95 JUN

VAPOR EXTRACTION TEST REPORT
April 6, 1994

FORMER MOBIL STATION 04-H6J
1024 Main Street
Pleasanton, California

Alton Project No. 30-0065

Prepared For:

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1.0 INTRODUCTION

This report presents the results of vapor extraction testing activities performed at Former Mobil Station 04-H6J located at 1024 Main Street in Pleasanton, California (Figure 1).

The vapor extraction testing activities were conducted to:

- Assess the feasibility of using vapor extraction to mitigate hydrocarbon-affected soil beneath the site;
- Estimate air extraction rates;
- Calculate the approximate vacuum radius of influence; and
- Estimate influent hydrocarbon vapor concentrations from wells used for vapor extraction.

Test results may be used to:

- Design an extraction well field array;
- Estimate the cumulative flow rate capacity of the treatment equipment; and
- Select the type of treatment technology.

Appendix A includes definitions of terms and abbreviations used in this report.

2.0 BACKGROUND

2.1 HYDROGEOLOGIC SETTING

The site is located within the Amador Subbasin of the Livermore Valley Ground Water Basin. Ground water in the shallower deposits is generally unconfined. The estimated depth to regional ground water is approximately 90 feet below grade (fbg) with a westerly to northerly gradient direction (Ritchie, Edwin A., 1988).

2.2 SUBSURFACE STRATIGRAPHY

Soil types encountered in the vadose zone consist of interbedded clayey silt, silty clay, sandy silt, silty sand, sand, and sandy gravel.

2.3 HYDROCARBON-AFFECTED SOIL

Hydrocarbon concentrations in soil are present in the vicinity of the former underground storage tanks, product lines, and dispenser islands. Hydrocarbon concentrations in soil extend vertically to ground water in the vicinity of the former underground storage tanks to a depth of approximately 40 feet below grade.

2.4 CONSTRUCTION OF TEST WELLS

The monitoring wells used in the vapor extraction tests are constructed of 2-, 4-, and 6-inch-diameter PVC casing with 0.010, 0.020, and 0.030-inch-slot screened intervals. Backfill material at the screened intervals consists of No. 2/16, No. 3 Monterey, and medium and coarse aquarium sand. Refer to Tables 1 and 2 for the screened intervals of the wells used in the vapor extraction testing.

3.0 VAPOR EXTRACTION TEST ACTIVITIES

Vapor extraction tests were performed at this site as outlined in Appendix B. Each test array consisted of extracting vapors from one well (the test well) and observing vacuum responses in other wells (the observation wells).

The test conditions were as follows:

- Test date: November 18, 1993
- Test wells: Vapor Monitoring Well VMW-1 (13 to 35 feet below grade), and Monitoring Wells MW-1 (35 to 37 feet below grade), MW-2 (30 to 38 feet below grade), and MW-7 (10 to 30 feet below grade) (see Figure 2 for well locations)
- Observation wells: Vapor Monitoring Wells VMW-1, VMW-2, VMW-3, and VMW-4, Monitoring Wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-7, MW-9 and MW-10, and Recovery Well RW-1 (see Figure 2 for well locations)
- Test types: constant-flow-rate and step-flow-rate
- Test durations: 30 to 60 minutes
- Distance between test wells and observation wells: 19 to 83 feet

For the purpose of determining the range of hydrocarbons present in the subsurface, air samples were collected from Vapor Monitoring Well VMW-1 and Monitoring Well MW-1. The samples were analyzed for:

- Total petroleum hydrocarbons (TPH) using EPA Method 8015 modified; and
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) using EPA Method 8020

Refer to Appendix C for a description of the analytical methods used, and copies of the official Laboratory Reports, QA/QC Reports, and Chain of Custody Records.

4.0 CHARACTERIZATION ANALYSIS

Stabilized vacuum responses in the observation wells were assumed to be at steady-state conditions, and were used to calculate the soil transmissibility to air (kh/μ), the soil permeability (k), and an effective radius of influence (ERI). In order to estimate these parameters, a steady-state solution of Darcy's law, as applied to compressible gas flow, was used to simulate the subsurface flow conditions. Refer to Appendix D for a mathematical description of the Darcy analytical solution, and for calculations performed to estimate the soil transmissibility to air, soil permeability, and ERI.

Transient vacuum data were analyzed using the Hantush method. This method assumes air leakage from the ground surface and no air storage. This analysis method permits the calculation of the soil transmissivity to air (T), storativity (S), and the dimensionless leakage factor (r/B). The soil permeability to air (k) is calculated from the soil transmissivity. Refer to Appendix E for a mathematical description of the Hantush analytical solution and type-curve matching techniques.

5.0 FINDINGS AND DISCUSSION

5.1 FIELD OBSERVATIONS

Field observations recorded during the tests were as follows:

- During the step-rate test from Vapor Monitoring Well VMW-1, vacuum levels of 38 to 111 in. H_2O were detected in the extraction well while extracting vapors at flow rates ranging from 21 to 54 standard cubic feet per minute (scfm).

- During the step-rate test from Monitoring Well MW-1, vacuum levels of 50 to 222 in. H_2O were detected in the extraction well while extracting vapors at flow rates ranging from 10 to 20 standard cubic feet per minute (scfm).

- During the constant-flow-rate test from Vapor Monitoring Well VMW-1, a near-steady-state vacuum level of 110 in. H_2O was detected in the extraction well while extracting vapors at a flow rate of approximately 54 scfm. Vacuum levels ranging from 0.06 to 0.67 in. H_2O were detected in Vapor Monitoring Wells VMW-2, VMW-3, and VMW-4, and Monitoring Wells MW-1, MW-2, and MW-4. These monitoring wells are located at distances ranging from 19 to 42 feet from the extraction well. A vacuum level of 3 in. H_2O was detected in Recovery Well RW-1, which is located 4 feet to the northwest of Vapor Monitoring Well VMW-1.

- During the constant-flow-rate test from Monitoring Well MW-1, a near-steady-state vacuum level of 222 in. H_2O was detected in the extraction well while extracting vapors at a flow rate of approximately 22 scfm. Vacuum levels ranging from 0.02 to 4.7 in. H_2O were detected in Vapor Monitoring Wells VMW-2, VMW-3, VMW-4 and Monitoring Wells MW-4, MW-5 MW-9, and MW-10. These observation wells are located at distances ranging from 13 to 78 feet from the extraction well.

- During an abbreviated constant-flow-rate test from Monitoring Well MW-2, a vacuum level of approximately 230 in. H_2O was detected in the extraction well while extracting vapors at a flow rate of approximately 9 scfm. No vacuum responses were detected in any of the observation wells which were located at distances ranging from 10 to 78 feet from the extraction well.

- During the constant-flow-rate test from Monitoring Well MW-7, a vacuum level of approximately 63 in. H_2O was detected in the extraction well while extracting vapors at a flow rate of approximately 55 scfm. All observation wells were located to the east of the extraction well during this test due to the site well layout and the proximity of MW-7 to Santa Rita Road. No vacuum responses were detected in any of the observation wells which were located at distances ranging from 26 to 100 feet to the east of the extraction well.

Refer to Tables 1 and 2 for a summary of the field observation data from the step-flow-rate and constant-flow-rate tests.

5.2 SOIL PERMEABILITY TO AIR

Soil transmissibility to air values (kh/μ) were calculated by applying pairs of vacuum and distance data obtained in the field to the Darcy solution. Transmissibilities to air were calculated from the pairs of observation well data that meet the criteria outlined in Appendix D. No values could be obtained for the zones affected by Monitoring Wells MW-2 and MW-7 due to a lack of pertinent data. The soil parameters calculated from the steady state test results are as follows:

Vapor Monitoring Well VMW-1 (15 to 35 feet below grade):

- Soil transmissibility to air value (kh/μ): 124,442 d-ft/cp
- Vertical extraction interval (h): 35 feet
- Soil permeability to air (k): 64 darcy

Monitoring Well MW-1 (35 to 37 feet below grade):

- Soil transmissibility to air value (kh/μ): 8,087 d-ft/cp
- Vertical extraction interval (h): 37 feet
- Soil permeability to air (k): 3.64 darcy

These soil permeability values fall within the range of permeabilities considered appropriate for vapor extraction (Johnson et al., 1988). A summary of the soil parameters derived from the steady-state tests is presented in Table 3.

Using the Hantush type-curve matching, the soil parameters calculated from the transient test results are as follows:

Vapor Monitoring Well VMW-1 (15 to 35 feet below grade):

- Soil transmissivity value: 0.093 to 0.32 ft^2/min
- Soil permeability to air: 20.63 to 70.99 darcy

Monitoring Well MW-1 (35 to 37 feet below grade):

- Soil transmissivity values: between 0.01 to 0.07 ft^2/min
- Soil permeability to air: between 1.94 to 13.59 darcy

The permeability values calculated using the Hantush method are in general agreement with the calculated steady state values derived from the Darcy equation, however, some of the assumptions included in the Hantush model are not met. A summary of the soil parameters derived from the transient tests is presented in Table 4. The Hantush type-curve matches are included in Appendix E.

5.3 EFFECTIVE RADIUS OF INFLUENCE

The estimated effective radius of influence (ERI) (distance at which a pressure drawdown of 0.10 in. H_2O is expected to prevail, resulting in air flow through the subsurface) is computed using the estimated soil transmissibility values. The average ERI values for each zone are as follows:

Vapor Monitoring Well VMW-1:

- Flow rate: 54 scfm
- ERI: 41 feet

Monitoring Well MW-1:

- Flow rate: 22 scfm
- ERI: 44 feet

Monitoring Well MW-2:

- Flow rate: 9 scfm
- ERI: less than 10 feet

Monitoring Well MW-7:

- Flow rate: 55 scfm
- ERI: less than 26 feet

5.4 LABORATORY ANALYSIS OF VAPOR SAMPLES

Laboratory analysis of air samples collected from VMW-1 and MW-1 indicate hydrocarbon concentrations as follows:

Vapor Monitoring Well VMW-1:

• Purgeable hydrocarbons:	90,000 ug/l or 19,305 (parts per million by volume) ppmv
• Benzene:	2,500 ug/l or 784 ppmv
• Toluene:	3,400 ug/l or 904 ppmv
• Ethylbenzene:	300 ug/l or 69 ppmv
• Xylene:	1,200 ug/l or 277 ppmv

Monitoring Well MW-1:

• Purgeable hydrocarbons:	200,000 ug/l or 42,900 ppmv
• Benzene:	4,200 ug/l or 1,317 ppmv
• Toluene:	3,800 ug/l or 1,010 ppmv
• Ethylbenzene:	610 ug/l or 141 ppmv
• Xylene:	1,700 ug/l or 392 ppmv

6.0 CONCLUSIONS

- The levels of pressure communication detected within the unsaturated zone indicate that vapor extraction is a feasible remediation alternative for the mitigation of hydrocarbon-affected soil in the vadose zone at the site.

- The results of the test reflect the extremely variable soil types at the site and anisotropic conditions. The site stratigraphy of interbedded lenses of medium to coarse material (sand and silty sand of higher permeability) with fine grained material (silt and clay of low permeability), affects the direction and magnitude of vacuum propagation. This can be seen in the lack of pressure communication during the test conducted from MW-7 (screened 10-30 fbg). At flow rates of approximately 55 scfm no responses were detected within 26 feet of this extraction well. This effect is likely a result of flow from this well being drawn through sand lenses that extend to the west of the extraction well under Santa Rita Road. The lack of response to the east is likely due to the presence of less permeable soils between MW-7 and the observation wells. In comparison, responses from extraction well VMW-1 (screened 13-35 fbg) were recorded at a distance of 41 feet from the extraction well to the west in VMW-4 (screened 10 to 30 fbg). Minor responses were recorded as far as 78 feet to the north of extraction well MW-1, in Monitoring Well MW-10. However, to the east of extraction well MW-1 no responses were recorded only 19 feet away in RW-1, indicating anisotropic conditions. Differences in soil permeability such as those demonstrated during vapor extraction testing, will cause hydrocarbons to be preferentially removed from the more permeable soil horizons, and asymmetric radii of influence during vapor extraction. Careful placement of vapor extraction wells, and screen intervals during well installation, can accommodate some of these variances in soil permeability for vapor extraction.

- Laboratory analysis of air samples from Vapor Monitoring Well VMW-1 and Monitoring Well MW-1 indicate that significant quantities of hydrocarbons can be recovered by vapor extraction.

- The calculated soil permeability to air values from Vapor Monitoring Well VMW-1 are indicative of a clean sand unit. The calculated soil permeability to air values from Monitoring Well MW-1 are indicative of a silt to a silty sand (Freeze & Cherry, 1979).

- Vacuum levels achieved in MW-1 (222 in. H_2O) were twice as high as those achieved in Vapor Monitoring Well VMW-1 (110 in. H_2O) at flow rates of approximately 22 to 54 scfm, respectively.

- The estimated ERI is approximately 41 feet in the vicinity of Vapor Monitoring Well VMW-1 for flow rates of approximately 54 scfm, and 44 feet in the vicinity of MW-1 for flow rates of approximately 22 scfm. The effective radius of influence is greatly influenced by the site stratigraphy. Because of the heterogeneous soil types, and consequently the extremely variable permeabilities at the site, the actual effective radius of influence is likely more on the order of approximately 20-30 feet throughout the extraction interval. In silty or clayey areas of the site with low permeability, such as around MW-2, the ERI will likely be less than 10 feet.

LIMITATIONS

The vapor extraction test activities and analyses presented in this report have been conducted in accordance with current practice and the standard of care exercised by geologists, hydrogeologists, and engineers performing similar tasks in this area. The findings and conclusions are based solely upon an analysis of the observed conditions. If actual conditions differ from those described in this report, our office should be notified.

7.0 REFERENCES

Alton Geoscience, Supplemental Site Investigation: Assessment and Remedial Investigation of Hydrocarbon Affected Soil and Ground Water, dated July 31,1992.

Alton Geoscience, Supplementary Site Assessment Report, dated January 28, 1994.

Dake, L.P., Fundamentals of Reservoir Engineering, Elsevier Scientific Publishing Company, Amsterdam, 1978.

Freeze, R.A., and Cherry, J.A., Groundwater, Prentice-Hall, Inc.,Englewood Cliffs, New Jersey, 1979.

Geraghty & Miller, Inc., AQTESOLV Aquifer Test Solver, Version 1.11, Geraghty & Miller Modeling Group, Reston, Virginia, 1991.

Hantush, M.S., "Analysis of Data from Pumping Tests in Leaky Aquifers," American Geophysical Union Trans., Vol. 37, pp. 702-714, 1956.

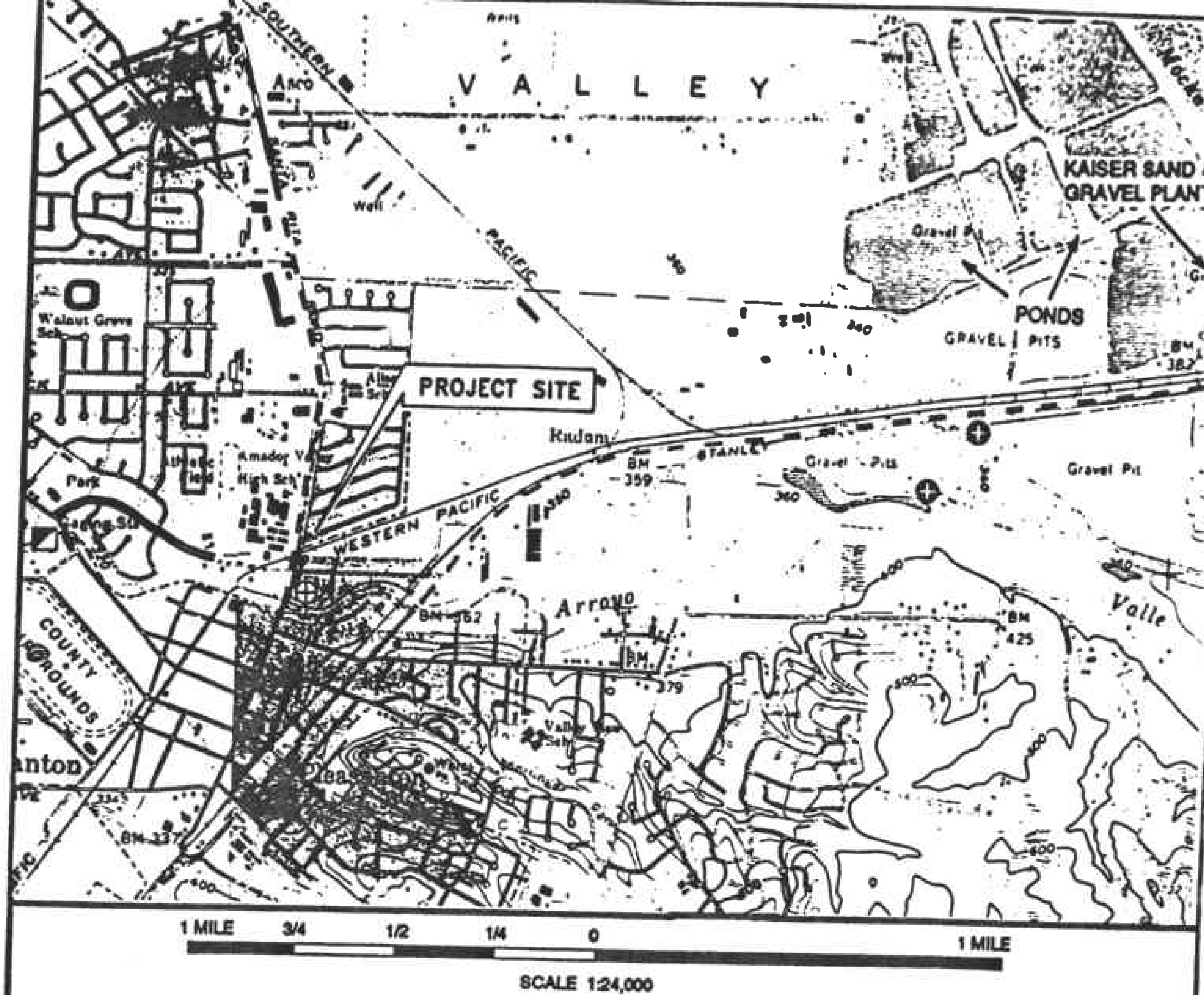
H20 Science, Inc., Borehole Geophysical Survey Report, dated September 10, 1993.

Johnson, P.C., Kemblowski, M.W., and Colthart, J.D. "Practical Screening Models for Soil Venting Applications," Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration," NWWA/API, Houston, Texas, November 1988.

Johnson, P.C., Stanley, C.C., Byers, D.L., Benson, D.A., and Acton, M.A. "Soil Venting at a California Site: Field Data Reconciled with Theory," Houston, Texas, March 1990.

Lee, J. W., Well Testing, Society of Petroleum Engineers of AIME Textbook Series, Volume 1, Dallas, Texas, 1988.

Theis, C. V., "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground Water Storage," American Geophysical Union Transactions, Vol. 16, pp. 519-524, 1935.



N

Source: U.S.G.S. Map
Livermore Quadrangle
California
7.5 Minute Series

LEGEND

- U.S.G.S. Gauging Station
- City of Pleasanton Monitoring Well
- Kaiser Discharge to Arroyo Valle

VICINITY MAP

Former Mobil Station 04-H6J
1024 Main Street
Pleasanton, California

FIGURE 1

ALTON GEOSCIENCE
Livermore, California

Project No. 30-0065

Table 1

Pressure Drawdown Data From Step-Flow-Rate Tests
November 18, 1993
Mobil Station 04-H6J

Extraction Well	Observation Well	Screen Interval (feet)	r (feet)	Pressure Drawdown (in. of H2O)		
				Q = 21	40	54
VMW-1		13-35	0	38	56	111
	VMW-2	15-35	24	0.04	0.18	0.26
	VMW-3	15-32	30	0.05	0.3	0.5
	VMW-4	13-35	42	0.06	0.1	0.1
	MW-1	35-55	21	0.1	0.45	0.7
	MW-2	30-55	19	0.01	0.02	0.05
	MW-3	13-35	52	0.01	0.05	0.09
	MW-4	29-48	26	0.01	0.05	0.09
	MW-5	14-34	55	0	0	0
	MW-7	10-30	47	0	0	0
	MW-9	25-55	55	0	0	0
	MW-10	25-55	83	0	0	0
	RW-1	25-55	4	0.05	0.1	0.2
				Q = 10	20	--
MW-1		35-55	0	50	222	--
	VMW-1	13-35	22	0	0	
	VMW-2	15-35	19	0.3	0.83	--
	VMW-3	15-32	13	1.8	4.5	--
	VMW-4	12-35	24	0.08	0.2	--
	MW-2	30-55	29	0	0.01	--
	MW-3	12-35	38	0	0	
	MW-4	29-48	24	0	0.03	--
	MW-5	14-34	51	0	0	--
	MW-7	10-30	26	0	0	--
	MW-9	25-55	68	0	0	
	MW-10	25-55	78	0	0	--
	RW-1	25-55	19	0	0	--

Notes: Q = flow rate in standard cubic feet per minute
r = horizontal distance from extraction well

Table 2

Pressure Drawdown From Constant-Flow-Rate Tests
November 18, 1993
Mobil Station 04-H6J

Extraction Well	Observation Well	Screen Interval (feet)	Flow Rate (cfm)	r (feet)	Pressure Drawdown (in. of H2O)
VMW-1		13-35	54	0	110
	VMW-2	15-35		24	0.24
	VMW-3	15-32		30	0.48
	VMW-4	12-35		42	0.06
	MW-1	35-55		21	0.67
	MW-2	30-55		19	0.3
	MW-3	12-35		52	0
	MW-4	29-48		26	0.19
	MW-5	14-34		55	0
	MW-7	10-30		47	0
	MW-9	25-55		55	0
	MW-10	25-55		83	0
	RW-1	25-55		4	3
MW-1		35-55	22	0	222
	VMW-1	13-35		22	0
	VMW-2	15-35		19	1.1
	VMW-3	15-32		13	4.7
	VMW-4	12-35		24	0.3
	MW-2	30-55		24	0
	MW-3	12-35		38	0
	MW-4	29-48		24	0.02
	MW-5	14-34		51	0.05
	MW-7	10-30		26	0
	MW-9	25-55		68	0.05
	MW-10	25-55		78	0.05
	RW-1	25-55		19	0
MW-2	no response in any wells at a maximum flowrate of 9 cfm				
MW-7	no response in any wells at a maximum flowrate of 55 cfm				

Notes: Q = flow rate in standard cubic feet per minute
r = horizontal distance from extraction well

Table 3

Calculated Soil Parameters from Steady-State-Data Analysis
November 18, 1993
Mobil Station 04-H6J

Extraction Well	Flow Rate (cfm)	Transmissibility (d-ft/cp)	Permeability (darcys)	ERI (feet)
VMW-1	54	124,442	64	41
MW-1	22	8,087	3.64	44
MW-2	9	--	--	--
MW-7	55	--	--	--

Notes:
ERI = estimated effective radius of influence
cfm = cubic feet per minute
d-ft/cp = darcy-feet/centipoise
-- = could not be determined

Table 4

Calculated Soil Parameters for Transient Data Analysis
November 18, 1993
Mobil Station 04-H6J

Extraction Well	Observation Well	Flow Rate (cfm)	Transmissivity (ft2/min)	Permeability (darcys)
VMW-1	MW-4	54	0.28	62.11
	MW-2		0.17	37.71
	VMW-2		0.32	70.99
	VMW-3		0.11	24.40
	MW-1		0.093	20.63
MW-1	VMW-3	22	0.01	1.94
	VMW-2		0.03	5.82
	VMW-4		0.07	13.59

Notes: cfm = cubic feet per minute
ft2/min = square feet per minute

APPENDIX A

GLOSSARY OF TERMS AND ABBREVIATIONS

Conductivity

Soil conductivity is defined as a soil parameter proportional to the soil permeability and the properties of the fluid flowing through the porous medium.

Darcy's Law

Darcy's law describes the flow mechanism of a fluid in a porous medium; it gives a mathematical relationship between the fluid velocity and the hydraulic gradient under which the fluid is flowing.

Effective Radius of Influence

The effective radius of influence is defined as the distance from an air extraction well at which the calculated pressure drawdown is 0.1 in. H_2O. During the transient period, the radius of influence is a function of extraction time, the soil hydraulic parameters, and the location of recharge boundaries.

Observation Well

An observation well is a non-extracting well used to observe the vacuum response at a given distance from the test well. The observation well ideally has a screened casing interval similar to the air extraction well.

Permeability

In Darcy's law, the permeability (k) is a constant of proportionality that relates the flow velocity and the pressure gradient. In single-phase flow, the permeability is only a function of the porous medium, and has dimensions of length squared.

Steady-State Flow

Steady-state flow conditions prevail after a period of air extraction. At steady state, the vacuum impressed at a given distance from an air extraction well does not change as a function of time. The closer an observation well is to an air extraction well the less time is required to reach steady-state flow.

Storativity

Storativity is the volume of air a soil zone releases from, or takes into, storage per unit surface area of the zone per unit change in pressure.

Test Array

A test array is comprised of one vapor extraction well and a number of observation wells used for vacuum monitoring. The number of test arrays depends on the availability of existing monitoring wells that are suitably spaced and constructed (extraction and observation wells with similar screened casing intervals).

Transient Flow

Transient flow is the early-time flow period that precedes the attainment of steady-state conditions. During this flow period, the vacuum response observed at a given distance changes as a function of elapsed time.

Transmissibility

Soil transmissibility to air, or the ability of the vadose zone to transmit air to the extraction well, is mathematically defined as the product of the permeability (k) of the vadose zone and its thickness (h) divided by the average hydrocarbon-saturated air viscosity (μ). The soil transmissibility is used to model subsurface air flow since estimates of the air viscosity and vadose zone flow thickness are not always readily available.

Transmissivity

Transmissivity is defined as the product of the vadose zone thickness (h) by the conductivity of the vadose zone (K).

Vadose Zone

The vadose zone, or unsaturated zone, is the section of soil above the ground water table through which air flow is taking place.

Abbreviations

ARB - Air Resources Board
ARS - automatic recovery system
BTEX - benzene, toluene, ethylbenzene, xylene
cfm - cubic feet per minute
cp - centipoise
d - darcy
EPA - Environmental Protection Agency
ERI - effective radius of influence
fbg - feet below grade
ft/min - feet per minute
ft/day - feet per day
ft^2/min - square feet per minute
ft^2/day - square feet per day
gpm - gallons per minute
h - height of screen interval or vadose zone thickness
in. H_2O - inches of water
k - soil permeability to air
NA - not available
ND - not detected above detection limit
ppm - parts per million
psi - pounds per square inch
psia - pounds per square inch absolute
Q - air flow rate
r - distance from extraction well or between observation wells
VES - vapor extraction system
VFH - volatile fuel hydrocarbons
μ - air viscosity

APPENDIX B

VAPOR EXTRACTION TEST PROTOCOL

Following is a general description of the vapor extraction test protocol and data acquisition procedures.

TEST PROTOCOL

One extraction well is connected to the V.R. Systems internal combustion unit; at least two other vapor extraction/monitoring wells are used as pressure drawdown observation points. During a series of tests, it is typical that a particular well will function both as an extraction well and an observation well.

While air is extracted, the pressure level in the observation wells is monitored and recorded. Data are recorded as net drawdown from the initial soil air (atmospheric) pressure within the sealed well casing. Each test is conducted until vacuum effects nearly stabilize at the farthest observation point. Pressure drawdown data are then used in a modeling analysis to estimate soil air transmissibility. These parameters are necessary to determine the effective area of influence.

PRESSURE MONITORING

Suction pressure was recorded with a magnehelic gauge fitted at the influent end of the blower to determine air flow rate; well caps fitted with magnehelic pressure gauges with sensitivity levels as low as 0.01 in. H_2O were used to record the pressure drawdown data from the observation wells.

AIR FLOW RATE

The air flow rate is obtained by recording the pressure on a magnehelic gauge fitted on a Pitot tube at the influent end of the vapor conduit hose. Vacuum readings are converted to flow rate by referring to the appropriate Pitot tube size conversion chart.

VAPOR EXTRACTION TEST EQUIPMENT

The vapor extraction test equipment used is the V.R. Systems Model Number V3. The system uses an internal combustion engine (Ford 460-cubic-inch 4-cycle engine). The system extracts vapor using the vacuum created by the engine. The extracted vapors are mixed with a separate fuel source (propane) and combusted in the engine. If the well effluent vapor concentrations are higher than 40,000 ppm-C_6, propane is not required as an additional fuel source.

APPENDIX C

Official Laboratory Report and Chain of Custody Record

SEQUOIA ANALYTICAL
1900 Bates Avenue • Suite LM • Concord, California 94520
(510) 686-9600 • FAX (510) 686-9689

Alton Geoscience
30-A Lindbergh Ave.
Livermore, CA 94550
Attention: Ron Scheele

Client Project ID: Mobil 04-HGJ / 30-0065
Sample Matrix: Air
Analysis Method: EPA 5030/8015/8020
First Sample #: 311-1683

Sampled: Nov 18, 1993
Received: Nov 22, 1993
Reported: Nov 29, 1993

TOTAL PURGEABLE PETROLEUM HYDROCARBONS with BTEX DISTINCTION

Analyte	Reporting Limit µg/L	Sample I.D. 311-1683 MW-1	Sample I.D. 311-1684 VMW-1
Purgeable Hydrocarbons	5.0	200,000	90,000
Benzene	0.05	4,200	2,500
Toluene	0.05	3,800	3,400
Ethyl Benzene	0.05	610	300
Total Xylenes	0.05	1,700	1,200
Chromatogram Pattern:		Gasoline	Gasoline

Quality Control Data

Report Limit Multiplication Factor:	1,000	1,000
Date Analyzed:	11/22/93	11/22/93
Instrument Identification:	HP-4	HP-4
Surrogate Recovery, %: (QC Limits = 70-130%)	124	105

Purgeable Hydrocarbons are quantitated against a fresh gasoline standard.
Analytes reported as N.D. were not detected above the stated reporting limit.

SEQUOIA ANALYTICAL

Karen L. Enstrom
Project Manager

RECEIVED
DEC 07 1993

3111683.ALT <1>

SEQUOIA ANALYTICAL
1900 Bates Avenue • Suite LM • Concord, California 94520
(510) 686-9600 • FAX (510) 686-9689

Alton Geoscience
30-A Lindbergh Ave.
Livermore, CA 94550
Attention: Ron Scheele

Client Project ID: Mobil 04-HGJ / 30-0065
Matrix: Air

QC Sample Group: 3111683-84

Reported: Nov 29, 1993

QUALITY CONTROL DATA REPORT

ANALYTE	Benzene	Toluene	Ethyl Benzene	Xylenes
Method:	EPA 8020	EPA 8020	EPA 8020	EPA 8020
Analyst:	J.F.	J.F.	J.F.	J.F.
MS/MSD Batch#:	112293B	112293B	112293B	112293B
Date Prepared:	11/22/93	11/22/93	11/22/93	11/22/93
Date Analyzed:	11/22/93	11/22/93	11/22/93	11/22/93
Instrument I.D.#:	HP-4	HP-4	HP-4	HP-4
Conc. Spiked:	20 µg/L	20 µg/L	20 µg/L	60 µg/L
Matrix Spike % Recovery:	100	100	100	102
Matrix Spike Duplicate % Recovery:	100	95	100	98
Relative % Difference:	0.0	5.1	0.0	4.0

LCS Batch#:	LCS112293	LCS112293	LCS112293	LCS112293
Date Prepared:	11/22/93	11/22/93	11/22/93	11/22/93
Date Analyzed:	11/22/93	11/22/93	11/22/93	11/22/93
Instrument I.D.#:	HP-4	HP-4	HP-4	HP-4
LCS % Recovery:	102	100	104	103
% Recovery Control Limits:	71-133	72-128	72-130	71-120

SEQUOIA ANALYTICAL

Karen L. Enstrom
Project Manager

Please Note:
The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

MW

Mobil Chain of Custody

SEQUOIA ANALYTICAL

Redwood City: (415) 364-9600
Concord: (510) 686-9600
Sacramento: (916) 921-9600

Consulting Firm Name: ALTON GEOSCIENCE

Address: 30A ~~LIVERMORE~~ LINDBERGH

City: LIVERMORE State: CA Zip Code: 94550

Telephone: (510) 606-9150 FAX #: (510) 6069260

Project Contact: RON SCHEELE Sampled by: KEVIN KEEGAN

Site SS#: 04-H6J

Mobil Site Address: 1024 MAIN STREET PLEASANTON

Mobil Engineer: CHERNE FOUTCH

Consultant Project #: 30-0065

Sequoia's Work Order Release #:

Phase of Work:
- ☐ A. Emrg. Response
- ☒ B. Site Assessment
- ☐ C. Remediation
- ☐ D. Monitoring
- ☐ E. OGC/Claims

Turnaround Time: ☐ Standard TAT (5- 10 Working Days)
☒ Other 72 hrs. *

Analyses Requested

	Client Sample I.D.	Date/Time Sampled	Matrix Description	# of Containers	Sequoia's Sample #	TPH Gas/BTEX	TPH Diesel	TRPH by I.R. EPA 418.1	Oil & Grease EPA 413.2				Comments
1.	MW-1 AIR	11/18/93 17:00	AIR	1		X							3111683
2.	VMW-1	11/18/93 11:30	AIR	1		X							1684
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	11-19	6:30			
			[signature]	11/93	18:30

Method of Shipment

APPENDIX D

DARCY FLOW MODEL

This appendix includes a description of the Darcy flow model. The steady-state form of Darcy's equation as applied to radial flow conditions is used to model air flow through the subsurface and to estimate the soil parameters.

DARCY FLOW MODEL CONDITIONS

Steady-state conditions prevail, after a transient period, for a well extracting a drainage area (cell) with a completely open outer boundary. The steady-state conditions assume that air extracted from the soil will be exactly balanced by air entering the soil at the outer boundary.

In the Darcy model, the radius of influence is defined as the outer radius of the drainage area at which point the pressure is always equal to the initial (atmospheric) pressure once steady-state flow conditions prevail.

GOVERNING EQUATIONS FOR THE DARCY FLOW MODEL

The general form of the compressible-flow radial diffusivity equation is:

$$\frac{1}{r}\frac{\delta}{\delta r}\left(\frac{p}{\mu z}\, r\, \frac{\delta p}{\delta r}\right) = \frac{\phi}{k}\frac{\delta}{\delta t}\left(\frac{p}{z}\right) \qquad (1)$$

where:
- p = pressure
- r = radius
- ϕ = porosity
- k = permeability
- μ = viscosity
- z = gas compressibility factor ($z=1$ for ideal gas flow)

For steady state, the following boundary conditions apply:

$p = p_e$ = pressure at $r = r_e$ (outer boundary)

$\frac{\delta p}{\delta t} = 0$ for all r and t ($z = 1$)

The general form of Darcy's law for radial flow is:

$$q = \frac{k}{\mu} 2\pi rh \frac{dp}{dr} \tag{2}$$

By applying the above boundary conditions, assuming ideal gas flow, and integrating to solve for the pressure p(r), Darcy's law becomes:

$$p(r) = [p_e^2 - q_{sc}T\mu p_{sc} / (19.88khT_{sc}) \ln(r_e/r)]^{1/2} \tag{3}$$

where:

- $p(r)$ = pressure at a radius r, psi
- p_e = pressure at outer boundary, psi
- q_{sc} = air extraction rate, cfd
- T = soil temperature, 515 °R
- T_{sc} = temperature at which q_{sc} is measured, 520 °R
- μ = air viscosity, 0.018 centipoise (cp)
- p_{sc} = pressure at which q_{sc} is measured, 14.7 psia
- k = air permeability, darcy
- h = height of the extraction interval, ft.
- r_e = radius of influence, ft.
- r = radius, ft.

Equation (3) can be applied to the steady-state pressure responses observed in the field to calculate the soil transmissibility and radius of influence.

Estimates of transmissivities and radii of influence have been calculated for pairs of observation wells that meet the following criteria:

1. The distances of the two observation wells from the test wells should differ by a minimum of 10%.

2. The difference in vacuum pressures between the two observation wells should be at least 0.3 in. H_2O, and the two observation well pressures should be non-zero.

These conditions allow better definition of the vacuum gradient in the computation of the air transmissibility and the radius of influence.

CALCULATION OF TRANSMISSIBILITY AND PERMEABILITY

Rearranging equation (3) and applying it to a pair of observation well data, the transmissibility (kh/μ) can be calculated. The equation is as follows:

$$kh/\mu = q_{sc}Tp_{sc} \ln(r_2/r_1) / 19.88T_{sc}(p_2^2 - p_1^2) \quad (4)$$

where: subscripts 1 and 2 refer to two observation wells

An average transmissibility value is calculated from the values computed for pairs of observation data that meet the above-mentioned criteria. Using the average transmissibility value, an estimated extraction interval (h), and air viscosity (μ) of 0.018 cp, the permeability of the soil is calculated using the following equation:

$$k = \text{Transmissibility}*\mu/h \quad (5)$$

CALCULATION OF RADIUS OF INFLUENCE

Using the average transmissibility (kh/μ), the radius of influence is calculated from the data for each observation well as follows:

$$r_e = r \exp[19.88T_{sc}((p_e^2 - p_{(r)}^2)/q_{sc}Tp_{sc}) \; kh/\mu] \quad (6)$$

<u>Notes</u>:

1. Static atmospheric pressure is taken as 14.7 psia or 407 in. H_2O.

2. Calculated transmissibility and radius of influence values that are significantly higher or lower than others are eliminated from averaging calculations.

Site: Mobil Station 04-H6J
Project/Task No.: 30-0065
Location: Pleasanton Ca.

T(R) = 515 Psc(psi) = 14.7
Tsc(R) = 520 Psc(in) = 407
=1440*T*Psc/Tsc/19.88*407^2/14.7^2 = 808391

		DISTANCE	VACUUM	Re	Re(used)
XTRACT	MW-1	0.167	222		
OBSERV	VW-3	13	4.7	70.6	71
	VW-2	19	1.1	27.5	27
	VW-4	24	0.3	25.8	26
	MW-5	51	0.05	50.1	50

Q (cfm) =	22
h (ft) =	40
ONST = C * Q =	1.78E+07
T(avg) =	8087
k (D) =	3.64
Re(avg) =	44

OBS. PAIR		|P1-P2|	R1/R2	k*h/mu	T(used)
MW-1	VW-3	217.30	0.01	607	
MW-1	VW-2	220.90	0.01	645	
MW-1	VW-4	221.70	0.01	674	
MW-1	MW-5	221.95	0.00	774	
MW-1	0	222.00	#DIV/0!	#DIV/0!	
VW-3	VW-2	3.60	0.68	2320	2320
VW-3	VW-4	4.40	0.54	3063	3063
VW-3	MW-5	4.65	0.25	6460	
VW-3	0	4.70	#DIV/0!	#DIV/0!	
VW-2	VW-4	0.80	0.79	6391	6391
VW-2	MW-5	1.05	0.37	20575	20575
VW-2	0	1.10	#DIV/0!	#DIV/0!	
VW-4	MW-5	0.25	0.47	65903	
VW-4	0	0.30	#DIV/0!	#DIV/0!	
MW-5	0	0.05	#DIV/0!	#DIV/0!	

		DISTANCE	VACUUM	Re	Re(used)
XTRACT	VMW-1	0.167	110		
OBSERV	MW-2	19	0.3	30.2	30
	VMW-2	24	0.24	33.2	33
	MW-4	26	0.19	32.0	32
	VMW-3	30	0.48	72.4	72
	VMW-4	42	0.06	38.3	38

Q (cfm) =	54
h (ft) =	35
ONST = C * Q =	4.37E+07
T(avg) =	124442
k (D) =	64.00
Re(avg) =	41

OBS. PAIR		|P1-P2|	R1/R2	k*h/mu	T(used)
VMW-1	MW-2	109.70	0.01	2677	
VMW-1	VMW-2	109.76	0.01	2807	
VMW-1	MW-4	109.81	0.01	2851	
VMW-1	VMW-3	109.52	0.01	2941	
VMW-1	VMW-4	109.94	0.00	3118	
MW-2	VMW-2	0.06	0.79	208943	
MW-2	MW-4	0.11	0.73	153008	153008
MW-2	VMW-3	0.18	0.63	-136214	
MW-2	VMW-4	0.24	0.45	177325	177325
VMW-2	MW-4	0.05	0.92	85896	
VMW-2	VMW-3	0.24	0.80	-49905	
VMW-2	VMW-4	0.18	0.57	166789	
MW-4	VMW-3	0.29	0.87	-26485	
MW-4	VMW-4	0.13	0.62	197895	
VMW-3	VMW-4	0.42	0.71	42991	42991

APPENDIX E

HANTUSH FLOW MODEL

The type curve developed by Theis (1935) for aquifer response analysis, and modified by Hantush (1956) for leaky aquifers, is used for the vapor extraction test transient data analysis. The theory of aquifer drawdown analysis as applied to vadose zone pressure drawdown analysis is outlined below.

HANTUSH FLOW MODEL AND TYPE CURVE

The most fundamental type curve in hydrogeology is the Theis (1935) curve; it is a plot of the well dimensionless head drawdown W(u) versus the dimensionless time change (u) for a confined aquifer. In different types of aquifers, however, W(u) can also be a function of other parameters that are incorporated into the Theis type curve.

The radial diffusion equation that describes fluid flow through a confined aquifer is as follows (Fetter, 1988):

$$\frac{\delta^2 h}{\delta r^2} + \frac{1}{r}\frac{\delta h}{\delta r} = \frac{S}{T}\frac{\delta h}{\delta t} \qquad (1)$$

where: h = hydraulic head
r = radial distance to a pumping well
S = aquifer storativity
T = aquifer transmissivity
t = time

Hantush (Hantush, 1956) modified the Theis equation to allow consideration for fluid leakage from above or below the zone of testing. The Hantush equation is applied to vapor extraction testing. The leaking fluid is assumed to be supplied by an infinite reservoir, which is the earth's atmosphere for the case of vapor extraction testing. The rate of fluid leakage is controlled by the gradient, and by the vertical permeability of the material through which leakage occurs.

The assumptions and conditions included in the derivation by Hantush, as applied to vapor extraction analysis, are as follows:

1. The flow zone is cylindrical, homogeneous, isotropic, of uniform thickness, and of infinite areal extent.

2. The flow rate is constant.

3. The test wells are fully penetrating the flow zone, which is semi-confined.

4. Flow to the extraction well is horizontal and unsteady.

5. Fluid is released instantaneously from storage with decline in pressure level. The initial pressure is constant and uniform.

6. The diameter of the extraction well is very small so that storage in the wells is negligible.

7. The confining beds have infinite areal extent, uniform vertical conductivity, and uniform thickness.

8. The confining beds are overlain or underlain by an infinite constant-pressure plane source.

9. Flow in the confining layer is vertical.

The solution is then as follows:

$$(h_o - h) = Q/(4\pi T)\ \ Ei(u, r/B) \qquad (2)$$

where: $Ei(u)$ = exponential-integral function [the well function $W(u)$]

$u = \frac{r^2 S}{4Tt}$

r = radius from extraction well

T = air transmissivity of the extraction zone

t = time

S = storativity

Q = pumping rate

$(h_o - h)$ = pressure drawdown

$B = (Tb_v/K_v)^{1/2}$

b_v = thickness of confining layer through which leakage occurs

K_v = vertical conductivity of confining layer through which leakage occurs

Equation (2) is called the Hantush solution of the radial diffusion equation for leaky aquifers with no storage in confining zone. The exponential-integral function Ei(u) is a dimensionless drawdown that is plotted against the dimensionless time or its reciprocal (u or 1/u) on the Hantush type curve, for different values of r/B.

To analyze the pressure drawdown data from a vapor extraction test, the analyst converts the pressure drawdown data (in. H_2O) to ft. of air. The conversion factor is calculated to be 69.4 ft. of air per in. H_2O.

The analyst then plots the pressure drawdown (ft. of air) versus the elapsed time (t) on a log-log scale. A curve is fitted to the actual test data plot and the transmissivity (T), the storativity (S), and the r/B term related to the confining zone are obtained from a match point.

The soil permeability is calculated from the estimated soil transmissivity value. The calculation is as follows:

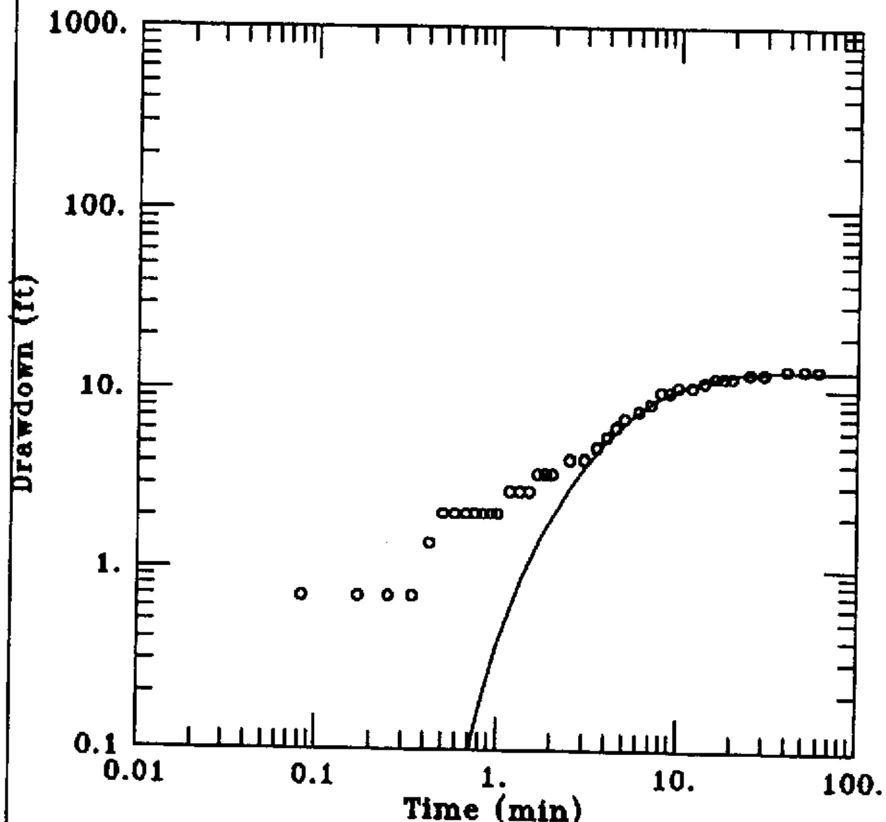
$$k = T\mu/hdg \qquad (3)$$

where:
- k = soil permeability
- T = soil transmissivity
- μ = air viscosity (0.018 cp)
- h = vadose zone thickness
- D = air density (0.075 lb/ft^3 or 0.0012 g/cm^3)
- g = gravitational acceleration constant (32.2 ft/sec^2 or 981 cm/sec^2)

Curve-fitting methods can be applied either manually, or by using a computer. A commercially available software (Geraghty & Miller, 1991) was used to plot and fit a curve through the data points. The use of the computer to perform curve fitting is advantageous in that it is more accurate and less time-consuming than manual methods.

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 1



DATA SET:
T1.dat
02/13/94

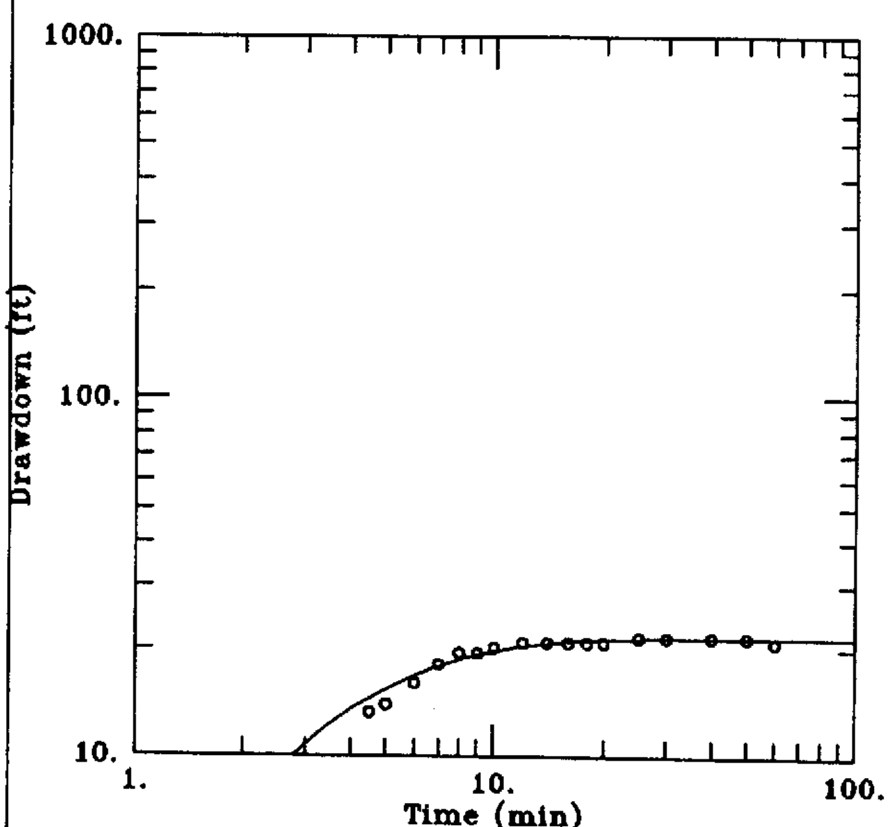
AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
VAPOR MONITORING WELL VMW-1
OBS. WELL:
MONITORING WELL MW-4

ESTIMATED PARAMETERS:
T = 0.2803 ft^2/min
S = 0.004122
r/B= 1.

TEST DATA:
Q = 54. ft^3/min
r = 25. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 2



DATA SET:
T2.dat
02/13/94

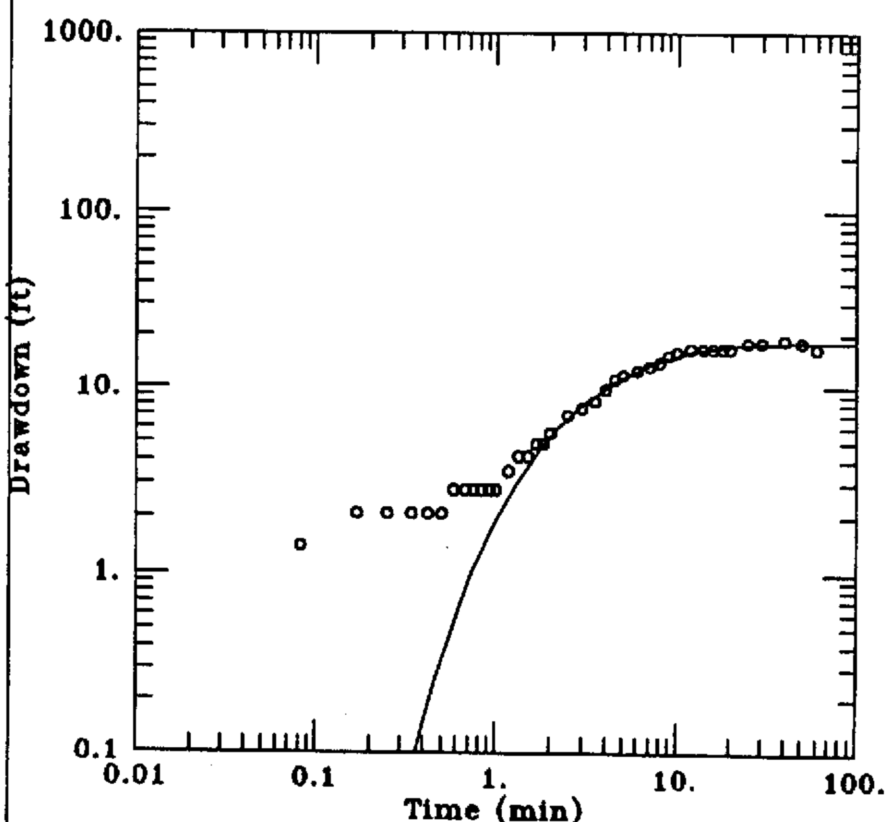
AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
VAPOR MONITORING WELL VMW-1
OBS. WELL:
MONITORING WELL MW-2

ESTIMATED PARAMETERS:
T = 0.1685 ft^2/min
S = 0.002803
r/B= 1.

TEST DATA:
Q = 54. ft^3/min
r = 19. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 3



DATA SET:
t3.DAT
02/13/94

AQUIFER TYPE:
Leaky

SOLUTION METHOD:
Hantush

TEST DATE:
11/18/93

TEST WELL:
VAPOR MONITORING WELL VMW-1

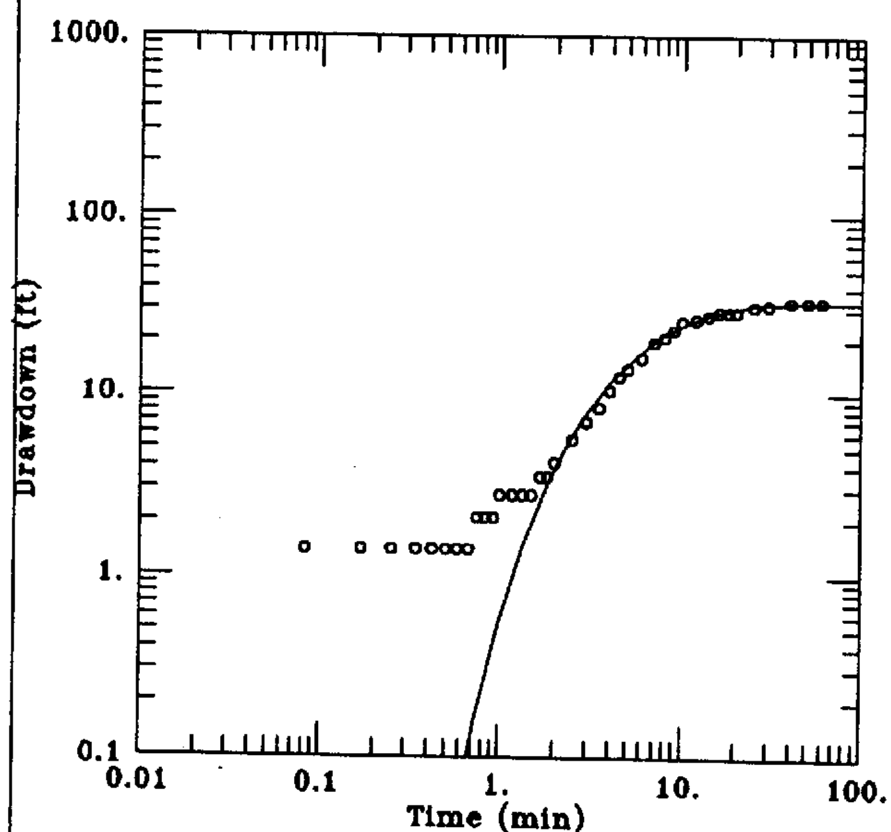
OBS. WELL:
VAPOR MONITORING WELL VMW-2

ESTIMATED PARAMETERS:
T = 0.318 ft^2/min
S = 0.002711
r/B= 0.7

TEST DATA:
Q = 54. ft^3/min
r = 24. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 4



DATA SET:
T4.DAT
02/13/94

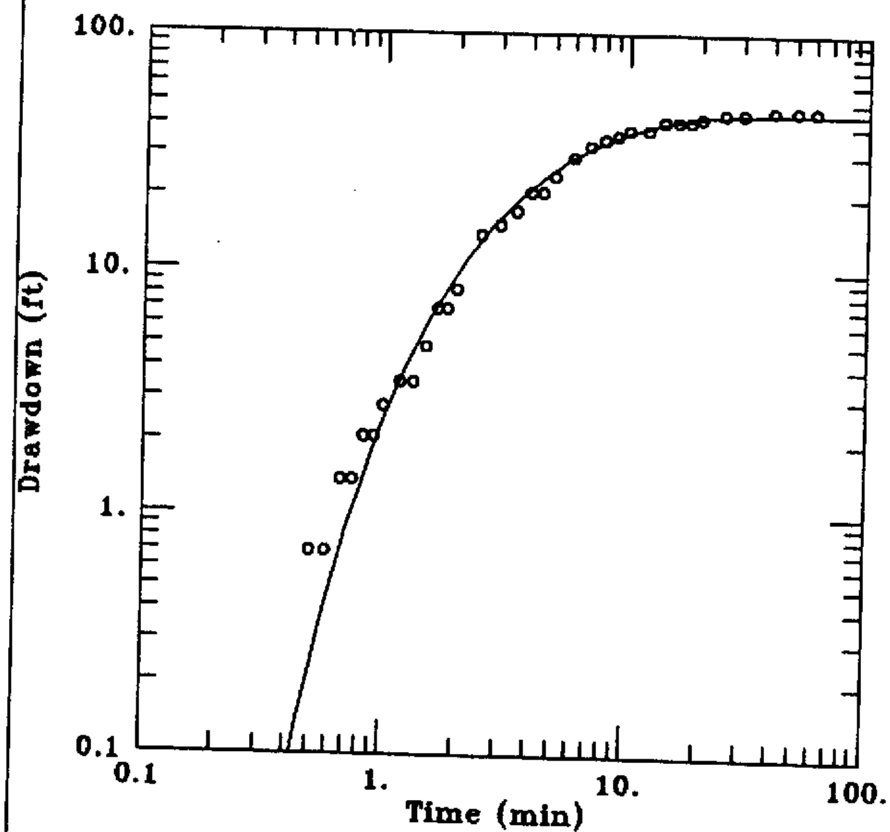
AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
VAPOR MONITORING WELL VMW-1
OBS. WELL:
VAPOR MONITORING WELL VMW-3

ESTIMATED PARAMETERS:
T = 0.1086 ft^2/min
S = 0.001395
r/B= 1.

TEST DATA:
Q = 54. ft^3/min
r = 30. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 5



DATA SET:
t5.DAT
02/13/94

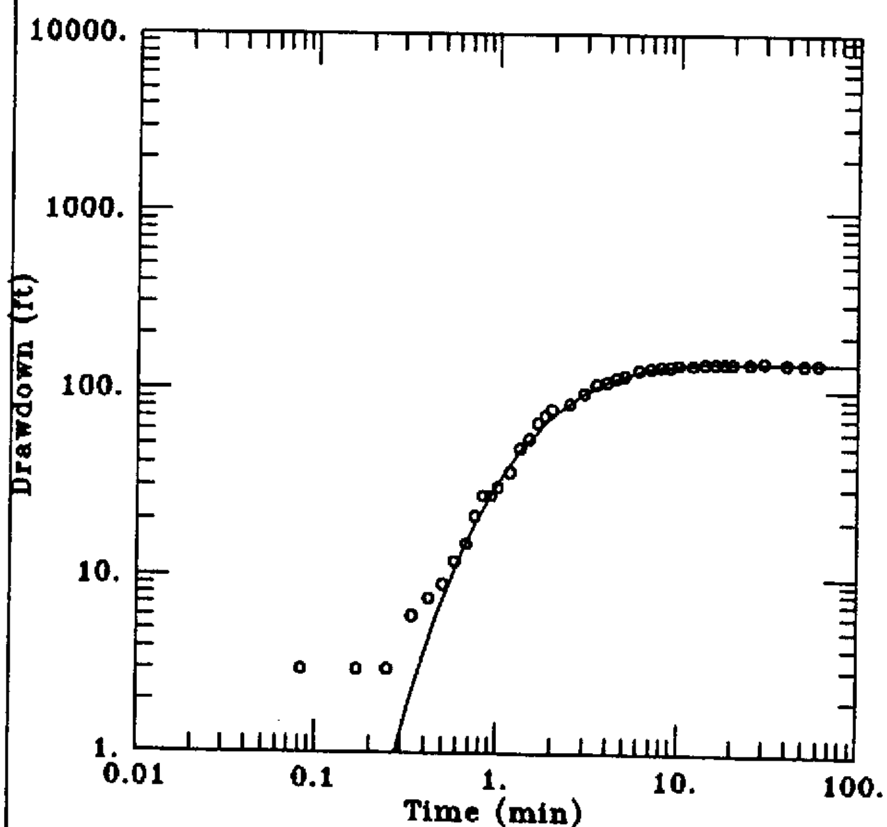
AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
VAPOR MONITORING WELL VMW-1
OBS. WELL:
MONITORING WELL MW-1

ESTIMATED PARAMETERS:
T = 0.093 ft^2/min
S = 0.0016
r/B= 0.9

TEST DATA:
Q = 54. ft^3/min
r = 21. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 6



DATA SET:
t6.DAT
02/13/94

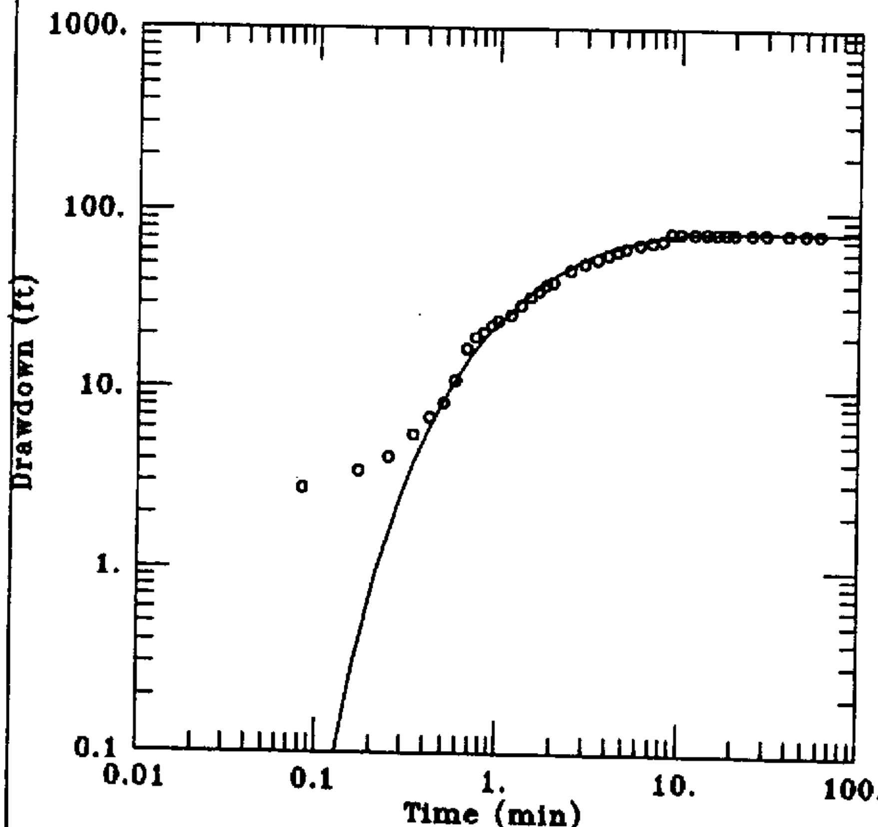
AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
MONITORING WELL MW-1
OBS. WELL:
VAPOR MONITORING WELL VMW-3

ESTIMATED PARAMETERS:
T = 0.01038 ft^2/min
S = 0.0002489
r/B = 1.

TEST DATA:
Q = 22. ft^3/min
r = 13. ft
rc = 0.17 ft
rw = 0.5 ft

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREET PLEASANTON

MOBIL STATION 04H6J, TEST 7



DATA SET:
t7.DAT
02/13/94

AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
MONITORING WELL MW-1
OBS. WELL:
VAPOR MONITORING WELL VMW-2

ESTIMATED PARAMETERS:
T = 0.03 ft^2/min
S = 0.0002
r/B= 0.7

TEST DATA:
Q = 22. ft^3/min
r = 19. ft
rc = 0.17 ft
rw = 0.5 ft

ESTIMATING AIR PERMEABILITY IN SOIL

AIR PERMEABILITY

TEST NO.1

description:	VMW-1 TO MW-4		
transmissivity (T) =	0.28 ft2/min	or	0.004667 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	35 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	62.11 darcy		

TEST NO.2

description:	VMW-1 TO MW-2		
transmissivity (T) =	0.17 ft2/min	or	0.002833 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	35 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	37.71 darcy		

TEST NO.3

description:	VMW-1 TO VMW-2		
transmissivity (T) =	0.32 ft2/min	or	0.005333 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	35 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	70.99 darcy		

TEST NO.4

description:	VMW-1 TO VMW-3		
transmissivity (T) =	0.11 ft2/min	or	0.001833 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	35 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	24.40 darcy		

TEST NO.5

description:	VMW-1 TO MW-1		
transmissivity (T) =	0.093 ft2/min	or	0.00155 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	35 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	20.63 darcy		

TEST NO.6

description:	MW-1 TO VMW-3		
transmissivity (T) =	0.01 ft2/min	or	0.000167 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	40 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	1.94 darcy		

TEST NO.7

description:	MW-1 TO VMW-2		
transmissivity (T) =	0.03 ft2/min	or	0.0005 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	40 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	5.82 darcy		

TEST NO.8

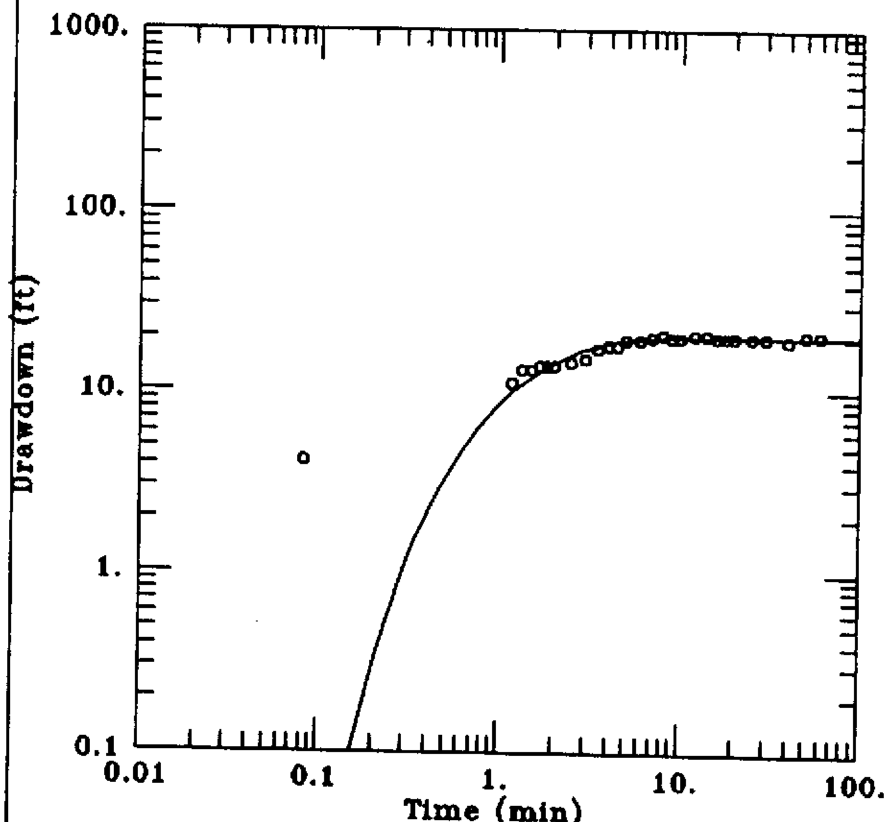
description:	MW-1 TO VW-4		
transmissivity (T) =	0.07 ft2/min	or	0.001167 ft2/sec
air viscosity (u) =	0.018 cp	or	3.76E-07 lb-sec/ft2
vadose zone thickness (h) =	40 ft		
air density(d) =	0.075 lb/ft3		
gravitation accelaration (g) =	32.2 ft/sec2		
permeability of air in soil (k) =	13.59 darcy		

(k) values for all tests:

Test 1 =	62.11	VMW-1 TO MW-4
Test 2 =	37.71	VMW-1 TO MW-2
Test 3 =	70.99	VMW-1 TO VMW-2
Test 4 =	24.40	VMW-1 TO VMW-3
Test 5 =	20.63	VMW-1 TO MW-1
Test 6 =	1.94	MW-1 TO VMW-3
Test 7 =	5.82	MW-1 TO VMW-2
Test 8 =	13.59	MW-1 TO VW-4

ALTON GEOSCIENCE	Client: MOBIL
Project No.: 30-0065	Location: 1024 MAIN STREE PLEASANTON

MOBIL STATION 04H6J, TEST 8



DATA SET:
T8.DAT
02/13/94

AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
11/18/93
TEST WELL:
MONITORING WELL MW-1
OBS. WELL:
VAPOR MONITORING WELL VMW-4

ESTIMATED PARAMETERS:
T = 0.0725 ft^2/min
S = 0.0003053
r/B= 1.

TEST DATA:
Q = 22. ft^3/min
r = 24. ft
rc = 0.17 ft
rw = 0.5 ft

Calculated (K):

	Transmissivity	Thick.	K(ft/min)	K(cm\s)
Test 1 =	0.28	35	0.008	0.00407
Test 2 =	0.17	35	0.005	0.00247
Test 3 =	0.32	35	0.009	0.00465
Test 4 =	0.11	35	0.003	0.00160
Test 5 =	0.093	35	0.003	0.00135
Test 6 =	0.01	40	0.000	0.00013
Test 7 =	0.03	40	0.001	0.00038
Test 8 =	0.07	40	0.002	0.00089