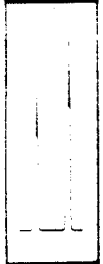


Tracer Research Corporation



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SHALLOW SOIL GAS INVESTIGATION
PERSON GENERATING STATION
ALBUQUERQUE, NEW MEXICO

MAY 1990



Sec July 11, 1990
cover letter

PREPARED FOR:


**Public Service Company of New Mexico
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Albuquerque, New Mexico 87158
(505) 848-2998**



**SHALLOW SOIL GAS INVESTIGATION
PERSON GENERATING STATION
ALBUQUERQUE, NEW MEXICO**

MAY 1990

SUBMITTED BY:


Tracer Research Corporation

**1-90-350-S
PSNMALB.REP**

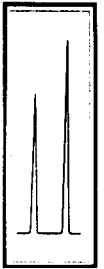


TABLE OF CONTENTS

INTRODUCTION 1

SHALLOW SOIL GAS INVESTIGATION - METHODOLOGY 1

EQUIPMENT 2

SAMPLING PROCEDURES 3

ANALYTICAL PROCEDURES 3

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES 4

RESULTS 6

SOIL GAS/GROUNDWATER CORRELATIONS 7

CONCLUSIONS 8

APPENDIX A

 CONDENSED DATA 9

APPENDIX B

 TABLES 10

APPENDIX C

 FIGURES 11



INTRODUCTION

A shallow soil gas investigation was performed by Tracer Research Corporation (TRC) at the Person Generating Station in Albuquerque, New Mexico. The investigation was conducted from May 14 to 16, 1990 under contract to the Public Service Company of New Mexico. The purpose of the investigation was to determine the extent of contamination in the shallow subsurface.

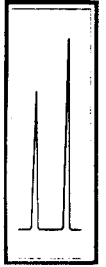
During this survey, a total of 53 soil gas samples were collected and analyzed in the field. The analytical equipment was calibrated for the following compounds:

- 1,1 dichloroethene (1,1 DCE)
- cis 1,2 dichloroethene (1,2-DCE)
- trichloroethane (TCA)
- tetrachloroethene (PCE)

The compounds in this suite were chosen as target compounds based on their suspected presence in the subsurface and their amenability to soil gas detection. Soil gas samples were screened on the electron capture detector (ECD).

SHALLOW SOIL GAS INVESTIGATION - METHODOLOGY

Shallow soil gas investigation refers to a method developed by TRC for investigating underground contamination from volatile organic chemicals (VOCs) such as industrial solvents, cleaning fluids and petroleum products by looking for their vapors in the shallow soil gas. The method involves pumping a small amount of soil gas out of the ground through a hollow probe driven into the ground and analyzing the gas for the presence of volatile contaminants. The presence of VOCs in shallow soil gas indicates the observed compounds may either be in the vadose zone near the probe or in groundwater below the probe. The soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil



gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The contamination acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. The concentration gradient in soil gas between the source and ground surface may be locally distorted by hydrologic and geologic anomalies (e.g. clays, perched water); however, soil gas mapping generally remains effective because distribution of the contamination is usually broader in areal extent than the local geologic barriers and is defined using a large data base. The presence of geologic obstructions on a small scale tends to create anomalies in the soil gas-groundwater correlation, but generally does not obscure the broader areal picture of the contaminant distribution.

Soil gas contaminant mapping helps to reduce the time and cost required to delineate underground contamination by volatile contaminants. The soil gas investigation does this by outlining the general areal extent of contamination. Conventional bore holes or observation wells are used to verify both the presence and extent of the subsurface contamination as indicated in the soil gas survey. In this manner, soil gas contaminant mapping can assist in determining the placement of monitoring wells. Thus, the likelihood of drilling unnecessary monitoring wells is reduced. The soil gas survey is not intended to be a substitute for conventional methodology, but rather to enable conventional methods to be used efficiently.

EQUIPMENT

Tracer Research Corporation utilized a one ton Ford analytical field van that was equipped with one gas chromatograph and two Spectra Physics SP4270 computing integrators. In addition, the van has two built-in gasoline powered generators which provide the electrical power (110 volts AC) to operate all of the gas chromatographic instruments and field equipment. A specialized hydraulic mechanism consisting of two cylinders and a set of jaws was used to drive and withdraw the sampling probes. A hydraulic hammer was used to assist in driving probes past cobbles and through unusually hard soil.



SAMPLING PROCEDURES

Sampling probes consist of 7 foot lengths of 3/4 inch diameter hollow steel pipe that are fitted with detachable drive tips. Soil gas probes were advanced to 6 feet below grade. Once inserted into the ground, the above-ground end of the sampling probes were fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum pump.

To adequately purge the volume of air within the probe, 2 to 5 liters of gas is evacuated with a vacuum pump. During the soil gas evacuation, samples are collected in a glass syringe by inserting a syringe needle through a silicone rubber segment in the evacuation line and down into the steel probe. Ten milliliters of gas are collected for immediate analysis in the TRC analytical field van. Soil gas is subsampled (duplicate injections) in volumes ranging from 1 uL to 2 mL, depending on the VOC concentration at any particular location.

Sample probe vacuum pressures measured with a vacuum gauge ranged from 3-5 inches Hg. Maximum vacuum pump pressure was measured at twenty-two inches Hg.

ANALYTICAL PROCEDURES

A Varian 3300 gas chromatograph, equipped with an electron capture detector (ECD), was used for the soil gas analyses. The ECD was used for the analysis of 1,1 DCE, cis-1,2-DCE, TCA and PCE. Separation of the ECD compounds was achieved on a 6' by 1/8" OD packed column with OV-101 as the stationary phase. The columns were contained in a temperature controlled oven at 50°C. Nitrogen was used as the carrier gas.

Halocarbons detected in the soil gas were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day and system blanks were run at the beginning of the day to check for contamination in the soil gas sampling equipment. Air samples were also routinely analyzed to check for background levels in the atmosphere.



Detection limits for the compounds of interest are a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit varies with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest must be kept within the linear range of the analytical equipment. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause increased detection limits for other compounds in the analyses.

The detection limits range down to approximately 0.00002 ug/L for those compounds screened on the ECD depending on the conditions of the measurement, in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <0.00002 ug/L). Detection limits obtained from GC analyses are calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Tracer Research Corporation's normal quality assurance procedures were followed in order to prevent any cross-contamination of soil gas samples.

- . Steel probes are used only once during the day and then washed with high pressure soap and hot water spray or steam-cleaned to eliminate the possibility for cross-contamination. Enough probes are carried on each van to avoid the need to reuse any during the day.
- . Probe adaptors (TRC's patented design) are used to connect the sample probe to the vacuum pump. The adaptor is designed to eliminate the possibility of exposing the sample stream to any part of the adaptor. Associated tubing connecting the adaptor to the vacuum pump is replaced periodically as needed during the job to insure cleanliness and good fit. At



the end of each day the adaptor is cleaned with soap and water and baked in the GC oven.

- . Silicone tubing (connecting the adaptor to the vacuum pump) is replaced as needed to insure proper sealing around the syringe needle. This tubing does not directly contact soil gas samples.
- . Glass syringes are usually used for only one sample per day and are washed and baked out at night. If they must be used twice, they are purged with carrier gas (nitrogen) and baked out between probe samplings.
- . Injector port septa through which soil gas samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column.
- . Analytical instruments were calibrated each day by analytical standards from Chem Service, Inc. Calibration checks are also run after approximately every five soil gas sampling locations.
- . 2 cc subsampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph.
- . Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to a concurrently sampled air analysis.
- . All sampling and 2 cc subsampling syringes are decontaminated each day and no such equipment is reused before being decontaminated. Microliter size subsampling syringes are reused only after a nitrogen carrier gas blank is run to insure it is not contaminated by the previous sample.
- . Soil gas pumping is monitored by a vacuum gauge to insure that an adequate gas flow from the vadose zone is maintained. A reliable gas sample can be obtained if the negative pressure reading on the vacuum pump is at least 2 inches Hg less than the maximum pump capacity.



RESULTS

Elevated concentrations of the selected VOCs were detected in soil gas samples collected at the Person Generating Station in Albuquerque, New Mexico. A total of 53 soil gas samples and 6 ambient air samples were collected and analyzed in the field. Analytical data is reported in micrograms per liter (ug/L) in Appendix A. Maps with sampling locations, compound concentrations and contour lines (Figures 1-5) are included in Appendix B.

Ambient air samples collected during the course of the investigation were screened for the selected VOCs. TCA was detected in one of the ambient air samples collected on 05-16-90 with a concentration of 0.001 ug/L. None of the selected VOCs were detected in any of the other ambient air samples.

A sampling grid with approximately 50 foot spacing had already been established from a previous survey and selected samples from this grid were collected (Figure 1). Sampling location SG-01 was the first location and the rest of the sampling locations were selected as data became available and the survey progressed.

Significant levels of all the target compounds were detected and contour maps were generated. The highest level of 1,1 DCE detected was at sampling location SG-90 with a concentration of 23 ug/L (Figure 2). An open-ended 10 ug/L contour line was generated around this location. Two contour lines ranging down to 0.1 ug/L were generated to shadow the 10 ug/L contour line all open to the west and covering a 600 foot area.

The highest concentration of cis 1,2 DCE was detected at sampling location SG-84 with a concentration of 9 ug/L (Figure 3). One 1 ug/L contour line was generated for cis 1,2 DCE with Sampling location SG-84 as the focal point. Again this plume was open to the west.

TCA was detected in the highest concentration at sampling locations SG-90 and SG-71 with concentrations of 44 ug/L and 14 ug/L respectively (Figure 4). These two points were contained within a 10 ug/L contour line. Contour lines ranging down to 0.01



ug/L were generated shadowing these two locations and all were open to the west. The TCA plumes covered a slightly larger area than the DCE's extending 750 feet.

The PCE plume covered the largest area of all the VOC's and again was centered on sampling location SG-90 with a concentration of 65 ug/L (Figure 5). Contours ranging down to 0.01 ug/L and open to the west were generated shadowing location SG-90 and extending 900 feet.

SOIL GAS/GROUNDWATER CORRELATIONS

Correlation coefficients were calculated for TCA, PCE and 1,1 DCE concentrations in soil gas (ug/L) and groundwater (ug/L) based on the results of TRC sampling near 5 existing monitoring wells (Figure 1).

At first glance, the regression lines indicated that the 0.01 ug/L contours in soil gas hypothetically correspond to the 1 ug/L (ppb) contour in groundwater (see further discussion below). The correlation coefficients for TCA ($r=0.98$), PCE ($r=0.97$) and 1,1 DCE ($r=0.77$) were quite high, which is characteristic of deep aquifers overlain by relatively dry and sandy soils. However, the regression equations were calculated assuming that detection limits (i.e. <1 ug/L) were the actual values of TCA, PCE and 1,1 DCE in the monitoring wells and soil gas samples, and using soil gas values for SG-90 located near the known vadose zone source. Due to these assumptions and the limited sample size available for performing the regression, a high degree of uncertainty is inherent in the correlation calculations. It should also be noted that the detection limits for the water samples were an order of magnitude higher than in previous analyses. This had the effect of elevating the correlation by one order of magnitude. A more realistic correlation would be that the 0.01 ug/L contour in soil gas corresponds to the 0.1 ug/L contour in groundwater.

The slope of the regression lines for TCA, PCE and 1,1 DCE were similar, suggesting that the areal extent of the soil gas plumes are comparable. In other words, the 0.01 ug/L contours for TCA, TCE and 1,1 DCE in the soil gas represent approximately the same boundary values in groundwater.



CONCLUSIONS

Elevated levels of the selected VOCs were detected in the soil gas at the Person Generating Station the most significant levels being those of PCE around sampling location SG-90. PCE was detected in the highest levels of any of the selected VOCs and produced the most significant and broad sweeping contours. The 1,1 DCE and Cis 1,2 DCE contours were contained almost entirely within the fenced area and the TCA and PCE contours were just outside the fenced area. Sampling location SG-90 had the highest concentrations of the majority of the target compounds. All the contours generated followed the same basic pattern and were open to the west. To completely close these contours more sampling locations would be necessary.



APPENDIX A: CONDENSED DATA

PUBLIC SERVICE OF NEW MEXICO/ALBUQUERQUE, NEW MEXICO JOB#1-90-350-S

05-14-90

CONDENSED DATA

SAMPLE	CIS			
	1,1 DCE ug/l	1,2 DCE ug/l	TCA ug/l	PCE ug/l
AIR	<0.005	<0.09	<0.00008	<0.00004
SG-01-6'	<0.005	<0.09	0.00008	0.008
SG-03-6'	<0.02	4	0.01	0.06
SG-04-6'	<0.02	7	0.07	0.1
SG-08-6'	<0.005	<0.09	<0.00008	0.004
SG-09-6'	<0.005	<0.09	<0.00008	<0.00004
SG-11-6'	<0.02	<0.4	<0.0004	0.009
SG-10-6'	<0.005	<0.09	<0.00008	0.002
SG-12-6'	<0.005	<0.09	0.004	0.06
SG-13-6'	<0.02	<0.4	0.01	0.2
SG-14-6'	<0.05	<0.9	0.03	0.4
SG-15-6'	0.2	<0.4	0.06	0.8
SG-16-6'	0.4	<0.4	0.1	2
SG-56-6'	<0.02	<0.4	0.02	0.2
SG-57-6'	<0.005	<0.09	0.004	0.04
SG-23-6'	<0.005	<0.09	0.002	0.02
AIR	<0.005	<0.09	<0.00008	<0.00004

Analyzed by: M. Flack

Checked by: B. Pheil

Proofed by: _____



PUBLIC SERVICE OF NEW MEXICO/ALBUQUERQUE, NEW MEXICO JOB#1-90-350-S

05-15-90

CONDENSED DATA

SAMPLE	CIS			
	1,1 DCE ug/l	1,2 DCE ug/l	TCA ug/l	PCE ug/l
AIR	<0.002	<0.04	<0.00005	<0.00002
SG-27-6'	<0.005	<0.07	<0.0001	<0.00004
SG-25-6'	<0.002	<0.04	0.0009	0.003
SG-24-6'	<0.002	<0.04	0.001	0.004
SG-43-6'	<0.002	<0.04	0.001	<0.00002
SG-44-6'	<0.002	<0.04	0.001	<0.00002
SG-22-6'	<0.005	<0.07	0.001	0.001
SG-18-6'	<0.005	<0.07	0.02	0.2
SG-19-6'	<0.01	<0.1	0.004	0.02
SG-49-6'	<0.01	<0.1	0.02	0.2
SG-54-6'	<0.01	<0.1	0.002	0.005
SG-53-6'	<0.01	<0.1	0.006	0.03
SG-50-6'	<0.005	<0.07	0.003	0.01
SG-20-6'	<0.005	<0.07	0.001	0.00005
SG-51-6'	<0.005	<0.07	0.0008	<0.00004
SG-52-6'	<0.005	<0.07	0.01	<0.00004
SG-38-6'	<0.01	<0.1	0.01	0.004
SG-37-6'	<0.01	<0.1	0.02	0.04
SG-36-6'	<0.01	<0.1	0.04	0.2
SG-35-6'	<0.05	<0.7	0.09	0.7
SG-33-6'	<0.05	<0.7	0.08	0.8
SG-17-6'	<0.05	<0.7	0.08	0.8
SG-83-6'	0.2	4	0.4	0.2
SG-84-6'	8	9	4	4
SG-86-6'	4	3	2	2
SG-78-6'	2	0.7	0.2	2
AIR	<0.01	<0.1	<0.0002	<0.00009

Analyzed by: M. Flack

Checked by: B. Pheil

Proofed by: _____



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05-16-90

CONDENSED DATA

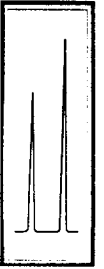
SAMPLE	1,1 DCE ug/l	CIS 1,2 DCE ug/l	TCA ug/l	PCE ug/l
AIR	<0.008	<0.1	<0.0002	<0.0001
SG-89-6'	2	<1	0.2	2
SG-88-6'	<0.008	<0.1	0.005	0.0001
SG-68-6'	<0.04	<0.5	<0.001	0.05
SG-69-6'	<0.04	<0.5	0.06	0.05
SG-70-6'	2	<0.5	0.8	0.5
SG-66-6'	2	2	1	0.6
SG-85-6'	7	2	6	5
SG-87-6'	0.6	<0.5	0.2	0.2
SG-71-6'	8	<1	14	6
SG-67-6'	<0.008	<0.1	0.0008	0.002
SG-90-6'	23	<5	44	65
AIR	<0.004	<0.05	0.001	<0.00005

Analyzed by: M. Flack

Checked by: B. Pheil

Proofed by: _____





APPENDIX B: TABLES



TABLE 1

PERSON STATION SOIL GAS AND GROUNDWATER QUALITY PLAN

Well No.	SG No.	Soil Gas	Water April 90	Water Oct 89
		[TCA]	[TCA]	[TCA]
1	90	44	177	744
5	8	<0.00008	<1	<1
6	17	0.08	<1	1
7	38	0.01	<1	-
8A	13	0.01	27	11
		[PCE]	[PCE]	[PCE]
1	90	65	490	1303
5	8	0.004	<1	<1
6	17	0.8	3	10
7	38	0.004	<1	-
8A	13	0.2	80	25
		[1,1 DCE]	[1,1 DCE]	[1,1 DCE]
1	90	23	156	387
5	8	<0.005	<1	<1
6	17	<0.05	<1	4
7	38	<0.01	<1	-
8A	13	<0.02	78	31



LINEAR REGRESSION TABLES

TABLE 2

TCA Regression Output:

Constant	-1.68827
Std Err of Y Est	3.346212
R Squared	0.978287
No. of Observations	5
Degrees of Freedom	3

X Coefficient(s)	0.253823
Std Err of Coef.	0.021832

PCE Regression Output:

Constant	-2.27583
Std Err of Y Est	5.380553
R Squared	0.974107
No. of Observations	5
Degrees of Freedom	3

X Coefficient(s)	0.134586
Std Err of Coef.	0.012669

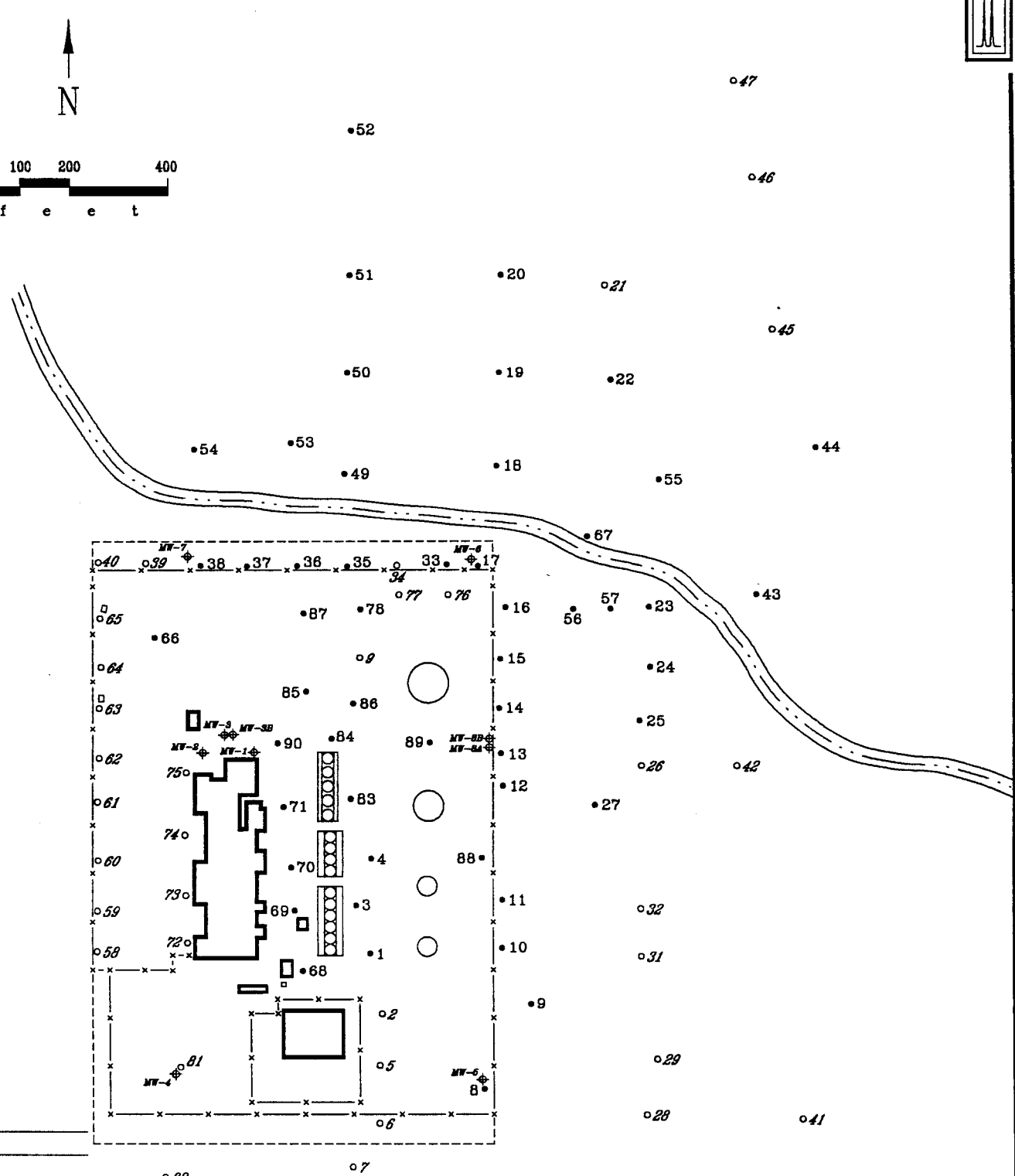
DCE Regression Output:

Constant	-1.54698
Std Err of Y Est	5.71297
R Squared	0.768207
No. of Observations	5
Degrees of Freedom	3

X Coefficient(s)	0.130042
Std Err of Coef.	0.041241



APPENDIX C: FIGURES



EXPLANATION

- 84 Soil Gas Sampling Location
- 82 Previous Survey Sampling Location
- ⊕ MW-1 Monitoring Well Location

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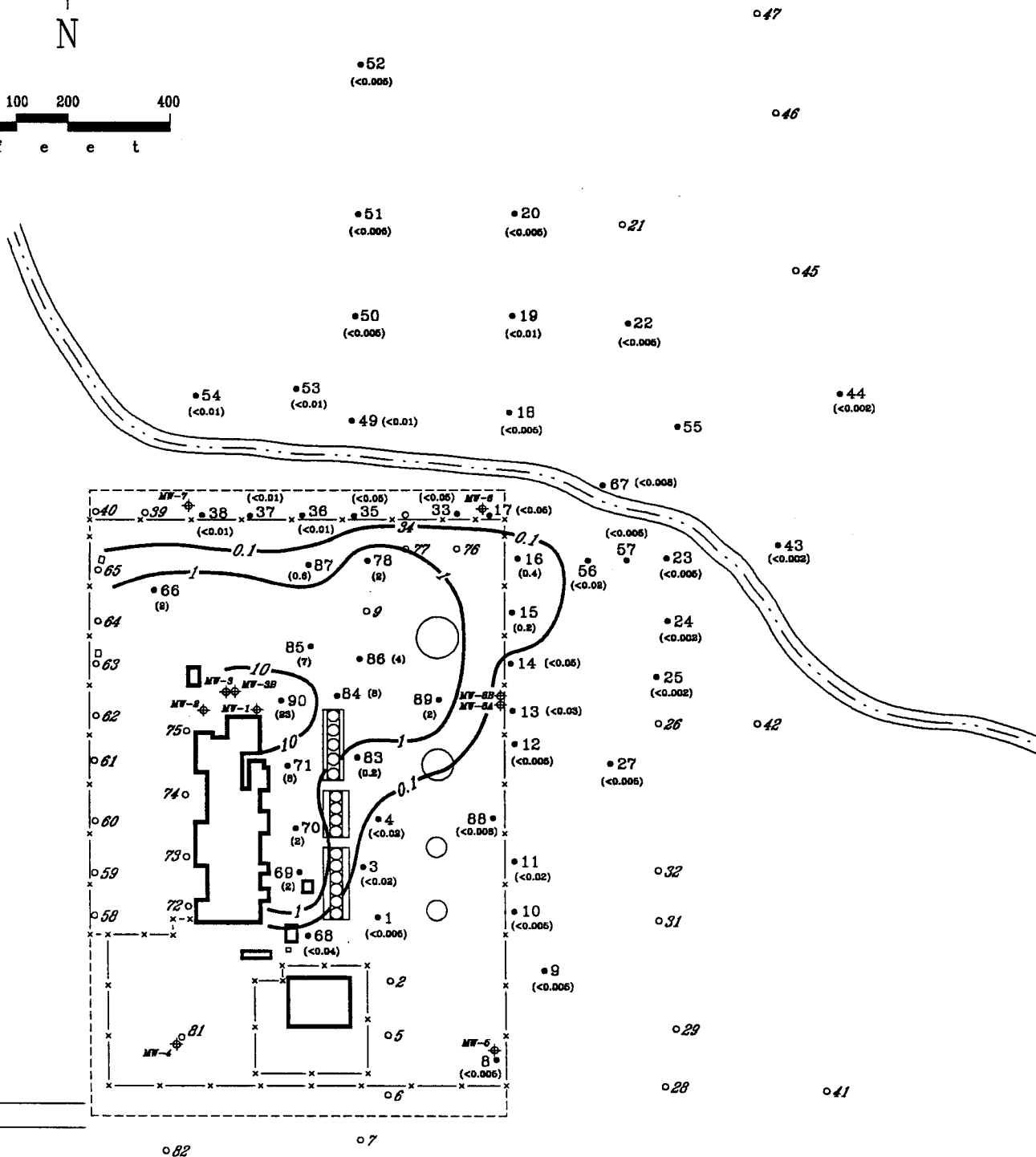
SAMPLING LOCATIONS

JUNE 1990

Figure 1



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f e e t



EXPLANATION

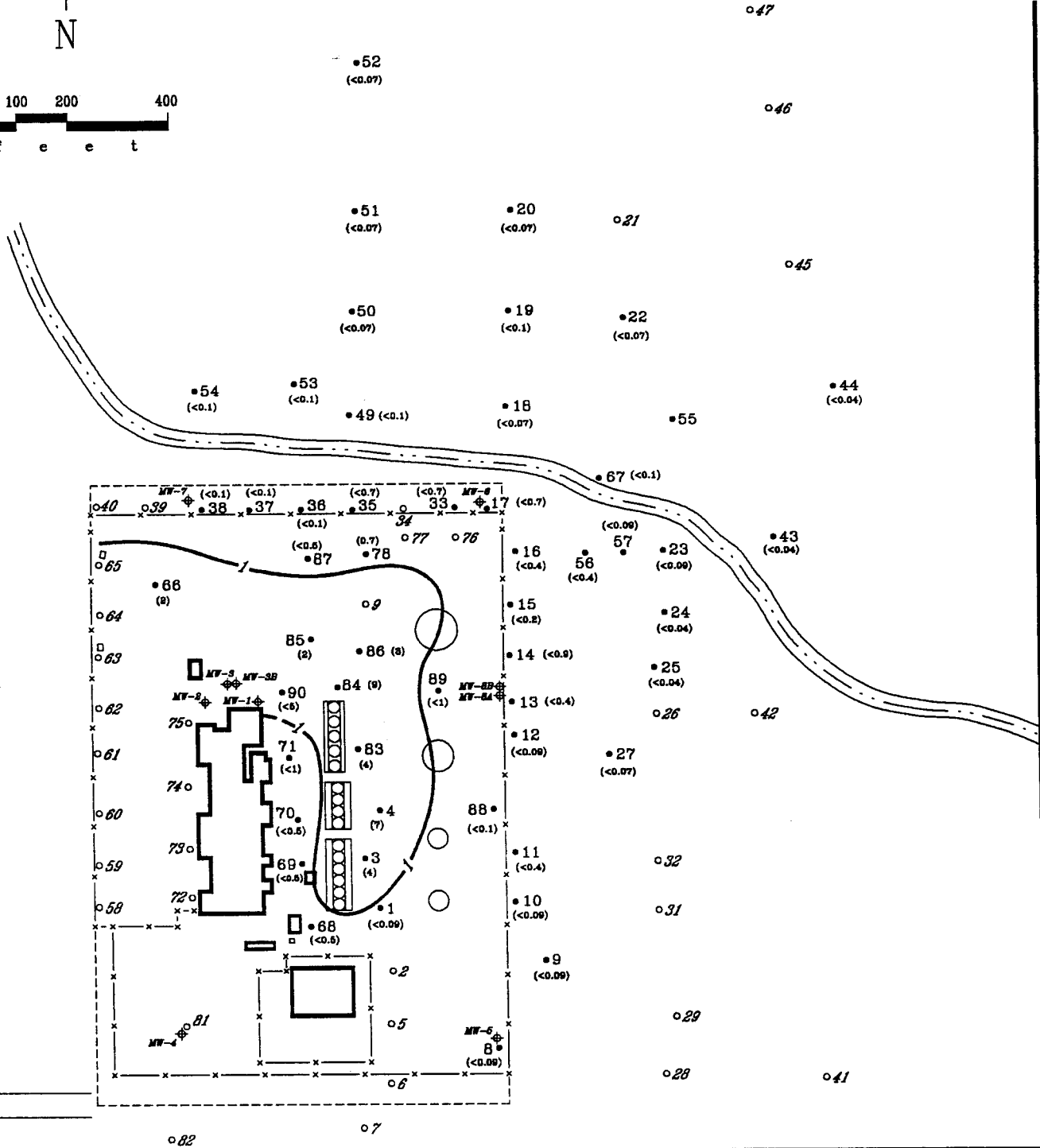
- 84 Soil Gas Sampling Location
- 82 Previous Survey Sampling Location
- ⊕ MW-1 Monitoring Well Location
- (8) Soil Gas Sample Value (ug/l)
- - - Isoconcentration Line (ug/l)

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1, 1 - DICHLOROETHENE

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Figure 2



EXPLANATION

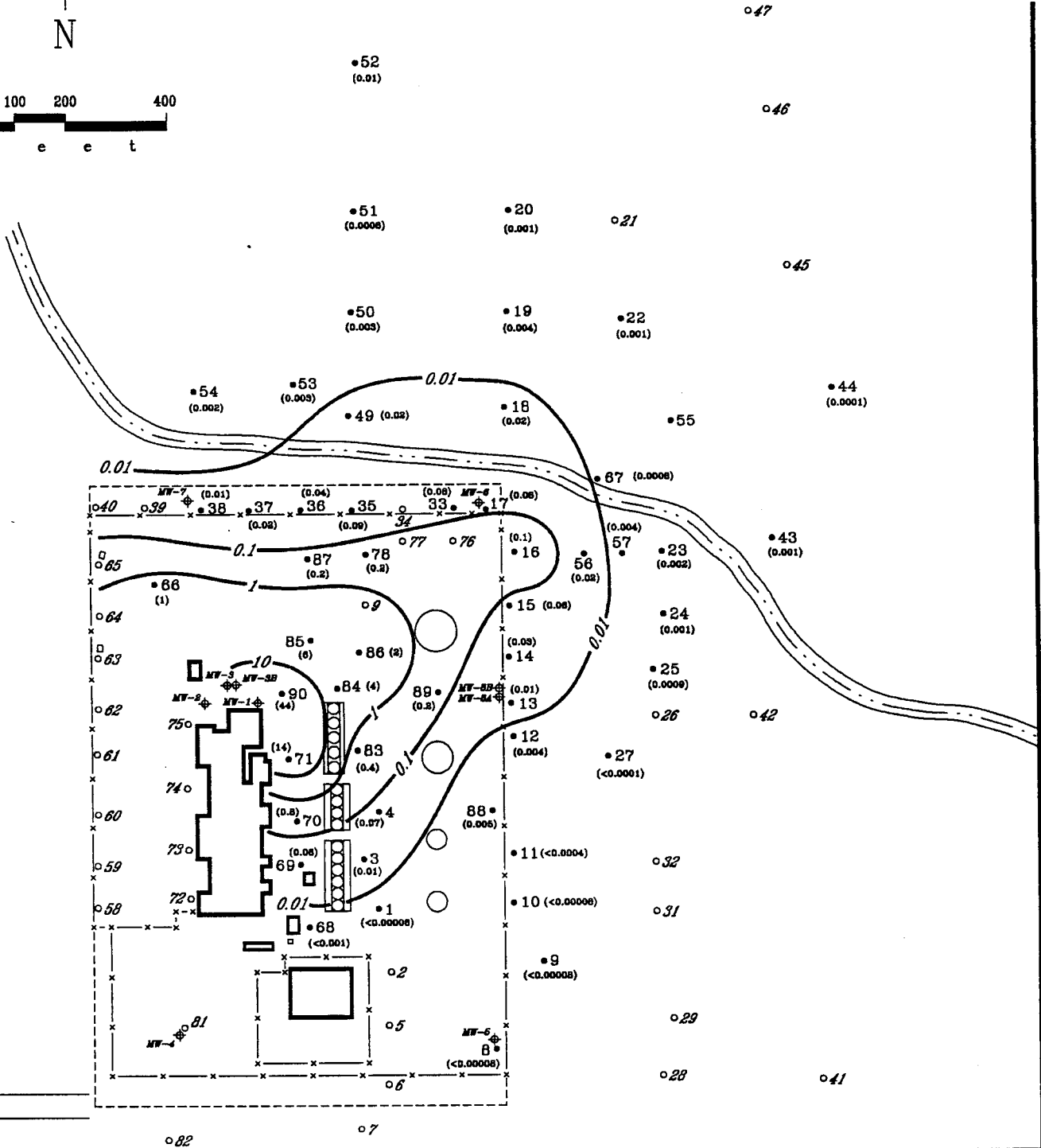
- 84 Soil Gas Sampling Location
- 82 Previous Survey Sampling Location
- ⊕ MW-1 Monitoring Well Location
- (e) Soil Gas Sample Value (µg/l)
- - - Isoconcentration Line (µg/l)

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cis - 1, 2 - DICHLOROETHENE

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Figure 3



EXPLANATION

- 84 Soil Gas Sampling Location
- 82 Previous Survey Sampling Location
- ⊕ MW-1 Monitoring Well Location
- (4) Soil Gas Sample Value (µg/l)
- - - Isoconcentration Line (µg/l)

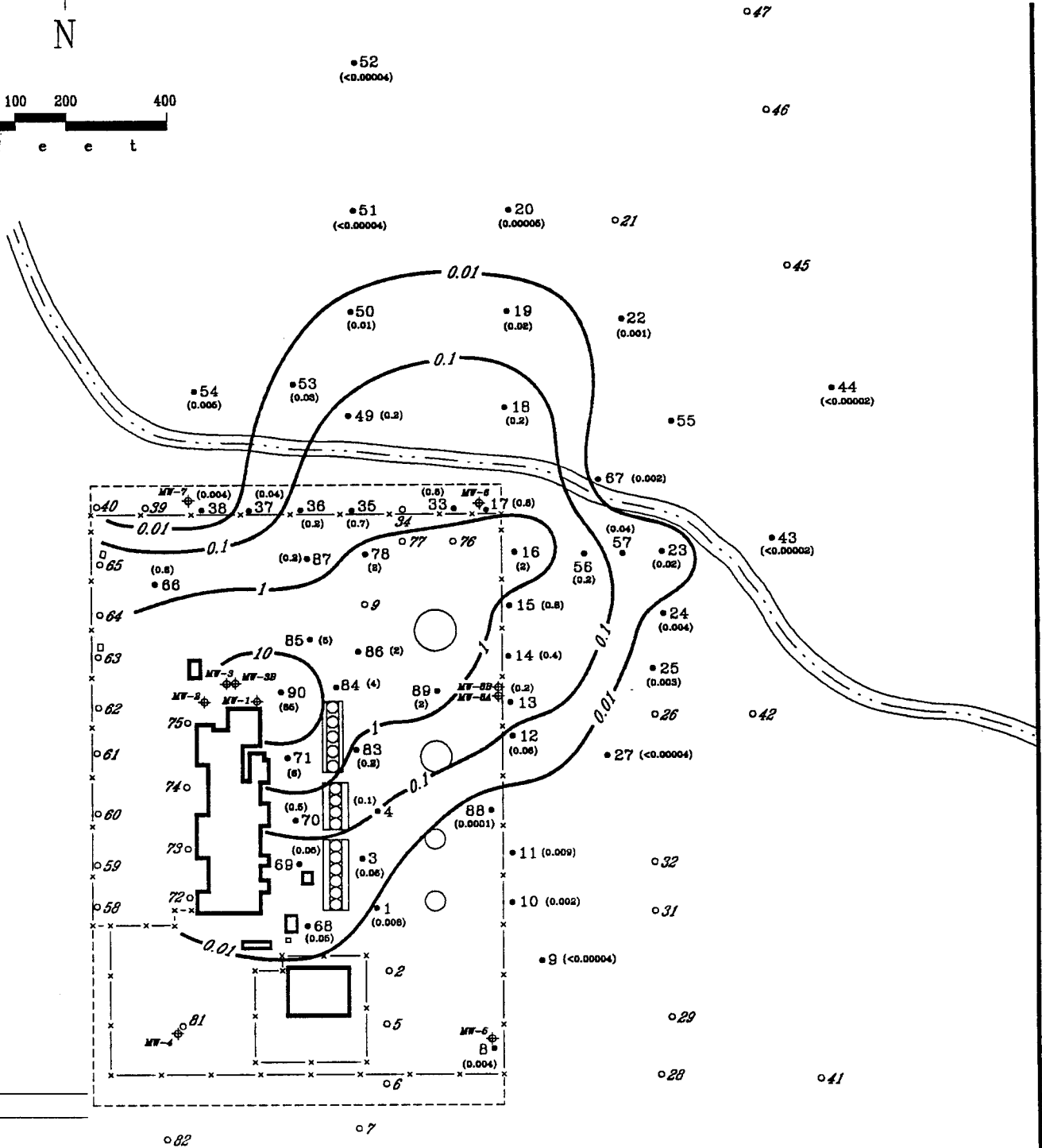
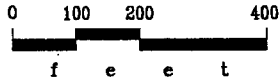
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ALBUQUERQUE, NEW MEXICO

TRICHLOROETHANE (TCA)

JUNE 1980

Figure 4



EXPLANATION

- 84 Soil Gas Sampling Location
- 82 Previous Survey Sampling Location
- ◆ MW-1 Monitoring Well Location
- (4) Soil Gas Sample Value (µg/l)
- Isoconcentration Line (µg/l)

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TETRACHLOROETHENE (PCE)

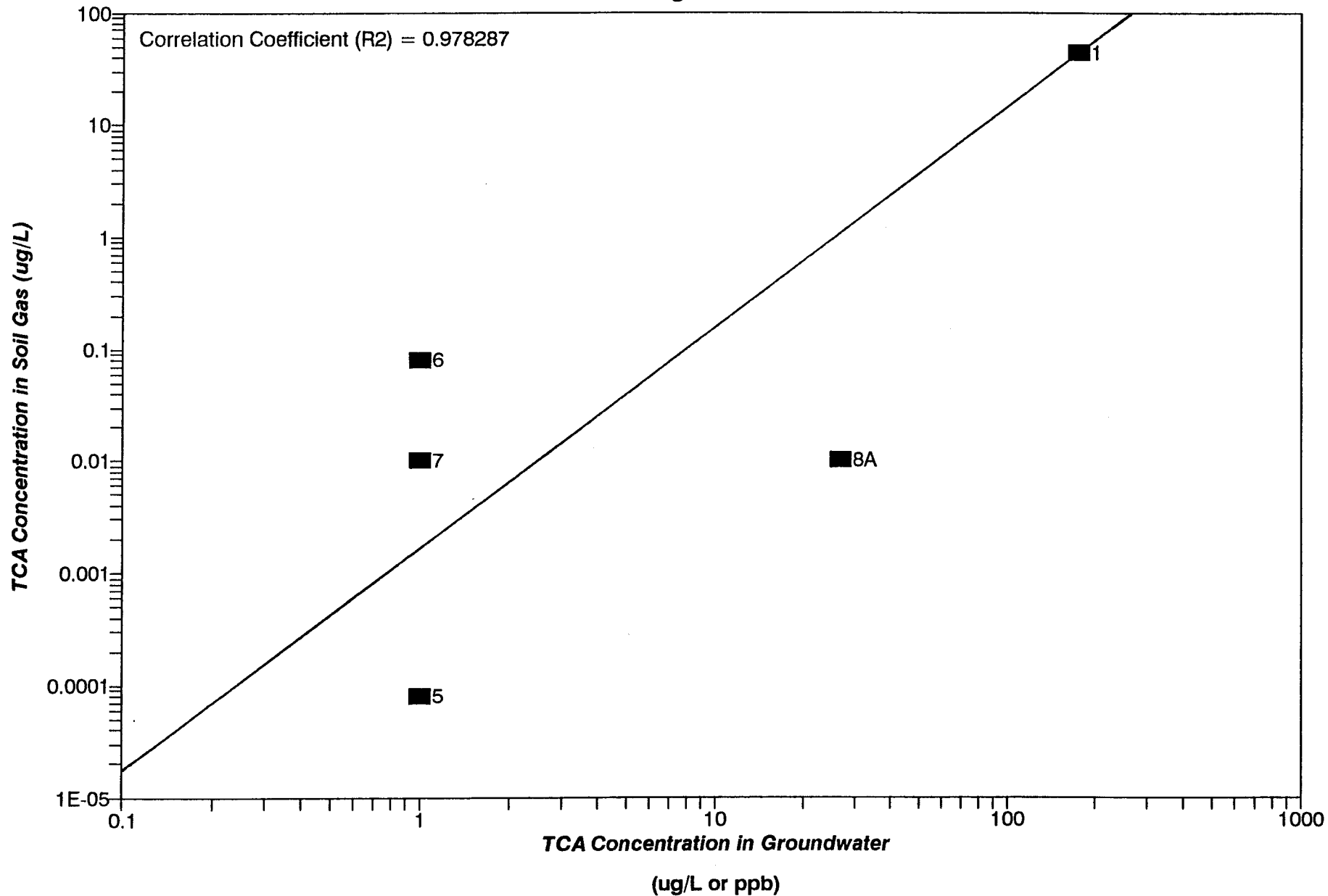
JUNE 1990

Figure 5

Groundwater vs. Soil Gas Concentrations

TCA

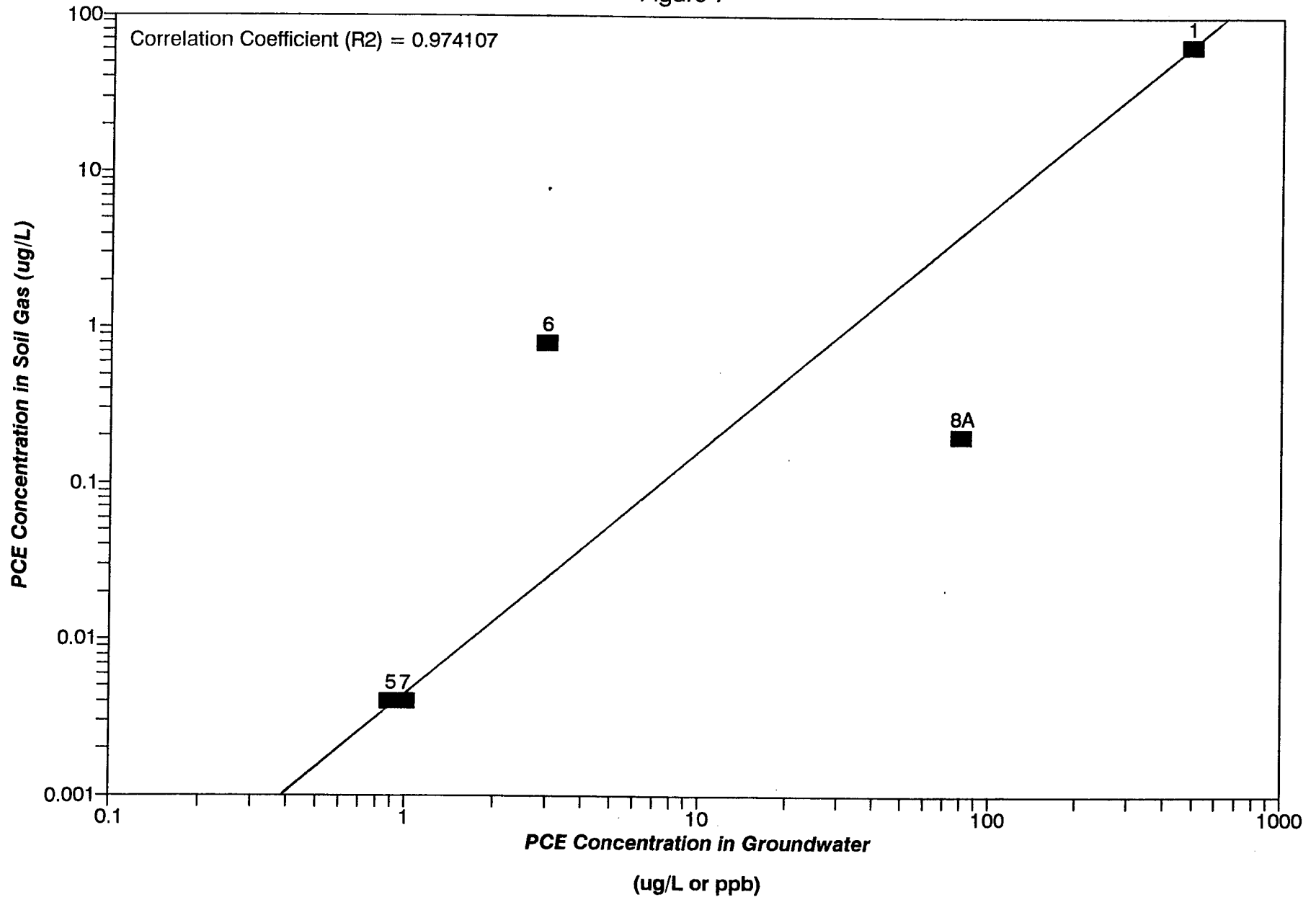
Figure 6



Groundwater vs. Soil Gas Concentrations

PCE

Figure 7



Groundwater vs. Soil Gas Concentrations

1,1 DCE

Figure 8

