constant head drawdown: the drawdown in a well when a constant head condition has been attained. Here measured from the static water level at the end of the constant head test.

Constant head level: the water level in a well at the end of the constant head test. Measured from the top of the casing.

Constant head pumping rate: a constant pumping rate at which a stable water level is attained. The pumping rate during the constant head test.

Constant head test: a pumping test in which pumping rate and drawdown are kept constant with time. For this report a rate of change of less than 0.5 feet (6 inches) per hour is taken as constant.

Drawdown: the decline in the water level in a well during pumping. Measured from the static water level prior to pumping.

Hydropneumatic tank: a tank which uses compressed air to maintain pressure in a water supply system. It is only secondarily a water storage tank.

Peak demand rate: the average rate of water use by a household during peak demand periods.

Peak demand test: a pumping test conducted to evaluate the capability of a well to supply peak demand needs of a household. The test is conducted at a rate equal to or greater than the peak demand rate for the peak time.

Peak load: the volume of water required by a household during each peak demand period. In this report, the peak load is assumed to be half the estimated total daily household water consumption.

Peak time: the length in minutes of each of two daily peak demand periods.

Shortfall time: the time needed to pump the shortfall volume from a well at the peak demand pumping rate.

Shortfall volume: the volume of water needed in addition to the assured volume to make up the peak load.

Static level: the water level in a well before a pumping test when all effects of drilling and previous pumping on the aquifer have dissipated and the well is in equilibrium with atmospheric pressure.

Storage contribution: the proportion of the well flow at any given time which comes from storage in the well.

Well flow: the flow rate of water from a well at a given time. It is the sum of the aquifer contribution and the well storage contribution.

Well storage: the volume of water stored within a well which is available for pumping.

UNITS OF MEASUREMENT

Foot-pound-second (english) units of measurement are used in this report. These can be converted to International Standard (SI) units as follows:

Multiply	by	to obtain
inches	2.54	centimeters
feet	0.305	meters
gallons	3.79×10^{-3}	cubic meters
gallons/minute	6.31×10^{-2}	liters/second
gallons/day	3.79×10^{-3}	cubic meters/day

Aquifer Restoration

- Aquifer restoration to 5 ppb of tetrachloroethylene (PCE), 5 ppb of trichloroethylene, 7 ppb of 1,1-dichloroethylene, and 2 ppb of vinyl chloride.

8ppb

- Cleanup of groundwater by air stripper at 99.9% efficiency if levels of vinyl chloride concentration in all exhaust gas discharged to the atmosphere do not exceed 10 ppm.

8,

Description of Alternative

The groundwater from the Parella well will be pumped through a merry-go-round air stripper capable of reducing the anticipated groundwater contaminant concentration from 260 ppm in the influent to the system to <5 ppb in the effluent. Thus, we will treat the groundwater to the NY State revised standard of 5 ppb (New York State MCLs, effective January 9, 1989).

The innovative merry-go-round system, designed by Robert Cobiella, the past USEPA on-scene-coordinator (OSC) for the site, supersedes the conventional packed column air stripper design. The packed column air stripper is a single air lift while the merry-go-round air stripper is a series of air stripping lifts. At each air stripping lift, air is entrained into the water stream and volatilizes the contaminant at a rate proportional to the Henry's Constant of the volatile contaminant and the temperature of the air and water.

The treated water may then be infiltrated into the tetrachloroethylene contaminated soils on site to induce cleaning of the soils and leaching of the contaminants that will be intercepted by the cone of depression of the Parella well. There is the added opportunity to draw contaminants from the vapor space in the well - particularly if the well is not cased (open hole) above the the water level.

Data Needs

The data required to permit the equipment will be supplied by the planned pump test.

Feasibility

The system has been operated with success at Pompey, New York at a National Priority Listed (NPL) site by the USEPA Emergency Response Division, Site Mitigation Section, Edison, New Jersey. The system was moved after 9 months upon completion of this groundwater cleanup. The air stripper reduced the contaminants from 700 ppb to non detectable in three months. There was a rebound in concentration to 240 ppb upon shut down at three months that required the further six months of treatment to address.

Since 1989, the system has operated at the American Thermostat NPL site in South Cairo, New York about 1-hours drive from the Wallkill site. The system is operating in the same fractured bedrock type of aquifer. A videotape of this operation is available upon request.

Air stripping efficiency depends on the transfer rate of the contaminant from water to air. A measure of the resistance to mass transfer from water to air is the Henry's Law Constant, H (Mackay, et al, 1979). The larger the Henry's Law Constant, the greater will be the equilibrium concentration of the contaminant in the air. Thus, contaminants with large Henry's Law Constants are more easily removed by air stripping (Kavanaugh and Trussell, 1980).

The Henry's Law Constants for each of the organic contaminants identified by the U.S. Attorney is presented in the table below and Figure 19. In this table are vapor pressure and water solubility data for each compound. Mackay and Wolkoff (1973) and Mackay and Leinonen (1975) suggested that these two parameters be combined to give an effective Henry's Law Constant for organic materials in water:

In general, it can be said that the combination of high Henry's Law Constant, high vapor pressure, and low solubility indicate a potential for successful air stripping. McCarty, et al (1979) noted that those compounds such as tetrachloroethylene, with a Henry's Constant value greater than 10-3 atm m3/mole are good candidates for removal by air stripping (Figure 19).

TABLE 3. HENRY'S CONSTANT

	Tetrachloro ethylene (PCE)	Trichloro ethylene	1,1-Dichloro ethylene	Vinyl chloride.
Henry's Law Constant (atm:m3/mole)	28.7 $\times 10^{3}$	11.7 $\times 10^{-3}$	15 $\times 10^{-3}$	640 $\times 10^{-3}$
Vapor Pressure (torr,25%C)	14	57.9	591	2660
Solubility in Water (mg/l, 25%C)	150	100	5000	1.1
Effective Henry's Law Constant	10^{2}	10^{-2}	10^{-2}	10_{-1}
Evaluation of Stripping Efficiency	Very Good	Very Good	Very Good	Excellent

The evaluation row in Table 3 summarizes the Henry's Law Constant, vapor pressure, solubility of the compounds of concern at the site to indicate the amenability of each compound to removal by air stripping. The evaluations for the compounds presented range from Excellent to Very Good and indicate that air stripping is feasible for these compounds.

Such systems have been demonstrated to achieve 99+ % removal efficiency with tetrachloroethylene.

The proposed system will consist of a series of 10 air lifts (Figure 21) that in series air strip the volatile contaminants from the well water. The yield of influent water from the Parella well is no more than 4 gpm and based on past sampling is expected to be initially at 260 ppm tetrachloroethylene, stabilizing at 95 ppm. However, as the contribution from soil leaching begins to affect the groundwater captured, the contaminant strength may increase to its initial value.

The air lift units will be piped in a merry-go-round arrangement that will take water from the well and from a 250 gallon storage tank and discharge into a second 250 gallon holding tank. The water will be circulated through the series of air lifts and at each air lift experiences air stripping at approximately 65% removal efficiency.

TABLE 4. SUMMED REMOVAL PERCENTAGES

Number of Air Lifts	Summed Removal Percentage	Concentration
1	67.75%	250,000 ppb
2	71.54	
3	82.15	
4	88.39	
5	92.46	
6	95,10	
7	96.82	
8	97.93	
9	99.125	
10	99.43	
11	99.64	
12	99.76	
13	99.84	
14	99.9	
15	99.93	17.5 ppb On first pass

The air stripping lifts sum up to 99.9% removal of the volatile contaminant from the groundwater. The 10 air lifts will drain from the first 250 gallon storage tank. These air lifts will overflow into the second 250 gallon tank with overflow to the distribution system. An imbiber bead filter may be used to further reduce the effluent concentrations before discharge.

The removal percent follows a diminishing return curve, while the removal efficiency remains the same, the amount of contaminant removed decreases in proportion to the reduced total concentration to be treated such that the largest expense is incurred in reducing the concentration below 65% of the initial concentration.

To enhance removal of the volatile the air lifts will circulate water through them at twice the influent and over flow rate of 4 gpm. Thus, the Merry-Go-Round air stripper, revolving at 8 gpm, will be more efficient and complete the cleanup quickly.

In iron-rich shale formations above 0.5% iron content, a practical limit of removal of 99.8% removal is determined by the entrainment of Tetrachloroethylene in iron flocculate that forms and fouls the system. This, apparent practical limit for air stripping can be overcome by allowing the iron floc to settle out by pH adjustment.

Nutrients of basal salts and glucose in the form of Epsom salts and pellet fertilizer at 0.1% of the flow and Karo Syrup at 0.01% of the flow may be added to the second tank. The first tank is seeded with treatment plant sludge. The microbes in turn assimilate the tetrachloroethylene and iron and precipitate magnesium salts that are filtered out with two down-draining sand filters arranged in parallel to allow for cleaning and maintenance.

Transmission Pipes: The water recovered from the Parella well will be conveyed to the General Switch property where the air stripper will be operated. The lines will be constructed of 2"-diameter schedule 40 PVC and installed during the reconditioning of the Parella well indicated in the Pump Test plan, and laid in a trench 3 feet deep; below the frost line. Similar pipes will be laid to the infiltration points at each excavation.

The thrust of this remedial action is to also treat the contaminated soils on site by leaching and biological activity. The glacial till is only moderately to poorly permeable. A simple french-drain leaching field will be employed in the area of the loading dock to disseminate the leaching water. Two open pools will be used to surcharge the soil in the less trafficed areas: TPA and TP6.

It is advantageous to establish and disseminate a bacterial colony into the contaminated soil by adding nutrients and oxygenation to the overflow. But, care must be taken to avoid a nutrient/bacteria rich discharge from the treatment plant that will cause an impermeable algal gel growth in the surface soils, leaching field and the bottom of any infiltration lagoon. Provision will be made to prevent the formation and allow breakup of such an impermeable coating.

If nutrients are not added to the second tank the remaining bacteria will consume the remaining tetrachloroethylene in the tank and the population will decline. An established nutrified and aerated bacterial colony will infiltrate into the soil in the same manner that the solvent did and will digest the tetrachloroethylene in the soil. A cap on the site will not be employed and surface water infiltration will be encouraged during treatment. Additional water for soil infiltration and plume capture may be obtained as needed by hydrofracturing the Parella well.

To operate the merry-go-round air stripper with 10 lifts, at 8 gpm, a 120 scfm air supply is required. Throughput capacities for multistage systems are slightly lower than the calculated flow capacity of a single airlift (12 to 15 times the cross-sectional area of the riser pipe in square inches = gpm), at least in the smaller size strippers. This system can be operated at about 10 gpm per square inch of riser pipe area. Air flow capacity per stage operates at about 1 scfm per gpm per lift, yielding an air to water ratio per stage of 7.48 to 1. Laboratory reported removal rates for single lifts at this ratio are 62-68%.

TABLE 5. REQUIRED AIR SUPPLY FOR AIR STRIPPER

Lifts	Water Flow (gpm)	Air Flow scfm
1	4	4
2	4	8
3	4	12
4	4	16
15	4	60
15	8	120

The airlift stripping system at American Thermostat has been fully operational since February 24, 1987. The current operation is unattended, running at a flow rate of about 3000 gpd (2 gpm). The proposed Wallkill project will treat groundwater at 5700 gpd. Flows, pressures and vacuum controls will be in a manually set balance. An automatic shutoff will be installed to prevent overflow in the event of transfer pump failure. For the first two weeks the system initially will be checked twice a week by Shakti Consultants. Then the system will be checked once per month and winterized in December.

Samples will be taken periodically according to the approved sampling plan and analyzed by a commercial laboratory.

The initial data for American Thermostat indicated raw water at 10,300 ppb tetrachloroethylene, and effluent water treated with a seven stage air stripper averaging 48 ppb, for a removal rate of 99.53%. Data from September 1988 indicated groundwater at 12,000 ppb was being captured in the pumping well and no Tetrachloroethylene was detectable to 10 ppb detection limit in the effluent, with the addition of a sprinkler system on the effluent pipe. Removal rates have ranged from 99.5 to 99.86% during the operation to date. With this system the influent groundwater concentration was reduced from 144,500 ppb to 2,000 ppb in 15 months. This system was not provided with the added enhancement of the secondary biological reactor.

To reach an effluent criteria of 5 ppb is a matter of increasing the number of air lifts, employing biological polishing and incurring slightly higher power and supervision costs. Multistage airlift stripping can easily be scaled up to meet the needs of any groundwater/surface water/aquifer volatile cleanup action. These multistage air strippers can be sized for flow rates up to millions of gallons per day, and costs per gallon can reasonably be expected to be lower for larger systems than for the smaller ones, and also lower for longer remedial actions than for short term projects as the initial capital investment is offset by more gallons treated.

Robert Cobiella is available for clarification of the feasibility of the method. He and George Zachos, Section Chief of the Site Mitigation Section have offered their assistance to Mel Hauptman, the USEPA technical staff on this project, monitoring the remedial effort. This may begin when a letter of understanding exchanged between the two USEPA Sections.

Advantages

A full scale model has already been proven to be effective and has completed the treatment operation at an NPL site during which many design refinements were incorporated. The system will be cheaper to construct than a packed-column air stripper and operates unattended for long periods of time. An Air 100 Permit was not required for the American Thermostat system and meeting the air discharge criteria were not a problem. A permit was obtained for the Hicksville MEK spill. The NY State Air Permits branch is developing policy with regard to permitting air strippers.

Sufficient information is in hand at this time to evaluate the field performance of the multistage airlift stripping technology. It is a high efficiency, low cost technique for purging volatile organic chemicals from water. It is effective, practical, operable, flexible, reliable, amenable to fabrication in the field at a scale tailored to the problem of the site and simple enough to be fabricated by readily available construction-level skilled tradesmen. It can be fabricated of materials capable of withstanding high or low pH liquids. It will readily move viscous liquids or high solid content liquids. It has no moving parts in contact with the liquid being stripped and so is relatively free from the effects of abrasive materials.

Residuals Generated

No solids are generated as a result of air stripping of volatile organics.

Secondary Environmental Impact

Air stripping has a potential air pollution problem associated with it. Existence of an actual problem depends on the geographical location (state, air quality region, etc.) of the stripper, the efficiencies of the stripper and the expected concentration of contaminants in the influent water.

Previous Applications

Applications of air stripping to the removal of organic pollutants are numerous.

O&M Requirements

Air stripping requires minimal operator attention, maintenance of the pumps and blowers, and electricity. The stripper itself contains no moving parts. Attention to mineral deposition and biological matting of the column packing will be required.

Interferences

High iron content of the groundwater would interfere with packed column air stripping of volatile organics. This problem is avoided with an airlift system. Reliability of air stripper operation can be a problem for installations where cold weather operation is required. Cold weather would decrease the driving force for volatilization. Heating the influent water may be required for winter operation or a shut down for the months of January, February and March may be considered.

Disadvantages

State regulatory authorities may require air emission source registration and permitting. Requirement for vapor recovery may be imposed adding additional capital and operating expense.

Time Frame

The fabrication of the air stripper began on April 4, 1990. The equipment could be operational within a further 150 days.

We propose to treat groundwater at Wallkill by air stripping to below the acceptable drinking water criteria and in the final remedial action discharge that groundwater into the ground. We request that the USEPA confer with the NY State DEC to define the terms under which infiltration of treated water will be allowed.

Costs

The system is not an expensive proposition. At American Thermostat the cost as of April 1, 1987 for the groundwater treatment was $55,000 for the construction, fabrication, running-in and operation of the airlift system for the first month. The cost included a shelter building and all its internal and external component items. Total treated throughput in the first month as of April 1, 1987 was over 150,000 gallons of contaminated groundwater. The capital and operating cost of the airlift stripping was 36¢ per gallon at this time. Projected system shut-down will be at the 300,000 gallons treated, and the cost at that time is forecast at $60,000 attributable to airlift stripping. Final cost per gallon for the completed action is thus expected to be about 20¢ per gallon.

For comparison purposes, the purification of 5.7 million gallons of groundwater at the Hicksville, L.I., New York site by a heated-feed, packed-column air stripper, admittedly a much more difficult to strip material (MEK), but also a much larger system used for an extended period of time, cost about 18¢ per gallon. At the Wallkill site, after 18 months of operation, 3 million gallons of water will have been treated and recycled.

We are in the process of building the air stripper so that it may be used for the air stripping of the water from the pump test. Neil Isabel, the Regional Air Pollution Engineer for Region III, NYDEC, has given verbal permission to conduct the pump test on the Parella well without a permit in order to obtain hard data on the removal efficiency and exhaust vapor concentration. Caesar Manfredi, NYSDEC Division of Water, will give a temporary authority to conduct a pump test contingent upon review of the air stripper Remedial Design Plan.

TABLE 6. CAPITAL COST ESTIMATE
MERRY-GO-ROUND AIR STRIPPING

For 18 month operation:

Multistage Stripper	$11,500	
2 x 6,000 gallon tanks (Rental $200/mo plus 500 x 2 liners)	4,500	
Flow Meter	3,000	
Pipes, Valves, Specialties	1,000	
Feed Pumps (2 blowers, 1 vac*, 1 turbine)	7,000	
Electrical at 12%	3,500	
Piping at 8%	2,500	
Instrumentation at 5%	1,500	
Insulated Trailer @ $\$15/\text{ft}^2$	12,000	
Site Work at 5%	1,500	
Excavation	3,000	
Subtotal	$51,000	$51,000
Contingency at 25%		13,000
TOTAL CAPITAL COST		$64,000

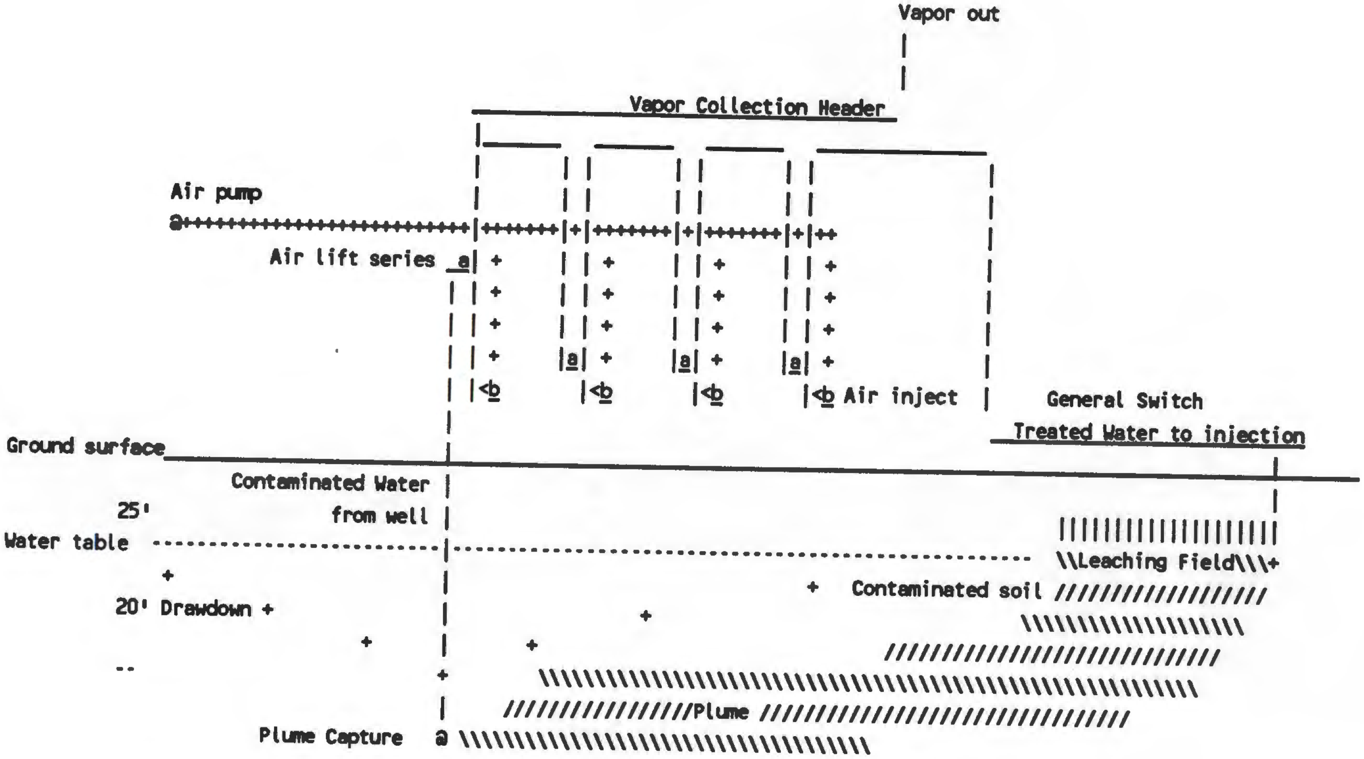
TABLE. ANNUAL COST ESTIMATE - AIR STRIPPING

Labor ($500/month discounted in house)	$3,000
Power at $0.10/kWh ($300/mo)	5,500
Chemicals ($50/mo)	1000
Maintenance at 4% of Capital Cost	2,500
TOTAL ANNUAL COST At double (8 gpm operation)	$12,000

$/gallons-$0.20-35

Suppliers

Fabrication - Local
Piping - Kimax, Amsco Sales, Fairfield NJ.(201) 575-8350
Pumps - Ring Compressor, Fuji, NY (212) 697-0116
Impeller - Wright-Austin, Detroit, Michigan
(dealer Koechlein, NJ 201 652-6274)



Pump 10' Submergence below Drawdown Cone for Turbine Pump

Figure 20: Multistage Airlift System

• TECHNICAL BULLETIN •

EXPANDABEADS

A new and better way [illegible] control PCB liquid

Expandabeads: Composition

Expandabeads are tiny absorbent beads composed of lightly cross-linked polymer chains. The cross-linking permits Expandabeads to absorb and entrap *PCB's* and other organic liquids within their physical structure. Once absorbed, *PCB* liquid cannot be released from the Expandabeads.

Expandabeads: Absorption

Expandabeads can *absorb* and *contain* up to 27 times their own volume. The swelling and sealing properties of Expandabeads are unique in the whole "sorbent" area. Expandabeads are *hydrophobic.* They will not absorb water or brine solutions, which makes them ideal for waterway, coastline or reservoir applications.

ABsorption and ADsorption

ADsorption is a surface phenomenon in which the material taken up is distributed over the surface of the adsorbing material. ADsorbed material can be easily released or squeezed out.

With *ABsorption*, the material taken up is distributed throughout the body of the ABsorbent. ABsorbed material cannot be released from Expandabeads because it is trapped permanently in the physical structure of the beads themselves. Expandabeads are *true ABsorbents,* and can swell to 3 diameters with absorbed *PCB's* or other compatible fluids. If the matrix or solid portion of the sorbent does not swell and contain the fluid, it is an *AD*sorbent, rather than an *AB*sorbent or imbiber.

Expandabeads: Organic fluids absorbed

Expandabeads can absorb and hold a wide range of organic liquids, including

- *Dielectric fluids: PCB's* (polychlorinated biphenyls) such as Aroclor, Inerteen and Pyranol
- *Chlorinated solvents* such as carbon tetrachloride, methyl chloroform, trichlorobenzene
- *Transportation fluids* such as gasoline, No.'s 1, 2 and 3 fuel oils, jet fuels and diesel fuels
- *Aromatic solvents* such as benzene, toluene, cumene, xylene, ethylbenzene, styrene and methylnaphthalene
- *Many polar compounds* such as methylisobutylketone, tetrahydrofuran and ethylacrylate

(See reverse side for a complete *Expandabead Absorption List*)

Expandabeads: Application

Solidification of PCB's: best with low-viscosity fluids which other sorbents handle poorly. Best available technology to handle *PCB's.*

Recommended dosage: 3 - 5 lbs. or more of *PCB's*: 1 lb. of Expandabeads.

Equipment required: Manual or mechanical. Expandabeads offer excellent protection to personnel.

Reaction time: Fast with low-viscosity fluids; slower as viscosity increases.

Disposal: Can be safely stored or incinerated with the approval of local, provincial and federal authorities.

Toxicity: Expandabeads prior to their use are not toxic. However, after absorption has taken place the solid mass should be regarded as the material which has been absorbed.

Caution: Do not use Expandabeads where oxidizing agents are present.

Expandabeads: Available formats

Beads, packets, blankets.

NOTE: Expandabead packets and blankets for the control of spills are made of a strong, porous polyester material.

Expandabeads: Potential uses/users

- *PCB* storage and transportation
- Transformer/capacitor spills
- Leaks in underground and surface tanks
- De-watering fuel storage tanks without loss of product
- Waste management and disposal
- Nuclear and hydro generating facilities
- Environmental engineers
- Industrial spills
- Laboratory and research spills
- Scintillation liquids storage and transportation
- Prevention of leakage in sample-size shipments
- Coast Guard and Port authorities

Expandabeads won't release absorbed organic fluids — even when cut in half!

• TECHNICAL BULLETIN • EXPANDABEADS •

Absorption • EXCELLENT •

- Allybromide
- n-Amylbenzene
- Amyl Acetate
- Amylene
- Benzene
- Benzyl Chloride
- 2 Bromoethylbenzene
- Bromotrichloro Methane
- Butyl Acrylate
- t-Butylbenzene
- sec-Butylbenzene
- Butyl Cellosolve
- t-Butylstyrene
- Butyraidehyde
- Carbon Disulfide
- Cellosolve Acetate
- 2-Chlorobenzaldehyde
- Chlorobenzol
- o-Chloroethylbenzene
- Chloro-2-Methyl Propene
- Chloropentanes
- 1-Chloronaphthalene
- 3-Chloropropenyl Benzene
- chloroform
- Cyclohexane
- Cyclooctone
- Decahydronaphthalene (Decalin)
- 1 5-Dibromopentane
- Dibutyl Ether
- 1 2-Dichloroethylene
- aa-Dichloro-m-Xylene
- Diethyl Carbonate
- Diisobutylamine
- Diisobutylketone
- Diisopropyl Ketone
- N.N.-Dimenthyl Benzelomine
- 1 2-Dimethyl Cyclohezane
- Dimethylsulfide
- Dipentene
- Dipenyloxide
- Allychloride
- t-Amylbenzene
- Amyl Chloride
- Benzaidehyde
- Benzylamine
- Bromobenzene
- 1 Bromobutane
- Butyl Acetate
- Butylbutyrate
- n-Butylbenzene
- Butylbenzoate
- Butylene Oxide
- t-Butyltoluene
- Butyric Acid
- Carbon Tetrachloride
- m-Chloroaniline
- Chlorobenzene
- Chlorobromomethane
- Chloroform
- 3-Chloro-2-Methyl Propene
- a-Chloro-m-Xylene
- 2-Chloropropene
- Chlorostyrene
- 2-Chlorotoluene
- Cyclohexyl Chloride
- p-Cymene
- 1 2-Dibromopentane
- 1 2-Dibromopropane
- Dichlorobenzene
- Dichloroisopropyl Ether
- Diethyl Benzene
- Diethylketone
- Diisobutylene
- p-Diisopropyl Benzene
- Dimethoxymethane
- N.N.-Dimethylcaproamide
- Dimethoxypropane
- Dioxane
- 1 1-Diphenylethylene
- Dipropylamine
- Epochlorohydrine
- 1 2-Epoxydodecane
- Ethylbenzene
- Ethylbromide
- Ethylchloride
- Ethylenedichloride
- 2-Ethylehexylamine
- Ethylisobutyl Ether
- Ethylenebromide
- Ethyllaurate
- Ethyltoluene
- Gasoline
- 2-Heptanone
- Iodohexane
- Isobutylacetate
- Isooctane
- Isopropylbenzene
- Methaxynaphthalene
- Methylamylacetate
- Methylbutylamine
- Methylene Chloride
- Methylisobutylketone
- Methylmethacrylate
- Mineral Spirits
- Naptha 107-142
- Octane
- Oil of Citronello
- 3-Pentanone
- Petroleum Ether 32-59
- 2-Phenyl-4-Methyl
- Propylenedichloride
- Pyridine
- Styrene
- Tetrahydrofuron
- Thionyl Chloride
- Toluene
- 1.1.2-Trichloroethane
- aaa-Trichloratoluene;
- Benzotrichloride
- Valeronitrile
- Vinylpyridine
- VMSP Naptho
- Ethylacetate
- Ethyl Acrylate
- Ethylbromobenzene
- Ethylbutyrate
- Ethyldichloride
- 2-Ethylhexyl Acrylate
- Ethyliodide
- Ethylpropyl Ether
- Ethylenetrichloride
- Ethyloxazolene
- Freon 113°
- Heptane
- Hexane
- Iodomethane
- Isobutylamine
- Isopropyl acetate
- Mesitylene
- Methylacrylate
- Methylbenzoate
- Methylcyclohexane
- Methylethylketone
- Methylisopropyl Ketone
- Methylpropionate
- Naphtha
- Nitrobenzene
- 2-Octene-1
- Pentane
- Perchloroethylene
- 2-Phenylethylamine
- Propylacetate
- Propylene Oxide
- Quinoline
- Styrene Oxide
- Tetrachloroethane
- Thiophene
- Trichlorobenzene
- 1,1,2-Trichloroethylene
- Trichloropropane
- Turpentine
- Vinyl Acetote
- Vinyitoluene
- Xylene

Absorption • GOOD •

PCB's (polychlorinated biphenyls):
● Aroclor ● Inerteen ● Pyranol

- Acetophenone
- Benzenesulfonyl Chloride
- Chloroacetone
- Diacetone
- #2 Diesel Union-Prem.
- N,N,-Dimethylpiperazine
- Ethyloctynol
- Fluorobenzene
- #2 Fuel Oil
- Isoamylisovalerate
- Kerosene
- 2-Methylbenzothiazole
- Stearoyl Chloride
- Triethanolamine
- 50 Aniline/50 Nitrobenzene
- n-Butylstearate
- 2-Chlorothiazone
- #2 Diesel
- Dimethyldodecylamine
- Ethyleneimine
- 1-Ethynyl-1-Cyclo-Hexanol
- #1 Fuel Oil
- Glycerol Monochlorohydrin
- Isopropylacetophenone
- Methylacetate
- Pentylacetate
- m-Toluidine

Absorption • FAIR •

- 2 Amino 2 Methyl Propanol
- Cyclopentanol
- Dimethylaniline
- Dodecyltoluene
- 2-Ethylhexanoic Acid
- Isoamylnitrite
- Methylacetoacetate
- Naphtol
- Oleic Acid
- Benzylacetate
- Dimethylhexynol
- Dodecylbenzene
- Ethylbenzoate
- #4 Fuel Oil (mixture)
- Isopar E
- Modified #4 Fuel & Oil
- Nitrooctane
- Wesson Oil

BIG'O'

LIQUITROL
SORBENT PRODUCTS

Big 'O' Inc.
235 Thames Road E.
Exeter, Ontario NOM 1S3
Tel. (519) 235-0870
Fax (519) 235-2144

Big 'O' (US) Inc.
2890 Highway 49 N.
Concord, North Carolina
28025

Big 'O' (UK) Limited
233 Birchfield Road
Redditch, Worcestershire
England BN7 4LX

A new and better way to control organic chemicals

With today's increasing public and governmental concern over the escape of pollutants into the environment, much greater attention must be paid to the responsible control and disposal of these potentially dangerous elements.

Expandabeads offer a new, yet proven, way to deal with many of the problems encountered in storing, handling and shipping organic liquids. **Expandabeads** can prevent many organic chemicals from escaping into the environment, and can provide invaluable assistance in controlling and cleaning up spills when they occur.

What are Expandabeads?

Expandabeads are tiny polymer (plastic) spheres that are made up of lightly crosslinked polymer chains. Because of the crosslinking, they display unusual behaviour in the presence of organic solvents. Instead of dissolving into the solvent, they swell and expand. An **Expandabead** can contain and hold **up to 27 times its own volume!**

What organic fluids can Expandabeads absorb?

Expandabeads can contain and hold a wide variety of organic materials, including

- **Transportation fluids** like gasoline, No. 1, 2 and 3 fuel oils, jet fuels and diesel fuels
- **Chlorinated solvents** such as carbon tetrachloride, methyl chloroform, trichlorobenzene, and polychlorinatedbiphenyls (PCB's)
- **Aromatic solvents** such as benzene, toluene, cumene, xylene, ethylbenzene, styrene and methylnaphthaline
- **Many polar compounds** such as methylisobutylketone, tetrahydrofuran and ethylacrylate.

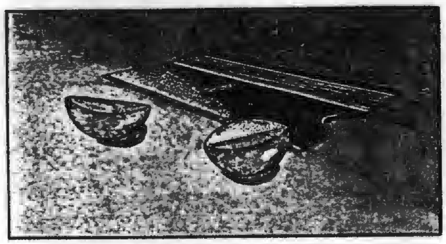
Expandabeads will **not** contain solids, high viscosity oils, low molecular weight alcohols, glycols, acetic acid, acetonitrile, nitromethane and highly polar materials.

Expandabeads are manufactured to ASTM Performance Standards.

Expandabeads are hydrophobic

Because of their unique spherical structure, water can pass right through a packed bed of **Expandabeads.** But when an active organic liquid such as those listed above contacts an **Expandabead**, the solid bead begins to swell, rapidly filling the void space in the container and preventing further flow.

Unlike most commercially available adsorbents, thickeners and gellants, **Expandabeads** actually **absorb** the offending organics, making them an integral part of the molecular matrix of the **Expandabeads.** Once entrapped, they cannot be squeezed from the beads. Even if you cut an **Expandabead** in half, it will not release any of its absorbed liquid.



***Expandabeads** won't release absorbed organic fluids — even when cut in half!*

Expandabeads: typical applications

The potential of **Expandabeads** in controlling and immobilizing PCB's and other organic chemicals is tremendous. For containing hazardous chemicals for safe haulage to disposal sites, **Expandabeads** have no equals.

In the workplace, where the key concern is worker safety, **Expandabeads** will not only immobilize hazardous chemicals permanently, but also control their harmful vapours.

For workers, the public, and the environment, **Expandabeads** represent the ultimate in the safe containment and immobilization of organic chemicals. Their unequalled performance is solidly based on the most modern technology available. Applications include use by:

- Environmental engineers
- Industrial safety engineers
- Waste management and disposal personnel
- Research laboratories
- Agriculture
- Chemical manufacturers and distributors
- Transportation and haulage industries
- The Military
- Courier Services
- Coast Guard and Port authorities
- Nuclear and Hydro Electric energy generating facilities

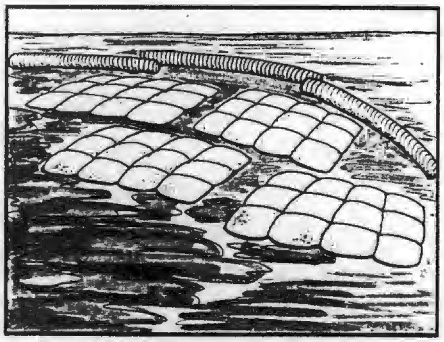
The remarkable properties of **Expandabeads** can be utilized in a wide variety of ways for industrial, marine and environmental cleanups.

1. Cleanup of spills

Hydrocarbon spills in diked storage areas can be cleaned up efficiently with Big 'O' **Expandabead** pillows or blankets. When the spill occurs, simply place the pillow or blanket on top of the spilled material to contain it for safe disposal.

Spills in waterways can be effectively contained by placing an **Oil Buoy** boom around the spill area, then floating **Expandabead** blankets behind the boom. The blankets will absorb the spill and prevent any of its floating liquid layer from being stripped underneath the boom by currents or tides. The **Expandabead** blankets will continue to absorb until completely saturated.

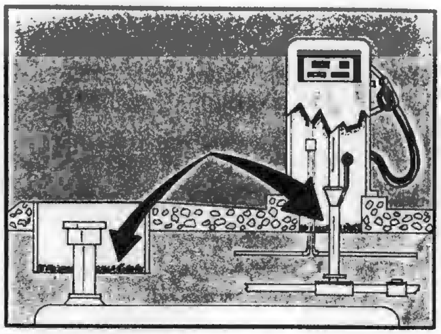
To recover high-density organics that sink to the bottom, weighted blankets can be attached to a line for retrieval when saturated.



Expandabead blankets and Oil Buoy booms combine to contain a waterway spill.

For industrial plants, Expandabead blankets will effectively remove thin sheens from ditches or water outlets. Since the mere visibility of a sheen is sufficient to provoke a fine, it pays to eliminate the problem by placing **Expandabead** blankets across these areas.

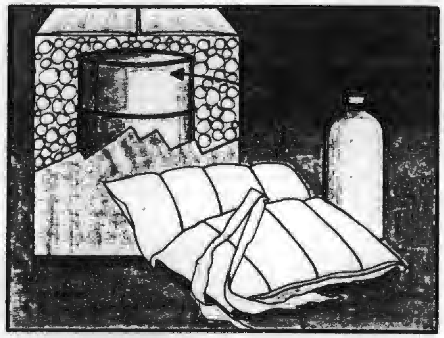
Service station spills of gasoline and diesel fuels usually occur under the metering pump or around the fill pipe of the storage tank. These can be cleaned up by placing a layer of **Expandabeads** under or around the pumps and in the fill-pipe pit. The swollen beads need be replaced only when they interfere with water drainage or the operation of the fill-pipe unit.



*Layers of **Expandabeads** clean up service station pump and fuel pit leaks.*

2. Safeguarding sample-size shipments

Many organic liquids can be shipped safely in packages containing **Expandabeads.** A sturdy, porous, double-walled pouch with **Expandabeads** occupying the space between the walls surrounds the organic liquid container. During transit the pouch itself minimizes the possibility of breakage. However, if a leak or spill should occur, the **Expandabeads** can quickly contain it together with any noxious fumes or vapours. Any danger to transit personnel, other shipments, or the carrier itself is thus safely eliminated.



Expandabead pouches — for safer shipment of organic liquid samples.

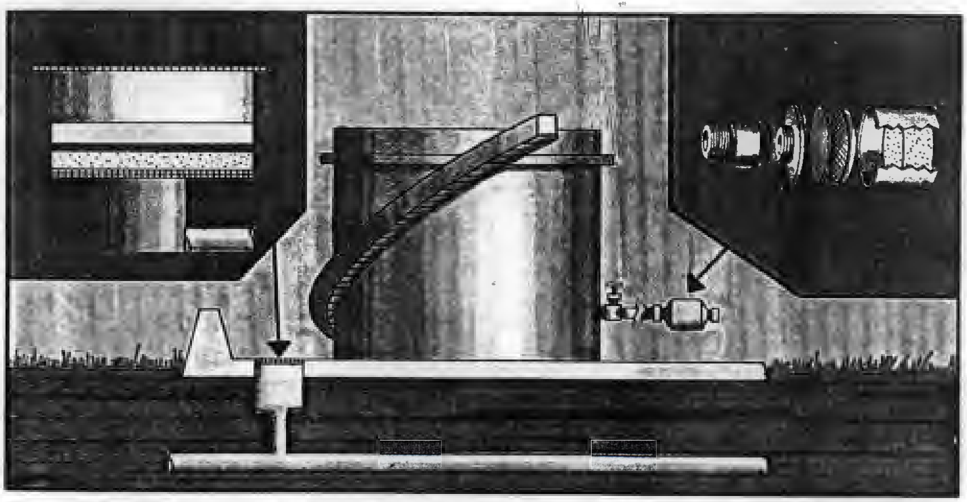
3. Removing water from storage tanks

Bulk storage tanks for organic fluids accumulate a layer of water that must be removed to prevent contamination of the product and to permit full utilization of the storage capacity. **Expandabead** valves and cartridges eliminate problems of product loss and costly cleanup. The valve is attached to the drawoff line, and water allowed to flow through it until the water/product interface reaches the beads. At that point, the **Expandabeads** will swell and prevent further flow.

4. Containing spills in diked areas

The diked areas around hydrocarbon storage tanks and tank farms must be designed to allow water to drain from them, but prevent hydrocarbons from escaping to contaminate ground or surface water.

Both of these requirements can be satisfied by employing a drain containing **Expandabeads.** Water entering the drain passes through a trash grating, a silt filter, and a contained bed of **Expandabeads.** If a large spill should occur, the beads expand, thus preventing any further flow of water and hydrocarbons into the drain until the spill can be cleaned up.



Expandabeads in storage tank drains and drawoff valves permit water flow, but prevent hydrocarbon escape.

Expandabeads: new applications

Expandabeads will not only improve the safety of existing operations, they will continue to open up new avenues of product development. The **Lab-Pack**, for example, was developed expressly to deal quickly and efficiently with organic chemical spills in the laboratory. **Lab-Packs** are packaged in a convenient counter top dispenser. Similar **Expandabead** products will be developed to fill future needs.

Expandabeads: product availability

Product	**EXB-BL Bulk Blended**	**EXB-6 Pouch**	**EXB-PU Pure Beads**	**EXB-23 Pillow**
Size, nominal **No./case**	10 lbs.	6" x 6" 36	10 lbs.	12" x 18" 6
LAB-PACK Contents	12 EXB-6 pouches			

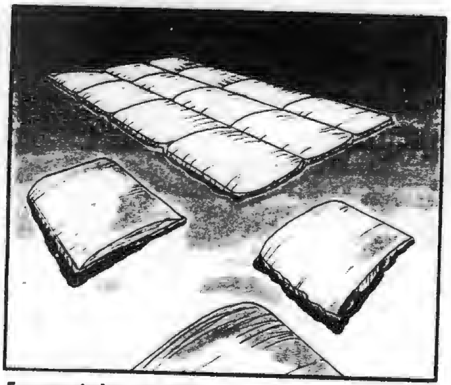
Product safety and disposal

For the control of spills, we recommend the use of Liquitrol pillows, packets and blankets. Loose beads can cause slippery conditions particularly on hard surfaces.

All commercially available sorbent products react to oxidizers in varying degrees. Most reactions are potentially dangerous. For safety purposes it is strongly recommended that **Expandabeads** not be used with oxidizers.

Before handling any oxidizing agents, consult knowledgeable authorities.

Expandabeads should be disposed of in accordance with the rules of those governmental agencies having jurisdiction over such matters.



Expandabead *pillows and blankets.*

Other new ideas from Liquitrol

- **Expandabead Valves**
  – as available
- **Expandabead Cartridges**
  – as available
- **EX-PACK PLUS - AS AVAILABLE**
  The ultimate emergency response kit. Specially designed to control spills of unknown substances — acids, polar compounds, and most organic chemicals. Blankets contain: **Expandabeads,** aquabeads (aqueous materials absorbent), a special absorbent for polar compounds, and a specially formulated bulk wicking mixture.

Size: 12" x 18"
No./case: 6

NOTE: Expandabead packets, pouches, pillows and blankets are all made of a strong, porous, polyolefin material.

CAUTION: Do not use Expandabead products where oxidizing materials are present

Expandabead *pillows protect a drain from a traffic accident spill.*

Lab Pack: *for quick containment of lab-chem spills.*

Contact local and Governmental authorities for approved disposal methods.

Notice — Warranty

In the event that any Big 'O' Liquitrol Sorbent Product is found to be defective in material, workmanship, or not performing as represented, then Big 'O' 's only obligation as your exclusive remedy shall be to repair, replace or refund the purchase price of such product upon Big 'O' being satisfied that the product is either defective or not performing as represented. This warranty is exclusive and is in lieu of any implied warranty of merchantability, fitness for a particular purpose, or other warranty of quality. Except as provided herein, Big 'O' shall not be liable or responsible for any loss or damage, whether direct, indirect, incidental, special or consequential arising out of the sale, use or misuse of Big 'O' Liquitrol Sorbent Product.

Big 'O' (U.S.) Inc.
2890 Hwy. #49 N.
Concord, North Carolina
28025
Tel.: (704) 786-3917
Telex: 57-2504
Fax: (704) 788-8514

Big 'O' (U.K.) Ltd.
233 Birchfield Road
Redditch, Worcestershire
England B974LX
Tel.: (0527) 402-646
Telex: 51-337881
Fax: 44 (0527) 402171

Big 'O' Inc.
254 Thames Rd. E.
Exeter, Ontario
Canada N0M 1S3
Tel.: (519) 235-0870
Telex: 064-5659
Fax: (519) 235-3033

LIQUITROL™
SORBENT PRODUCTS

BIG 'O'

Distributed by:

Appendix F

Correspondence

SHAKTI CONSULTANTS INC.
185, Gatzmer Avenue
Jamesburg, NJ 08831
(201) 521-2322

August 23, 1989

Dr. Fluoro Cuison
18 Long Drive
Liberty, NY 12754

Reviewed by Walter & Marty

Sent August 29th, 1989.

Dear Mr Cuison,

As we discussed by telephone, we are requesting access to your well at 320 Highland Avenue, Middletown and the use of your well for a groundwater remediation program we are undertaking. This groundwater remediation program is part of the environmental clean-up being carried out under the U.S. Environmental Protection Agency's direction.

In order to treat the groundwater in the vicinity of your property, it is necessary to pump the groundwater from your well. This groundwater will then be piped in a trench from the top of your well (adjacent to the East wall of your house) across to the General Switch property. There it will be treated in accordance with an Environmental Protection Agency approved process. It will be cleaned and then will recharge the aquifer.

After the initial installation of the piping and restoration of your property, all services to and from the well will be underground so as not to inconvenience the users of your property.

After the Environmental Protection Agency determines that the groundwater has been properly and completely treated, we will re-close the well head in accordance with the standards of the Middletown Department of Health code.

This work is a continuation of the Environmental Protection Agency's approved clean-up which was commenced several years ago. As part of that activity your property was connected to the Wallkill municipal water supply. At that time your well was decommissioned and your property placed into the public water supply distribution system.

Would you please indicate your permission by signing the attached copy of this letter and returning it to me in the attached envelope.

Yours sincerely,

John Bee: Regarding the former Parella Well

John Bee
President, Shakti Consultants, Inc.

Senior Geologist
CPG#6173 American Institute of
Professional Geologists

Dr. Fluoro Cuison

Stroock & Stroock & Lavan

Seven Hanover Square
New York, New York 10004-2594

212 806 5400
Telecopiers:
212 806 6006
212 806 5919
Telex:
177693 STROOCK UT

Direct Dial:
212-806-6469

August 2, 1990

Thomas Darcy, Esq.
Decker and Darcy
20 Roberts Street
P.O. Box A
Middletown, New York 10940

Subject: Access Agreement for Well at
320 Highland Avenue
Wallkill, New York

Dear Mr. Darcy:

You have indicated that your client Dr. Fluoro Cuison has agreed to permit access to the well located on his property at 320 Highland Avenue in Wallkill, New York for the purpose of work to be carried out under the Consent Decree in U.S. v. General Switch Corporation, 87 Civ. 8789 (RJW).

The initial phase of this work will consist of reconditioning the well and conducting a pump test. Reconditioning the well will involve opening the well and fitting it with a submersible pump and piping. The pump test to determine whether the well is suitable for extracting contaminated water from the well field will last a minimum of 72 hours and a maximum of 96 hours. (If the pump test confirms that the well is suitable for intercepting the contaminated groundwater, pumping from the well will continue, but that pumping will require only infrequent visits to the site for routine maintenance of the pump.) The parties requiring access to the well will be Laurwal Holding Corporation (f/k/a General Switch Corporation) and its authorized representatives and the U.S. Environmental Protection Agency and its representatives, including contractors. We have previously provided evidence of insurance for the work to be performed at the 320 Highland Avenue site.

Should you or Dr. Cuison at any time have any questions about the nature of the work, please do not hesitate to contact John Bee of

General Switch will then submit to the USEPA a Remedial Design Plan following the initial pump test program. The Remedial Design Plan will consist of the design and specifications of the air stripper and we will ask the USEPA to inspect and approve the air stripper as built. Following startup, and approval of the Remedial Design Plan, general switch will submit an Initial Testing Program. The results of this program will be submitted to the USEPA in an Initial Testing Program Report. The Initial Testing Program Report will detail the demonstrated efficiency of the proposed remedial soil and groundwater treatment systems and the plans for any proposed alternative water supply connections along with the appropriate schedules.

General Switch and its contractor will then be available for a Final Inspection in conjunction with EPA and/or its designated representatives and contractors. The Final Inspection will include a walk-through of the entire project to determine project consistency with the RD Report and EPA-approved O&M Plan prior to start up of the cleanup.

Sincerely,

John Bee

John Bee
President, Shakti Consultants, Inc.
Certified Professional Geologist # 6173
American Institute of Professional Geologists

SHAKTI CONSULTANTS INC.

185, Gatzmer Avenue
Jamesburg, NJ 08831
(201) 521-2322

Mr Walter Stern
General Switch Co.
Middletown, New York 10940

January 10, 1990

Martin Baker, Esq. and Gregory Belcamino
Stroock, Stroock and Lavan
Seven Hanover Square
New York, New York 10004

RE: United States v General Switch Corporation
<u>S.D.N.Y. (87 Civ. 8789)</u>

Dear Mr. Martin Baker and Gregory Belcamino,

According to the requirements of the Consent Order, we present the Sampling, Analysis and Monitoring Plan and the required attachments: the Quality Assurance/Quality Control Plan, Health and Safety, and Combined Overall Site Management and Operations & Maintenance Plans for General Switch Corporation. We have prepared the various protocols in detail for your review and EPA's acceptance so that they may be appended to the consent decree. We believe that the requirements for various plans prior to site work have been met. The connection to wells plan is incorporated into the Work Plan. The Initial Testing Program is detailed in the Sampling Plan and Pump Test Plan.

Initial Testing Program

Following fabrication of the air stripper, the pump test and sampling of neighborhood wells will be conducted along with a demonstration of the feasibility of the soil treatment. General Switch will submit the information from the pump test in a Pump Test Report.

Shakti Consultants, Laurwal Holding Corporation's Project Manager. Mr. Bee's telephone number is 201-521-2322.

Since the work is dependent upon the season, I appreciate your continuing attention to this matter. Please request Dr. Cuison to indicate that he agrees to allow access to his property for the purposes of this work by signing and returning to me the attached copy of this letter.

Thank you for your assistance in obtaining Dr. Cuison's consent to this Access Agreement. If you require any additional information, please do not hesitate to contact me.

Sincerely,

GRBelcamino

Gregory R. Belcamino
GRB:mfm

cc: John Bee

SHAKTI CONSULTANTS INC.
185 GATZMER AVENUE
P.O. BOX

DATE: 08/17/89
JOB No: 894356
PROJECT No:
SAMPLE RECEIVED: 08/04/89

ATTN: JOHN BEE

SAMPLE SUMMARY

SAMPLE No	COLLECTED DATE	COLLECTED TIME	COLLECTED BY	POINT OF COLLECTION
E916351	08/04/89	14:15	JMB	GROUND WATER - ERNEST, 353 HIGHLAND
E916352	08/04/89	14:10	JMB	GROUND WATER - SEELEY, 321 HIGHLAND
E916353	08/04/89	14:00	JMB	GROUND WATER - GILBERT, 323 HIGHLAND
E916354	08/04/89	23:45	JMB	GROUND WATER - STOUT, 316 HIGHLAND
E916355	08/04/89	23:30	JMB	GROUND WATER - WOOD, 319 HIGHLAND
E916356	08/04/89	14:35	JMB	GROUND WATER - GUILD MOLDERS, INDUSTRIAL PLACE

VINCENT J. PUGLIESE
VICE PRESIDENT

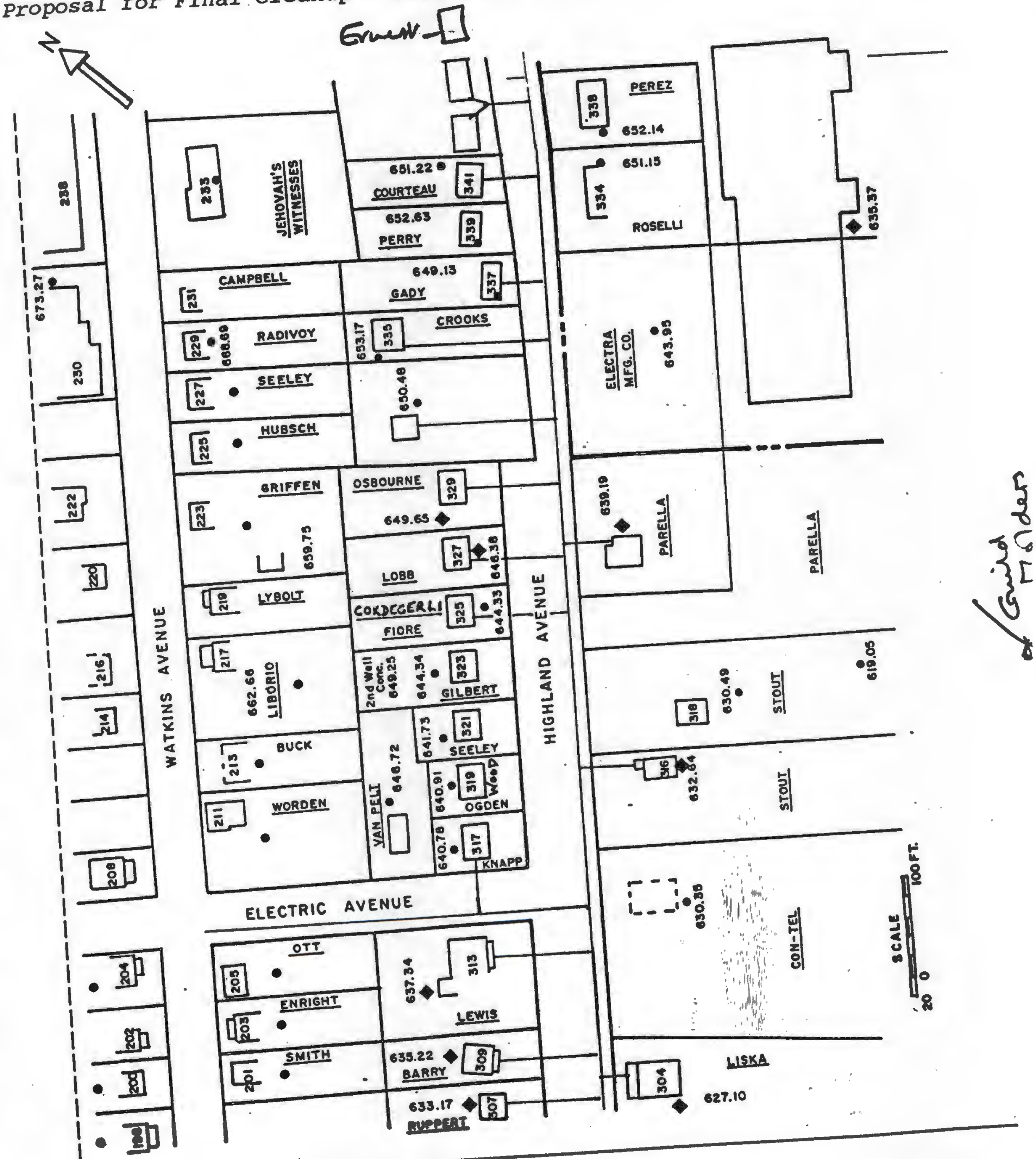


Figure 14. Location of Contaminated Wells & Water Supply Lines

Shakti Consultants, Inc.

LEGEND

◆ WELLS CONTAINING GREATER THAN 50 PPB PCE

● UNCOMTAMINATED WELLS

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ANALYSIS REPORT FOR VOLATILE ORGANICS BY GC/MS

CLIENT : SHAKTI CON.
LAB SAMPLE # : E916351
MATRIX : WATER

METHOD : EPA 624
ANALYSIS DATE : 08/08/89
DATA FILE : >A4554

	COMPOUND	RESULT (ug/L)	MDL (ug/L)	Q
1)	ACROLEIN	ND	100	
2)	ACRYLONITRILE	ND	100	
3)	BENZENE	ND	5.0	
4)	BROMOFORM	ND	5.0	
5)	BROMODICHLOROMETHANE	ND	5.0	
6)	BROMOMETHANE	ND	10	
7)	CARBON TETRACHLORIDE	ND	5.0	
8)	CHLOROBENZENE	ND	5.0	
9)	CHLOROETHANE	ND	10	
10)	2-CHLOROETHYL VINYL ETHER	ND	10	
11)	CHLOROFORM	ND	5.0	
12)	CHLOROMETHANE	ND	10	
13)	cis-1,3-DICHLOROPROPENE	ND	5.0	
14)	DIBROMOCHLOROMETHANE	ND	5.0	
15)	1,2-DICHLOROBENZENE	ND	5.0	
16)	1,3-DICHLOROBENZENE	ND	5.0	
17)	1,4-DICHLOROBENZENE	ND	5.0	
18)	1,1-DICHLOROETHANE	ND	5.0	
19)	1,2-DICHLOROETHANE	ND	5.0	
20)	1,1-DICHLOROETHYLENE	ND	5.0	
21)	trans-1,2-DICHLOROETHYLENE	ND	5.0	
22)	trans-1,3-DICHLOROPROPENE	ND	5.0	
23)	1,2-DICHLOROPROPANE	ND	5.0	
24)	ETHYLBENZENE	ND	5.0	
25)	METHYLENE CHLORIDE	ND	5.0	
26)	1,1,2,2-TETRACHLOROETHANE	ND	5.0	
27)	TETRACHLOROETHYLENE	ND	5.0	
28)	TOLUENE	ND	5.0	
29)	1,1,1-TRICHLOROETHANE	ND	5.0	
30)	1,1,2-TRICHLOROETHANE	ND	5.0	
31)	TRICHLOROETHYLENE	ND	5.0	
32)	TRICHLOROFLUOROMETHANE	ND	5.0	
33)	VINYL CHLORIDE	ND	10	
34)	m-XYLENE	ND	5.0	
35)	p,o-XYLENE	ND	5.0	

ND = NOT DETECTED
MDL= METHOD DETECTION LIMIT

QUALIFIERS (Q)

J =INDICATES AN ESTIMATED VALUE BELOW MDL
B =INDICATES COMPOUND FOUND IN THE ASSOCIATED BLANK AS WELL AS IN SAMPLE

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ANALYSIS REPORT FOR VOLATILE ORGANICS BY GC/MS

CLIENT : SHAKTI CON.
LAB SAMPLE # : E916352
MATRIX : WATER

METHOD : EPA 624
ANALYSIS DATE : 08/08/89
DATA FILE : >A4548

COMPOUND	RESULT (ug/L)	MDL (ug/L)	Q
1) ACROLEIN	ND	100	
2) ACRYLONITRILE	ND	100	
3) BENZENE	ND	5.0	
4) BROMOFORM	ND	5.0	
5) BROMODICHLOROMETHANE	ND	5.0	
6) BROMOMETHANE	ND	10	
7) CARBON TETRACHLORIDE	ND	5.0	
8) CHLOROBENZENE	ND	5.0	
9) CHLOROETHANE	ND	10	
10) 2-CHLOROETHYL VINYL ETHER	ND	10	
11) CHLOROFORM	ND	5.0	
12) CHLOROMETHANE	ND	10	
13) cis-1,3-DICHLOROPROPENE	ND	5.0	
14) DIBROMOCHLOROMETHANE	ND	5.0	
15) 1,2-DICHLOROBENZENE	ND	5.0	
16) 1,3-DICHLOROBENZENE	ND	5.0	
17) 1,4-DICHLOROBENZENE	ND	5.0	
18) 1,1-DICHLOROETHANE	ND	5.0	
19) 1,2-DICHLOROETHANE	ND	5.0	
20) 1,1-DICHLOROETHYLENE	ND	5.0	
21) trans-1,2-DICHLOROETHYLENE	ND	5.0	
22) trans-1,3-DICHLOROPROPENE	ND	5.0	
23) 1,2-DICHLOROPROPANE	ND	5.0	
24) ETHYLBENZENE	ND	5.0	
25) METHYLENE CHLORIDE	ND	5.0	
26) 1,1,2,2-TETRACHLOROETHANE	ND	5.0	
27) TETRACHLOROETHYLENE	ND	5.0	
28) TOLUENE	3.5	5.0	J
29) 1,1,1-TRICHLOROETHANE	ND	5.0	
30) 1,1,2-TRICHLOROETHANE	ND	5.0	
31) TRICHLOROETHYLENE	ND	5.0	
32) TRICHLOROFLUOROMETHANE	ND	5.0	
33) VINYL CHLORIDE	ND	10	
34) m-XYLENE	ND	5.0	
35) p,o-XYLENE	ND	5.0	

ND = NOT DETECTED
MDL= METHOD DETECTION LIMIT

QUALIFIERS (Q)

J =INDICATES AN ESTIMATED VALUE BELOW MDL
B =INDICATES COMPOUND FOUND IN THE ASSOCIATED BLANK AS WELL AS IN SAMPLE

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ANALYSIS REPORT FOR VOLATILE ORGANICS BY GC/MS

CLIENT : SHAKTI CON.
LAB SAMPLE # : E916353
MATRIX : WATER

METHOD : EPA 624
ANALYSIS DATE : 08/08/89
DATA FILE : >A4549

COMPOUND	RESULT (ug/L)	MDL (ug/L)	Q
1) ACROLEIN	ND	100	
2) ACRYLONITRILE	ND	100	
3) BENZENE	ND	5.0	
4) BROMOFORM	ND	5.0	
5) BROMODICHLOROMETHANE	ND	5.0	
6) BROMOMETHANE	ND	10	
7) CARBON TETRACHLORIDE	ND	5.0	
8) CHLOROBENZENE	ND	5.0	
9) CHLOROETHANE	ND	10	
10) 2-CHLOROETHYL VINYL ETHER	ND	10	
11) CHLOROFORM	ND	5.0	
12) CHLOROMETHANE	ND	10	
13) cis-1,3-DICHLOROPROPENE	ND	5.0	
14) DIBROMOCHLOROMETHANE	ND	5.0	
15) 1,2-DICHLOROBENZENE	ND	5.0	
16) 1,3-DICHLOROBENZENE	ND	5.0	
17) 1,4-DICHLOROBENZENE	ND	5.0	
18) 1,1-DICHLOROETHANE	ND	5.0	
19) 1,2-DICHLOROETHANE	ND	5.0	
20) 1,1-DICHLOROETHYLENE	ND	5.0	
21) trans-1,2-DICHLOROETHYLENE	ND	5.0	
22) trans-1,3-DICHLOROPROPENE	ND	5.0	
23) 1,2-DICHLOROPROPANE	ND	5.0	
24) ETHYLBENZENE	ND	5.0	
25) METHYLENE CHLORIDE	ND	5.0	
26) 1,1,2,2-TETRACHLOROETHANE	ND	5.0	
27) TETRACHLOROETHYLENE	ND	5.0	
28) TOLUENE	3.1	5.0	J
29) 1,1,1-TRICHLOROETHANE	ND	5.0	
30) 1,1,2-TRICHLOROETHANE	ND	5.0	
31) TRICHLOROETHYLENE	ND	5.0	
32) TRICHLOROFLUOROMETHANE	ND	5.0	
33) VINYL CHLORIDE	ND	10	
34) m-XYLENE	ND	5.0	
35) p,o-XYLENE	ND	5.0	

ND = NOT DETECTED
MDL= METHOD DETECTION LIMIT

QUALIFIERS (Q)

J =INDICATES AN ESTIMATED VALUE BELOW MDL
B =INDICATES COMPOUND FOUND IN THE ASSOCIATED BLANK AS WELL AS IN SAMPLE

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ANALYSIS REPORT FOR VOLATILE ORGANICS BY GC/MS

CLIENT : SHAKTI CON.
LAB SAMPLE # : E916354
MATRIX : WATER

METHOD : EPA 624
ANALYSIS DATE : 08/08/89
DATA FILE : >A4565
>A4618

	COMPOUND	RESULT (ug/L)	MDL (ug/L)	Q
1)	ACROLEIN	ND	100	
2)	ACRYLONITRILE	ND	100	
3)	BENZENE	ND	5.0	
4)	BROMOFORM	ND	5.0	
5)	BROMODICHLOROMETHANE	ND	5.0	
6)	BROMOMETHANE	ND	10	
7)	CARBON TETRACHLORIDE	ND	5.0	
8)	CHLOROBENZENE	ND	5.0	
9)	CHLOROETHANE	ND	10	
10)	2-CHLOROETHYL VINYL ETHER	ND	10	
11)	CHLOROFORM	ND	5.0	
12)	CHLOROMETHANE	ND	10	
13)	cis-1,3-DICHLOROPROPENE	ND	5.0	
14)	DIBROMOCHLOROMETHANE	ND	5.0	
15)	1,2-DICHLOROBENZENE	ND	5.0	
16)	1,3-DICHLOROBENZENE	ND	5.0	
17)	1,4-DICHLOROBENZENE	ND	5.0	
18)	1,1-DICHLOROETHANE	ND	5.0	
19)	1,2-DICHLOROETHANE	ND	5.0	
20)	1,1-DICHLOROETHYLENE	ND	5.0	
21)	trans-1,2-DICHLOROETHYLENE	19	5.0	
22)	trans-1,3-DICHLOROPROPENE	ND	5.0	
23)	1,2-DICHLOROPROPANE	ND	5.0	
24)	ETHYLBENZENE	ND	5.0	
25)	METHYLENE CHLORIDE	ND	5.0	
26)	1,1,2,2-TETRACHLOROETHANE	ND	5.0	
27)	TETRACHLOROETHYLENE	1300	100	
28)	TOLUENE	ND	5.0	
29)	1,1,1-TRICHLOROETHANE	ND	5.0	
30)	1,1,2-TRICHLOROETHANE	ND	5.0	
31)	TRICHLOROETHYLENE	190	5.0	
32)	TRICHLOROFLUOROMETHANE	ND	5.0	
33)	VINYL CHLORIDE	ND	10	
34)	m-XYLENE	ND	5.0	
35)	p,o-XYLENE	ND	5.0	

ND = NOT DETECTED
MDL= METHOD DETECTION LIMIT

QUALIFIERS (Q)

J =INDICATES AN ESTIMATED VALUE BELOW MDL
B =INDICATES COMPOUND FOUND IN THE ASSOCIATED BLANK AS WELL AS IN SAMPLE

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ANALYSIS REPORT FOR VOLATILE ORGANICS BY GC/MS

CLIENT : SHAKTI CON.
LAB SAMPLE #: E916355
MATRIX : WATER

METHOD : EPA 624
ANALYSIS DATE: 08/08/89
DATA FILE : >A4566

COMPOUND	RESULT (ug/L)	MDL (ug/L)	Q
1) ACROLEIN	ND	100	
2) ACRYLONITRILE	ND	100	
3) BENZENE	ND	5.0	
4) BROMOFORM	ND	5.0	
5) BROMODICHLOROMETHANE	ND	5.0	
6) BROMOMETHANE	ND	10	
7) CARBON TETRACHLORIDE	ND	5.0	
8) CHLOROBENZENE	ND	5.0	
9) CHLOROETHANE	ND	10	
10) 2-CHLOROETHYL VINYL ETHER	ND	10	
11) CHLOROFORM	ND	5.0	
12) CHLOROMETHANE	ND	10	
13) cis-1,3-DICHLOROPROPENE	ND	5.0	
14) DIBROMOCHLOROMETHANE	ND	5.0	
15) 1,2-DICHLOROBENZENE	ND	5.0	
16) 1,3-DICHLOROBENZENE	ND	5.0	
17) 1,4-DICHLOROBENZENE	ND	5.0	
18) 1,1-DICHLOROETHANE	ND	5.0	
19) 1,2-DICHLOROETHANE	ND	5.0	
20) 1,1-DICHLOROETHYLENE	ND	5.0	
21) trans-1,2-DICHLOROETHYLENE	ND	5.0	
22) trans-1,3-DICHLOROPROPENE	ND	5.0	
23) 1,2-DICHLOROPROPANE	ND	5.0	
24) ETHYLBENZENE	ND	5.0	
25) METHYLENE CHLORIDE	ND	5.0	
26) 1,1,2,2-TETRACHLOROETHANE	ND	5.0	
27) TETRACHLOROETHYLENE	ND	5.0	
28) TOLUENE	ND	5.0	
29) 1,1,1-TRICHLOROETHANE	ND	5.0	
30) 1,1,2-TRICHLOROETHANE	ND	5.0	
31) TRICHLOROETHYLENE	ND	5.0	
32) TRICHLOROFLUOROMETHANE	ND	5.0	
33) VINYL CHLORIDE	ND	10	
34) m-XYLENE	ND	5.0	
35) p,o-XYLENE	ND	5.0	

ND = NOT DETECTED
MDL= METHOD DETECTION LIMIT

QUALIFIERS (Q)

J =INDICATES AN ESTIMATED VALUE BELOW MDL
B =INDICATES COMPOUND FOUND IN THE ASSOCIATED BLANK AS WELL AS IN SAMPLE