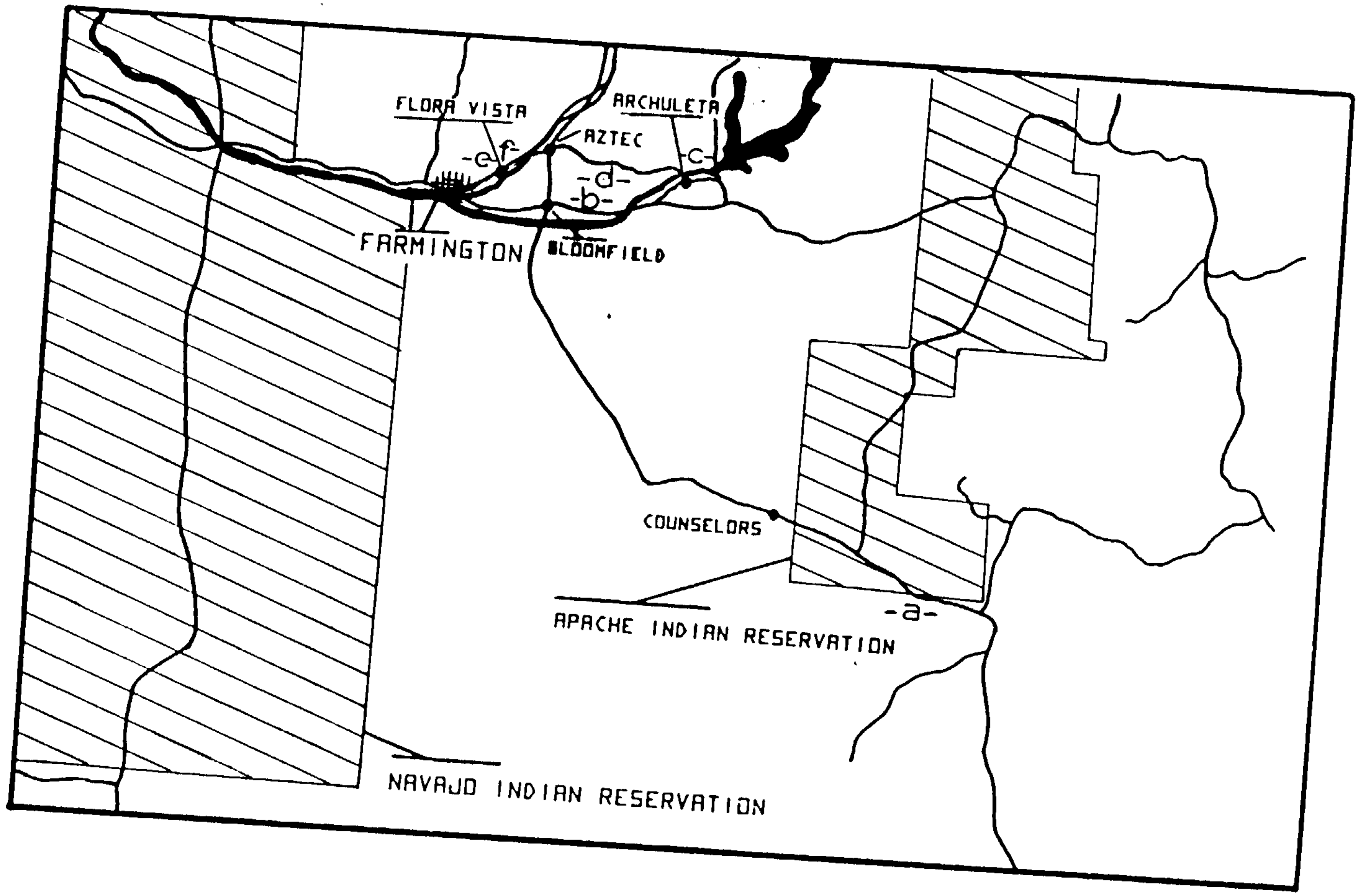
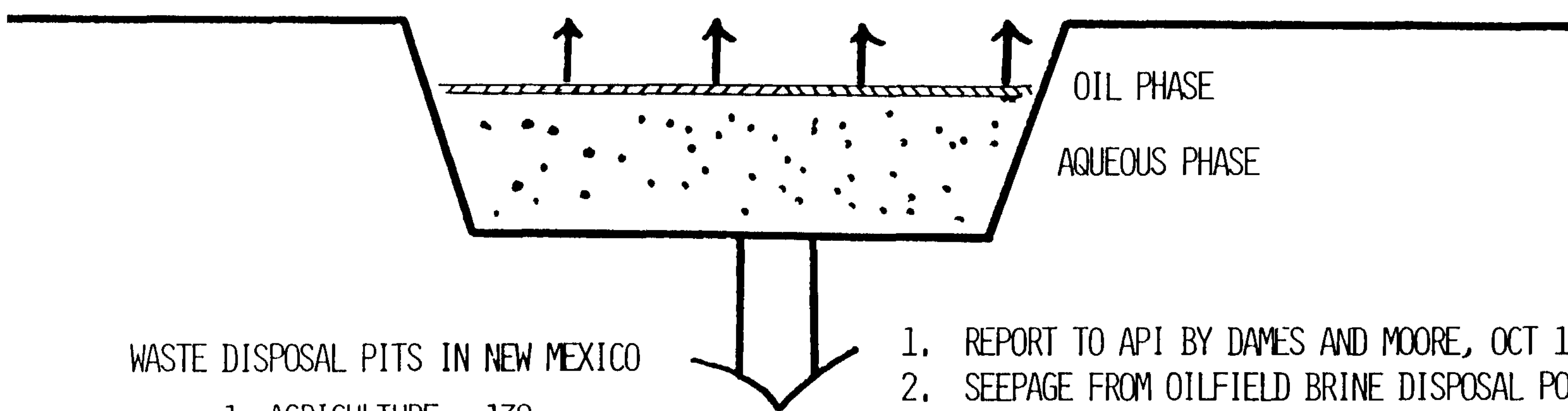

FLORA VISTA
ARCHULETA
AZTEC
-e-
-f-
-d-
-c-
-b-
FARMINGTON
BLOOMFIELD
COUNSELORS
-a-
APACHE INDIAN RESERVATION
NAVAJO INDIAN RESERVATION

3

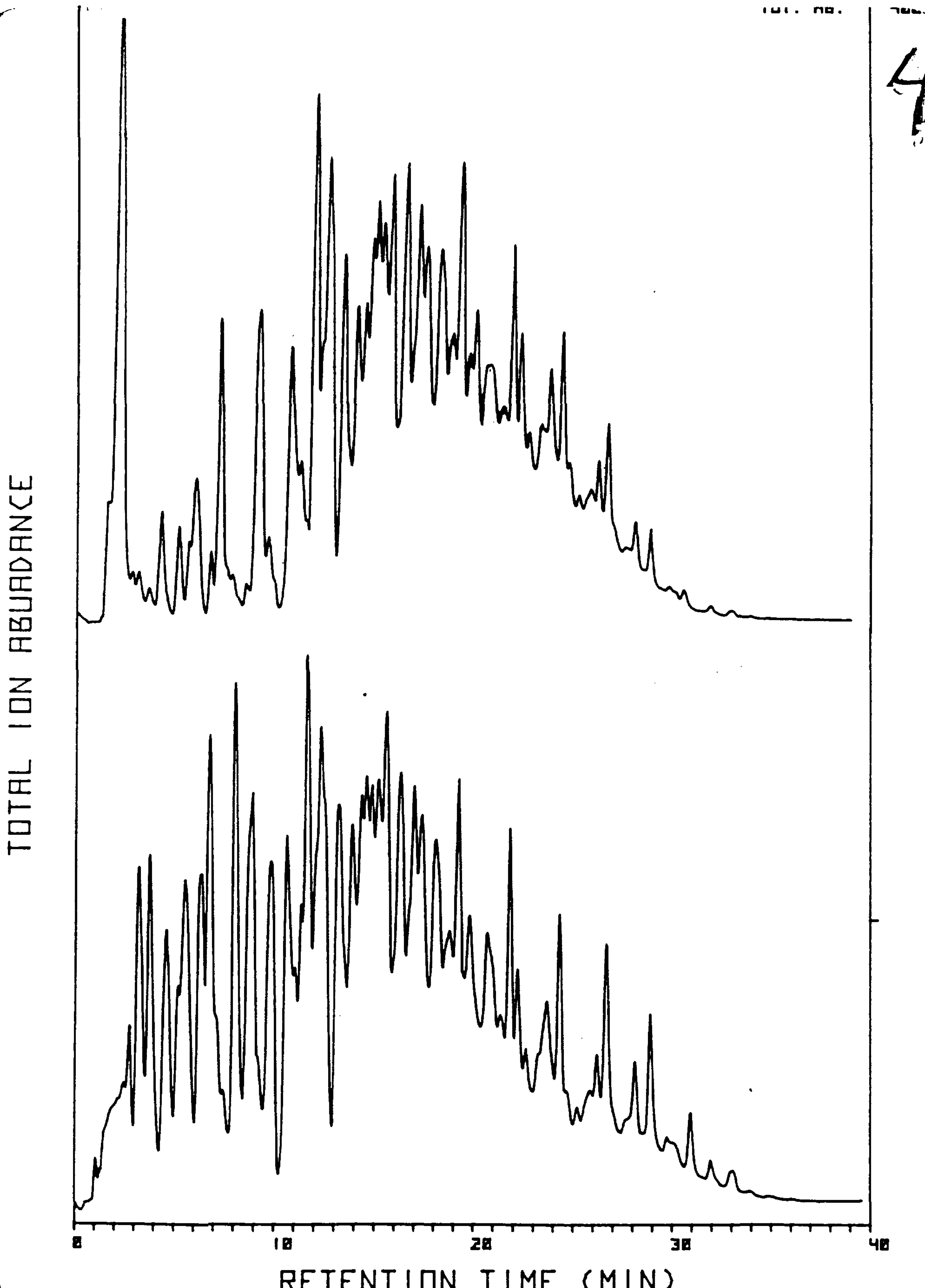
1. BAKER AND BRENDECKE, GROUNDWATER 1983,21,317-324



WASTE DISPOSAL PITS IN NEW MEXICO

1.	AGRICULTURE	138
2.	INDUSTRIAL	317
3.	MINING	838
4.	MUNICIPAL	703
5.	OIL AND GAS	15,761

1. REPORT TO API BY DAMES AND MOORE, OCT 1982
2. SEEPAGE FROM OILFIELD BRINE DISPOSAL PONDS IN UTAH, GROUNDWATER 1983,21,317-324.
3. INVESTIGATION AND REHABILITATION OF A BRINE-CONTAMINATED AQUIFER, GROUNDWATER 1975,15,155
4. OIL-FIELD POLLUTION...AND WHATS BEING DONE ABOUT IT. OGJ JUNE 1963, 76-86...2.25 BILLION BBL OF BRINE IN TX IN 1961.



4

TABLE 1: Summary of Volatile Organic Compounds in Aqueous Phase of Waste Pits from Natural Gas Production

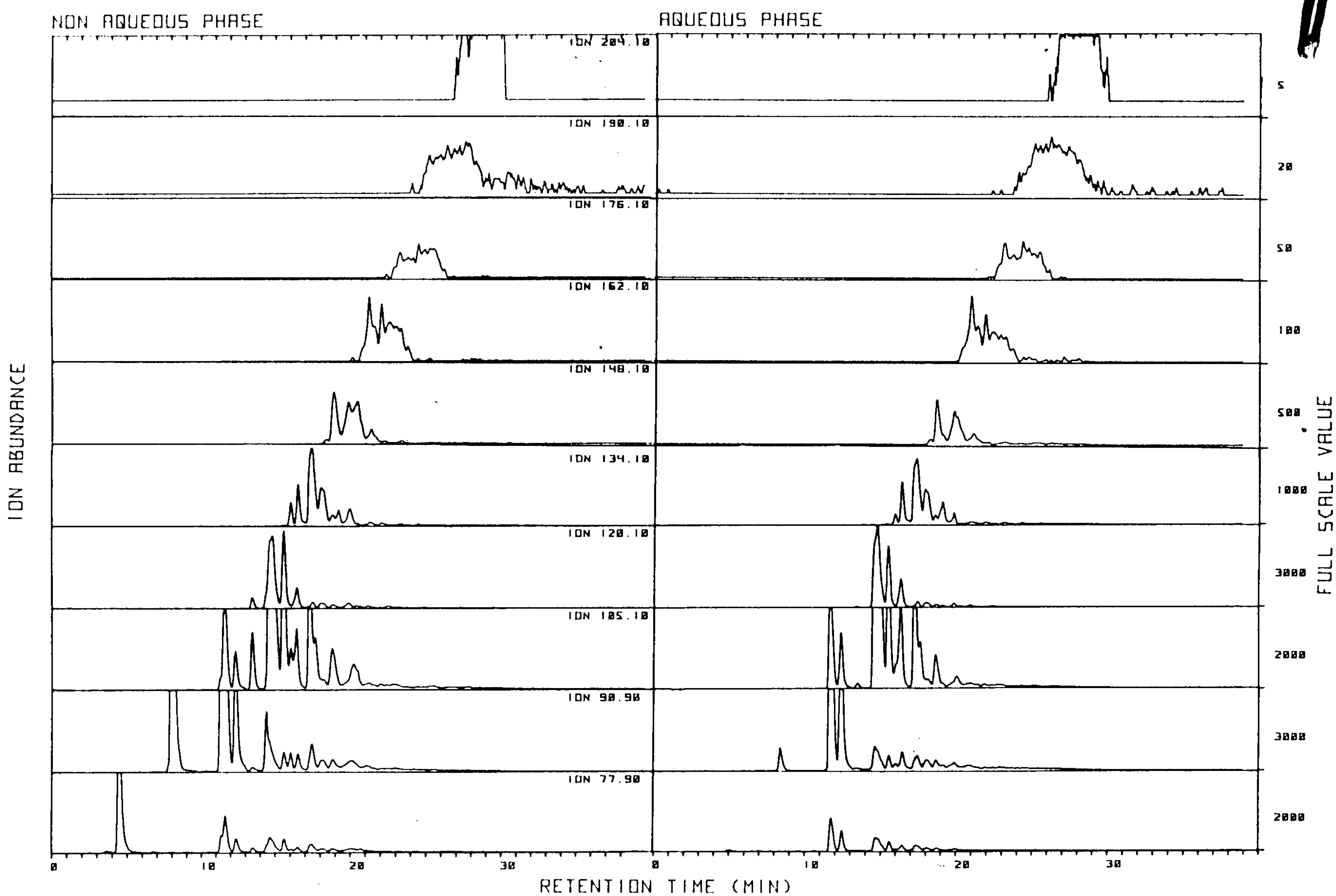
Retention Index	Compound	Cuba	Archuleta	Bloomfield	Flora Vista IE(A)
		Absolute MS Abundances			
693	C_4H_8(alkene)	1431	ND	-	ND
715	C_6H_{12}(alkene)	1190	-	1762	-
727	C_7H_{16} branched alkane	681	-	-	-
729	Benzene	-	3117	-	-
733	C_7H_{14} isomer	1159	-	1679	-
756	C_7H_{16} branched alkane	1249	-	2243	-
766	C_7H_{14} isomer	3945	-	3920	-
805	Toluene	730	3729	-	-
822	C_8H_{16} alkene	3984	-	-	-
820	C_8H_{16} alkene isomer	5589	-	6767	-
844	C_8H_{18} branched alkane	2843	-	-	-
849	Alkene (U)	-	287	-	-
851	C_8H_{18} branched alkane	-	-	5618	-
868	C_8H_{16} alkene	3599	351	-	-
873	C_8H_{16} alkene	-	-	3721	-
895	Xylene	13911	2848	26834	-
900	n-C_9H_{20}	2040	-	-	-
905	Branched alkane/alkene	-	-	-	3789
912	Xylene isomer	6025	758	14604	-
917	C_9H_{18} alkene	-	-	-	9448
932	Branched alkane C_9H_{22}	6114	806	7916	-
946	C_9H_{18} isomer	2073	1672	1735	-

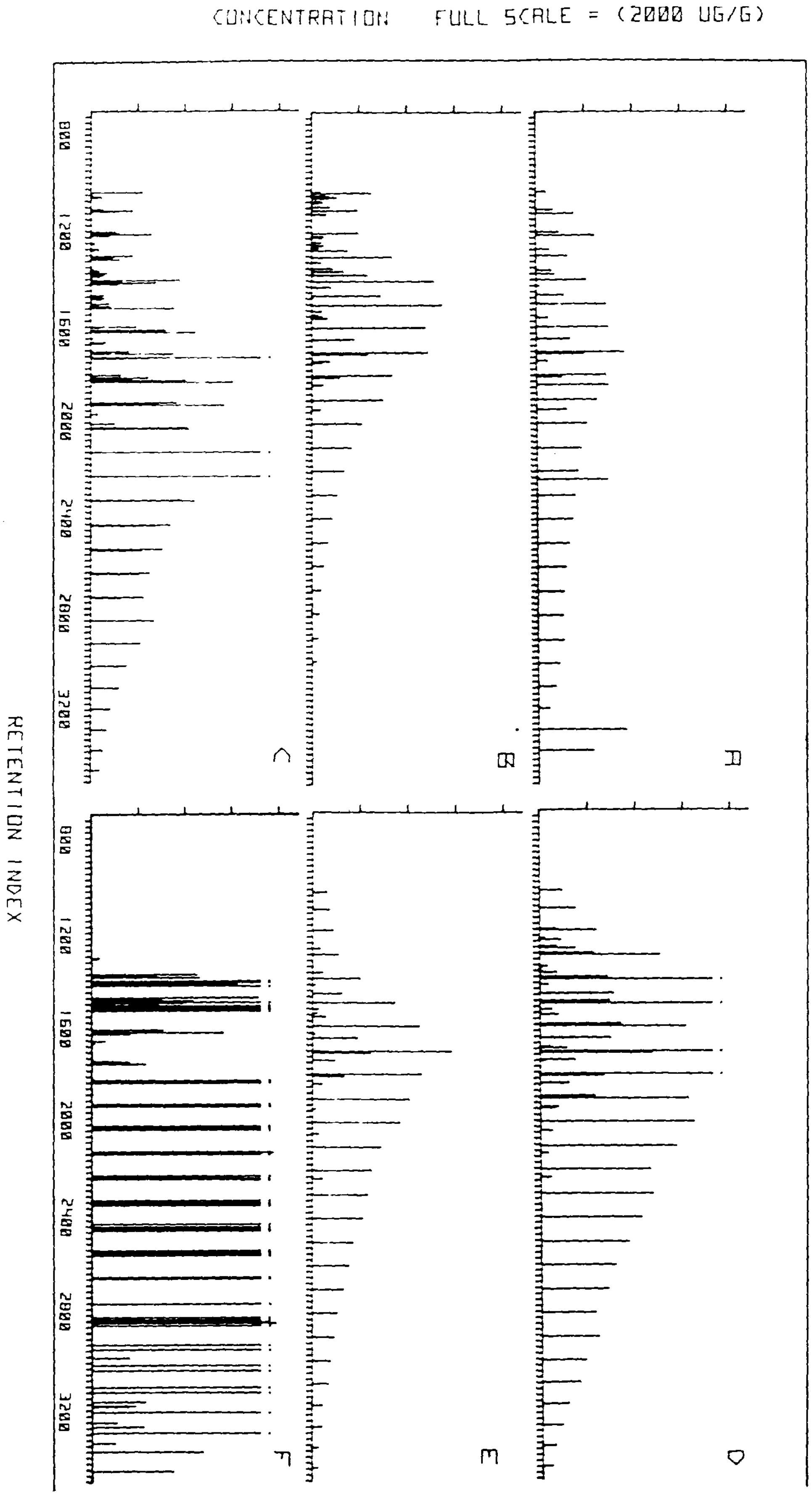
*Abundance for external benzene standard = 39460. Abundance Units for 14 mg/L.

TABLE 1 (continued)

Retention Index	Compound	Cuba	Archuleta	Bloomfield	Flora Vista 1E(A)
954	$C_{10}H_{22}$ isomer	1266	-	-	-
959	$C_{10}H_{20}$ alkene	1439	-	-	1837
971	C_3-benzene	5995	425	6989	-
976	$C_{10}H_{20}$ alkene	-	-	-	1315
993	C_3 benzene isomer	6283	395	8713	-
998	$C_{10}H_{20}$ alkene isomer	-	-	-	3630
1000	n-$C_{10}H_{22}$	7506	743	1345	-
1030	$C_{10}H_{20}$ isomer	2313	-	1615	-
1040	C_4-benzene	1955	-	1071	-
1067	Mixture C_4-benzene with unidentified alkane	2909	458	-	-
1070	C_4-benzene	-	-	1513	-
1089	C_5-benzene	952	-	393	-
1100	n-$C_{11}H_{22}$	7781	814	6063	-
1114	Branched alkane	544	-	428	-
1159	Naphthalene	2169	-	789	-
1200	n-$C_{12}H_{26}$	7555	-	2252	-
1231	$C_{12}H_{24}$ alkene	887	-	-	-
1300	n-$C_{13}H_{28}$	7528	1124	1376	-
1337	$C_{13}H_{26}$	5439	-	-	-
1353	Saturated alkane	5033	-	-	-
1373	Branched alkene	-	-	541	-

7


NON AQUEOUS PHASE
AQUEOUS PHASE
ION 204.10
ION 190.10
ION 176.10
ION 162.10
ION 148.10
ION 134.10
ION 120.10
ION 105.10
ION 90.90
ION 77.90
ION ABUNDANCE
FULL SCALE VALUE
5
20
50
100
500
1000
3000
2000
3000
2000
0
10
20
30
0
10
20
30
RETENTION TIME (MIN)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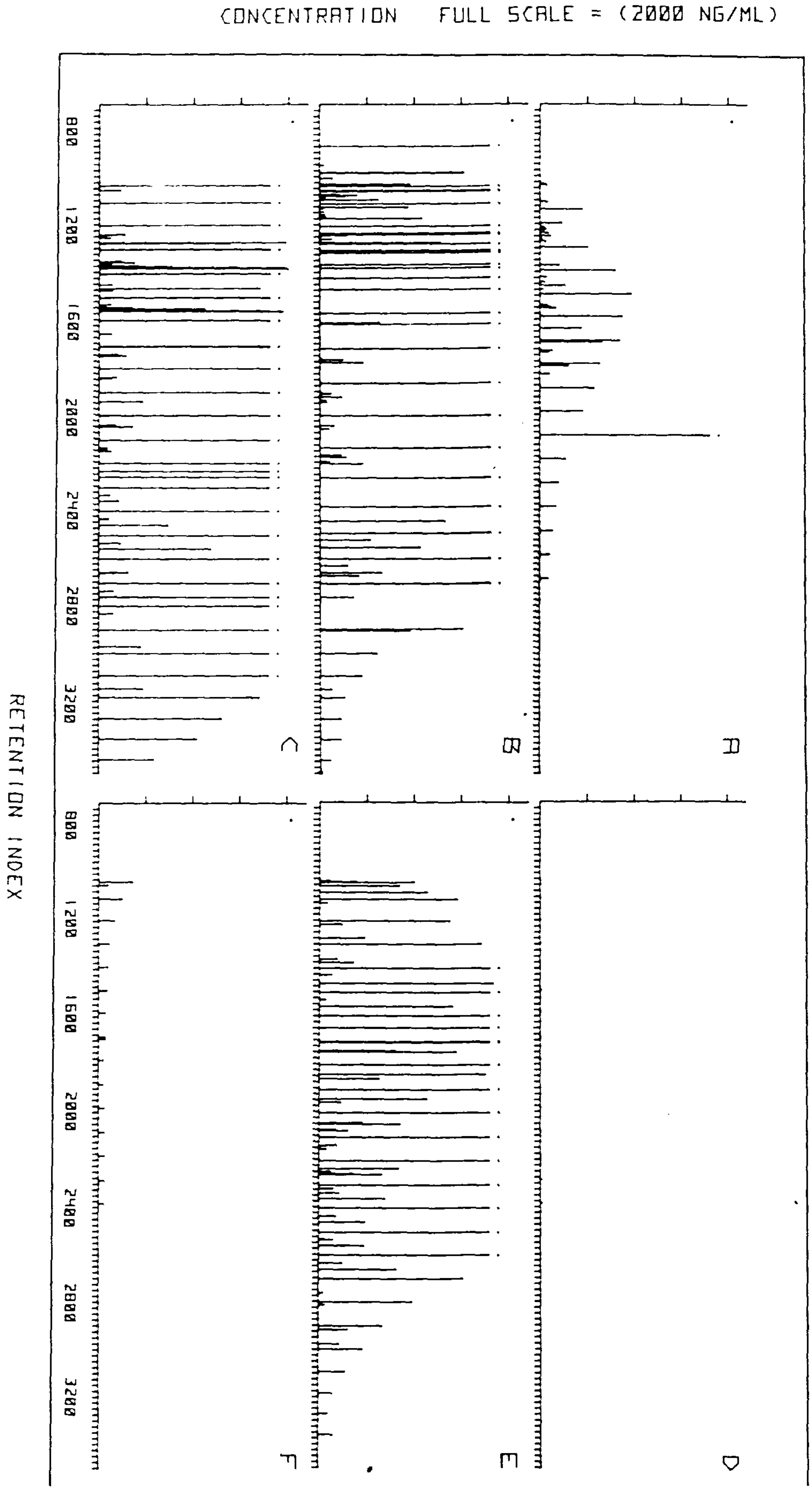
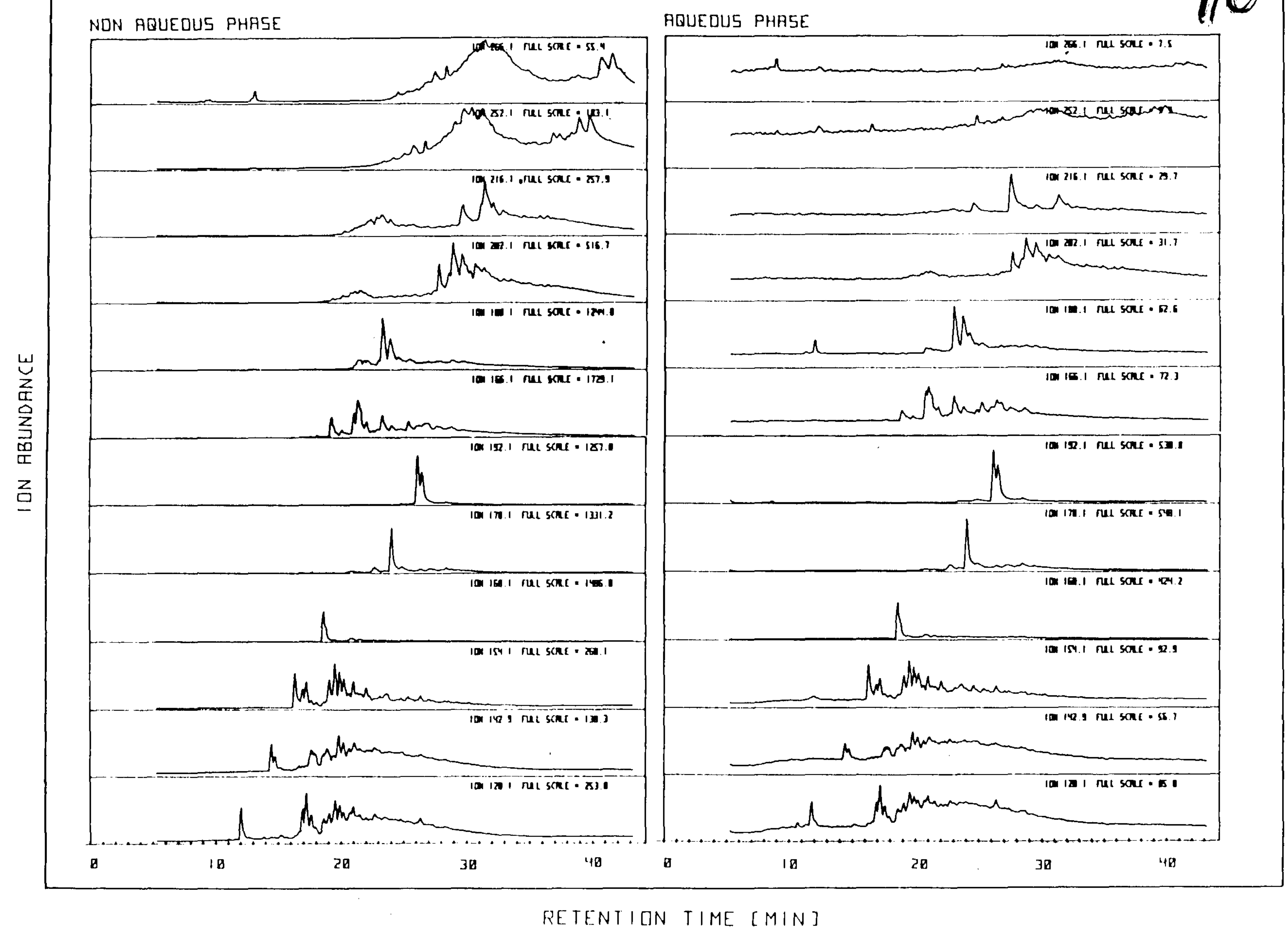
RETENTION INDEX
800
1200
1600
2000
2400
2800
3200
A
B
C
D
E
F


CONCENTRATION FULL SCALE = (2000 NG/ML)
RETENTION INDEX
800
1200
1600
2000
2400
2800
3200
A
B
C
D
E
F



NON AQUEOUS PHASE
ION 266.1 FULL SCALE = 55.4
ION 252.1 FULL SCALE
ION 216.1 FULL SCALE = 257.9
ION 202.1 FULL SCALE = 516.7
ION 188.1 FULL SCALE = 1244.0
ION 166.1 FULL SCALE = 1729.1
ION 192.1 FULL SCALE = 1257.0
ION 178.1 FULL SCALE = 1331.2
ION 168.1 FULL SCALE = 1486.0
ION 154.1 FULL SCALE = 268.1
ION 142.9 FULL SCALE = 130.3
ION 128.1 FULL SCALE = 253.0
AQUEOUS PHASE
ION 266.1 FULL SCALE = 7.5
ION 252.1 FULL SCALE
ION 216.1 FULL SCALE = 29.7
ION 202.1 FULL SCALE = 31.7
ION 188.1 FULL SCALE = 62.6
ION 166.1 FULL SCALE = 72.3
ION 192.1 FULL SCALE = 530.0
ION 178.1 FULL SCALE = 548.1
ION 168.1 FULL SCALE = 424.2
ION 154.1 FULL SCALE = 92.9
ION 142.9 FULL SCALE = 55.7
ION 128.1 FULL SCALE = 85.0
ION ABUNDANCE
0
10
20
30
40
RETENTION TIME (MIN)

TABLE 2: Concentrations of PAH in Aqueous Phase of Waste Pits from Natural Gas Production

	Cuba	Archuleta	Flora Vista 1E	Bloomfield	Flora Vista 1E(A)
	Concentration (µg/L)				
Naphthalene	850	480	ND	ND	500
C_1-Naphthalene	770	390	"	"	1900
C_2-Naphthalene	1300	2500	"	"	4200
C_3-Naphthalene	1400	2400	"	"	3600
Biphenyl	680	480	"	"	450
C_1-Biphenyl	850	720	"	"	1400
C_2-Biphenyl	1000	1700	"	"	1400
C_3-Biphenyl	1100	920	"	"	960
Anthracene	200	430	3.5	130	530
C_1-Anthracene	290	560	5.2	ND	1900
C_2-Anthracene	260	380	ND	"	2200
C_3-Anthracene	180	170	"	"	1700
Fluorene	82	140	ND	ND	320
C_1-Fluorene	180	360	"	"	650
C_2-Fluorene	140	390	"	"	870
C_3-Fluorene	78	430	"	"	650
Pyrene	13	200	300	ND	410
C_1-Pyrene	65	130	1400	"	260
C_2-Pyrene	46	100	ND	"	280
C_3-Pyrene	33	160	"	"	280
Benzopyrene	ND	ND	ND	ND	ND
C_1-Benzopyrene	"	"	"	"	"
C_2-Benzopyrene	"	"	"	"	"
C_3-Benzopyrene	"	"	"	"	"
TOTAL	9,517	14,740	1,709	130	24,460

ND - Not detected.

TABLE 3: Concentrations of PAH in Non-Aqueous Phase of Waste Pits from Natural Gas Production

Concentration (mg/kg)

	Cuba	Archuleta	Flora Vista 1E	Flora Vista 1E(A)	Flora Vista	Aztec
Naphthalene	160	23	240	80	375	ND
C_1-Naphthalene	110	22	290	410	250	"
C_2-Naphthalene	1500	190	4700	1000	2600	1100
C_3-Naphthalene	1600	170	3400	590	1200	360
Biphenyl	54	23	390	72	230	ND
C_1-Biphenyl	230	86	1200	250	450	33
C_2-Biphenyl	420	120	1100	280	300	160
C_3-Biphenyl	320	85	650	270	45	130
Anthracene	130	52	220	17	150	26
C_1-Anthracene	240	66	400	120	280	33
C_2-Anthracene	140	34	290	130	200	15
C_3-Anthracene	99	23	190	79	99	14
Fluorene	27	11	66	30	38	8
C_1-Fluorene	39	27	130	61	56	10
C_2-Fluorene	36	54	84	86	41	10
C_3-Fluorene	30	56	19	92	32	10
Pyrene	24	10	26	13	13	6
C_1-Pyrene	24	8.6	24	28	13	5
C_2-Pyrene	10	8.6	19	30	12	ND
C_3-Pyrene	9	11	11	33	11	"
Benzopyrene	ND	ND	ND	ND	ND	ND
C_1-Benzopyrene	"	"	"	"	"	"
C_2-Benzopyrene	"	"	"	"	"	"
C_3-Benzopyrene	"	"	"	"	"	"
TOTAL	5,202	1,055	13,449	3,541	11,895	1,920

ND - Not detected.

13

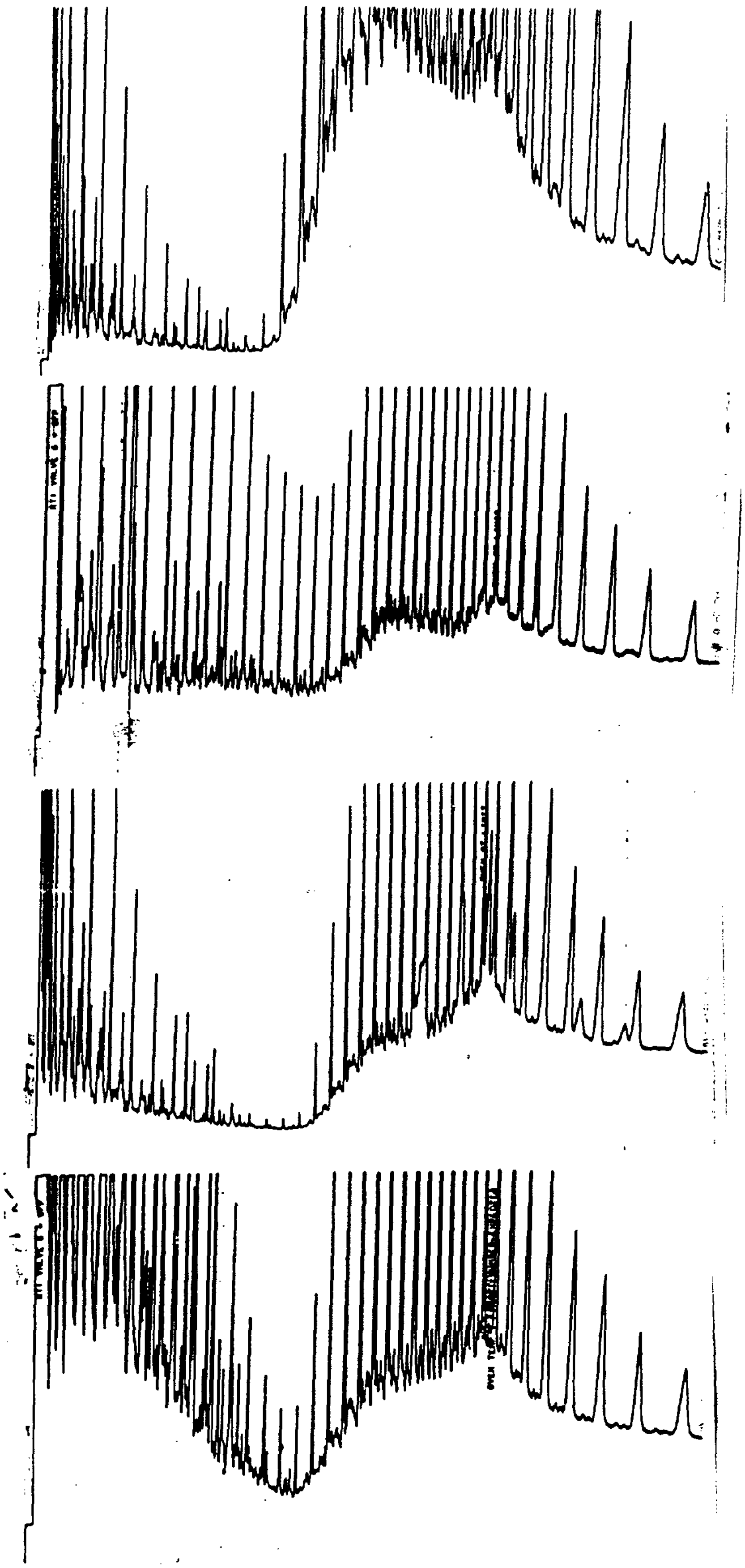
Table III Concentrations of PAH in Soils from Waste Pits

Compound	Concentration (μg/g) Compressor Station Pit #1	Production Pit #1	Production Pit #2
C_2-Naphthalenes	53	53	105
C_2-Biphenyls	66	42	91
Fluorene	33	18	42
C_1-Fluorenes	55	15	48
C_2-Fluorenes	52	17	47
Anthracene*	94	36	105
C_1-Anthracenes	205	49	276
C_2-Anthracenes	178	31	138
Pyrene**	25	5	20

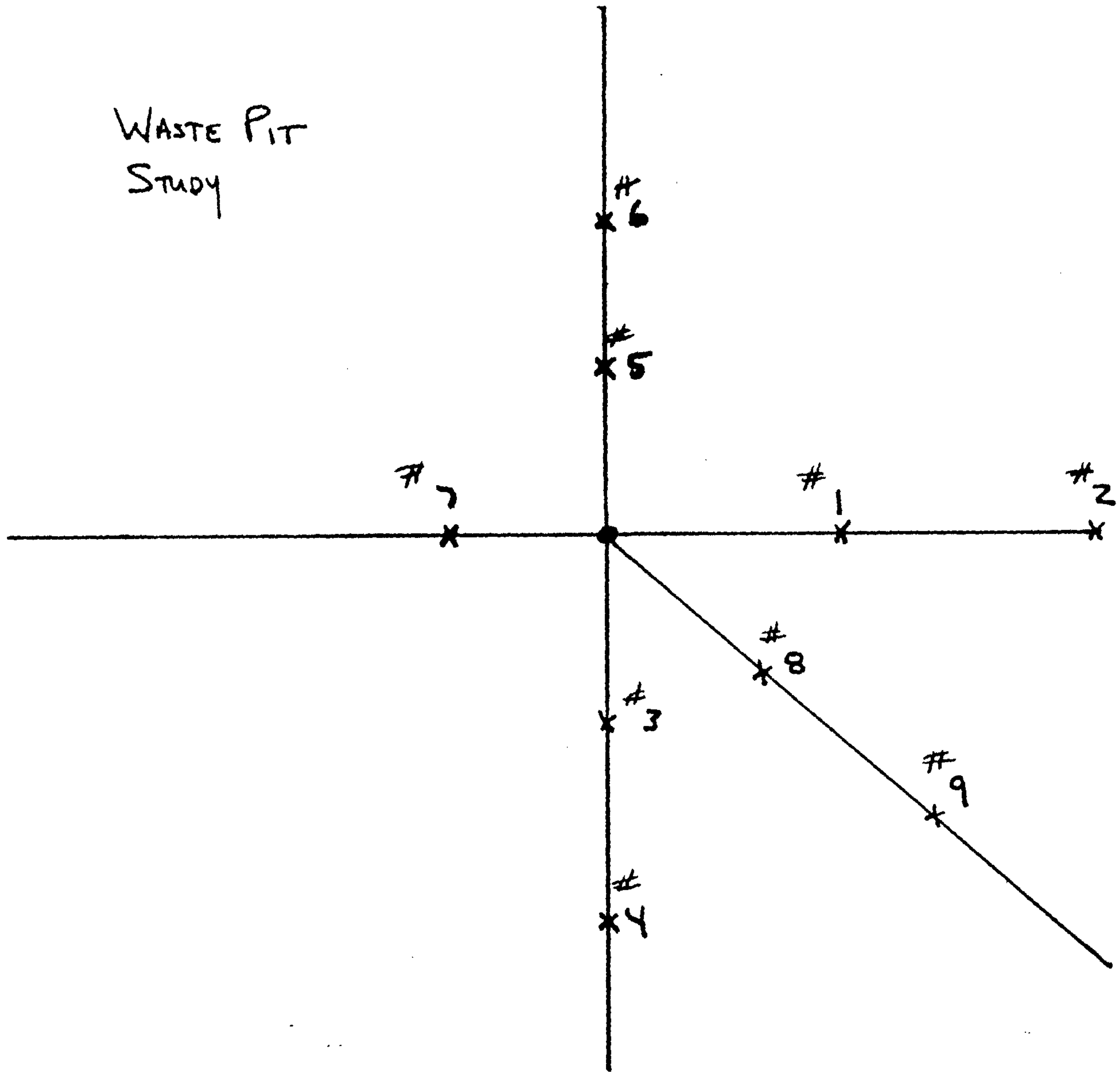
*Including phenanthrene

**Including benzanthracene

15



WASTE PIT
STUDY



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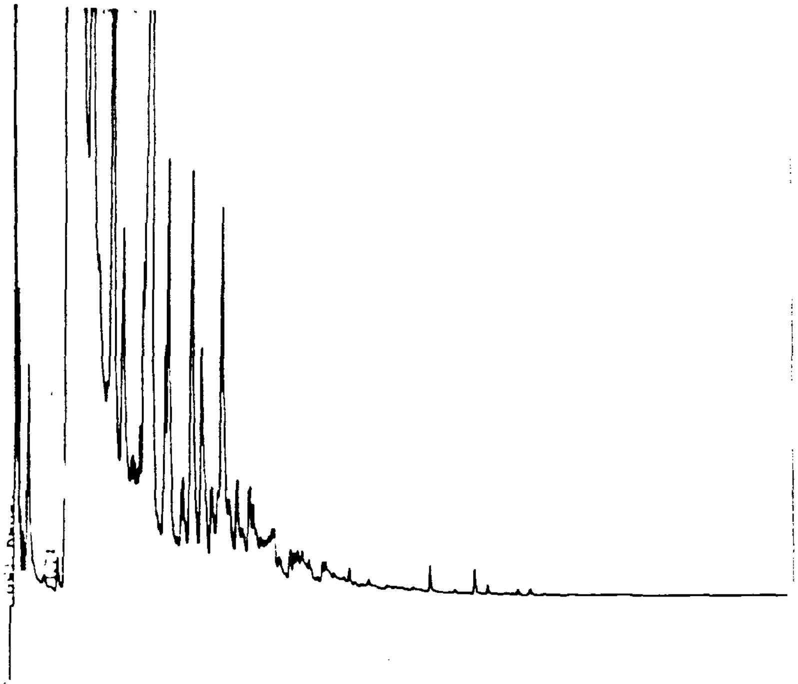
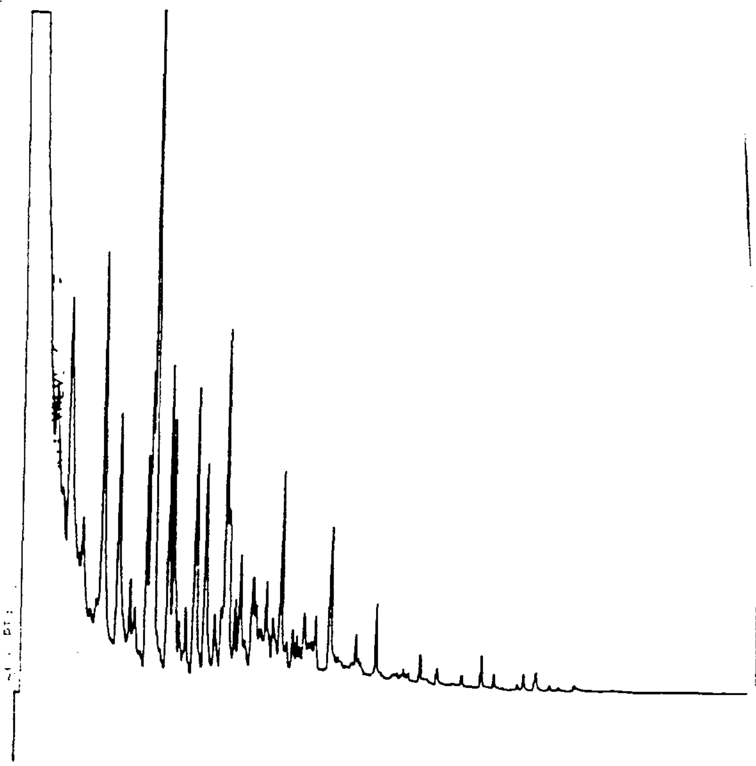
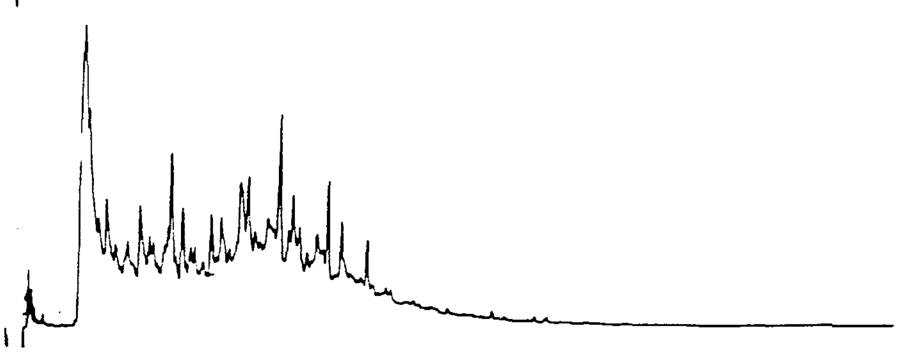
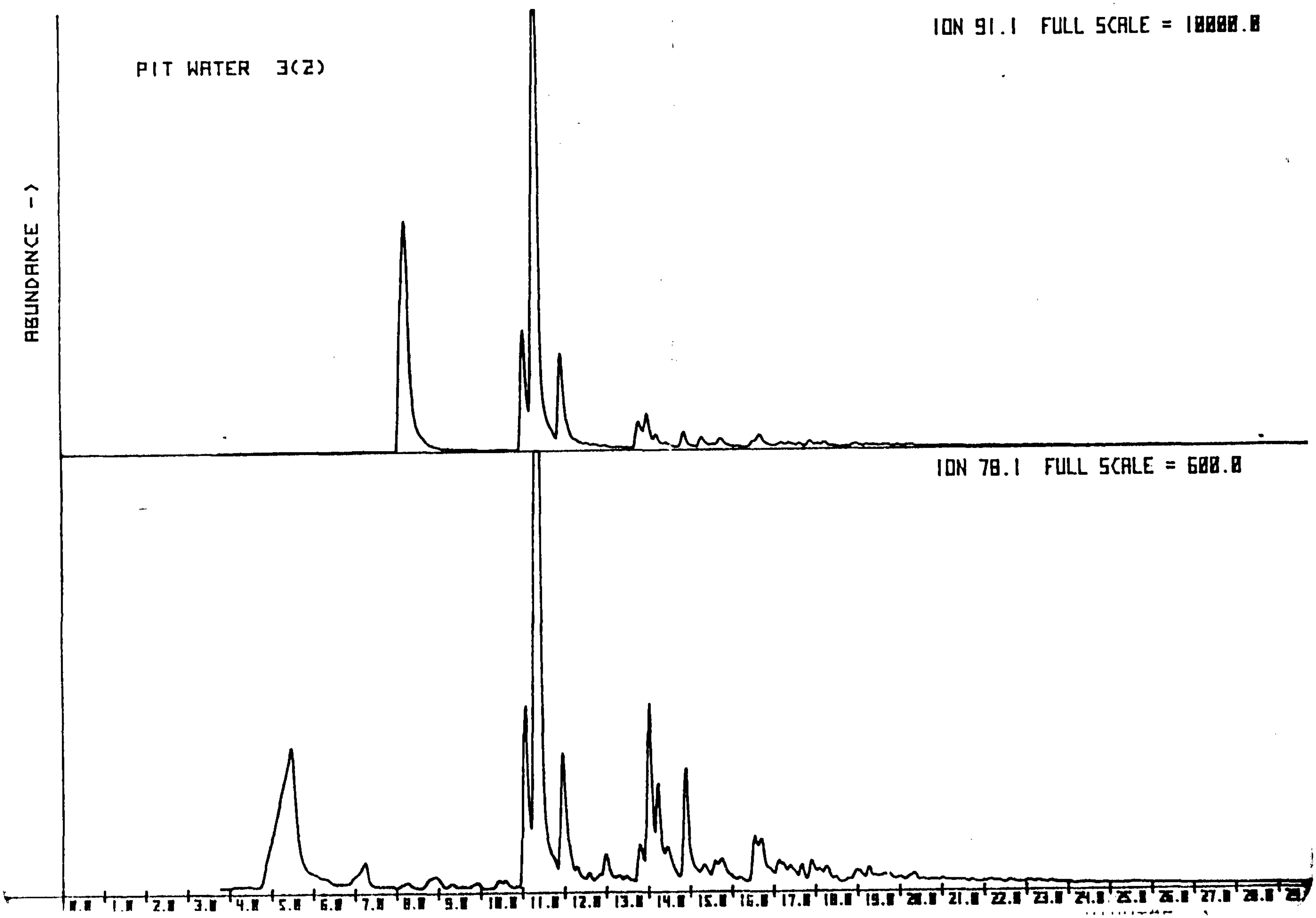






18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PIT WATER 3(2)
ABUNDANCE ->
ION 78.1 FULL SCALE = 600.0
0.0
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2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
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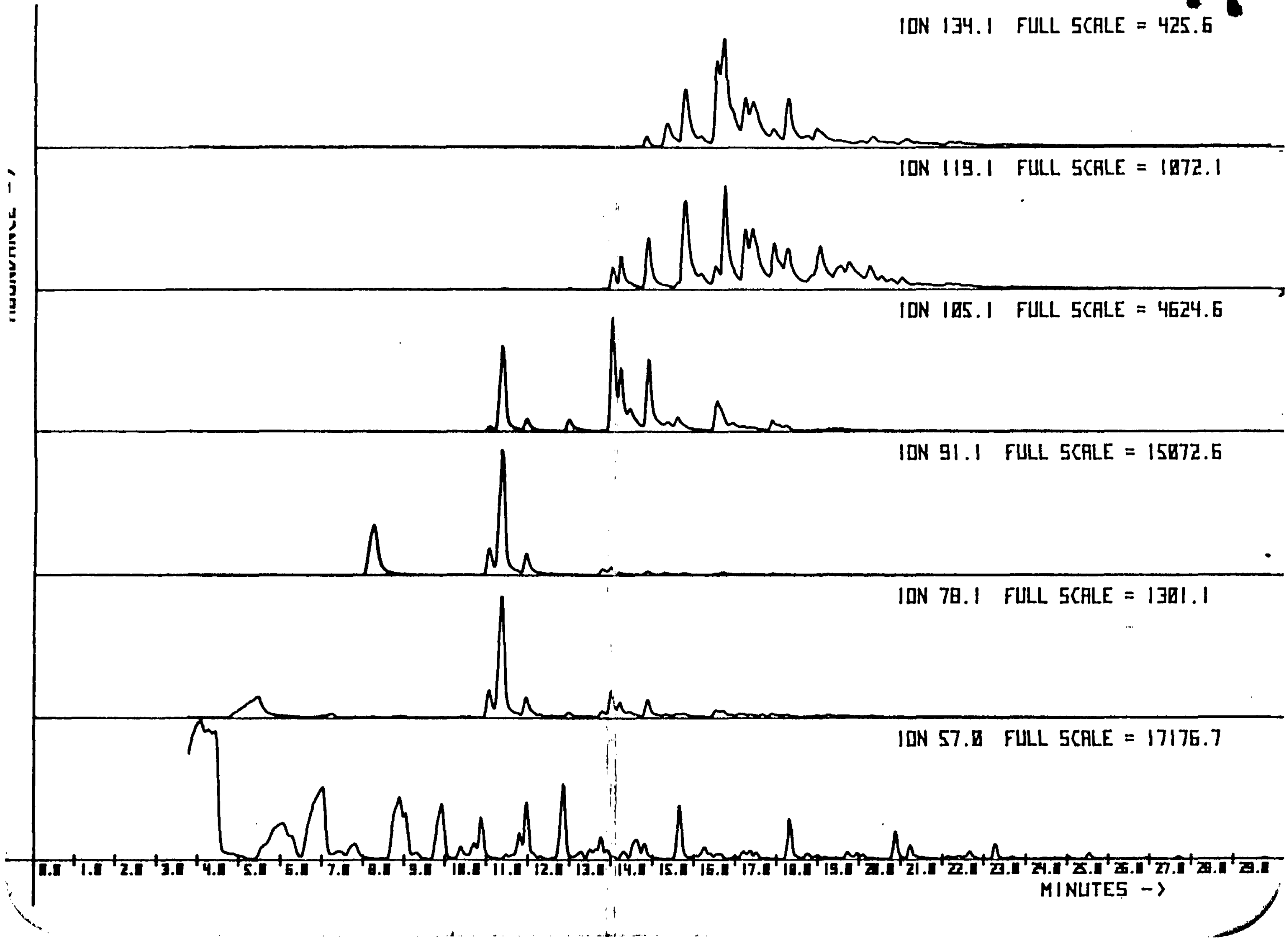
28.0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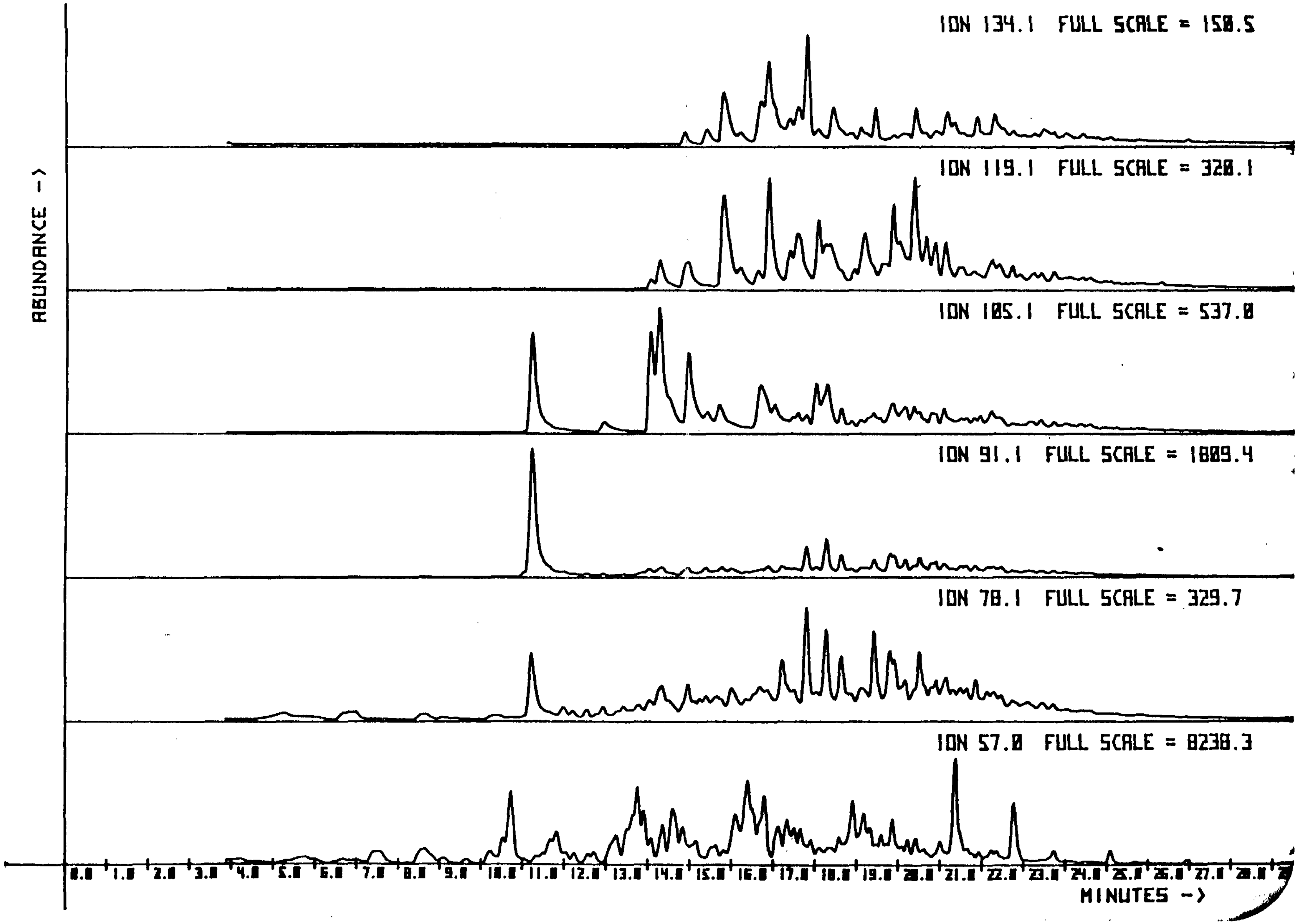
ION 119.1 FULL SCALE = 1072.1
ION 105.1 FULL SCALE = 4624.6
ION 91.1 FULL SCALE = 15072.6
ION 78.1 FULL SCALE = 1301.1
ION 57.0 FULL SCALE = 17176.7
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0
MINUTES ->


ION 134.1 FULL SCALE = 150.5
ION 119.1 FULL SCALE = 320.1
ION 105.1 FULL SCALE = 537.0
ION 91.1 FULL SCALE = 1809.4
ION 78.1 FULL SCALE = 329.7
ION 57.0 FULL SCALE = 8238.3
ABUNDANCE ->
MINUTES ->
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
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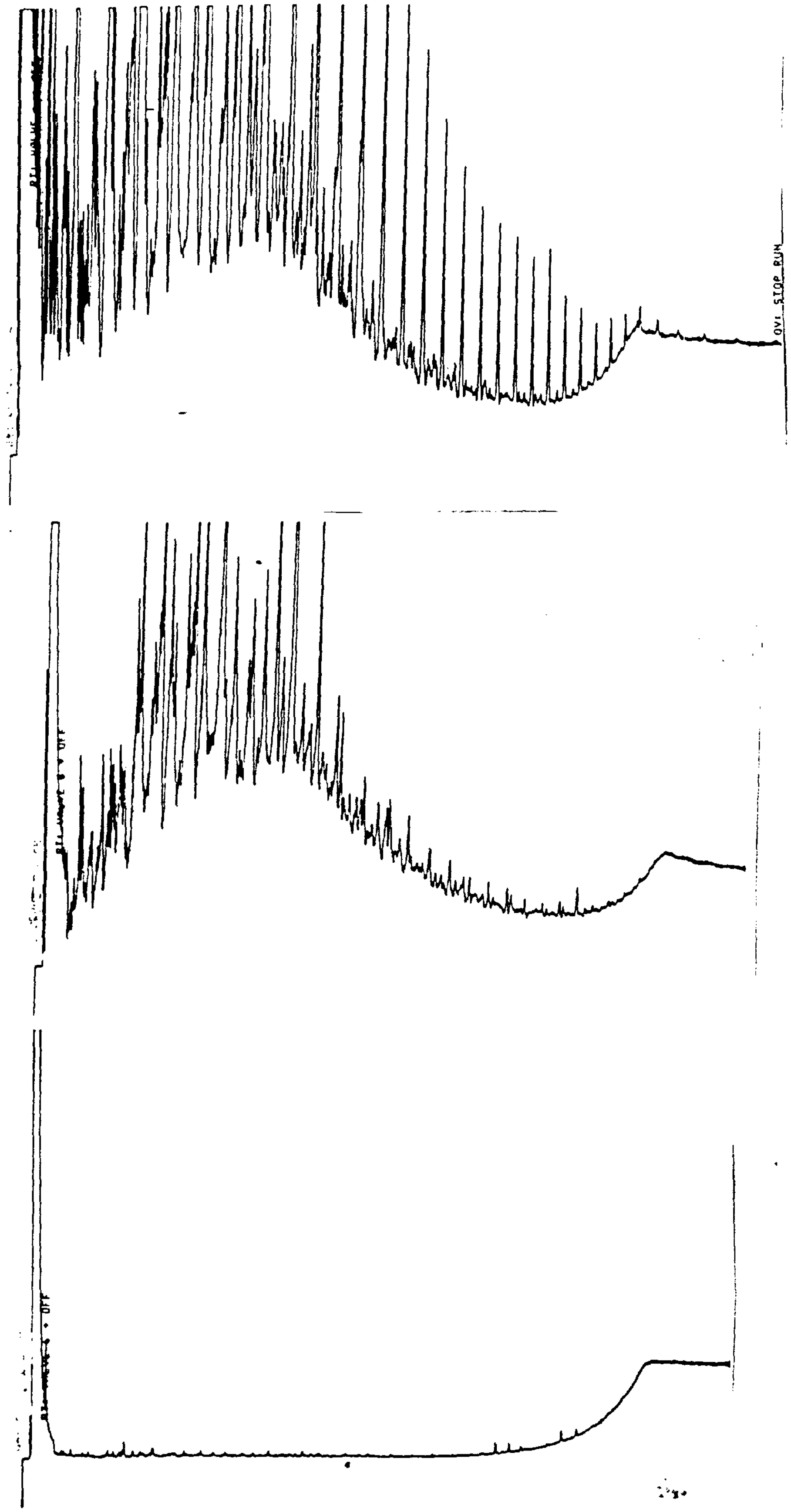
26.0
27.0
28.0



CURRICULUM VITAE

Name:	Gary Alan Eiceman
Addresses:	Home - 2020 Turrentine Drive Las Cruces, New Mexico 88005 Phone - (505) 524-1232 Work - Department of Chemistry New Mexico State University Las Cruces, New Mexico 88003 Phone - (505) 646-2146
Born:	November 28, 1952, at Reading, Pennsylvania
Citizenship:	USA
Education:	Conrad Weiser High School, Robesonia, PA, 1967-1970 West Chester State College, West Chester, PA, 1970-1974 University of Colorado, Boulder, CO, 1974-1978 University of Waterloo, Waterloo, ON, CANADA, 1978-1980
Degrees:	B.S. (Magna Cum Laude), Chemistry, 1974 Ph.D., Chemistry, 1978
Positions:	Analytical Chemist, Tri-Country Conservancy of the Brandywine, Inc., Chadds Ford, PA, 1973-1974 Research Assistant, Environmental Trace Substances Research Program, University of Colorado, 1976-1978 Postdoctoral Fellow, Guelph-Waterloo Centre for Graduate work in Chemistry, Department of Chemistry, University of Waterloo, 1978-1980 Assistant Professor, Department of Chemistry, New Mexico State University, August 1980 - August 1984 Visiting Professor, Facultad de Ciencias Quimicas, Universidad Antonoma de Chihuahua, Chihuahua, MEXICO, May 1983, January 1984, May 1984 Associate Professor, Department of Chemistry, New Mexico State University, Aug. 1984 to present

Professional Societies:	American Chemical Society Sigma Xi Analytical Chemistry Division (ACS)
Teaching at New Mexico State University:	Chemistry 421. Instrumental Methods of Analysis Chemistry 321. Quantitative Analysis Chemistry 571. Separation Chemistry Chemistry 101. General Chemistry
Awards:	American Chemical Society Outstanding Senior Chemistry major, WCSC. May 1974. Invitado de Honor at the combined celebration of 20th anniversary of the School of Chemistry at University of Chihuahua and the UN World Hunger Day, October 16, 1983.
Marital Status:	Married to Mary E. Wood, Toronto, Ontario, 1980.

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STATEMENT FOR THE RECORD OF THE APRIL 3, 1985 HEARING BEFORE THE OIL CONSERVATION COMMISSION

The Environmental Improvement Division (EID) supports efforts by the Oil Conservation Commission to develop regulations designed to ensure protection of ground water from liquids discharged to pits associated with oil and gas production wells in northwest New Mexico. EID representatives participated in the Short Term Study Group meetings held during the last 6 months, and EID generally supports the Recommendations document developed by that group at its meeting on January 9, 1985.

We submit the following calculations and discussion relevant to seepage of liquids from unlined pits and possible contaminant migration into the underlying aquifer. These calculations support our contention that no discharge should be permitted to unlined pits within vulnerable aquifer areas, unless site-specific field investigations demonstrate safe discharge levels.

Infiltration Rate

The rate at which a liquid infiltrates into a porous material can be described using the Green and Ampt equation (Bower, 1978, p 253):

$$v_i = \left[\frac{H_w + L_f - h_{cr}}{L_f} \right] K$$

Where
- v_i = infiltration rate
- K = hydraulic conductivity of the wetted zone
- H_w = depth of water above soil
- L_f = depth of wetting front
- h_{cr} = critical pressure head of soil for wetting
  - = > -20 cm for coarse sands;
  - = -20 to -60 cm for medium to fine sands; and
  - = -50 to < -200 cm for loams and clays.

  (Bouwer, 1978, p. 243.)

This equation can be used to estimate infiltrtion rates for any particular set of physical circumstances. The equation also illustrates the important concept that <u>infiltration will occur in the absence of ponded water on the soil surface</u> (ie when Hw = 0).

Example calculation using reasonable parameter values for the study area:

Assume
- $K = 1$ ft/day
- $H_w = 0$
- $L_f = 10$ ft
- $h_{cr} = -20$ inches $= -1.67$ feet (from Bouwer)

$$v_i = 1 \text{ ft/day} \; \frac{0 + 10 \text{ ft} - (-1.67 \text{ ft})}{10 \text{ ft}} \quad = \; 1.67 \text{ ft/day}$$

The rate at which a liquid infiltrates into a porous material is highest when the material is dry because the soil moisture tension is highest (i.e. the pressure head is more negative) under these conditions (see Figure 1). The infiltration rate decreases as the material becomes wetter because the soil moisture tension becomes lower (i.e. pressure head becomes less negative) and, if clay is present, because swelling occurs. The infiltration rate approaches a steady-state value, called the final infiltration rate, as the porous material becomes saturated. The final infiltration rate is numerically equal to the vertical hydraulic conductivity of the material. The final rate will remain essentially constant as long as the material remains saturated.

Infiltration rates are higher for coarse, open-textured materials (e.g. sandy soils) and are lower for materials having finer pores (e.g. clay soils). Hillel (1971, p. 140) states that final infiltration rates are typically greater than 20mm/hr (0.79 in/hr) for sands and between 10 and 20 mm/hr (0.39 to 0.79 in/hr) for sandy and silty soils. Initial infiltration rates would be considerably higher than these values.

Assuming a value of 20mm/hr, 0.49 gallons (0.066 ft^3) would infiltrate each hour for each square foot of wetted area. Thus, 12.3 gallons (0.29 barrel) would infiltrate per hour if the wetted area covers 25 square feet and 49.1 gallons (1.17 barrels) would infiltrate per hour if the wetted area covers 100 square feet. These values suggest that virtually all liquid discharged to an unlined pit (assuming an application rate of 0.5 barrel per day) potentially could infiltrate within two or three hours.

Length of time required to saturate porous materials beneath a pit.

The volume of liquid required to saturate an initially dry porous material is equal to the effective porosity of the material. Sand and gravel materials typically have porosities in the range 10% to 30%, unconsolidated fine to medium sands have porosities in the range 35% to 50%, and sandstones typically have porosities in the range 5% to 30% (Bouwer, 1978, p.22).

Assuming the water table is 10 feet below land surface, a material having a 5% porosity could hold 3.74 gallons (0.089 barrel) of liquid per square foot of wetted surface; a material having 30% porosity could hold 22.4 gallons (0.53 barrel) of liquid per square foot of wetted surface; and a material having 50% porosity could hold 37.4 gallons (0.89 barrel) of liquid per square foot of wetted surface. Using the intermediate porosity value (30%), the soil below a 25 square foot wetted area would be completely saturated after 13.3 barrels of liquid had infiltrated.

Negligi ble protection would be afforded to ground water if a discharge of 0.5 barrel per day were permitted since the available storage capacity of the vadose zone beneath the pit could be saturated within 27 days, assuming 25 square foot wetted area and 30% porosity.

Travel Time

Another important consideration is the rate or velocity of downward movement of the liquid. Under saturated conditions, this velocity will be equal to the vertical hydraulic conductivity of the porous material divided by its porositiy.

Typical hydraulic conductivity ranges for various materials are 2.83 to 2835 ft/day for clean sands (i.e., good aquifers); 0.0028 to 2.83 ft/day for clayey sands and fine sands (i.e., poor aquifers); and about 5.84 ft/day for sandstone having a 29% porosity (Davis and DeWiest, 1966, p. 162). These values are for horizontal hydraulic conductivity. A rule of thumb for sedimentary geologic materials is that vertical conductivity is about 10% of the horizontal conductivity.

Assuming a 30% porosity, vertical velocities would range from 0.001 foot per day in an unconsolidated clayey sand to 945 feet per day in a clean sand; and vertical velocities in a sandstone might be about 1.9 feet per day. Assuming an intermediate velocity of 1 foot per day, liquid introduced to an unlined pit would travel to the water table in just 10 days if the initial water table is 10 feet below land surface and the material below the pit is saturated.

If the porous material below the pit does not become saturated or does not remain saturated, the velocity of liquid movement would be reduced. This is because hydraulic conductivity under unsaturated conditions is a function of mositure content. Figure 2 illustrates how hydraulic conductivity decreases as a typical soil becomes drier. Figure 3 illustrates how unsaturated hydraulic conductivity, expressed as the ratio of unsaturated to saturated conductivity, decreases as a function of decreasing pressure head (i.e. as the porous material becomes drier). Information presented in these figures is important because it demonstrates that significant water movement occurs even under unsaturated flow conditions.

Velocity of regional ground-water flow

The average linear velocity of the liquid after it enters the regional ground-water system will be equal to the darcy velocity divided by the porosity of the formation. The darcy velocity is equal to the product of the hydraulic conductivity times the hydraulic gradient times negative 1.

Typical linear velocities for ground water in alluvium and sandstone in New Mexico are 4.3 and 2.0 feet/day, respectively (Wells and Lambert, 1981, p. 50). Velocities for specific sites can be calculated using the relationships presented in the previous paragraph if the local gradient and conductivity are known. However, the typical values presented above illustrate that rates of ground-water movement in river alluvium and sandstone could reasonably be expected to transport contaminants long distances from the point where they enter the aquifer.

Conclusions

Calculations presented in the preceding sections do not consider effects of evaporation, surface films or crusts, layering within the geologic materials, dispersion, adsorption, or biological degredation of contaminants. They do illustrate, however, that the potential exists for significant migration of contaminants from unlined pits to the ground water, if adequate control measures are not taken.

I reached the following conclusions based on calculations and assumptions described within previous paragraphs:

1. infiltration will occur even if ponded liquid is not present in the pit;

2. virtually all liquid discharged to unlined pits could infiltrate within

two or three hours;

3. the available storage capacity of the vadose zone beneath an unlined pit could be saturated within one month if 0.5 barrel per day was discharged to a pit located 10 feet above the water table;

4. the travel time required for liquid to move from the pit to the water table under saturated conditions could be on the order of 10 days; and

5. in the absence of significant retardation, contaminants which enter the regional ground water system might travel 2 to 4 feet per day.

Given this demonstrated potential for ground water pollution by contaminants discharged into unlined pits, EID recommends a conservative approach to establishing discharge limits. We feel that until and unless site-specific field investigations demonstrate safe discharge levels, there should be no discharge to unlined pits within vulernable aquifer areas. EID therefore fully supports the position of the Oil Conservation Division that there should be no blanket small-volume exemption for discharges within vulnerable aquifer areas.

FIGURE 1

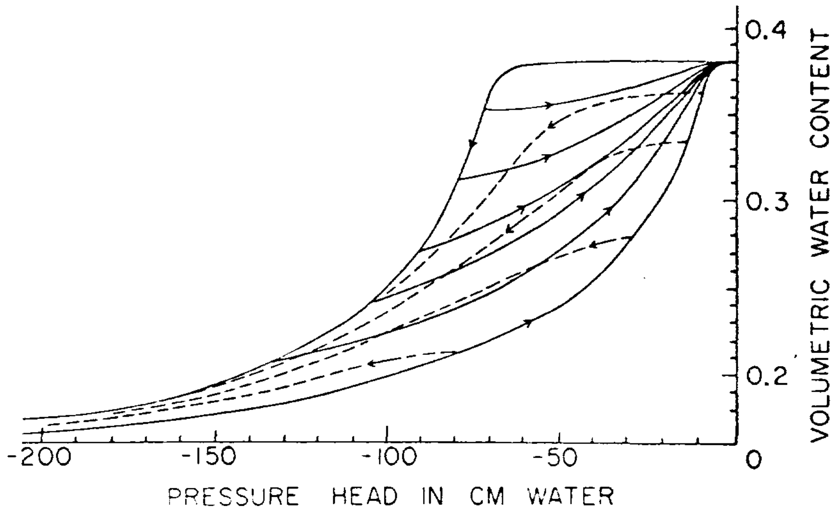

Figure 7.27 Hysteretic relations between h and θ for Rubicon sandy loam. (*From Topp, 1969, as redrawn by Watson, 1974.*)

[illegible] 1978, p. 238

FIGURE 2

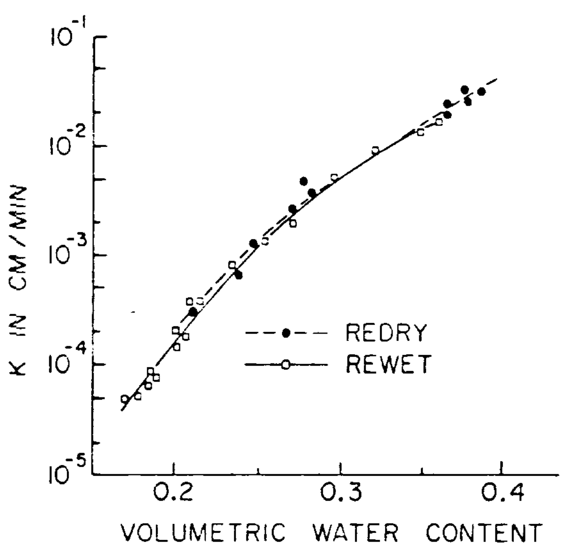

Figure 7.26 Relation between K_θ and θ for Rubicon sandy loam with different wetting and drying histories. (*Redrawn from Topp, 1969.*)

[illegible], 1978, p. 237.

FIGURE 3

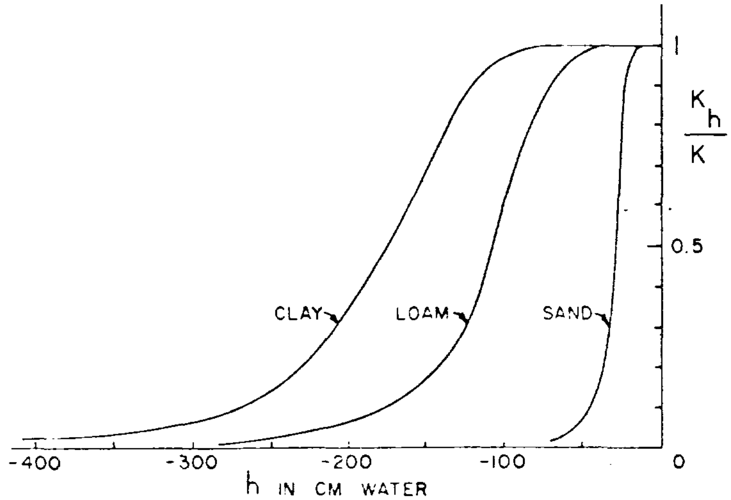

Figure 7.28 Schematic relations between K_h (expressed as K_h/K) and h for sand, loam, and clay.

from [illegible] 1978, p. 228
K_h is the unsaturated hydraulic conductivity, K is the saturated hydraulic conductivity and h is the hydraulic head.

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Statement of Qualifications

NAME: Douglas Earp

EMPLOYER: New Mexico Environmental Improvement Division
Ground Water Surveillance Section
P.O. Box 968 - Crown Building
725 St. Michaels Drive
Santa Fe, NM 87504

EDUCATION: M.S., HYDROLOGY, University of Arizona, December, 1981. Course work included Hydrogeology, Surface Water Hydrology, Soil Water Dynamics, Subsurface Fluid Dynamics, Aquifer Mechanics, Development of Ground-Water Resources, Statistical Hydrology, Water Quality Dynamics, Pollution in the Hydrologic Environment, Geochemistry, Unsaturated Flow in Fractured Media, and Water Resource Policy and Administration.

Thesis research involved measurement and modeling of the diffusion of atmospheric fluorocarbon gases in unsaturated porous media.

B.A., BIOLOGY, (minor in Geology) University of New Mexico, December, 1972.

EXPERIENCE: WATER RESOURCE SPECIALIST, New Mexico Environmental Improvement Division (8/84 - present). Investigate existing and potential ground-water contamination problems; conduct area-wide ground-water quality studies.

STAFF RESEARCH ASSISTANT, University of Arizona (12/81 - 7/84). Project titled "Unsaturated Flow and Transport through Fractured Rock - Related to High-Level Waste Repositories". Responsibilities includeD laboratory and field development and evaluation of methods for measuring moisture potential in unsaturated fractured rock, field measurement of water content using electrical resistivity and neutron logging, data interpretation, and report preparation.

HYDROLOGIST, Aqua Science, Inc. (11/80 - 1/82). Project involved a basin-wide water quantity and quality assessment for an Indian Reservation in New Mexico. Responsibilities included study design and implementation, extensive literature review, data interpretation, report preparation, and proposal writing.

GRADUATE RESEARCH ASSISTANT, University of Arizona (1/79 - 12/80). Research involved measurement and modeling of the diffusion of fluorocarbon gases in unsaturated porous media.

GRADUATE RESEARCH ASSISTANT, University of Arizona (1/78 - 12/80). Project involved the development of a methodology for evaluating and comparing hydrologic features of potential nuclear waste burial sites.

ENVIRONMENTAL SCIENTIST, New Mexico Environmental Improvement Agency - Water Quality Division (1/75 - 12/77). Conducted water quality studies of rivers, lakes, and reservoirs. Work included field sampling, laboratory analyses, data analysis and interpretation, and report preparation.

ENVIRONMENTAL TECHNICIAN, New Mexico Environmental Improvement Agency - Air Quality Division (1/74 - 12/74). Set up and maintained a network of monitoring equipment of particulate, nitrous oxide, and sulfer dioxide pollutants.

PUBLICATIONS: Weeks, E. P., D. E. Earp, and G. M. Thompson, 1982. "Use of Atmospheric Fluocarbons F-11 and F-12 to Determine the Diffusion Parameters of the Unsaturated Zone in the Southern High Plains of Texas." Water Resources Research, 18:1365-1378.

Jan 31 1985

Health department alleges company dumped illegally

By Deborah Uroda
Herald Staff Writer

The San Juan Basin Health Unit says it will file a complaint this week with the state Oil and Gas Conservation Commission against the William Perlman Gas Co. for allegedly dumping "several hundred thousand gallons" of brine water into Salt Creek south of Oxford.

The health unit also said it will file a complaint with the Colorado Department of Health and will seek legal action through the district attorney's office.

Frank Singleton, Basin Health director, said on Thursday that he has evidence that shows the Perlman Gas Co. of Houston siphoned off several hundred thousand gallons of brine water from a gas-well pit located off County Road 311 and dumped it into Salt Creek.

Singleton said he and La Plata County Commissioners Doris Brennan and Rollie Roth had received a complaint that Perlman was dumping brine water into the creek. On Sunday, the three drove to the gas well and took water samples at the pit and in a pond fed by the creek.

The pit had a 4-inch siphon pipe in it and the ice covering the pond had been broken, indicating that the level of the pond "definitely had dropped," Singleton said. Drilling equipment at the pit had the Perlman logo on it, he said.

The pond water downstream from the gas-well pit contained salts measuring 8,000 parts per million (ppm). The pit contained brine measuring 2,000 ppm. "That's way over what would be permitted to be discharged. That couldn't be used for drinking water," Singleton said.

The higher concentrations in the pond downstream, he said, indicate that the heavier brine water had been siphoned from the bottom of the gas-well pit into the stream, which eventually drains into the Florida River about three miles southwest of the Durango-La Plata County Airport.

Singleton said that state health regulations require that brine water be dumped in a licensed pit. The nearest licensed disposal pit is in Cedar Hill, N.M.

Bill Smith, director of the state Oil and Gas Commission in Denver, said on Thursday that he had received a verbal complaint about the alleged illegal discharges from Singleton. However, he must receive a written complaint before the commission takes action.

"From what I understand, it seems to be a flagrant violation," Smith said. He said that the commission will conduct an investigation into the matter once the written complaint is filed.

If Perlman is found in violation of commission regulations for dumping brine into surface waters, it can be fined up to $1,000 for the initial infraction and up to $1,000 a day for each day that the violation continues, Smith said.

No one answered the phone Thursday at the Perlman Gas Co.'s Ignacio offices, and no one returned calls made to Perlman's Houston offices.

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NOTICE

Reading and Bates Petroleum Co. has filed an application with the State of New Mexico Oil Conservation Division to convert an existing wellbore to an injection well for the purpose of the disposal of salt water. The proposed injection well is the Navajo Tocito No. 4 located 1963' FSL, 977' FWL Section 10 - Township 26 North - Range 18 West; San Juan County, NM. The proposed injection zone is the Pennsylvania "D" at a depth of 6,382-6,392' KB. The maximum injection rate is estimated at 2000 barrels of water per day with the maximum injection pressure estimated at 500 psi.

All interested parties must file objections or requests for hearing with the Oil Conservation Division, PO Box 2088, Santa Fe, NM 87501 within 15 days.

The applicant may be contacted at the following address:

Reading & Bates Petroleum Co. 1125 - 17th St. Suite 2300 Denver, CO 80202 Phone: 303-295-1447 Attention: T. Bruce Petitt

Legal No. 16491 published in the Farmington Daily Times, Farmington, New Mexico on Saturday, February 9, 1985.

Statement of Qualifications

Name William F. Lorang

Employer: El Paso Natural Gas Company
P. O. Box 1492
El Paso, Texas 79978

Education: BSCE 1969 NMSU
MSCE 1972 NMSU

Subject of Thesis: The Hydraulics of Unconfined Aquifer Recharge, November, 1971.

Professional Registration: Registered by the New Mexico State Board of Registration for Professional Engineers and Land Surveyors and authorized to practice Professional Engineering; Certificate #5668.

Related Work Experience: Mr. Lorang was employed by EPNG June 15, 1969 and since then has worked on various water resource problems related to natural gas transmission, preparation of coal mining plans and environmental statements in the states of Oklahoma, Texas, New Mexico, Wyoming, North Dakota, Arizona and Utah. During this time, numerous monitoring facilities for ground and surface water were designed and operated and aquifer tests were performed and evaluated.

Disposition of Produced Waters

This is a statement for the record of the hearing called by the New Mexico Oil Conservation Commission to define the extent of aquifers potentially vulnerable to contamination by the surface disposition of water produced in conjunction with the production of oil and gas in McKinley, Rio Arriba, Sandoval and San Juan counties, New Mexico. The Oil Conservation Commission seeks to define such areas and prohibit and/or limit the disposition of such produced waters on the surface of the ground.

This statement is intended as testimony to be presented at a hearing February 20, 1985 in Santa Fe, New Mexico. The statement provides information in support of continued use of certain unlined pits in the area. The statement also urges the Commission to consider exemptions to any forthcoming order which would provide for the continued use of certain unlined earthen pits.

El Paso Natural Gas Company (EPNG) has been in business in the San Juan Basin of northwest New Mexico for some 33 years. Gas reserves have been developed through our own exploration and development, and through the purchase of gas from many other operators. EPNG operates some 5000 wells in the Basin and has tied literally thousands of others into its gathering system.

We feel that we have operated these many years in a prudent manner as good citizens and good neighbors. There are some 1966 EPNG employees in New Mexico generating about $54,000,000 combined annual income. We also pay our taxes as a good citizen must. EPNG paid in excess of $61,000,000 in taxes to New Mexico last year.

In all our 33 years of operation, we have never had a complaint of groundwater contamination from landowners or groundwater users in the San Juan Basin. This record strongly suggests that a large problem of groundwater contamination simply does not exist. If there were a problem, surely in the last three decades evidence would have appeared in one of the 300 shallow water wells in the area.

The Short Term Water Study Committee has delineated a vulnerable area which, in the committee's opinion, includes the bulk of the area now being used for shallow water supply. This vulnerable area lies principally along the river bottoms of the San Juan, Animas and La Plata Rivers. The committee also identified other "special" areas which should be protected much like the vulnerable area.

Within the vulnerable and special areas, EPNG has 547 earthen pits. These pits vary in size and purpose. Some are used for disposal of water from primary separation of water from produced hydrocarbons, others are used only for disposal of water separated and/or dehydrated from the gas stream. To replace all these pits with tankage would cost EPNG in the neighborhood of $1.8 million.

The amount of water discharged to these various pits is generally not measured. Thus, we are uncertain of the volumes of water that, over a period of time, are discharged to them. We do know, however, that many pits are normally dry while others normally contain produced water. Of the 547 pits EPNG has in the vulnerable areas, 421 of them are normally dry. We offer that if a pit has water discharged to it less than 10 days in any calendar month, it can be considered normally dry.

We feel that we have a very large stake in the protection of the State's environment and that each incident of probable contamination of the groundwwater should be checked. However, to line normally dry pits would not provide any additional protection to the State's groundwaters, but would reduce the economic benefits to our stockholders, our employees, and the State of New Mexico. Therefore, we feel that we must have a small volume exemption to the pit control order from OCD.

If water is discharged onto soil, we have all observed that the soil is wetted but after a time again dries to its original condition by evapotranspiration. Soils will dry to depths of several feet due to the high evaporation and low precipitation rates common to the San Juan Basin. If water is discharged to a pit at a frequency to allow drying between discharges, then saturated soil conditions will not exist thereby precluding the transport of contaminants.

It is our understanding that many pits in which occasional discharges containing small amounts of crude oil have been made tend to be relatively impervious due to the sealing of pit bottom and sides. In such cases, the only means available for water to leave the pit is evaporation, thus further reducing any threat to the groundwater. It is also our understanding that water in a pit must have a driving force - a hydraulic head - before significant infiltration takes place. Absence of a hydraulic head - such as in the case of a normally dry pit - would indicate that there is no threat to groundwater.

Once the water infiltrates, native soils have an affinity to adsorb various substances - crude oil being one - thus providing an attenuation of contaminant transport. If the pit lies substantially above the water table, the infiltrating water passes through a column of soil thus providing the contact for adsorption of contaminants.

In short, at least two conditions are necessary in order for a pit to be a threat to the local groundwater. First, the pit must contain enough water to maintain a hydraulic head sufficient to act as the driving force of infiltration and overcome any sealing of surface pores. Second, it must be near the groundwater table for otherwise contaminants percolating downward would be adsorbed on soil particles before reaching the water table.

We would offer that there are many pits that don't meet the aforementioned criteria for being a threat. If they lie substantially above the water table and are normally dry - receiving discharges of water less than 10 days in a calendar month, they would not contain sufficient water to effect the transport of contaminants into the groundwater. Indeed, of EPNG's 547 pits, 421 - more than 3/4 - are normally dry. Such normally dry pits should be exempt from any order of regulation.

I repeat that EPNG believes each incident of probable contamination should be checked. And, EPNG is presently inspecting all of its pits with or without a pit control order from OCD. I believe that EPNG may have pits in use today which should be lined, or replaced with a tank. But, there is the continuing problem of determining which pits are a threat and which are not. We are aware of at least three laboratories, Sandia National Laboratory, Woodward Clyde Consultants, and the Southwest Research Institute, which are working on technology to determine the leaking potential of a particular pit at a cost which the government and industry could afford. EPNG is planning to provide Sandia National Laboratories in Albuquerque with several site locations for field testing of such technologies to verify its commercial applicability.

In summary, we urge the Commission to consider the fact that there are many pits, both in the vulnerable areas and elsewhere, that are doing no harm. Those pits should be allowed to continue unlined because they meet one of two critical criteria: 1) they are substantially above the groundwater table or 2) they are normally dry.

EPNG urges the Commission to adopt as a part of any order for control of unlined pits an exemption for those pits which meet the criteria of minimal threat. By providing for such exemptions, the resources available can be utilized to address those situations where there is a real threat to groundwater and to try new technologies in detecting those situations where the threat to groundwater is not clear.

EPNG, therefore recommends that any requirement of an order to prohibit and/or limit the disposition of produced waters should contain the following language:

Exemptions: The following earthen pits are exempt from the requirements of this order.

1) Pits lying outside vulnerable or special areas;
2) Pits to which no more than 5 barrels of produced water are discharged per day except where the depth to groundwater is less than 10 feet; and
3) Pits which are normally dry, i.e. to which produced water is discharged less than 10 days in any calendar month.

Thank you for this opportunity to express our concerns with respect to the pending order.

William F. Lorang, P.E.
Manager, Environmental Engineer
Environmental Affairs Department
El Paso Natural Gas Company
P. O. Box 1492
El Paso, Texas 79978

mts