

University of Jordan

Water Research and Study Center

Amman - Jordan



الجامعة الاردنية

مركز البحوث والدراسات المائية

عمان - الاردن

Ref: _____

..... : الرقم

Date: _____

..... : التاريخ

To Dr. Thomas Naff

% Ruth Matson

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Yarmouk Basin / Jordan

①

Yarmouk catchment area in both Jordan and Syria 6790 km^2

catchment area in Jordan 1160 km^2

average annual precipitation $280 \text{ mm} \pm 80 \text{ mm}$
↑
standard deviation

in $\text{mm/yr} = 324 + 93$

Monthly av. Precipitation

42 years av.

S	Oct.	N	D	J	F	M	A	M	J	
0.0	7	31	52	70	51	50	17	3	0.0	mm



35 45'

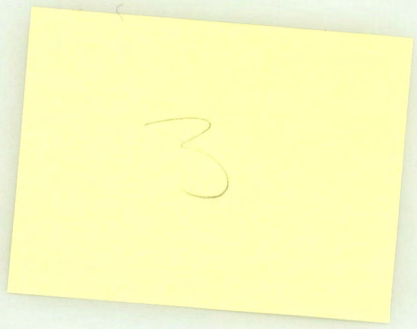
36 00'

36 15'

36 30'

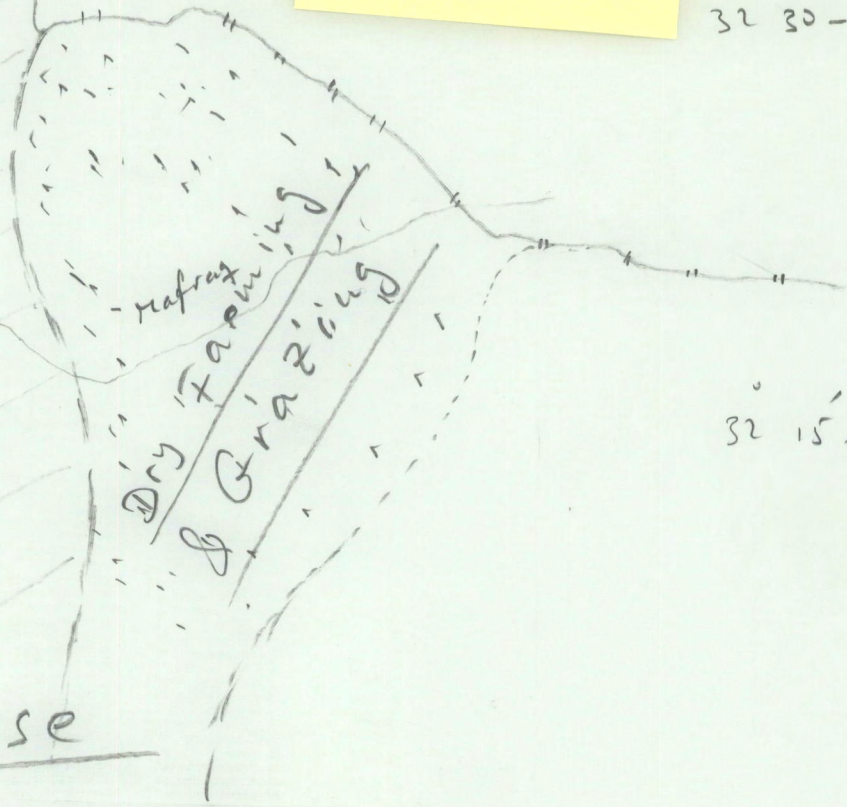
32 45'

Syria



32 30'

32 15'



Land Use

1:500 000

Tiberias

35°45'

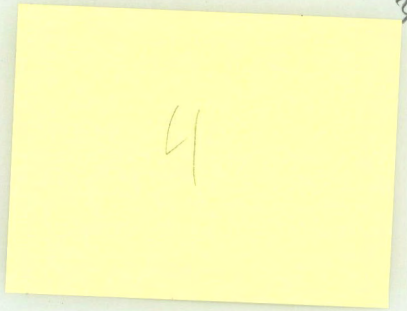
39°00'

250

15'

30'

31°45'



Yarmouk

Syria

Irbid

32°30'

Ajlun

Water shed

Mafraq

Zarash

Jordan

32°15'

catchment area in Jordan

36° 00'

36° 30'

5

Yarmuk

1800

Irbid

1900

water shed

Rafiq

2000

1900

Zarash

1800

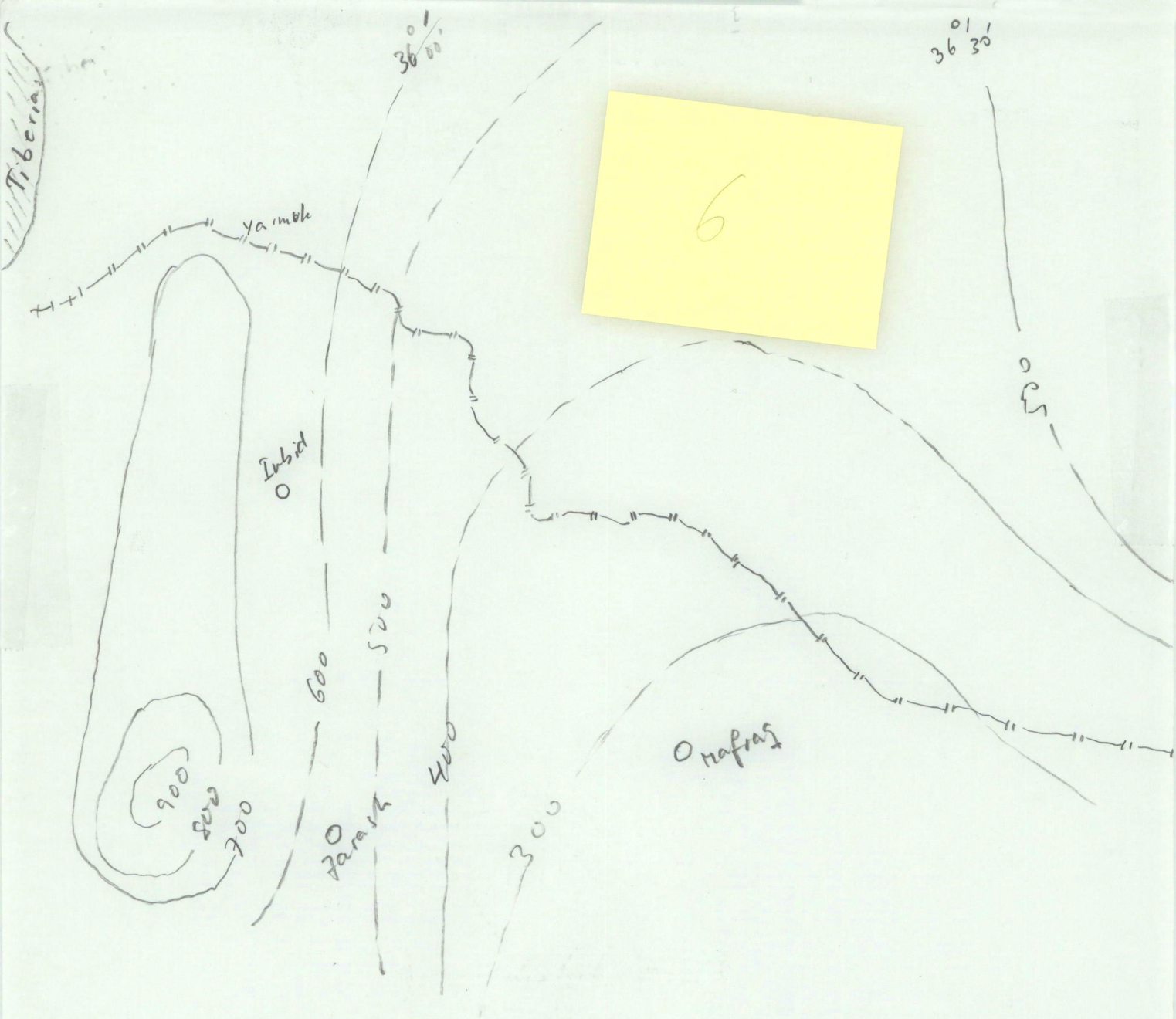
1700

1600

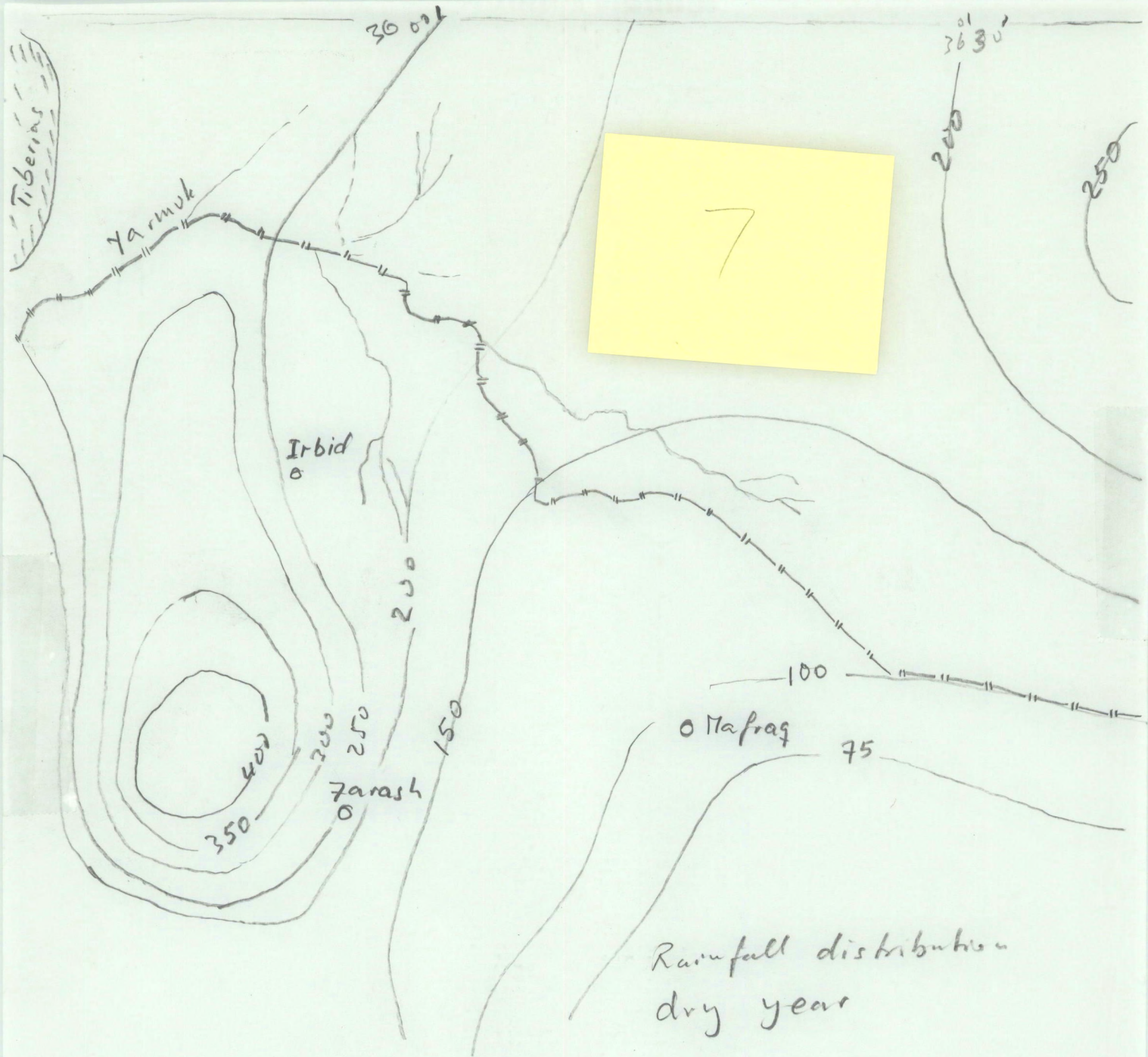
1900

Potential Evaporation

1: 500 000



Rainfall distribution (wet year)



Surface Water Resources

Three gaging stations are available on the Yarmouk River:

	<u>NO</u>	<u>Elevation</u>	<u>Drainage area</u>
Magarin	AD5	+12 m ASL*	5950 km ²
Hemmah	AD3	-175 m BSL*	6760 km ²
Adasiya	AD2	-212 m BSL	6790 km ²

Annual Average Discharge: 1954 -		1930 - 1953	
AD5	251 MCM	365 MCM	
AD3	no registration	—	—
AD2	318 MCM	467 MCM	

All over average 1930 - 1977

AD5	318 MCM
AD2	391 MCM

Monthly average (MCM)

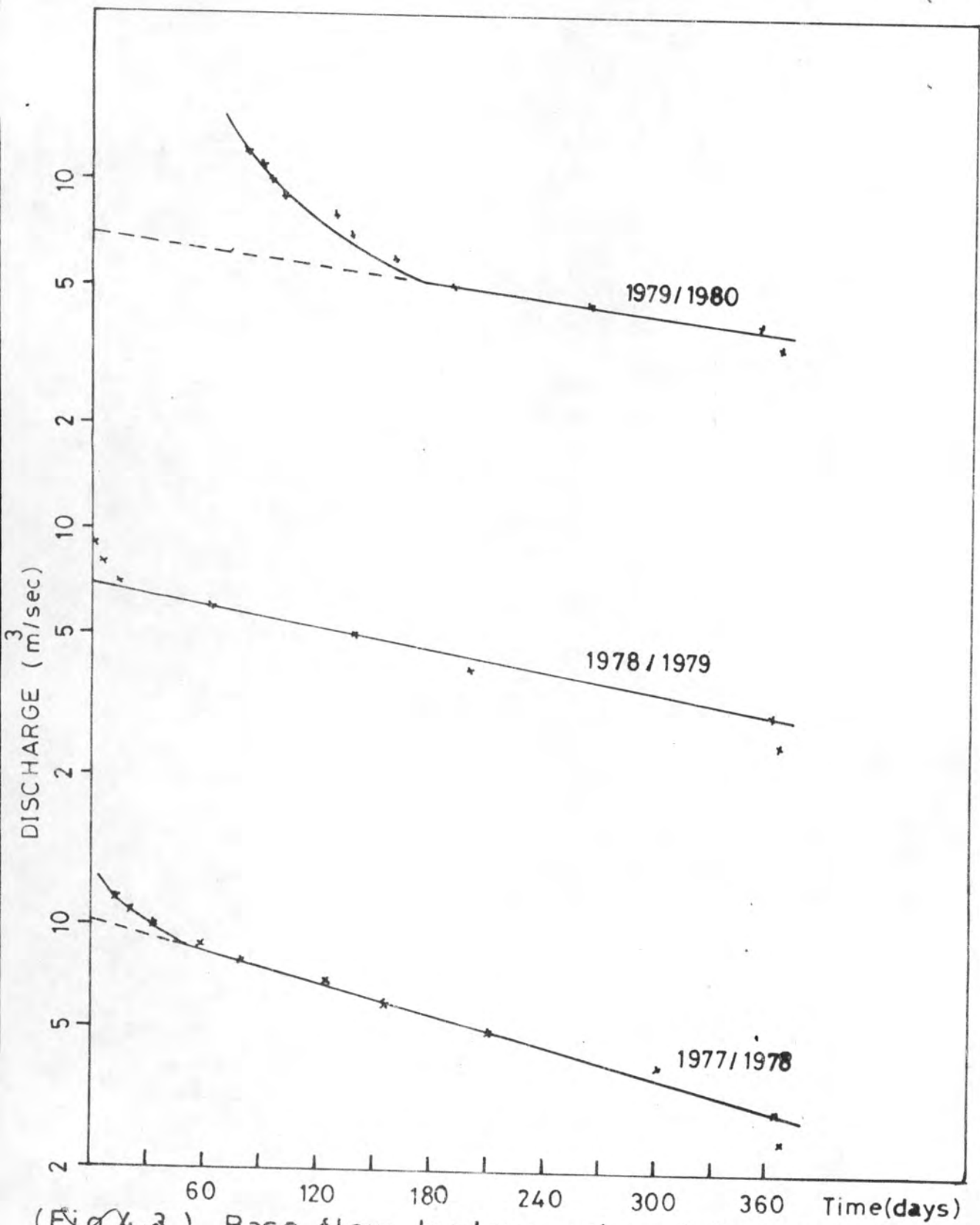
RD	OCT.	N	D	F	F	M	A	M	J	J	A	S	
AD5	15.6	16.2	23.3	34.3	35.1	32.7	22.4	14.9	13.5	14.0	14.6	14.9	} 1954-1977
AD2	18.4	19.6	29.6	47.9	57.9	41.3	21.5	17.3	16.0	15.9	16.1	16.3	
AD5	22.6	24.0	33.8	71.6	111.5	66.4	35.3	24.3	19.8	19.3	19.5	19.9	} 1930-1953
AD2	14.5	16.2	25.4	61.0	97.7	55.8	27.1	17.0	12.9	12.0	12.1	12.4	
AV. Monthly Discharge													
AD5	18.8	20.1	28.5	53	73.3	49.5	28.8	19.5	16.6	16.6	17.1	17.4	} AV-1930-1977
AD2	16.4	17.9	27.5	54.5	77.8	46.5	24.3	17.1	14.5	14.0	14.1	14.3	

*ASL = Above Sea Level

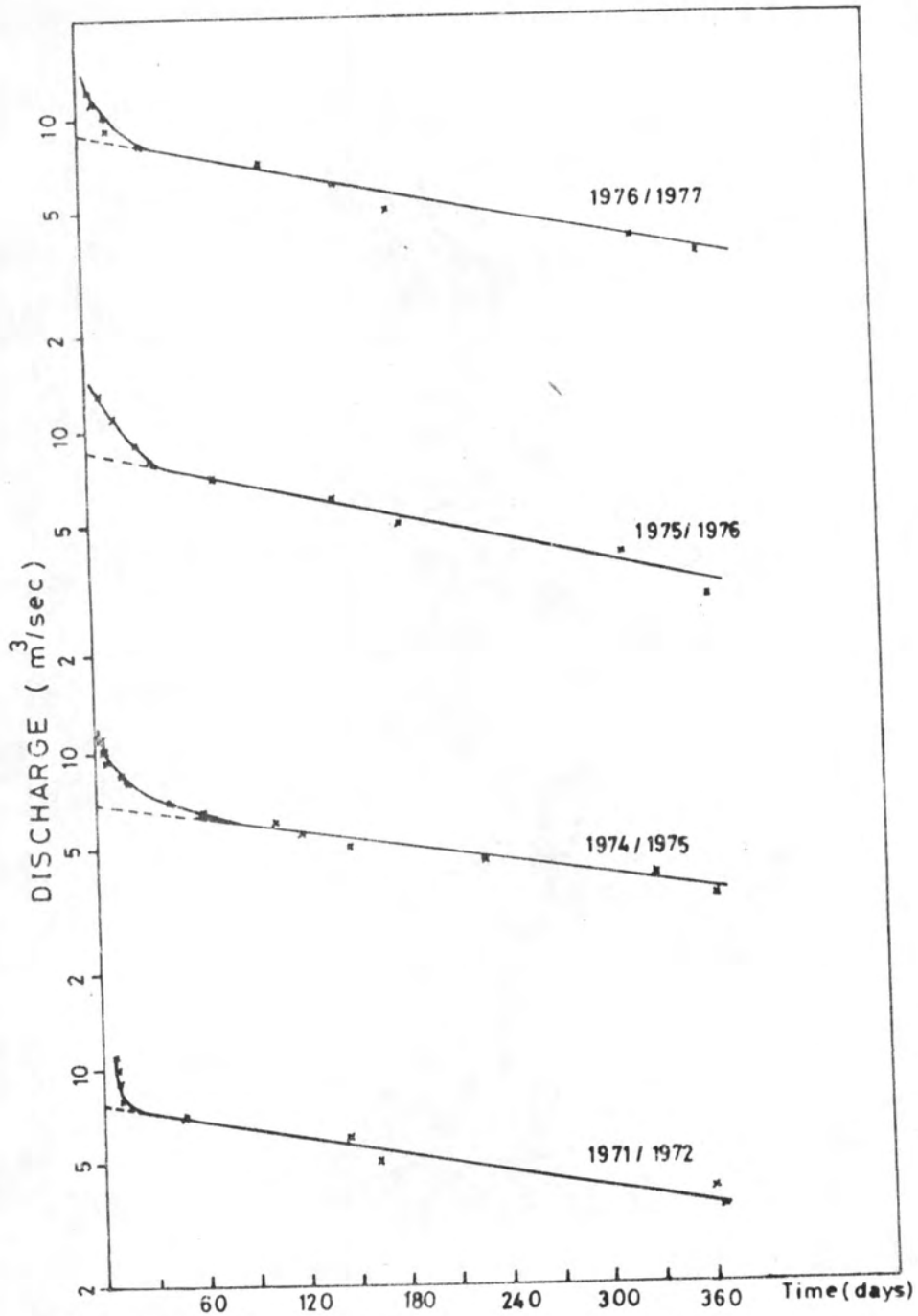
*BSL = Below " "

Table (4.1) Duration Table of the Discharge at station AD-5

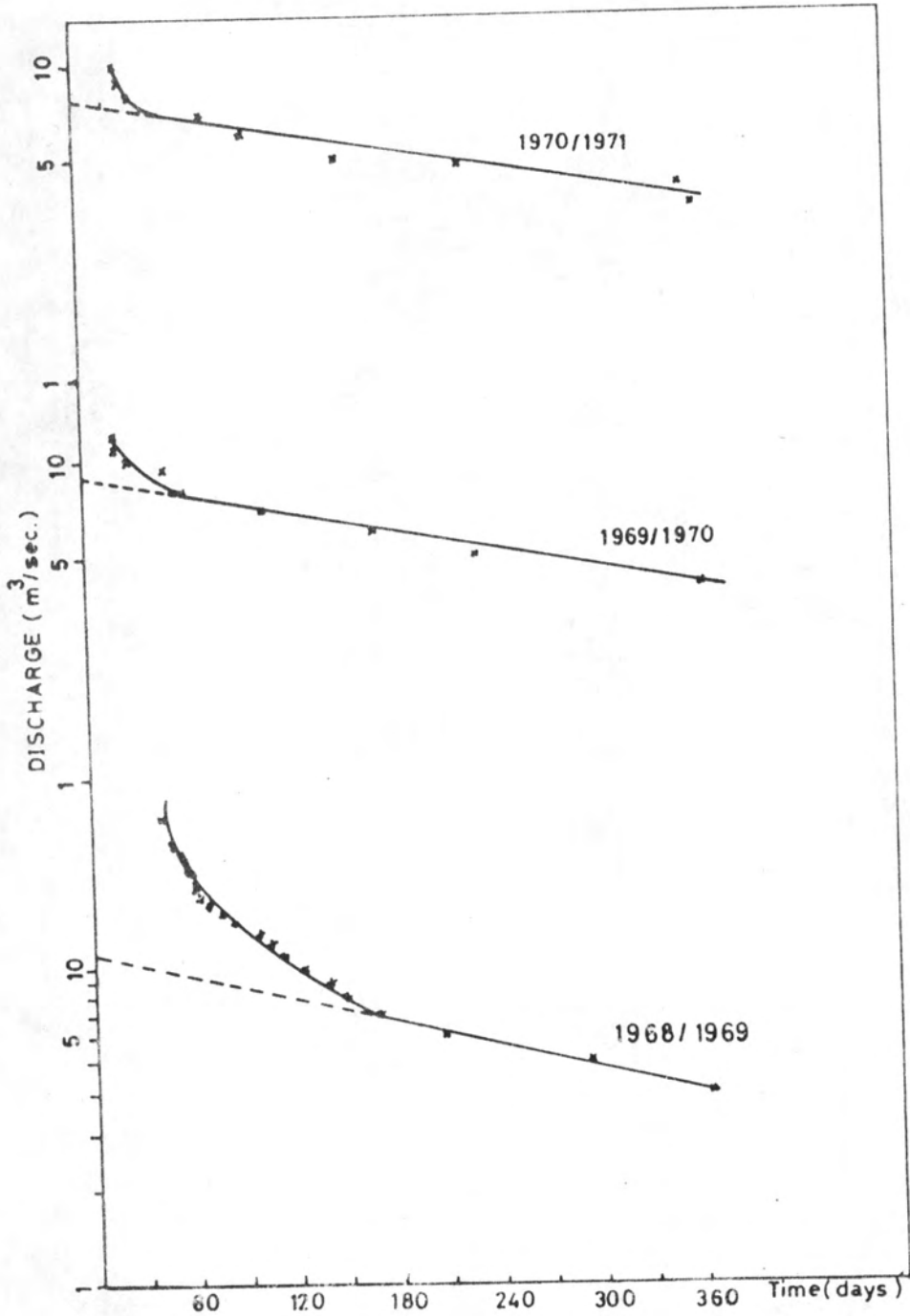
Discharge m ³ /sec.	1968/1969 days	1969/1970 days	1970/1971 days	1971/1972 days	1974/1975 days	1975/1976 days	1976/1977 days	1977/1978 days	1978/1979 days	1979/1980 days	1980/1981 days
> 18	60	12	14	3	-	5	2	7	-	42	42
17	63	13	15	3	-	5	3	7	-	45	45
16	68	14	17	4	-	5	3	8	-	65	65
15	76	14	17	4	-	7	5	9	-	69	69
14	83	15	17	5	-	7	6	10	-	74	74
13	99	16	19	5	-	8	6	12	-	78	78
12	106	19	21	5	1	11	7	14	-	81	81
11	112	19	24	7	1	16	10	22	-	91	91
10	124	26	25	8	5	23	15	33	-	95	95
9	140	47	27	10	13	29	18	59	1	111	111
8	148	59	33	10	19	38	37	79	5	131	131
7	168	105	75	47	43	74	107	124	14	138	138
6	206	170	100	145	106	148	151	156	63	161	161
5	292	231	155	162	149	184	182	211	140	193	193
4	364	364	358	360	330	316	326	301	202	355	355
3	364	364	365	366	365	366	365	364	362	365	365
2	364	364	365	366	365	366	365	365	364	365	365



(Fig 4.3) Base flow hydrographs of Yarmouk River



(Fig 2) Base flow hydrographs of Yarmouk River



(Fig. 1) Base flow hydrographs of Yarmouk River

Historic Discharge in MCN

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Year	AD5	AD2	Year	AD5	AD2
1930	306	555 402	1959	201	302
31	460	268 572	1960	205	244
32	277	890 377	61	232	289
33	156	402 248	62	245	389
34	257	572 354	63	221	327
35	464	377 577	64	252	412
36	217	248 319	65	289	447
37	352	354 458	66	189	258
38	427	577 544	67	421	613
39	311	319 436	68	203	138
1940	338	458 451	69	532	123
41	315	577 426	1970	224	76
42	367	477	71	269	92
43	478	599	72	182	280
44	366	490	73	—	244
45	550	670	74	—	—
46	245	353	75	156	298
47	219	315	76	131	—
48	305	420	77		
49	354	476	78		
1950	291	404	79		
51	283	387	1980		
52	542	652	81		
53	496	615	82		
54	348	664	83		
55	190	289	84		
56	282	457	85		
57	266	360	86		
58	240	373			

2005-06

111 AD-3

GAGING STATION ADS Y. MAQARIN

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WET	DRY	TOTAL
50/51	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
51/52	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
52/53	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
53/54	15.0	18.0	19.0	55.0	110.0	33.0	25.0	15.0	14.0	15.0	13.0	16.0	258.0	90.0	348.0
54/55	19.0	20.0	22.0	21.0	15.0	16.0	14.0	13.0	11.0	12.0	13.0	14.0	108.0	82.0	190.0
55/56	15.0	24.0	31.0	42.0	31.0	26.0	21.0	18.0	17.0	19.0	19.0	19.0	175.0	107.0	282.0
56/57	19.0	19.0	23.0	23.0	30.0	41.0	20.0	18.0	17.0	19.0	19.0	18.0	156.0	110.0	266.0
57/58	19.0	20.0	24.0	31.0	23.0	20.0	18.0	16.0	16.0	18.0	18.0	17.0	136.0	104.0	240.0
58/59	17.0	18.0	17.0	17.0	16.0	19.0	16.0	17.0	16.0	16.0	17.0	17.0	101.0	100.0	201.0
59/60	17.0	18.0	17.0	18.0	17.0	18.0	18.0	18.0	17.0	16.0	17.0	16.0	104.0	101.0	205.0
60/61	17.0	18.0	19.0	23.0	27.0	23.0	19.0	20.0	17.0	16.0	16.0	17.0	129.0	103.0	232.0
61/62	19.3	18.9	36.4	27.6	31.0	20.6	14.3	14.5	13.7	14.5	16.1	18.1	148.8	96.2	245.0
62/63	20.3	11.5	21.5	21.4	26.2	25.8	17.1	16.3	13.9	14.4	16.2	17.2	123.5	93.3	221.8
63/64	17.4	17.1	22.1	19.7	45.9	34.8	17.9	18.1	14.7	14.4	16.0	16.6	157.5	95.2	252.7
64/65	16.1	17.2	28.1	58.5	51.1	22.3	18.6	15.9	14.5	15.5	15.8	15.5	195.8	93.3	289.1
65/66	16.9	15.3	17.7	17.2	17.8	24.2	15.1	12.0	11.9	12.4	13.0	14.8	107.8	81.0	188.8
66/67	20.4	18.8	41.8	34.2	62.3	93.6	31.3	19.6	20.4	22.7	25.4	25.4	287.0	133.9	420.9
67/68	7.8	9.2	11.7	69.4	37.8	9.0	8.1	8.5	9.8	9.3	10.6	11.7	145.2	57.8	203.0
68/69	16.6	17.2	61.9	142.0	81.8	113.0	31.0	17.0	12.4	12.8	13.4	13.2	446.9	85.4	532.3
69/70	16.7	19.6	17.5	27.3	21.5	44.2	15.4	13.9	11.8	12.2	12.2	11.8	145.5	78.6	224.1
70/71	12.2	11.8	12.2	20.3	22.8	24.6	103.0	14.9	11.9	11.4	11.9	11.6	194.7	73.9	268.6
71/72	12.2	11.8	13.2	19.7	24.7	18.8	18.1	17.2	12.0	10.8	11.8	11.6	106.3	75.6	181.9
72/73	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
73/74	0.0-	0.0-	0.0-	53.3	71.2	62.4	0.0-	13.9	11.7	11.2	11.7	12.1	0.0-	60.6	0.0-
74/75	0.0-	8.0	17.2	15.4	21.8	24.1	11.3	11.3	11.5	13.0	10.7	11.3	97.8	57.8	155.6
75/76	12.9	14.0	16.7	17.1	22.5	29.9	18.0	0.0	0.0	0.0	0.0	0.0	118.2	12.9	131.1
AVERAGES															
	15.6	16.2	23.3	34.3	35.1	32.7	22.4	14.9	13.5	14.0	14.6	14.9	163.9	87.5	251.4

0.0- ... NO DATA AVAILABLE

III A-3.2
Page 5

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GAGING STATION A3 JORD WAHADNEH

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WET	DRY	TOTAL
50/51	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
51/52	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
52/53	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
53/54	0.0-	0.0-	0.0-	0.0-	380.0	240.0	160.0	130.0	80.0	68.0	67.0	66.0	0.0-	411.0	0.0-
54/55	84.0	74.0	96.0	66.0B	32.0	44.0B	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
55/56	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
56/57	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
57/58	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
58/59	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
59/60	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
60/61	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
61/62	0.0-	0.0-	0.0-	157.0	180.0	58.9	22.5	21.7	18.6	21.7	22.4	27.3	0.0-	111.7	0.0-
62/63	40.0B	75.3	55.1	64.4	116.0	124.0	50.6	69.1	26.3	19.4	13.5	17.5	485.4	185.8	671.2
63/64	26.4	45.3	179.0	61.0	239.0	216.0	96.4	49.4	21.5	16.0	16.3	15.6	836.7	145.2	981.9
64/65	21.1	102.0	148.0	224.0	239.0	47.7	34.8	17.3	19.7	14.5	12.2	16.0	795.5	100.8	896.3
65/66	27.4	25.1	33.6	41.6	57.4	47.4	23.3	12.4	12.0	9.9	10.3	13.4	228.4	85.4	313.8
66/67	23.3	21.5	76.1	100.0	162.0	332.0	146.0	36.4	16.2	13.0	10.4	13.7	837.6	113.0	950.6
67/68	18.1	24.1	99.1	361.0	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
68/69	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
69/70	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
70/71	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
71/72	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
72/73	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
73/74	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
74/75	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-
75/76	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-	0.0-

AVERAGES

27.6	53.8	98.4	98.2	162.7	153.4	70.2	36.9	19.1	14.6	12.5	15.2	636.7	126.0	762.8
------	------	------	------	-------	-------	------	------	------	------	------	------	-------	-------	-------

0.0- ... NO DATA AVAILABLE
 B- ... THE FIGURES ARE ESTIMATED ONLY FOR FEW DAYS
 STATION WAS CLOSED AFTER WAR 1967

water quality
Yarmouk River

During flood flows the total dissolved solids (TDS) content ranges from 260 mg/l up to 900 mg/l

The base flow has a TDS of 420 up to 490 mg/l

Representative analysis can be seen from the attached tables.

Trace metals have also very low ~~const~~ concentrations.

From the chemical point of view Yarmouk River water is suitable for drinking and domestic and irrigational purposes.

Table (5.1) : Chemical Composition of the Yarmouk River Water.

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Sample Number	Yarmouk River	Wach-Maddana	Wadi Ehrer	Yarmouk River	Yarmouk River	Yarmouk River	
Date	3.8.80	16.8.80	1.10.80	16.8.80	12.3.81	22.4.81	
Type of Source	River	River	River	River	River	River	
Temperature °C	24.5°C	25.0	23.0	26.0	-	-	
pH	6.5	6.8	6.8	6.8	6.8	-	
Ca ⁺⁺	mg/l	30.06	46.09	50.10	32.06	30.60	28.06
	m eq/l	1.50	2.30	2.50	1.60	1.50	1.40
	m eq%	18.87	26.41	30.53	21.53	30.86	20.12
Mg ⁺⁺	mg/l	32.83	30.40	25.54	24.32	13.38	26.75
	m eq/l	2.70	2.50	2.10	2.00	1.10	2.20
	m eq%	33.96	28.70	25.64	26.92	22.63	31.61
Na ⁺	mg/l	83.83	87.36	80.47	86.44	49.4	75.87
	m eq/l	3.65	3.80	3.50	3.76	2.15	3.30
	m eq%	45.91	43.63	42.74	50.61	44.24	47.41
K ⁺	mg/l	3.96	4.30	3.52	2.74	4.82	2.35
	m eq/l	0.10	0.11	0.09	0.07	0.11	0.06
	m eq%	1.26	1.26	1.10	0.94	2.26	0.86
Total Cations	m eq/l	7.95	8.71	8.19	7.43	4.86	6.06
CO ₃ ⁻⁻⁻	mg/l	24.01	18.02	18.02	12.00	0.00	12.00
	m eq/l	0.80	0.60	0.60	0.40	0.00	0.40
	m eq%	9.49	7.02	7.59	5.26	0.00	0.40
HCO ₃ ⁻	mg/l	207.47	207.47	195.26	189.19	158.65	176.96
	m eq/l	3.40	3.40	3.20	2.10	2.60	2.90
	m eq%	40.33	39.77	40.46	40.74	51.08	40.79
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	88.67	80.42	80.42	82.48	54.46	75.25
	m eq/l	2.5	2.27	2.27	2.23	1.54	2.12
	m eq%	29.66	26.55	28.70	29.30	30.26	29.82
NO ₃ ⁻	mg/l	14.55	12.91	15.62	16.81	11.10	14.52
	m eq/l	0.24	0.21	0.25	0.27	0.18	0.23
	m eq%	2.85	2.56	3.16	3.55	3.54	3.24
SO ₄ ⁻⁻⁻	mg/l	71.43	99.42	76.19	77.40	36.73	70.77
	m eq/l	1.49	2.07	1.59	1.61	0.77	1.46
	m eq%	17.68	24.21	20.10	21.10	4.13	20.77
Total Anions	m eq/l	8.43	8.55	7.91	7.61	4.89	7.11

Cont. Table 5.1

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Sample Number		Y. River	Y. River	Spring No. 3	Spring No. 3
Date		9.12.80	25.5.81	4.8.80	22.4.81
Type of Source		River	River	Spring	Spring
Temperature °C		-	-	27.0	-
pH		6.5	9.0	6.8	6.8
Ca ⁺⁺	mg/l	26.05	38.08	62.12	38.08
	m eq/l	1.30	1.90	3.10	1.90
	m eq%	27.96	24.87	36.91	32.93
Mg ⁺⁺	mg/l	19.46	24.36	17.02	18.24
	m eq/l	1.66	2.00	1.40	1.50
	m eq%	34.41	26.18	16.67	26.00
Na ⁺	mg/l	39.08	83.55	85.06	52.88
	m eq/l	1.70	3.63	3.70	2.30
	m eq%	36.56	47.51	44.05	39.86
K ⁺	mg/l	1.96	4.09	7.82	2.74
	m eq/l	0.05	0.11	0.20	0.07
	m eq%	1.08	1.44	2.38	1.21
Total Cations	m eq/l	4.65	7.64	8.40	5.77
CO ₃ ⁻	mg/l	0.00	24.01	0.00	0.00
	m eq/l	0.00	0.80	0.00	0.00
	m eq%	0.00	9.70	0.00	0.00
HCO ₃ ⁻	mg/l	152.55	175.96	256.28	195.24
	m eq/l	2.40	2.90	4.20	3.20
	m eq%	47.34	35.15	49.41	53.33
OH ⁻	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	57.33	86.14	85.57	55.45
	m eq/l	1.63	2.43	2.41	1.56
	m eq%	32.15	24.46	28.35	26.00
NO ₃ ⁻	mg/l	13.10	16.58	11.88	10.57
	m eq/l	0.21	0.27	0.19	0.17
	m eq%	4.14	3.27	2.24	2.83
SO ₄ ⁻	mg/l	39.87	88.77	81.75	51.27
	m eq/l	0.83	1.85	1.70	1.07
	m eq%	16.37	22.42	20.00	17.83
Total Anions	m eq/l	5.07	8.25	8.50	6.00
T.D.S	mg/l	273.53	454.06	479.36	326.85

Table 5.2: Trace Metal Composition Yarmouk River Water

Location	Date	pH	T.D.S p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.b	Fe p.p.m	Co p.p.b	Cd p.p.b	Mo p.p.b
Y.R.	3.8.80	6.5	421.11	7.23	4.93	11.35	11.32	0.05	19.63	0.194	5.17	N.D.	N.D.
	16.8.80	6.8	482.66	7.24	12.14	18.55	13.06	0.02	20.22	0.170	15.58	1.22	18.21
	16.8.80	6.8	447.51	5.85	7.55	10.18	11.29	0.22	21.29	0.178	14.16	N.D.	N.D.
	16.8.80	6.8	-	4.18	5.93	10.91	9.88	0.41	21.29	0.213	9.91	N.D.	N.D.
Y.R.	1.10.80	6.8	428.85	6.91	8.72	12.22	16.56	5.25	46.89	0.305	N.D.	1.65	8.38
		6.5	-	3.95	5.23	9.70	14.87	0.02	N.D.	0.039	13.29	N.D.	N.D.
		6.8	-	3.46	2.91	12.58	13.18	0.02	11.98	0.052	N.D.	N.D.	N.D.
	9.12.80	6.5	273.53	11.63	13.63	29.12	18.27	0.02	21.14	0.497	12.39	N.D.	14.72
	12.3.81	6.8	279.76	7.55	2.04	11.80	15.29	0.02	N.D.	0.147	10.84	N.D.	15.46
	22.4.81	-	393.55	6.58	4.97	17.42	14.04	0.05	20.15	0.151	14.03	1.64	12.63
	25.5.81	9.0	454.06	2.75	6.56	20.99	6.83	0.01	12.48	0.297	17.92	1.81	15.05
	23.6.81	6.8	468.09	7.71	6.56	18.78	6.41	0.02	18.15	0.204	11.69	2.89	N.D.

Y.R. : Yarmouk River

N.D. : Not detected

- : Not determined

19

Sediment Load

20

No significant sediment transport is found during the dry season.

By volume the amount of sediment load is estimated to be 0.3% of the annual flood volume.

By an ~~average of~~ discharge average of 319 MCM/yr for Magarin a sediment load of about
 $0.3\% \times 319 = 0.96 \text{ MCM of sediments}$
 $\hat{=} 2 \text{ Million tons of solid and suspended loads.}$

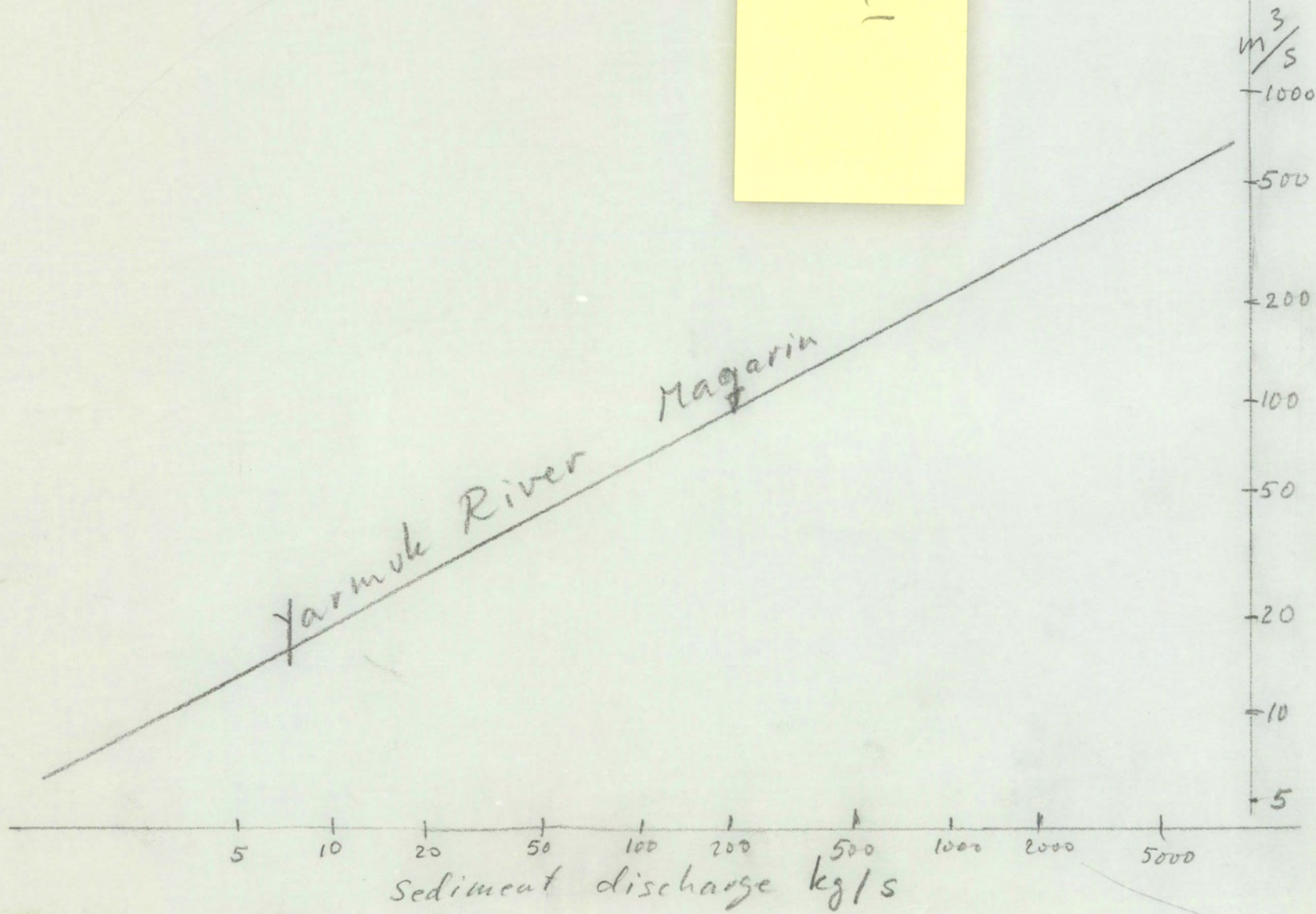
For Adasiya by an average discharge of 391 MCM^{1/yr} it equals $391 \times 0.3\% = \hat{=} 1.17 \text{ MCM of}$
sediment load $\hat{=} 2.3 \text{ Million tons.}$

Pollution

As can be seen from the major water constituents as well as trace metal contents the Yarmuk River water is chemically not polluted. The physical parameters are also very suitable for domestic and irrigational uses.

care must be taken by using chlorinating this water after long exposures to light, where the organic carbon contents increase due to the activities of microorganisms and Chloroform and bromoform are ~~produced~~ ^{then} produced by adding chlorine to disinfect the water.

21



The catchment area is covered by calcareous - siliceous rocks in the western catchment and by basalts in the eastern part. The weathering of these two rock types resulted, under the prevailing climate in the formation of two soil types:

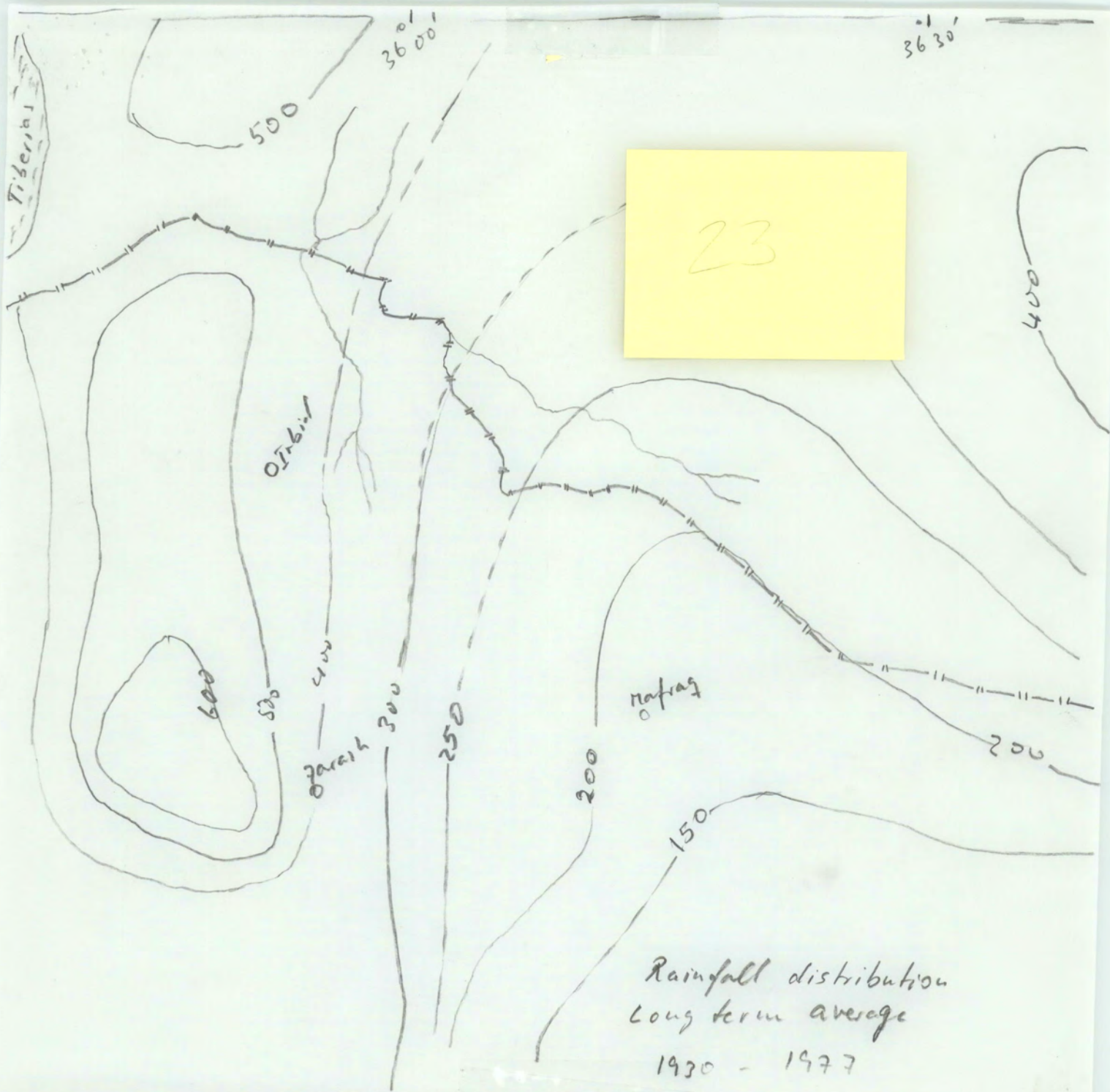
a. Yellow Mediterranean Soils:

They are related to the Brown Soils and differ from them by their extremely high calcareous content. They develop over basalt rocks (including lava) and have in some parts a dense cover of basalt boulders. In the Jordanian part of the Yarmouk Catchment they occupy the area to the east of NS-line ($36^{\circ} 07'$)

b. Red Mediterranean Soils

They develop from calcareous and silicious sediments. They differ from the typical Red Med. Soils by their high CaCO_3 content and by their base saturation of clay complex. This type of soil ~~develops~~ present in the area develop as a subgroup of typical Red. Med. Soils ~~by over rocks~~ in areas receiving lower amounts of precipitation.

In our area they occupy the highlands to the west of $36^{\circ} 07'$ N-S _{westward} to the slopes over the Jordan Valley



36° 30'

36° 00'

Tiberias

500

23

400

Qirbin

600

500

400

300

250

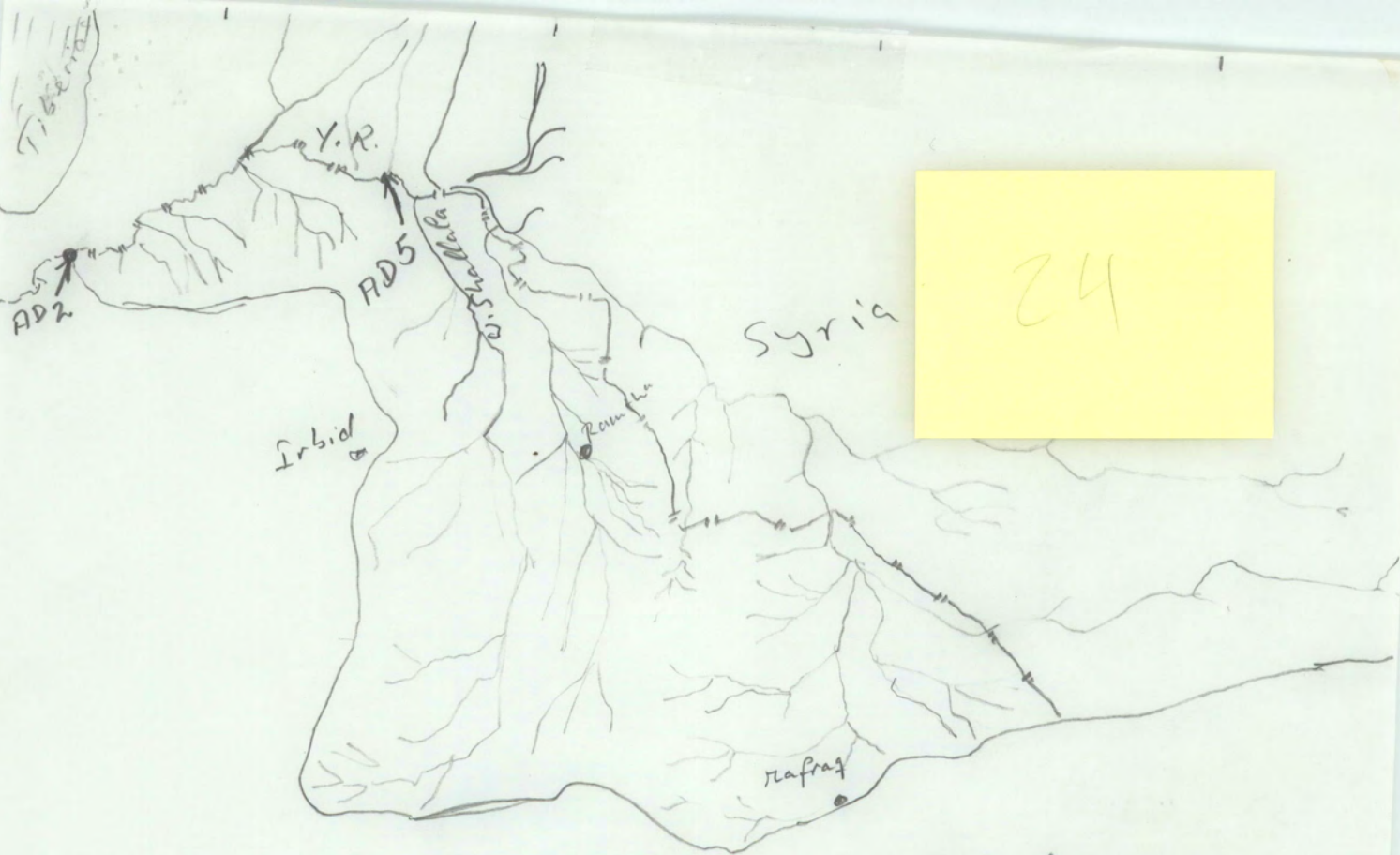
200

nafaq

200

150

Rainfall distribution
long term average
1930 - 1977



Drainage Basin in Jordan

1: 500 000

The amount of precipitation and the topography allows only for certain landuses mainly Dry Farming

Average altitude, Basin climatic Index, Soil classification, average precipitation allows to calculate a landuse factor of 0.8-0.85 with an average Runoff - precipitation factor as follows

	<u>ppt</u>	<u>av. Altitude</u>	<u>Runoff-coefficient %</u>		
			<u>Flood</u>	<u>base</u>	<u>Total</u>
Y.R. Adasiya	592 mm	900	14.1%	9.9%	24%
" " Magarin	326 "	700	5.5%	6.9%	12.4%

(National Water Master plan / Jordan 1977)

These springs issue from B4,5 and their overlying recent sediment rocks of Basalts and soils. (Lower Tertiary and Pleistocene). It includes Lower Chalky Unit, Cherty Unit, and Upper Chalky Unit. Basalts and Soils. (compare columnar section)!

Table (5.5) Chemical Composition of the Springs Water.

Sample Number	Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardas
Date	4.8.80	4.8.80	4.8.80	24.9.80	24.9.80	9.8.80
Type of Source	Spring	Spring	Spring	Spring	Spring	Spring
Temperature °C	34.5	32.0	32.0	20.5	20.5	23.0
pH	6.9	6.8	6.8	8.5	6.8	6.8
Ca ⁺⁺	mg/l	88.18	72.14	90.18	78.16	20.04
	m eq/l	4.40	3.60	4.5	3.90	100
	m eq%	34.06	35.33	50.28	39.80	4.43
Mg ⁺⁺	mg/l	52.29	42.56	30.40	25.54	15.81
	m eq/l	4.30	3.50	2.50	2.10	1.30
	m eq%	33.28	34.35	27.93	21.43	29.35
Na ⁺	mg/l	91.96	66.90	41.38	85.06	46.91
	m eq/l	4.00	2.91	1.80	3.70	2.05
	m eq%	30.95	28.56	20.11	37.76	46.05
K ⁺	mg/l	4.69	7.84	5.87	3.91	5.46
	m eq/l	0.12	0.18	0.15	0.10	0.09
	m eq%	0.93	1.77	1.68	1.02	2.03
Total Cations	m eq/l	12.82	10.19	8.95	9.80	4.43
CO ₃ ⁻⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	427.14	488.16	366.12	213.57	152.55
	m eq/l	7.00	7.80	6.00	3.50	2.21
	m eq%	48.54	68.24	64.87	35.90	48.15
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	177.33	96.91	64.95	113.41	44.33
	m eq/l	5.00	2.73	1.83	3.20	1.25
	m eq%	34.67	23.89	19.46	32.82	27.23
NO ₃ ⁻	mg/l	1.07	0.64	0.60	136.19	18.71
	m eq/l	0.02	0.01	0.00	2.20	0.30
	m eq%	0.14	0.09	0.00	22.56	6.54
SO ₄ ⁻⁻⁻	mg/l	117.46	42.75	68.25	40.80	16.20
	m eq/l	1.49	0.89	1.42	0.85	0.34
	m eq%	10.33	7.79	15.35	7.42	7.42
Total Anions	m eq/l	14.82	10.19	8.95	9.80	4.43

Cont. Table (5.5) :

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Sample Number		Ain Q. e. ba	Ain Quelba	Ain Quelba	Ain Quelba	Ain et Trab	Ain Shalaq
Date		8.3.72	14.12.77	7.5.80	10.11.80	8.9.80	21.7.79
Type of Source		Spring	Spring	Spring	Spring	Spring	Spring
Temperature °C		-	-	-	-	24.0	-
pH		-	-	-	-	6.8	-
Ca ⁺⁺	mg/l	70.54	68.14	70.54	68.14	68.18	60.92
	m eq/l	3.523	3.40	3.52	3.40	3.40	3.04
	m eq%	80.09	71.88	77.88	72.08	67.73	52.96
Mg ⁺⁺	mg/l	4.38	6.06	4.74	7.30	7.30	11.68
	m eq/l	0.36	0.50	0.39	0.60	0.60	0.96
	m eq%	8.24	10.57	8.63	12.71	11.95	16.73
Na ⁺	mg/l	10.35	18.39	13.79	15.17	22.99	39.08
	m eq/l	0.45	0.80	0.60	0.66	1.00	1.70
	m eq%	10.30	16.91	13.27	13.98	5.02	29.62
K ⁺	mg/l	2.35	1.17	0.39	2.35	0.78	1.56
	m eq/l	0.06	0.03	0.01	0.06	0.02	0.04
	m eq%	1.37	0.63	0.22	1.27	0.40	0.70
Total Cations	m eq/l	4.37	4.73	4.52	4.72	5.02	5.74
CO ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	10.20
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.84
	m eq%	0.00	0.00	0.00	0.00	0.00	5.87
HCO ₃ ⁻	mg/l	211.13	211.13	205.03	207.47	225.77	183.06
	m eq/l	3.46	3.46	3.36	3.40	3.70	3.00
	m eq%	77.75	80.65	72.41	77.63	76.61	51.81
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	20.56	28.01	21.99	22.68	22.68	54.25
	m eq/l	0.58	0.79	0.62	0.64	0.64	1.53
	m eq%	13.03	18.42	13.36	14.61	13.25	26.43
NO ₃ ⁻	mg/l	0.00	0.00	33.49	24.90	22.30	32.34
	m eq/l	0.00	0.00	0.54	0.34	0.36	0.44
	m eq%	0.00	0.00	11.64	0.71	7.45	0.77
SO ₄ ⁻	mg/l	19.69	1.02	5.76	0.00	6.15	24.21
	m eq/l	0.41	0.04	0.12	0.00	0.13	0.44
	m eq%	9.21	0.93	2.59	0.85	2.69	6.91

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Cont. Table (5.5) :-

Sample Number	Ain-Shalaq	Ain-Um Jrain		Spring NO.7	Ain-Ba'houl	Ain-Sombal
Date	20.7.80	21.7.79	20.7.80	6.9.80	6.9.80	6.9.80
Type of Source	spring	spring	spring	spring	spring	spring
Temperature °C	-	-	-	22.50	23.00	23.00
pH	-	-	-	6.80	6.80	6.80
Ca ⁺⁺	mg/l	66.13	52.10	63.73	104.21	128.26
	m eq/l	3.30	2.60	3.18	5.20	6.40
	m eq%					
Mg ⁺⁺	mg/l	14.59	10.46	13.62	23.10	41.34
	m eq/l	1.20	0.86	1.12	1.90	3.40
	m eq%					
Na ⁺	mg/l	42.76	57.48	62.99	22.99	41.38
	m eq/l	1.86	2.50	2.74	1.00	1.80
	m eq%					
K ⁺	mg/l	3.13	1.56	3.91	2.74	2.35
	m eq/l	0.08	0.04	0.10	0.07	0.06
	m eq%					
Total Cations		6.00	7.14	8.17	11.66	8.24
	m eq/l					
CO ₃ ⁻⁻⁻	mg/l	0.00	2.40	0.00	0.00	0.00
	m eq/l	0.00	0.08	0.00	0.00	0.00
	m eq%	0.00	1.37	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	223.33	147.67	237.98	378.32	390.53
	m eq/l	3.66	2.42	3.90	6.30	6.40
	m eq%		41.44	52.07		
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	61.35	81.56	82.98	39.18	79.39
	m eq/l	1.73	2.30	2.34	1.11	2.24
	m eq%		39.39	31.24		
NO ₃ ⁻	mg/l	46.51	39.69	56.43	6.09	6.40
	m eq/l	0.75	0.64	0.91	0.14	0.10
	m eq%		10.96	12.15		
SO ₄ ⁻⁻⁻	mg/l	16.23	31.70	5.76	62.69	111.71
	m eq/l	0.34	0.66	0.12	1.11	2.23
	m eq%					

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Table (5.6): Trace Metal Composition of the Springs Water

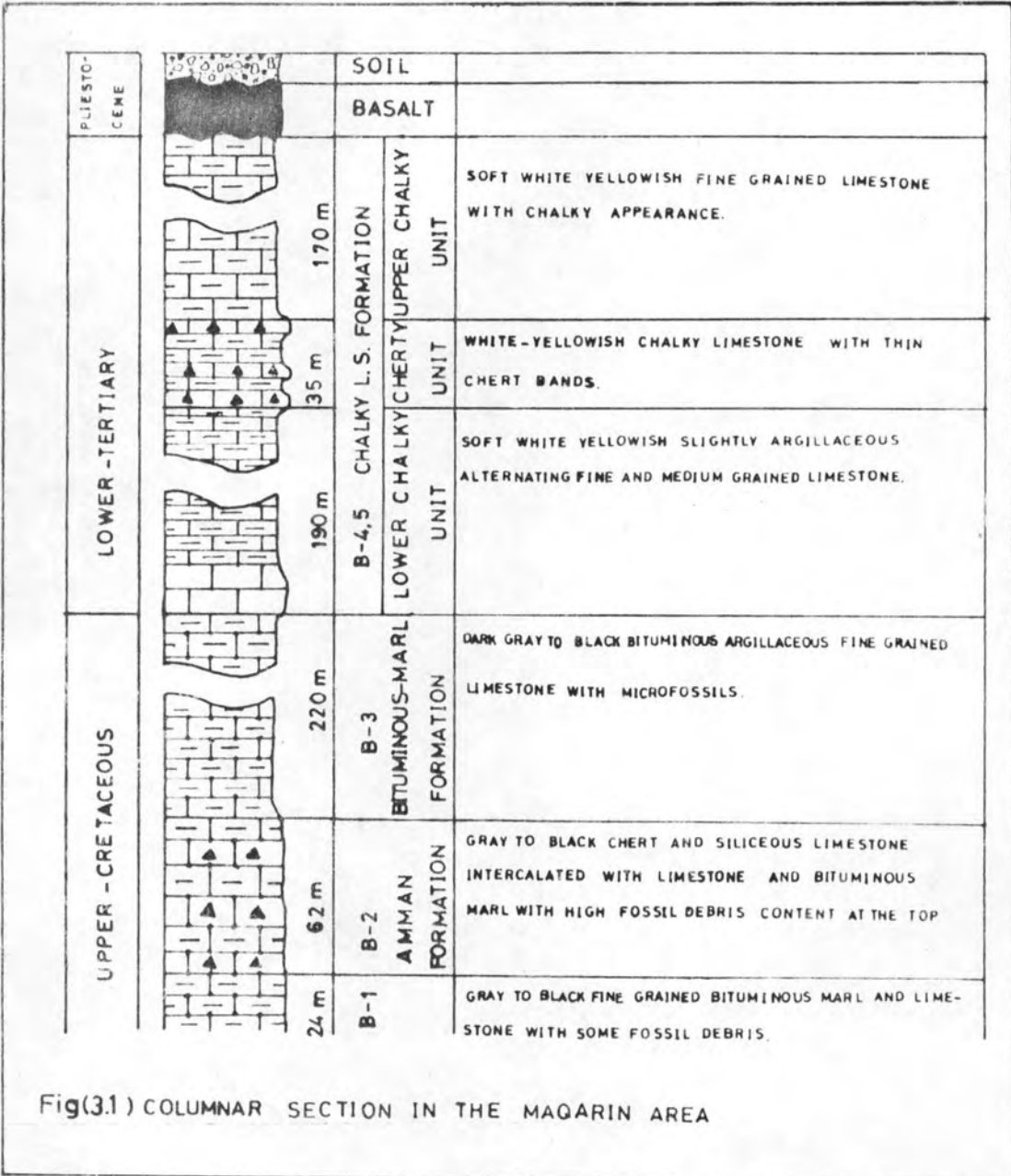
Location	pH	T.D.S p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.b	Fe p.p.m	Co p.p.b	Cd p.p.b	As p.p.b
SP5 No 4	6.9	746.55	5.32	17.81	7.22	15.65	0.01	18.60	0.063	9.60	2.34	N.D.
" " 9	6.8	573.02	5.53	6.30	3.44	12.99	0.02	21.70	0.123	13.29	1.54	N.D.
" " 2	6.8	484.69	4.68	20.27	3.44	13.65	0.02	N.D.	0.076	5.91	2.14	N.D.
" " 3	6.8	479.36	5.96	5.21	7.22	10.99	0.03	14.03	0.116	6.65	N.D.	N.D.
" " "	6.8	326.85	3.39	7.22	15.57	8.97	0.03	12.31	0.396	10.13	1.55	N.D.
Quscir	8.5	589.86	13.65	25.02	3.09	15.55	0.09	23.81	0.371	N.D.	1.51	N.D.
Charab	6.8	247.74	2.58	4.83	7.20	8.11	0.02	15.87	0.180	N.D.	1.00	8.0
No. 7	6.8	450.76	6.46	3.78	6.18	29.65	0.03	19.16	0.086	9.94	1.79	N.D.
Ba'bool	6.8	606.40	8.07	25.08	19.27	7.41	0.02	27.67	0.196	N.D.	1.79	20.00
Sombal	6.8	444.34	6.68	4.85	4.00	31.17	0.04	17.03	0.080	N.D.	2.03	8.0
el-Trab	6.8	502.86	6.93	5.12	2.74	12.17	0.02	12.27	0.052	5.94	0.97	N.D.
Quelba	6.8	258.68	8.89	9.01	4.31	19.61	1.59	55.91	0.122	12.46	2.17	N.D.
Murda Lia	6.8	796.57	8.67	20.23	12.00	19.77	0.03	24.48	0.266	18.41	2.28	N.D.

N.D. : Not detected

Table (2.1): Location of Sampling sites not plotted on the map.

Coordinates.

Sampling Site	N	E
Spring No. 4	237,799.2	232,676.9
Ain El Merdashia	236,451.49	233,397.96
Spring No. 7		
Ain Ba'bul	234,380.0	233,402.2
Ain Sombal	235,118.8	233,229.0
Ain et Trab	229.900	226.900
Ain el Quseir	Springs Issue from the basalts in the Syrian Side.	
NRA-Saham Exp. 234.000	234.000	222.000
Travertine Zone seepage	236,981.7	232.739,96
Ain Quelbe	231.600	231.000
Ain Shelaq	221.000	238.400
Ain Um jrain	221.200	240.100



Fig(3.1) COLUMNAR SECTION IN THE MAQARIN AREA

Chemical composition of high pH water

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cont. Table(5.3)

upper portion of B-3/Biduminous
Marl Formation (compare columnar
section!)

Sample Number		FS-1	Travertine zone	AFS-2	A-1	A-4
Date		5.8.80	16.8.80	5.8.80	5.9.77	6.9.77
Type of Source		Seepage	Seepage	Seepage	Seepage	Seepage
Temperature °C		24.5	-	24.5	-	-
pH		12.5	12.5	12.5	12.5	12.5
Ca ⁺⁺	mg/l	923.84	735.47	679.36	710.10	310.62
	m eq/l	46.10	36.70	33.90	35.43	15.50
	m eq%	94.82	83.33	92.55	91.81	79.01
Mg ⁺⁺	mg/l	Zero	6.08	3.65	Zero	7.30
	m eq/l	0.00	0.5	0.30	Zero	0.60
	m eq%	0.00	1.14	0.82	0.00	3.08
Na ⁺	mg/l	45.98	124.15	50.58	59.77	68.97
	m eq/l	2.00	5.40	2.20	2.60	3.00
	m eq%	4.11		6.01	6.74	15.41
K ⁺	mg/l	20.33	75.85	20.72	21.90	14.47
	m eq/l	0.52	1.94	0.53	0.56	0.37
	m eq%	1.07	12.26	1.45	1.45	1.90
Total Cations	m eq/l	48.62	44.04	36.63	38.59	19.47
CO ₃ ⁻	mg/l	36.01	162.05	60.02	42.33	18.31
	m eq/l	1.20	5.46	2.00	1.41	0.61
	m eq%	2.47	12.58	5.50	3.33	3.09
HCO ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
OH ⁻	mg/l	682.10	435.46	474.58	523.06	175.88
	m eq/l	40.10	25.60	27.90	30.75	10.34
	m eq%	82.44	59.62	76.69	72.51	52.51
Cl ⁻	mg/l	101.04	253.63	74.23	95.74	92.91
	m eq/l	2.85	7.15	2.09	2.70	2.62
	m eq%	5.86	16.65	5.75	6.37	13.25
NO ₃ ⁻	mg/l	2.25	32.94	8.18	7.75	2.86
	m eq/l	0.04	0.53	0.13	0.13	0.05
	m eq%	0.08	1.23	0.36	0.31	0.25
S ⁻	mg/l	223.34	204.61	204.61	356.38	200.20
	m eq/l	4.65	4.20	4.20		
	m eq%	9.56	8.78	11.71	17.00	10.25
Total Anions	m eq/l	48.64	44.04	36.38	42.41	19.47
T.D.S.	mg/l	1000.00	2000.00	1575.00	3711.76	6977.08

Cont. Table (5.3)

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Sample Number		W.S.-see- page	W.S.-see- page	W.S.-see- page	W.S.-see- page	W.S.-see- page	W.S.-see- page
Date		5.8.80	.1.81	12.3.81	22.4.81	23.6.81	14.2.77
Type of Source		seepage	seepage	seepage	seepage	seepage	seepage
Temperature °C		29.0	-	-	-	-	-
pH		12.5	12.5	12.5	12.5	12.5	12.5
Ca ⁺⁺	mg/l	815.63	545.29	456.91	454.91	795.59	611.22
	m eq/l	40.70	27.21	22.80	22.70	39.70	30.50
	m eq%	94.78	91.90	89.59	91.72	39.63	89.13
Mg ⁺⁺	mg/l	0.00	Zero	1.22	Zero	Zero	7.30
	m eq/l	Zero	Zero	0.10	Zero	Zero	0.60
	m eq%	0.00	0.00	0.39	0.00	0.00	1.75
	m e						
Na ⁺	mg/l	39.08	45.98	48.28	39.08	47.46	59.77
	m eq/l	1.70	2.00	2.10	1.70	2.07	2.60
	m eq%	3.96	6.76	8.25	6.87	4.88	7.60
K ⁺	mg/l	21.11	15.69	17.60	13.69	24.53	20.33
	m eq/l	0.54	0.40	0.45	0.35	0.63	0.52
	m eq%	1.26	1.35	1.77	1.41	1.49	1.52
Total Cations	m eq/l	42.94	29.61	25.45	24.75	42.40	34.22
CO ₃ ⁻⁻	mg/l	108.04	30.01	66.02	36.01	24.01	15.61
	m eq/l	3.60	1.00	2.20	1.20	0.80	0.52
	m eq%	8.55	3.28	8.71	4.83	1.93	1.44
HCO ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
OH ⁻	mg/l	523.91	385.72	243.24	284.41	534.11	395.31
	m eq/l	30.80	21.50	14.30	16.70	31.40	23.24
	m eq%	73.18	70.58	56.63	67.20	75.74	64.16
Cl ⁻	mg/l	91.76	90.23	87.13	69.71	93.07	108.51
	m eq/l	2.59	2.55	2.46	1.96	2.63	3.06
	m eq%	6.15	8.37	9.74	7.89	6.34	8.45
NO ₃ ⁻	mg/l	8.86	10.65	10.75	6.66	7.44	0.00
	m eq/l	0.14	0.17	0.17	0.11	0.12	0.00
	m eq%	0.33	0.56	0.67	0.44	0.29	0.00
SO ₄ ⁻⁻	mg/l	238.23	260.30	293.94	324.39	321.43	451.45
	m eq/l	4.96	5.42	6.12	4.88	6.59	9.60
	m eq%	11.78	17.79	24.24	19.64	16.14	25.05
Total Anions	m eq/l	42.09	30.64	25.25	24.65	41.46	36.22
T.D.S.	mg/l	1865.94	1363.84	1225.62	1140.90	1227.64	1553.52

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Table 5.4: Trace metal Composition of High pH waters.

Date	pH	T.D.S. p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.b	Fe p.p.m	Co p.p.b	Cd p.p.b	Mo p.p.b
10.1.81	12.5	-	11.97	8.90	415.82	39.88	0.03	49.09	0.085	24.37	5.04	42.69
10.1.81	12.5	1289.62	5.51	7.83	467.81	27.61	0.08	47.32	0.184	38.20	6.54	32.30
12.3.81	12.5	1175.97	5.58	4.33	425.12	22.21	0.03	31.02	0.056	37.94	5.96	32.39
22.4.81	12.5	1226.06	6.18	7.38	437.35	25.62	0.05	55.97	0.120	33.51	5.89	28.42
25.5.81	12.5	1285.02	8.62	6.21	419.48	20.07	0.02	38.56	0.133	38.96	6.93	28.42
23.6.81	12.5	1127.87	6.79	2.76	400.70	18.79	0.02	41.97	0.125	47.53	6.35	27.63
25.8.80	12.5	1866.94	17.54	5.38	523.32	67.41	0.10	95.79	0.081	39.65	9.76	49.62
10.1.81	12.5	1363.86	-	7.99	466.05	31.43	0.11	59.40	0.139	41.52	7.46	44.17
12.3.81	12.5	1225.08	8.37	5.39	348.76	24.64	3.06	48.13	0.113	36.39	5.97	39.02
22.4.81	12.5	1140.89	8.17	8.18	383.98	21.35	0.02	43.85	0.090	31.74	6.54	26.50
23.6.81	12.5	1847.46	7.52	10.01	635.78	29.47	0.05	73.72	0.125	52.21	10.06	26.84
10.8.80	12.5	2030.24	33.13	14.02	422.74	66.00	0.13	81.96	0.113	38.94	8.54	38.07
5.8.80	12.5	2868.94	16.71	19.42	161.08	75.53	0.10	81.15	0.161	50.22	9.91	80.77
25.8.80	12.5	1575.93	14.48	16.18	265.46	59.65	0.10	69.19	0.096	36.81	9.76	46.35

Adits for the construction of "Majra in Dam" left side of Yamruk River.

W.S - Seepages

Fr-Zone

FS-1

Adit-RFS

: Not detected.
: " determined.

Table (5.7) : Chemical composition of Amman Formation waters.

Compare columnar section of the area

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Sample Number		FS-36	FS-36	FS-36	FS-36	FS-52	FS-52
Date		9.12.80	22.4.81	25.5.81	23.6.81	4.8.80	22.4.81
Type of Source		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		-	-	-	-	26.5	-
pH		6.80	-	7.20	7.10	6.50	-
Ca ⁺⁺	mg/l	96.19	86.17	92.18	90.18	76.15	52.10
	m eq/l	4.80	4.30	4.60	4.50	3.30	2.60
	m eq%	48.39	43.66	46.23	45.32	35.58	35.23
Mg ⁺⁺	mg/l	27.97	34.05	30.40	32.82	40.13	24.36
	m eq/l	2.30	2.50	2.50	2.70	3.30	2.00
	m eq%	23.19	28.43	25.13	27.49	30.90	27.1
Na ⁺	mg/l	63.91	62.07	63.28	60.81	75.87	62.07
	m eq/l	2.78	2.70	2.75	2.65	3.30	2.70
	m eq%	28.02	27.41	27.64	26.69	30.90	36.59
K ⁺	mg/l	1.56	1.96	3.83	3.07	10.95	3.13
	m eq/l	0.04	0.08	0.10	0.08	0.28	0.08
	m eq%	0.40	0.81	1.01	0.81	2.62	1.08
Total Cations	m eq/l	9.92	9.85	9.95	9.93	10.68	7.38
Cl ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	402.73	390.53	378.32	409.33	256.28	250.18
	m eq/l	6.60	6.40	6.20	6.60	4.20	4.10
	m eq%	67.76	65.11	63.46	62.44	41.26	54.16
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	79.39	76.24	79.21	80.20	109.29	74.26
	m eq/l	2.24	2.15	2.23	2.26	3.08	2.09
	m eq%	23.00	21.87	22.83	21.38	30.26	27.61
NO ₃ ⁻	mg/l	1.00	0.20	0.00	0.00	0.75	2.22
	m eq/l	0.02	0.00	0.00	0.00	0.01	0.04
	m eq%	0.21	0.00	0.00	0.00	0.10	0.53
SO ₄ ⁻	mg/l	42.48	61.62	64.12	82.14	138.09	64.20
	m eq/l	0.88	1.20	1.34	1.71	2.89	1.34
	m eq%	9.04	12.21	13.72	16.11	26.32	11.51
Total Anions	m eq/l	9.74	9.83	9.77	10.57	10.10	7.27
T.D.S. mg/l		512.31	517.54	522.18	553.90	590.17	487.11

Cont. Table (5.7)

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Sample Number		Borehole FS-35	Borehole FS-35	Borehole FS-35	Well NRA-W.S	Well NRA-W.S.	Well NRA-W.S.
Date		9.9.80	12.3.81	22.4.81	7.9.80	12.3.81	25.5.81
Type of Source		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		30.0	-	-	26.0	-	-
pH		7.1	6.8	-	6.8	6.8	7.4
Ca ⁺⁺	mg/l	33.06	58.12	50.10	106.21	70.14	96.17
	m eq/l	1.60	2.90	2.50	5.30	3.40	4.80
	m eq%	32.85	33.68	34.82	41.31	29.80	39.15
Mg ⁺⁺	mg/l	3.65	35.26	32.26	32.83	49.86	55.94
	m eq/l	0.30	2.90	2.70	4.10	4.60	4.10
	m eq%	6.16	33.68	37.60	31.96	40.32	33.44
Na ⁺	mg/l	64.37	62.07	43.91	71.27	69.86	69.21
	m eq/l	2.80	2.70	1.91	3.10	3.04	3.01
	m eq%	57.50	31.36	26.60	24.16	26.64	24.55
K ⁺	mg/l	6.65	4.30	2.74	2.90	14.86	13.80
	m eq/l	0.17	0.11	0.07	0.33	0.36	0.35
	m eq%	3.49	1.28	0.98	2.57	3.16	
Total Cations	m eq/l	4.87	8.61	7.18	12.83	11.41	11.41
CO ₃ ⁻⁻⁻	mg/l	36.01	0.00	0.00	0.00	0.00	0.00
	m eq/l	1.20	0.00	0.00	0.00	0.00	0.00
	m eq%	25.32	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	67.12	305.10	323.41	292.90	280.69	280.69
	m eq/l	1.10	5.00	5.30	4.80	4.60	4.60
	m eq%	23.21	59.45	78.99	39.80	39.76	39.18
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	80.42	77.33	40.59	143.31	144.56	133.66
	m eq/l	2.27	2.18	1.15	4.04	4.56	3.77
	m eq%	47.89	25.92	17.14	33.50	39.41	32.11
NO ₃ ⁻	mg/l	2.18	0.90	0.11	2.46	1.80	1.35
	m eq/l	0.04	0.02	Zero	0.04	0.03	0.02
	m eq%	0.84	0.24	Zero	0.33	0.26	0.17
SO ₄ ⁻⁻⁻	mg/l	6.45	58.12	12.50	152.74	114.05	160.71
	m eq/l	0.13	1.21	0.26	3.11	2.31	3.11
	m eq%	2.70	14.39	3.88	24.21	20.87	25.00
Total Anions	m eq/l	4.70	9.41	6.71	12.86	11.57	11.57
T.D.S.	mg/l	256.45	448.65	349.43	619.20	611.56	665.11

Cont. Table (5.7)

Sample Number	FS-74	HV-11	HV-11	FS-4	FS-4
Date	24/9.80	10.9.80	12.3.81	10.8.80	12/3.81
Type of Source	-	G.W	G.W	G.W	G.W
Temperature °C	-	29.0	-	29.0	-
pH	6.9	7.0	7.3	6.8	6.8
Ca ⁺⁺	m eq/l	24.05	14.03	8.02	90.18
	m eq/l	1.20	0.70	0.40	3.90
	m eq%	15.06	11.09	8.55	43.67
Mg ⁺⁺	mg/l	26.75	9.73	Zero	30.40
	m eq/l	2.20	0.80	Zero	2.50
	m eq%		12.68	Zero	28.00
Na ⁺	mg/l	91.96	105.29	24.81	41.38
	m eq/l	4.00	4.58	4.12	2.30
	m eq%	27.58	88.03	25.76	19.32
K ⁺	mg/l	22.25	7.42	6.26	5.87
	m eq/l	0.57	0.23	0.16	0.23
	m eq%	7.15	3.65	3.42	2.58
Total Cations m eq/l	7.97	6.31	4.68	8.93	6.42
CO ₃ ⁻	mg/l	18.01	12.00	12.00	0.00
	m eq/l	0.60	0.40	0.40	0.00
	m eq%		6.53	8.49	0.00
HCO ₃ ⁻	mg/l	201.37	42.71	24.41	366.14
	m eq/l	3.30	0.70	0.40	6.00
	m eq%		11.42	8.49	65.95
OH ⁻	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	118.57	168.03	137.62	64.95
	m eq/l	3.34	4.74	3.88	1.85
	m eq%	40.19	77.33	82.38	20.33
NO ₃ ⁻	mg/l	4.50	2.60	1.85	0.60
	m eq/l	0.07	0.04	0.03	0.06
	m eq%	0.84	0.65	0.64	0.66
SO ₄ ⁻	mg/l	62.40	12.00	5.00	68.25
	m eq/l	1.30	0.25	0.19	1.19
	m eq%	15.64	4.08	2.27	11.30
Total anions m eq/l	8.31	6.13	4.71	9.10	6.42
T.D.S. mg/l	469.22	352.45	277.77	484.69	340.00

Cont. Table (5.7)

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Sample Number		FS-34	FS-34	FS-37	FS-17	FS-26	FS-63
Date		9.9.80	9.12.80	1.81	4.8.80	8.9.80	9.9.80
Type of Source		G.W	G.W	G.W	G.W	G.W	G.W
Temperature °C		26.5	-	-	26.5	27.0	25.0
pH		12.0	12.0	6.8	6.8	7.5	12.0
Ca ⁺⁺	mg/l	206.41	96.19	90.18	104.21	68.14	44.09
	m eq/l	10.30	4.80	4.50	5.20	3.40	2.20
	m eq%	43.22	23.08	46.06	44.94	41.87	35.03
Mg ⁺⁺	mg/l	3.65	18.24	35.26	37.70	6.08	3.65
	m eq/l	0.30	1.50	2.90	3.10	0.50	0.30
	m eq%	1.26	7.21	29.68	26.79	6.16	4.78
Na ⁺	mg/l	108.05	117.94	52.88	72.85	101.16	78.17
	m eq/l	4.70	5.13	2.30	3.17	4.04	3.40
	m eq%	19.72	24.66	23.54	27.40	49.75	54.14
K ⁺	mg/l	333.52	366.37	2.74	4.69	7.04	14.86
	m eq/l	8.53	9.37	0.07	3.71	0.18	0.38
	m eq%	35.80	45.05	0.72	0.86	2.22	6.05
Total Cations	m eq/l	23.83	20.80	9.77	11.57	8.12	6.28
CO ₃ ⁻⁻⁻	mg/l	66.02	42.01	0.00	0.00	24.00	36.01
	m eq/l	2.20	1.40	0.00	0.00	0.80	1.20
	m eq%	9.37	6.27	0.00	0.00	10.30	19.14
HCO ₃ ⁻	mg/l	0.00	0.00	421.00	463.75	42.71	0.00
	m eq/l	0.00	0.00	6.90	7.60	0.70	0.00
	m eq%	0.00	0.00	68.66	66.55	9.01	0.00
OH ⁻	mg/l	45.93	69.01	0.00	0.00	0.00	8.51
	m eq/l	2.70	4.10	0.00	0.00	0.00	0.50
	m eq%	11.50	18.37	0.00	0.00	0.00	7.97
Cl ⁻	mg/l	90.73	84.54	77.33	86.60	113.41	113.41
	m eq/l	2.56	4.10	2.18	2.44	3.20	3.20
	m eq%	10.91	18.10	21.69	21.37	41.18	51.04
NO ₃ ⁻	mg/l	10.97	5.85	1.00	0.89	3.52	3.80
	m eq/l	0.18	0.09	0.02	0.01	0.06	0.06
	m eq%	0.77	0.40	0.20	0.09	0.77	0.96
SO ₄ ⁻⁻⁻	mg/l	760.32	606.62	45.59	65.87	144.57	84.60
	m eq/l	15.83	12.63	0.95	1.37	3.01	1.76
	m eq%	67.54	56.59	9.45	12.00	38.79	28.07
Total anions	m eq/l	23.47	22.32	10.05	11.42	7.77	
T.D.S.	mg/l	1625.60	1407.49	515.48	603.71	409.29	387.10

Cont. table (5.7)

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6		FS-62	FS-32	Exp.	NR-A-A (2)	FS-18
Sample Number						
Date		2.9.80	2.10.80	9.9.80	7.9.80	9.9.80
Type of Source		G.W	G.W	G.W	G.W	G.W
Temperature °C		26.0	24.5	25.0	25.5	28.0
pH		7.1	8.2	6.8	8.5	7.1
Ca ⁺⁺	mg/l	42.08	22.04	60.12	44.09	49.09
	m eq/l	2.10	1.10	3.00	2.20	2.30
	m eq%	34.04	21.87	38.66	31.56	31.59
Mg ⁺⁺	mg/l	9.73	10.94	36.48	3.65	25.04
	m eq/l	0.80	0.90	3.00	0.30	2.10
	m eq%	12.97	17.89	38.66	4.30	28.85
Na ⁺	mg/l	71.27	64.87	39.08	91.96	61.84
	m eq/l	3.10	2.82	1.70	4.00	2.69
	m eq%	50.24	56.06	21.91	57.39	36.95
K ⁺	mg/l	6.65	8.29	2.35	16.42	7.43
	m eq/l	0.17	0.21	0.06	0.47	0.19
	m eq%	2.76	4.18	0.77	6.74	2.61
Total Cations m eq/l		6.17	5.03	7.76	6.97	7.28
CO ₃ ⁻⁻	mg/l	24.01	24.01	0.00	30.01	12.00
	m eq/l	0.80	0.80	0.00	1.00	0.10
	m eq%	13.84	17.06	0.00	13.95	1.45
HCO ₃ ⁻	mg/l	79.33	54.92	341.71	0.00	36.61
	m eq/l	1.30	0.40	5.60	0.00	4.7
	m eq%	22.49	19.19	77.56	0.00	68.12
OH ⁻	mg/l	0.00	0.00	0.00	1.70	0.00
	m eq/l	0.00	0.00	0.00	0.10	0.00
	m eq%	0.00	0.00	0.00	1.40	0.00
Cl ⁻	mg/l	79.39	59.80	39.18	117.53	68.05
	m eq/l	2.24	1.69	1.119	3.32	1.92
	m eq%	38.75	36.03	15.37	46.30	27.83
NO ₃ ⁻	mg/l	5.28	5.84	1.90	1.96	3.31
	m eq/l	0.09	0.09	0.03	0.02	0.05
	m eq%	1.56	1.92	0.42	0.28	0.73
SO ₄ ⁻⁻	mg/l	69.00	58.20	22.80	130.95	6.24
	m eq/l	1.44	1.21	0.48	2.73	0.13
	m eq%	24.91	25.80	6.65	38.00	1.88
Total anions m eq/l		5.78	4.69	7.22	7.17	6.80
T.D.S. mg/l		347.08	281.45	372.77	430.00	300.00

Table 5.8: Trace Metal concentration
of Amman Formation Waters.

Location	Date	pH	T.D.S ppm	Cu ppb	Mn ppb	Cr ppb	Ni ppb	Zn ppm	Pb ppb	Fe ppm	Co ppb	Cd ppb	Mn ppb
FS-36	Aug. 80	6.5		5.11	16.99	2.06	23.31	8.20	24.80	0.146	N.D.	1.95	N.D.
"	Nov. 80	6.8		4.20	20.92	10.78	25.35	8.29	21.96	0.613	14.12	2.43	6.10
"	Jun. 81	6.8	512.31	3.88	19.74	N.D.	16.57	4.14	16.10	0.682	13.29	1.76	7.36
"	April 81	/	517.58	2.59	13.15	12.23	17.08	0.14	20.15	0.153	17.14	2.04	10.26
"	May 81	7.2	522.18	2.39	29.82	187.46	83.27	0.24	32.51	0.835	21.82	3.19	15.79
"	June 81	7.4	553.90	4.95	15.01	8.10	13.24	1.18	13.61	0.107	17.14	2.97	N.D.
FS-35	Sept. 80	7.1	265.45	18.67	11.65	6.87	17.51	3.19	53.18	0.361	N.D.	1.77	19.86
"	Dec. 80	8.0		5.19	N.D.	2.87	9.80	0.23	16.97	0.047	N.D.	N.D.	20.57
"	March 81	6.8	448.65	1.84	8.15	N.D.	14.44	2.81	32.22	0.111	8.52	N.D.	10.31
"	April 81	/	349.49	1.79	7.22	N.D.	6.41	0.76	16.79	0.125	12.39	1.55	6.36
NRA-W.S	Sept. 80	6.8	685.20	9.07	22.75	6.51	21.51	1.11	54.67	0.316	13.45	1.86	14.07
"	March 81	6.8	611.56	2.59	N.D.	N.D.	10.68	0.19	23.53	0.056	17.03	1.55	14.72
"	May 81	7.4	665.11	2.75	21.74	19.15	17.51	0.29	43.66	0.271	8.57	3.03	10.26
HV-11	Sept. 80	7.0	352.46	11.33	19.05	17.14	10.82	4.82	37.70	0.633	N.D.	3.43	11.43
"	March 81	7.3	277.77	2.25	2.35	N.D.	9.79	1.91	N.D.	0.078	14.71	N.D.	6.63
"	April 81	/		7.38	7.05	N.D.	8.97	1.26	42.54	0.304	13.16	1.47	N.D.
FS-37	Aug. 80	6.8		6.38	13.48	5.46	24.71	3.70	24.04	0.147	11.82	2.60	9.23
"	June 81	6.8	515.48	3.47	14.73	4.64	13.17	7.49	15.10	0.443	12.39	1.93	11.04
"	March 81	6.8		4.69	14.57	N.D.	4.67	11.38	20.13	0.051	6.97	N.D.	11.04
FS-52	Aug. 80	6.5	580.17	5.01	25.35	5.09	14.82	0.02	22.04	0.121	8.86	N.D.	N.D.
"	April 81	/	407.43	3.59	14.11	9.64	13.24	0.06	19.25	0.137	19.35	1.68	N.D.
FS-74	Sept. 80	6.9	469.22	8.50	20.05	3.59	18.53	1.16	22.96	0.196	N.D.	1.00	10.97
"	Dec. 80	6.8		18.52	9.59	3.59	17.58	0.54	52.91	0.100	12.46	N.D.	14.48
"	March 81	6.8	391.82	14.08	6.42	10.32	15.72	1.14	N.D.	0.107	11.61	N.D.	11.04

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Cont. Table 5.8

Location	Date	H	T.D.S ppm	Cu ppb	Mn ppb	Cr ppb	Ni ppb	Zn ppm	Pb ppb	Fe ppm	Co ppb	Cd ppb	Mo ppb
PS-34		12.0	1625.60	13.60	11.65	8.31	48.51	5.87	527.73	0.268	34.18	22.98	40.55
"		12.0	1407.49	23.46	6.68	7.19	45.30	0.83	534.09	0.032	36.54	3.04	54.10
PS-4	Aug. 80	6.8	458.60	6.17	15.62	5.16	19.37	1.72	N.D.	0.199	13.29	2.44	36.00
"	March 81	6.8	359.48	1.63	7.21	32.44	23.36	0.88	36.24	0.331	17.81	7.88	12.50
PS-17		6.8	603.70	6.60	34.25	5.85	17.31	4.31	14.47	0.529	5.91	2.73	N.D.
NRA-B		11.5		9.75	30.61	71.27	28.09	0.05	37.17	1.054	13.45	2.42	14.90
NRA-A ₂		8.5	438.27	11.73	21.40	6.87	22.25	3.00	171.65	0.206	9.91	N.D.	N.D.
PS-26		7.5	489.29	16.27	87.95	7.95	22.61	6.06	162.91	0.613	N.D.	0.97	11.59
PS-25		9.5		20.27	9.75	9.76	25.17	1.00	59.04	0.261	N.D.	1.94	18.21
PS-10		6.8		10.40	7.04	7.59	18.61	4.04	44.83	0.610	10.62	2.26	14.07
PS-63		12.0	387.10	16.53	41.45	2.12	19.33	7.05	281.25	0.420	11.15	1.77	23.17
PS-62		7.01	347.08	13.60	5.96	1.45	16.78	3.80	43.98	0.233	N.D.	N.D.	10.76
PS-21		7.5	432.71	16.00	14.36	3.25	15.68	15.28	227.05	2.636	N.D.	3.22	N.D.
PS-16		7.1	238.81	21.07	17.92	4.80	29.07	6.15	150.34	0.527	N.D.	3.46	8.28
NRA-Sahan Exp		6.8	372.77	48.53	5.40	2.40	17.24	0.01	18.41	0.151	N.D.	N.D.	N.D.
PS-22		7.4		41.72	23.61	7.20	30.42	10.51	169.64	0.338	26.01	2.42	48.00
PS-32		8.2	281.45	21.48	6.97	4.67	24.00	2.55	125.79	0.160	N.D.	N.D.	10.67
NRA-A ₁		6.8		25.34	32.24	8.68	21.89	15.82	557.60	1.034	4.96	5.33	N.D.

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Table (6.0): Chemical Composition of the Bituminous Marl Formation.

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A
Date		31.877	3.8.80	12.3.81	22.4.81	25.5.81	23.6.81
Type of Source		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		-	26.0	-	-	-	-
PH		8.02	6.5	6.8	6.8	6.9	6.8
Ca ⁺⁺	mg/l	83.97	86.17	82.16	88.17	84.17	88.18
	m eq/l	4.19	4.30	4.1	4.40	4.20	4.40
	m eq%	49.53	40.76	40.84	42.59	41.58	43.96
Mg ⁺⁺	mg/l	17.88	35.26	36.48	36.48	36.48	34.05
	m eq/l	1.47	3.30	3.00	3.00	3.00	2.80
	m eq%	17.38	31.28	29.88	29.04	29.70	27.97
Na ⁺	mg/l	62.07	64.37	64.37	64.37	63.77	61.55
	m eq/l	2.70	2.80	2.80	2.80	2.77	2.68
	m eq%	31.48	26.54	27.89	27.11	27.43	26.77
K ⁺	mg/l	4.69	5.87	5.47	5.98	5.11	4.85
	m eq/l	0.12	0.15	0.14	0.13	0.13	0.13
	m eq%	1.27	1.42	1.39	1.26	1.29	1.30
Total Cations	m eq/l	8.48	10.55	10.84	10.33	10.10	10.01
CO ⁻⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	383.83	475.96	421.04	445.45	427.14	433.24
	m eq/l	6.19	7.8	6.9	7.3	7.00	7.10
	m eq%	64.75	68.78	65.28	69.92	68.16	68.01
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	75.18	84.54	83.17	77.23	82.18	84.16
	m eq/l	2.12	2.38	2.35	2.18	2.32	2.37
	m eq%	22.18	20.99	22.23	20.88	22.59	22.70
NO ₃ ⁻⁻⁻	mg/l	2.86	0.96	1.40	1.20	0.85	1.24
	m eq/l	0.05	0.02	0.02	0.02	0.01	0.02
	m eq%	0.52	0.18	0.19	0.19	0.10	0.19
SO ₄ ⁻⁻⁻	mg/l	57.64	54.76	53.63	45.32	44.94	45.54
	m eq/l	1.10	1.14	1.12	0.94	0.94	0.95
	m eq%	12.95	10.05	10.50	9.60	9.15	9.15
Total Anions	m eq/l	9.86	11.34	10.57	10.44	10.27	10.27
T.D.S.	mg/l	576.00	569.91	537.20	540.58	531.07	536.19

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Cont. Table 5.9

Sample Number		FS-71	FS-71	S-41	S-70	BV-4	S-18
Date		10.9.80	22.4.81	20.9.80	24.9.80	25.9.80	10.9.80
Type of Source		28.5	-	28.0	25.0	26.0	28.0
pH		7.2	-	8.5	6.9	8.5	7.0
Ca ⁺⁺	mg/l	20.04	14.03	26.05	122.24	18.04	14.03
	m eq/l	1.00	0.70	1.30	3.90	0.90	0.70
	m eq%	14.93	11.82	26.59	36.93	25.35	13.59
Mg ⁺⁺	mg/l	14.59	7.30	09.73	31.62	8.51	13.30
	m eq/l	1.20	0.60	0.80	1.80	0.70	1.10
	m eq%	17.91	16.14	16.36	17.05	19.72	21.36
Na ⁺	mg/l	93.34	94.26	57.48	108.28	38.62	71.27
	m eq/l	4.06	4.10	2.50	4.71	1.68	3.10
	m eq%	60.60	69.26	51.13	44.60	47.32	60.19
K ⁺	mg/l	17.20	20.33	11.34	5.81	10.56	9.78
	m eq/l	0.44	0.52	0.29	0.15	0.27	0.25
	m eq%	5.57	8.78	5.93	1.42	7.61	4.85
Total Cations	m eq/l	6.70	5.92	4.89	10.56	3.55	5.15
CO ₃ ⁻⁻	mg/l	12.00	18.07	12.00	0.00	30.01	12.00
	m eq/l	0.40	0.60	0.40	0.00	1.00	0.40
	m eq%	5.95	9.67	8.49	0.00	29.67	8.25
HCO ₃ ⁻	mg/l	48.82	00.00	61.02	231.88	36.61	36.61
	m eq/l	0.80	0.00	1.00	3.80	0.60	0.60
	m eq%	11.91	0.00	21.23	33.51	17.80	12.42
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	105.16	105.94	67.02	103.10	57.74	89.70
	m eq/l	2.97	2.99	1.89	2.91	1.58	2.53
	m eq%	44.20	47.69	40.13	25.66	46.88	52.38
NO ₃ ⁻	mg/l	3.31	1.55	2.96	3.38	3.38	2.53
	m eq/l	0.05	0.03	0.05	0.06	0.06	0.04
	m eq%	0.74	0.48	1.66	0.59	1.78	0.83
SO ₄ ⁻⁻	mg/l	120.08	127.26	66.00	219.50	6.24	60.60
	m eq/l	2.50	2.65	1.37	4.57	0.13	1.26
	m eq%	37.20	42.27	29.09	40.30	3.80	20.20
Total Anions	m eq/l	6.72	6.27	4.71	11.34	3.37	4.73
Total	mg/l	410.13	380.68	283.09	702.87	101.40	291.60

Cont. Table 5.9

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Sample Number	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	
Date	19.5.78	3.8.80	3.6.81	24.9.80	12.3.81	12.3.81	
Type of Source	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	
Temperature °C	-	29.0	-	27.5	-	-	
pH	7.25	6.5	6.8	6.9	6.8	6.8	
Ca ⁺⁺	mg/l	72.34	78.15	74.8	100.20	88.18	98.20
	m eq/l	3.61	3.90	3.70	5.00	4.40	4.80
	m eq%	47.12	50.98	49.87	49.70	43.56	47.81
Mg ⁺⁺	mg/l	24.20	24.32	25.54	30.40	35.26	34.05
	m eq/l	1.99	2.00	2.10	2.50	2.90	2.80
	m eq%	26.35	26.14	28.30	24.85	28.71	27.89
Na ⁺⁺	mg/l	41.38	36.78	34.72	53.89	63.54	52.88
	m eq/l	1.80	1.60	1.51	2.34	2.76	2.30
	m eq%	23.84	20.92	20.25	23.26	27.33	22.91
K ⁺	mg/l	5.87	5.87	4.30	8.41	1.56	5.47
	m eq/l	0.15	0.15	0.11	0.22	0.04	0.14
	m eq%	1.99	1.96	1.48	2.19	0.40	1.39
Total Cations m eq/l	7.55	7.65	7.42	10.06	10.10	10.04	
CO ₃ ⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	321.83	341.71	303.90	262.39	292.90	280.69
	m eq/l	5.19	5.60	4.90	4.30	4.80	4.60
	m eq%	68.29	68.54	66.13	44.75	51.01	48.68
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	51.06	50.52	47.53	98.98	83.51	86.14
	m eq/l	1.44	1.42	1.34	2.79	2.35	2.44
	m eq%	18.95	17.38	18.08	29.03	25.08	25.82
NO ₃ ⁻	mg/l	2.17	0.29	0.00	1.42	1.05	1.00
	m eq/l	0.04	0.00	0.00	0.02	0.02	0.02
	m eq%	0.53	0.00	0.00	0.21	0.21	0.21
SO ₄ ⁻⁻	mg/l	44.67	55.23	56.20	120.00	106.43	114.62
	m eq/l	0.93	1.15	1.17	2.50	2.23	2.39
	m eq%	12.24	14.08	15.79	26.02	23.70	25.29
Total Anions m eq/l	7.60	8.17	7.41	9.61	9.41	9.45	
Total m eq/l	486.00	421.32	394.39	534.50	492.30	482.21	

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Cont. Table 5.9

Sample Number		HV-2	HV-2	S-29	HV-7	FS-26
Date		3.8.80	12.3.81	4.8.80	4.8.80	
Type of Source		Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		24.5	-	26.0	29.5	-
pH		6.8	6.8	6.8	6.8	-
Ca ⁺⁺	mg/l	76.15	66.13	104.21	68.14	68.14
	m eq/l	3.30	3.30	5.20	3.40	3.40
	m eq%	49.16	44.24	58.56	46.26	41.87
Mg ⁺⁺	mg/l	27.97	29.18	8.51	25.54	6.08
	m eq/l	2.30	2.40	0.70	2.10	0.50
	m eq%	29.75	32.17	7.88	28.57	6.16
Na ⁺	mg/l	34.43	36.78	64.37	39.08	101.16
	m eq/l	1.50	1.60	2.80	1.70	4.04
	m eq%	19.41	21.45	31.53	23.13	49.75
K ⁺	mg/l	5.19	6.26	7.04	5.87	7.74
	m eq/l	0.13	0.16	0.18	0.15	0.18
	m eq%	1.68	2.15	2.03	2.04	0.22
Total Cations	m eq/l	7.73	7.46	8.88	7.35	8.12
CO ₃ ⁻⁻	mg/l	24.01	0.00	0.00	0.00	24.01
	m eq/l	0.80	0.00	0.00	0.00	0.80
	m eq%	10.97	0.00	0.00	0.00	10.30
HCO ₃ ⁻	mg/l	280.69	305.10	353.92	341.71	42.71
	m eq/l	3.60	5.00	5.80	5.60	0.70
	m eq%	49.38	69.25	61.44	72.26	9.0
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	45.36	48.52	46.40	41.24	113.41
	m eq/l	1.28	1.73	1.31	1.16	3.20
	m eq%	17.56	23.96	13.88	14.97	41.18
NO ₃ ⁻	mg/l	0.71	0.95	0.55	0.60	3.52
	m eq/l	0.01	0.02	0.00	0.00	0.06
	m eq%	0.14	0.28	0.00	0.00	0.77
SO ₄ ⁻⁻	mg/l	28.57	39.90	111.91	47.97	14.27
	m eq/l	0.60	0.83	2.33	0.99	3.01
	m eq%	8.23	11.50	24.68	12.77	31.73
Total Anions	m eq/l	7.29	7.22	9.34	7.75	7.77

Cont. Table 5.9

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Sample Number		HV-10	HV-10	HV-10	HV-8	HV-8	HV-8
Date		19.5.78	3.8.80	3.6.81	24.9.80	12.3.81	12.3.81
Type of Source		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		-	29.0	-	27.5	-	-
pH		7.25	6.5	6.8	6.9	6.8	6.8
Ca ⁺⁺	mg/l	72.34	78.15	74.8	100.20	88.18	98.20
	m eq/l	3.61	3.90	3.70	5.00	4.40	4.80
	m eq%	47.12	50.98	49.87	49.70	43.56	47.81
Mg ⁺⁺	mg/l	24.20	24.32	25.54	30.40	35.26	34.05
	m eq/l	1.99	2.00	2.10	2.50	2.90	2.90
	m eq%	26.36	26.14	28.30	24.85	28.71	27.89
Na ⁺⁺	mg/l	41.38	36.78	34.72	53.89	63.54	52.88
	m eq/l	1.80	1.60	1.51	2.34	2.76	2.30
	m eq%	23.84	20.92	20.35	23.26	27.33	22.91
K ⁺	mg/l	5.87	5.87	4.30	8.41	1.56	5.47
	m eq/l	0.15	0.15	0.11	0.22	0.04	0.14
	m eq%	1.99	1.96	1.48	2.19	0.40	1.39
Total Cations	m eq/l	7.55	7.65	7.42	10.06	10.10	10.04
CO ₃ ⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	321.83	341.71	303.90	262.39	292.90	280.69
	m eq/l	5.19	5.60	4.90	4.30	4.80	4.60
	m eq%	68.29	68.54	66.13	44.75	51.01	48.68
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	51.06	50.52	47.53	98.98	83.51	86.14
	m eq/l	1.44	1.42	1.34	2.79	2.35	2.44
	m eq%	18.95	17.38	18.08	29.03	25.08	25.82
NO ₃ ⁻	mg/l	2.17	0.29	0.00	1.42	1.05	1.00
	m eq/l	0.04	0.00	0.00	0.02	0.02	0.02
	m eq%	0.53	0.00	0.00	0.21	0.21	0.21
SO ₄ ⁻⁻	mg/l	44.67	55.23	56.20	120.00	106.43	114.62
	m eq/l	0.93	1.15	1.17	2.50	2.23	2.39
	m eq%	12.24	14.08	15.79	26.02	23.70	25.29
Total Anions	m eq/l	7.60	8.17	7.41	9.61	9.41	9.43
Total	mg/l	486.00	421.32	394.39	544.50	526.39	532.71

Duplicate page

Cont. Table 5.9

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Sample Number		AV-2	AV-2	AV-2	AV-2	AV-1	AV-1
Date		23.8.80	12.3.81	25.5.81	23.5.81	25.5.81	23.5.81
Type of Source		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		28.0	-	-	-	-	-
PH		6.8	6.8	6.9	6.8	7.4	6.8
Ca ⁺⁺	mg/l	84.17	84.17	78.16	82.16	70.14	70.14
	m eq/l	4.20	4.20	3.90	4.10	3.50	3.50
	m eq%	44.21	51.41	52.56	51.57	45.81	54.26
Mg ⁺⁺	mg/l	25.54	30.40	23.47	27.97	29.18	17.02
	m eq/l	2.10	2.50	1.93	2.30	2.40	1.40
	m eq%	22.11	30.60	26.01	28.93	31.41	21.71
Na ⁺⁺	mg/l	68.97	29.89	32.13	31.14	37.08	32.63
	m eq/l	3.00	1.30	1.40	1.36	1.61	1.42
	m eq%	31.58	15.91	18.87	17.11	21.07	22.01
K ⁺	mg/l	7.82	6.65	7.40	7.41	5.11	4.85
	m eq/l	0.20	0.17	0.19	0.19	0.13	0.13
	m eq%	2.11	2.08	2.56	2.39	1.70	4.65
Total Cations	m eq/l.	9.50	8.17	7.42	7.95	7.64	6.45
CO ₃ ⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	378.32	317.30	311.20	317.30	311.20	274.59
	m eq/l	6.20	5.2	5.10	5.20	5.10	4.50
	m eq%	67.39	66.67	68.64	65.16	67.11	70.31
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00
CL ⁻	mg/l	43.30	44.56	46.54	43.56	45.55	47.53
	m eq/l	1.22	1.26	1.31	1.23	1.29	1.35
	m eq%	13.26	16.15	17.63	15.41	16.97	21.09
NO ₃ ⁻	mg/l	1.57	2.45	1.46	1.86	0.00	0.00
	m eq/l	0.03	0.04	0.02	0.03	0.00	0.00
	m eq%	0.33	0.51	0.27	0.38	0.00	0.00
SO ₄ ⁻	mg/l	84.13	63.45	68.70	73.21	50.23	41.07
	m eq/l	1.75	1.31	1.39	1.46	1.00	0.81
	m eq%	19.92	16.11	13.46	19.10	12.20	6.37
Total Anions	m eq/l	9.20	7.82	7.43	7.98	7.10	6.40
T.D.S.		504.56	420.22	413.46	425.56	370.89	350.54

Cont. Table 5.9

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Sample Number		BV-2	BV-2	BV-2	BV-2	BV-2
Date		31.8.77	3.8.80	12.3.80	22.3.81	25/5/81
Type of Source		Borehole	Borehole	Borehole	Borehole	Borehole
Temperature °C		-	28.2	-	-	-
pH		7.3	6.5	6.8	6.8	6.8
Ca ⁺⁺	mg/l	80.16	102.20	86.17	84.17	102.20
	m eq/l	4.00	5.10	4.30	4.20	5.10
	m eq%	53.41	56.67	56.21	54.40	67.55
Mg ⁺⁺	mg/l	23.10	24.32	23.10	26.75	12.16
	m eq/l	1.90	2.00	1.90	2.20	1.00
	m eq%	25.37	22.22	24.84	28.50	13.25
Na ⁺	mg/l	34.49	39.08	29.94	27.59	29.66
	m eq/l	1.50	1.70	1.30	1.20	1.29
	m eq%	20.03	18.89	16.99	15.54	17.09
K ⁺	mg/l	5.45	7.82	14.35	4.69	6.13
	m eq/l	0.14	0.20	0.15	0.12	0.16
	m eq%	1.34	2.22	1.96	1.55	2.12
Total Cations	m eq/l.	7.49	9.00	7.65	7.72	7.55
CO ₃ ⁻⁻⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻⁻⁻	mg/l	321.21	366.12	311.20	317.30	392.51
	m eq/l	5.18	6.00	5.10	5.20	5.40
	m eq%	69.34	69.61	70.25	68.06	69.23
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	45.39	44.33	43.56	40.59	41.58
	m eq/l	1.22	1.25	1.23	1.15	1.17
	m eq%	17.14	14.50	16.94	15.05	15.00
NO ₃ ⁻	mg/l	0.00	1.03	1.45	0.32	0.00
	m eq/l	0.00	0.02	0.02	0.00	0.00
	m eq%	0.00	0.23	0.28	0.00	0.00
SO ₄ ⁻⁻⁻	mg/l	48.51	64.29	43.73	61.44	58.97
	m eq/l	1.01	1.34	0.91	1.29	1.23
	m eq%	13.52	15.55	12.53	16.89	15.77
Total Anions	m eq/l.	7.47	8.52	7.26	7.64	7.80

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Table: 5.10 Trace Metal Composition of the Bituminous Marl Formation.

Date	pH	T.D.S p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.b	Fe p.p.m	Co p.p.b	Cd p.p.b	Mn p.p.b	Location
			x	x	x	x	x	x	x	x	x	x	
Aug., 77		576								5.91	2.89	25.38	HV - 5A
Aug, 80	6.5	570	6.81	41.37	8.25	17.98	0.04	20.67	0.360	10.80	1.39	N.D.	
Nov. 80	6.8		1.98	40.39	4.31	18.25	0.01	15.95	0.065	20.13	1.23	15.46	
March, 81	6.8	537	4.29	40.11	N.D.	9.77	0.03	9.63	0.907	18.58	2.13	N.D.	
April, 81	6.8	540	4.59	27.42	3.34	8.54	0.03	14.97	0.304	16.36	2.64	11.05	
May 81	6.9	531	4.22	43.48	39.04	11.53	0.02	13.61	0.347	15.58	3.13	N.D.	
June, 81	6.8	536	3.85	46.93	11.79	12.38	0.01	20.42	0.187				
										28.12	2.27	28.85	RV - 2
Aug., 80	6.8	505	4.47	36.44	4.13	22.64	0.09	17.57	0.446	21.08	1.88	9.57	
March, 81	6.8	420	5.18	26.94	4.45	19.64	0.10	11.77	0.350	19.48	1.96	17.37	
May, 81	6.9	413	2.75	18.98	7.73	14.95	0.18	22.39	0.607	18.25	2.64	N.D.	
June, 81	6.8	426	5.51	10.52	9.21	19.64	0.27	13.60	0.263				
										7.39	2.19	27.69	BV - 2
Aug., 80	6.5	466	8.51	14.80	5.85	3.33	0.04	17.57	0.249	13.94	n.d.	16.93	
March, 81	6.8	398	1.63	1.25	N.D.	12.32	0.02	N.D.	0.042	13.16	1.96	9.57	
April, 81	6.8	407	4.98	13.95	N.D.	21.78	0.03	14.97	0.153	16.36	2.70	15.00	
May, 81	7.2	383	N.D.	9.83	6.63	6.41	0.02	19.03	0.404	16.36	2.23	N.D.	
June, 81	6.8	447	3.12	34.33	11.79	7.69	0.01	N.D.	0.355				

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Cont. Table 5.10

Date	pH	T.D.S p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.m	Fe p.p.m	Co p.p.b	Cd p.p.b	Mo p.p.b
Aug., 80	6.5	421.3	9.36	14.52	3.10	16.32	0.04	16.53	0.120	N.D.	1.02	17.21
Jan., 81	6.8	394	3.49	13.11	12.52	13.67	0.01	22.63	0.131	20.26	2.89	13.42
Sept., 80	6.8	545	7.47	48.81	7.19	24.68	11.76	85.35	0.505	N.D.	1.59	13.71
Jan, 81	6.8	526	2.44	18.96	N.D.	12.38	0.59	19.13	0.329	40.69	2.35	19.88
March, 81	6.8	533	3.47	6.27	10.32	21.24	0.11	N.D.	0.129	19.36	1.43	15.46
May, 81	7.4	381	2.75	28.64	19.52	15.37	3.16	31.34	0.857	11.69	1.39	N.D.
June, 81	6.8	394	4.40	24.84	9.21	18.54	1.80	N.D.	0.200	16.36	2.14	N.D.
Aug., 80	6.8	383	10.00	13.15	7.22	20.64	3.59	21.73	0.325	N.D.	3.90	N.D.
	6.8	380	6.78	49.70	8.15	8.54	0.73	13.93	0.183	12.39	0.98	10.31
Aug., 80	6.8	520	5.32	11.51	2.75	13.65	1.41	14.03	0.088	8.86	1.46	N.D.
"	6.8	394	5.53	30.14	2.06	11.99	0.24	N.D.	0.393	19.94	1.71	13.85
	6.8		48.27	74.49	17.71	69.67	19.05	84.19	0.227	31.15	5.09	62.07
	6.8	466	11.47	70.43	3.25	12.77	0.33	33.89	0.477	6.37	N.D.	N.D.
	7.4	489	16.27	87.95	7.95	22.61	6.06	162.91	0.613	N.D.	0.97	11.59
	8.0		16.09	14.09	15.18	26.63	6.44	159.63	0.673	12.74	2.42	16.55

Loc. 10

HV-10

HV-8

RV-1

S20
 HV-2
 HV-1
 HV-7
 HV-29
 HV-26
 HV-22

5

Cont. Table 5.10

Date	Locatio-	T.D.S p.p.m	Cu p.p.b	Mn p.p.b	Cr p.p.b	Ni p.p.b	Zn p.p.m	Pb p.p.b	Fe p.p.m	Co p.p.b	Cd p.p.b	Mo p.p.b	
	S-8	12.5	1009.9	19.57	13.65	12.69	37.52	4.21	102.18	0.623	23.78	4.35	135
	S-26	7.0	1078.83	15.45	28.44	7.54	61.52	8.80	117.06	0.931	26.75	3.26	54.1
	FS-71	7.2	410.13	26.27	36.68	5.49	20.96	15.32	136.86	1.876	N.D.	1.50	N.D.
	S-18	7.0	291.57	12.10	14.22	10.63	12.17		39.68	0.593	N.D.	1.00	N.D.
	S-41	8.5	283.09	15.19	16.49	2.74	10.17	6.87	101.19	0.423	N.D.	N.D.	N.D.
	S-70	6.9	709.87	9.01	46.64	6.17	23.66	3.69	48.61	0.250	N.D.	1.51	24.3
	BV-5	8.2		21.37	13.08	7.90	19.94	14.91	754.84	0.512	N.D.	1.51	N.D.
	BV-4	3.5	224.97	24.98	24.73	8.62	13.18	14.60	1119.04	0.710	N.D.	1.22	6.10
	BV-5	6.8		20.99	61.02	13.65	40.56	12.38	560.53	0.781	13.29	4.51	8.38
	FS-5	3.5		15.80	21.50	6.83	27.38	17.96	1001.03	0.781	N.D.	2.52	41.11

Note:- N.D = Not Detected.

Yarmuk Basin - Jordan

The Yarmuk catchment area in both Jordan and Syria is 6790 km². The catchment area in Jordan is 1160 km². The average annual precipitation is 280 mm (\pm 80 mm standard deviation). In Mcm/yr this is 324 Mcm \pm 93 Mcm.

Table: Monthly Average Precipitation (42 Years Average)
(in mm)

Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
0	7	31	52	70	51	50	17	3	0	0	0

Surface Water Resources

Three gauging stations are available on the Yarmuk River:

	<u>No.</u>	<u>Elevation</u>	<u>Drainage Area (km²)</u>
Maqarin	AD5	+12 m above sea level	5950
Hemmah	AD3	-175 m below sea level	6760
Adasiya	AD2	-212 m below sea level	6790

The annual average discharge:

	<u>1954 -</u>	<u>1930 - 1953</u>
AD5	251 Mcm	365 Mcm
AD3 no registration	-	-
AD2	318 Mcm	467 Mcm

The overall average for 1930 - 1977:

AD5	313 Mcm
AD2	391 Mcm

Table: Monthly Average Discharge (Mcm)

	<u>1954-1977</u>		<u>1930-1953</u>		<u>1930-1977 (Avg.)</u>	
	<u>AD5</u>	<u>AD2</u>	<u>AD5</u>	<u>AD2</u>	<u>AD5</u>	<u>AD2</u>
Oct	15.6	18.4	22.1	14.5	18.8	16.4
Nov	16.2	19.6	24.0	16.2	20.1	17.9
Dec	23.3	29.6	33.8	25.4	28.5	27.5
Jan	34.3	47.9	71.6	61.0	53.0	54.5
Feb	35.1	57.9	111.5	97.7	73.3	77.8
Mar	32.7	41.3	66.4	55.8	49.5	46.5
Apr	22.4	21.5	35.3	27.1	28.8	24.3
May	14.9	17.3	24.3	17.0	19.5	17.1
Jun	13.5	16.0	19.8	12.9	16.6	14.5
Jul	14.0	15.9	19.3	12.0	16.6	14.0
Aug	14.6	16.1	19.5	12.1	17.1	14.1
Sep	14.9	16.3	19.9	12.4	17.4	14.3

Table: Duration of the Discharge at Station AD5

Discharge m ³ /sec.	68/69 days	69/70 days	70/71 days	71/72 days	74/75 days	75/76 days	76/77 days	77/78 days	78/79 days	79/80 days
18	60	12	14	3	-	5	2	7	-	42
17	63	13	15	3	-	5	3	7	-	45
16	68	14	17	4	-	5	3	8	-	65
15	76	14	17	4	-	7	5	9	-	69
14	83	15	17	5	-	7	6	10	-	74
13	99	16	19	5	-	8	6	12	-	78
12	106	19	21	5	1	11	7	14	-	81
11	112	19	24	7	1	16	10	22	-	91
10	124	26	25	8	5	23	15	33	-	95
9	140	47	27	10	13	29	18	59	1	111
8	148	59	33	10	19	38	37	79	5	131
7	168	105	75	47	43	74	107	124	14	138
6	206	170	100	145	106	148	151	156	63	161
5	292	231	155	162	149	184	182	211	140	193
4	364	364	358	360	330	316	326	301	202	355
3	364	364	365	366	365	366	365	364	362	365
2	364	364	365	366	365	366	365	365	364	365

Table: Historic Discharge (in Mcm)

<u>Year</u>	<u>AD5</u>	<u>AD2</u>	<u>Year</u>	<u>AD5</u>	<u>AD2</u>	<u>Year</u>	<u>AD5</u>	<u>AD2</u>
1930	306	402	1946	245	353	1962	245	389
1931	460	572	1947	219	315	1963	221	327
1932	277	377	1948	305	420	1964	252	412
1933	156	248	1949	354	476	1965	289	447
1934	257	354	1950	291	404	1966	189	258
1935	464	577	1951	283	387	1967	421	613
1936	217	319	1952	542	652	1968	203	138
1937	352	458	1953	496	615	1969	532	123
1938	427	544	1954	348	664	1970	224	76
1939	311	436	1955	190	289	1971	269	92
1940	338	451	1956	282	457	1972	182	280
1941	315	426	1957	266	360	1973	-	244
1942	367	477	1958	240	373	1974	-	-
1943	478	599	1959	201	302	1975	156	298
1944	366	490	1960	205	244	1976	131	-
1945	550	670	1961	232	289			

Table: Measured Streamflow (in Mcm)
 Gauging Station - AD5 Y. Maqarin

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	15.0	16.0	19.0	55.0	110.0	33.0	25.0	15.0	14.0	15.0	15.0	16.0	258.0	90.0	348.0
54/55	19.0	20.0	22.0	21.0	15.0	16.0	14.0	13.0	11.0	12.0	13.0	14.0	108.0	82.0	190.0
55/56	15.0	24.0	31.0	42.0	31.0	26.0	21.0	18.0	17.0	19.0	19.0	19.0	175.0	107.0	282.0
56/57	19.0	19.0	23.0	23.0	30.0	41.0	20.0	18.0	17.0	19.0	19.0	18.0	156.0	110.0	266.0
57/58	19.0	20.0	24.0	31.0	23.0	20.0	18.0	16.0	16.0	18.0	18.0	17.0	136.0	104.0	240.0
58/59	17.0	16.0	17.0	17.0	16.0	19.0	16.0	17.0	16.0	16.0	17.0	17.0	101.0	100.0	201.0
59/60	17.0	16.0	17.0	18.0	17.0	18.0	18.0	18.0	17.0	16.0	17.0	16.0	104.0	101.0	205.0
60/61	17.0	18.0	19.0	23.0	27.0	23.0	19.0	20.0	17.0	16.0	16.0	17.0	129.0	103.0	232.0
61/62	19.3	18.9	86.4	27.6	31.0	20.6	14.3	14.5	13.7	14.5	16.1	18.1	148.8	96.2	245.0
62/63	20.3	11.5	21.5	21.4	26.2	25.8	17.1	16.3	13.9	14.4	16.2	17.2	123.5	98.3	221.8
63/64	17.4	17.1	22.1	19.7	45.9	34.8	17.9	16.1	14.7	14.4	16.0	16.6	157.5	95.2	252.7
64/65	16.1	17.2	28.1	58.5	51.1	22.3	18.6	15.9	14.5	15.5	15.8	15.5	195.8	93.3	289.1
65/66	16.9	15.8	17.7	17.2	17.8	24.2	15.1	12.0	11.9	12.4	13.0	14.8	107.8	81.0	188.8
66/67	20.4	18.8	41.8	34.2	62.3	98.6	31.3	19.6	20.4	22.7	25.4	25.4	287.0	133.9	420.9
67/68	7.8	9.2	11.7	69.4	37.8	9.0	8.1	8.5	9.8	9.3	10.6	11.7	145.2	57.8	203.0
68/69	16.6	17.2	61.9	142.0	81.8	113.0	31.0	17.0	12.4	12.8	13.4	13.2	446.9	85.4	532.3
69/70	16.7	19.6	17.5	27.3	21.5	44.2	15.4	13.9	11.8	12.2	12.2	11.8	145.5	78.6	224.1
70/71	12.2	11.8	12.2	20.3	22.8	24.6	103.0	14.9	11.9	11.4	11.9	11.6	194.7	73.9	268.6
71/72	12.2	11.8	13.2	19.7	24.7	18.8	18.1	17.2	12.0	10.8	11.8	11.6	106.3	75.6	181.9
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	53.3	71.2	62.4	-	13.9	11.7	11.2	11.7	12.1	-	60.6	-
74/75	-	8.0	17.2	15.4	21.8	24.1	11.3	11.3	11.5	13.0	10.7	11.3	97.8	57.8	155.6
75/76	12.9	14.0	16.7	17.1	22.5	29.9	18.0	0.0	0.0	0.0	0.0	0.0	118.2	12.9	131.1
Averages															
	15.6	16.2	23.3	34.3	35.1	32.7	22.4	14.9	13.5	14.0	14.6	14.9	163.9	87.5	251.4

Table: Measured Streamflow (in Mcm)
Gauging Station - A3 Jord Wahadne

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	-	-	-	-	380.0	240.0	160.0	130.0	80.0	68.0	67.0	66.0	-	411.0	-
54/55	84.0	74.0	96.0	66.0*	32.0	44.0*	-	-	-	-	-	-	-	-	-
55/56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56/57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57/58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58/59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59/60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60/61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61/62	-	-	-	157.0	180.0	58.9	22.5	21.7	18.6	21.7	22.4	27.3	-	111.7	-
62/63	40.0*	75.3	55.1	64.4	116.0	124.0	50.6	69.1	26.3	19.4	13.5	17.5	485.4	185.8	671.2
63/64	26.4	45.3	179.0	61.0	239.0	216.0	96.4	49.4	21.5	16.0	16.3	15.6	836.7	145.2	981.9
64/65	21.1	102.0	148.0	224.0	239.0	47.7	34.8	17.3	19.7	14.5	12.2	16.0	795.5	100.8	896.3
65/66	27.4	25.1	33.6	41.6	57.4	47.4	23.3	12.4	12.0	9.9	10.3	13.4	228.4	85.4	313.8
66/67	23.3	21.5	76.1	100.0	162.0	332.0	146.0	36.4	16.2	13.0	10.4	13.7	837.6	113.0	950.6
67/68	18.1	24.1	99.1	361.0	-	-	-	-	-	-	-	-	-	-	-
68/69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69/70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70/71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71/72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74/75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75/76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Averages

27.6 53.8 98.4 98.2 162.7 153.4 70.2 36.9 19.1 14.6 12.5 15.2 636.7 126.0 762.8

* The figures are estimated for only a few days

(Station was closed after war 1967)

Water Quality - Yarmuk River

During flood flows the total dissolved solids (TDS) content ranges from 260 mg/l up to 900 mg/l. The base flow has a TDS of 420 up to 490 mg/l. Representative analysis can be seen from the attached tables. Trace metals have also very low concentration. From the chemical point of view Yarmuk River water is suitable for domestic and irrigational purpose.

Table: Chemical Composition of the Yarmuk River Water

Sample Number	Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3	
Date	3/8/80	16/8/80	1/10/80	16/8/80	12/3/81	22/4/81	9/12/80	25/5/81	4/8/80	22/4/81	
Source Type	River	River	River	River	River	River	River	River	Spring	Spring	
Temperature °C	24.5	25.0	23.0	26.0	-	-	-	-	27.0	-	
pH	6.5	6.8	6.8	6.8	6.8	-	6.5	9.0	6.8	6.8	
Ca ⁺⁺	mg/l	30.06	46.09	50.10	32.06	30.60	28.06	26.05	38.08	62.12	38.08
	m eq/l	1.50	2.30	2.50	1.60	1.50	1.40	1.30	1.90	3.10	1.90
	m eq%	18.87	26.41	30.53	21.53	30.86	20.12	27.96	24.87	36.91	32.93
Mg ⁺⁺	mg/l	32.83	30.40	25.54	24.32	13.38	26.75	19.46	24.36	17.02	18.24
	m eq/l	2.70	2.50	2.10	2.00	1.10	2.20	1.66	2.00	1.40	1.50
	m eq%	33.96	28.70	25.64	26.92	22.63	31.61	34.41	26.18	16.67	26.00
Na ⁺	mg/l	83.83	87.36	80.47	86.44	49.40	75.87	39.08	83.55	85.06	52.88
	m eq/l	3.65	3.80	3.50	3.76	2.15	3.30	1.70	3.63	3.70	2.30
	m eq%	45.91	43.63	42.74	50.61	44.24	47.41	36.56	47.51	44.05	39.86
K ⁺	mg/l	3.96	4.30	3.52	2.74	4.82	2.35	1.96	4.09	7.82	2.74
	m eq/l	0.10	0.11	0.09	0.07	0.11	0.06	0.05	0.11	0.20	0.07
	m eq%	1.26	1.26	1.10	0.94	2.26	0.86	1.08	1.44	2.38	1.21
Total cations (m eq/l)	7.95	8.71	8.19	7.43	4.86	6.96	4.65	7.64	8.40	5.77	

Table continued

Sample Number		Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3
CO ₃ ^{..}	mg/l	24.01	18.02	18.02	12.00	0.00	12.00	0.00	24.01	0.00	0.00
	m eq/l	0.80	0.60	0.60	0.40	0.00	0.40	0.00	0.80	0.00	0.00
	m eq%	9.49	7.02	7.59	5.26	0.00	0.40	0.00	9.70	0.00	0.00
HCO ₃ ⁻	mg/l	207.47	207.47	195.26	189.19	158.65	176.96	152.55	175.96	256.28	195.24
	m eq/l	3.40	3.40	3.20	2.10	2.60	2.90	2.40	2.90	4.20	3.20
	m eq%	40.33	39.77	40.46	40.74	51.08	40.79	47.34	35.15	49.41	53.33
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	88.67	80.42	80.42	82.48	54.46	75.25	57.33	86.14	85.57	55.45
	m eq/l	2.50	2.27	2.27	2.23	1.54	2.12	1.63	2.43	2.41	1.56
	m eq%	29.66	26.55	28.70	29.30	30.26	29.82	32.15	24.46	28.35	26.00
NO ₃ ⁻	mg/l	14.55	12.91	15.62	16.81	11.10	14.52	13.10	16.58	11.88	10.57
	m eq/l	0.24	0.21	0.25	0.27	0.18	0.23	0.21	0.27	0.19	0.17
	m eq%	2.85	2.56	3.16	3.55	3.54	3.24	4.14	3.27	2.24	2.83
SO ₄ ^{..}	mg/l	71.43	99.42	76.19	77.40	36.73	70.27	39.87	88.77	81.75	51.27
	m eq/l	1.49	2.07	1.59	1.61	0.77	1.46	0.83	1.85	1.70	1.07
	m eq%	17.68	24.21	20.10	21.16	15.13	20.54	16.37	22.42	20.00	17.83
Total anions (m eq/l)		8.43	8.55	7.91	7.61	5.09	7.11	5.07	8.25	8.50	6.00
T.D.S. (mg/l)		* figures missing from copy *						273.53	454.06	479.36	326.85

Table: Trace Metal Composition Yarmuk River Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Yarmuk R.	3/8/80	6.5	421.11	7.23	4.93	11.35	11.32	0.05	19.63	0.194	5.17	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	482.66	7.24	12.14	18.55	13.06	0.02	20.22	0.170	15.58	1.22	18.21
Yarmuk R.	16/8/80	6.8	447.51	5.86	7.55	10.18	11.29	0.22	21.29	0.178	14.16	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	-	4.18	5.93	10.91	9.88	0.41	21.29	0.213	9.91	N.D.	N.D.
Yarmuk R.	1/10/80	6.8	428.85	6.91	8.72	12.22	16.56	5.25	46.89	0.305	N.D.	1.65	8.38
Yarmuk R.		6.5	-	3.95	5.23	9.70	14.87	0.02	N.D.	0.039	13.29	N.D.	N.D.
Yarmuk R.		6.8	-	3.46	2.91	12.58	13.18	0.02	11.98	0.052	N.D.	N.D.	N.D.
Yarmuk R.	9/12/80	6.5	273.53	11.63	13.63	29.12	18.27	0.02	21.14	0.497	12.39	N.D.	14.72
Yarmuk R.	12/3/81	6.8	279.76	7.55	2.04	11.80	15.29	0.02	N.D.	0.147	10.84	N.D.	15.46
Yarmuk R.	22/4/81	-	393.55	6.58	4.97	17.42	14.04	0.05	20.15	0.151	14.03	1.64	12.63
Yarmuk R.	25/5/81	9.0	454.06	2.75	6.56	20.99	6.83	0.01	12.48	0.297	17.92	1.81	15.05
Yarmuk R.	23/6/81	6.8	468.09	7.71	6.56	18.78	6.41	0.02	18.15	0.204	11.69	2.89	N.D.

N.D. = not detected

Sediment Load

No significant sediment transport is found during the dry season. By volume the amount of sediment load is estimated to be 0.3% of the annual flood volume. By discharge average of 319 Mcm/yr for Maqarin there is a sediment load of about:

$$0.3\% \times 319 = 0.96 \text{ Mcm of sediments}$$

or about 2 million tons of solid and suspended loads. For Adasiya by an average discharge of 391 Mcm/yr it equals:

$$0.3\% \times 391 = 1.17 \text{ Mcm of sediment load}$$

or about 2.3 million tons.

Pollution

As can be seen from the major water constituents as well as trace metal contents the Yarmuk River water is chemically not polluted. The physical parameters are also very suitable for domestic and irrigational uses. Care must be taken by chlorinating this water after long exposures to light, where the organic carbon contents increase due to the activities of micro-organisms and [chloroform?] and [bromoform?] are then produced by adding chlorine to disinfect the water.

Soils

The catchment area is covered by calcereous-siliceous rocks in the western catchment and by basalts in the eastern part. The weathering of these two rock types resulted, under the prevailing climate, in the formation of two soil types.

a. Yellow Mediterranean Soils

They are related to the Brown Soils and differ from them by their extremely high calcereous content. They develop over basalt rocks (including lava) and have in some parts a dense cover of basalt boulders. In the Jordanian part of the Yarmuk catchment they occupy the area to the east of NS-line (36° 07').

b. Red Mediterranean Soils

They develop from calcereous and siliceous sediments. They differ from the typical Red Med. Soils by their high CaCO₃ content and by their base saturation of clay complex. This type of soil present in the area develop as a subgroup of typical Red Med. Soils in areas receiveing lower amounts of precipitation. In our area they occupy the highlands to the west of 36° 07' NS westward to the slopes over the Jordan Valley.

The amount of precipitation and the topography allows only for certain land uses, mainly dry farming. Average altitude, basin climate index, soil classification, average precipitation allow to calculate a Landuse Factor of 0.8-0.85 with an average Runoff-precipitation Factor as follows.

	Precipitation	Avg. Altitude	Runoff coefficient %		
			Flood	Base	Total
Adasiya	592 mm	900 m	14.1%	9.9%	24.0%
Maqarin	326 mm	700 m	5.5%	6.9%	12.4%

(National Water Master Plan / Jordan 1977)

Table: Chemical Composition of the Spring Water

These springs issue from B4,5 and their overlying recent rocks of basalts and soils. (Lower Tertiary and pleistocene). It includes Lower chalky unit, chalky unit, upper chalky unit. Basalts and Soils. Compare columnar section.

Sample Number	Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba	
Date	4/8/80	4/8/80	4/8/80	24/9/80	24/9/80	9/8/80	8/3/72	14/12/77	7/5/80	10/11/80	
Source Type	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	
Temperature °C	34.5	32.0	32.0	20.5	20.5	23.0	-	-	-	-	
pH	6.9	6.8	6.8	8.5	6.8	6.8	-	-	-	-	
Ca ⁺⁺	mg/l	88.18	72.14	90.18	78.16	20.04	94.19	70.54	68.14	70.54	68.14
	m eq/l	4.40	3.60	4.50	3.90	1.00	4.70	3.52	3.40	3.52	3.40
	m eq%	34.06	35.33	50.28	39.80	4.45	30.92	80.09	71.88	77.88	72.03
Mg ⁺⁺	mg/l	52.29	42.56	30.40	25.54	15.81	71.74	4.38	6.06	4.74	7.30
	m eq/l	4.30	3.50	2.50	2.10	1.30	5.90	0.36	0.50	0.39	0.60
	m eq%	33.28	34.35	27.93	21.43	29.35	38.82	8.24	10.57	8.63	12.71
Na ⁺	mg/l	91.96	66.90	41.38	85.06	46.91	103.46	10.35	18.39	13.79	15.17
	m eq/l	4.00	2.91	1.80	3.70	2.05	4.50	0.45	0.80	0.60	0.66
	m eq%	30.95	28.56	20.11	37.76	46.05	29.61	10.30	16.91	13.27	13.98
K ⁺	mg/l	4.69	7.84	5.87	3.91	5.46	3.91	2.35	1.17	0.39	2.35
	m eq/l	0.12	0.18	0.15	0.10	0.09	0.10	0.06	0.03	0.01	0.06
	m eq%	0.93	1.77	1.68	1.02	2.03	0.66	1.37	0.63	0.22	1.27
Total cations (m eq/l)	12.82	10.19	8.95	9.80	4.43	15.20	4.37	4.73	4.52	4.72	

Table continued

Sample Number		Spring No. 4	Spring No. 9	Spring No. 2	Ein el Ouseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba
CO ₃ ^{..}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	427.14	488.16	366.12	213.57	152.55	390.53	211.13	211.13	205.03	207.47
	m eq/l	7.00	7.80	6.00	3.50	2.21	6.40	3.46	3.46	3.36	3.40
	m eq%	48.54	68.24	64.87	35.90	48.15	44.57	77.75	80.65	72.41	77.63
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	177.33	96.91	64.95	113.41	44.33	165.99	20.56	28.01	21.99	22.68
	m eq/l	5.00	2.73	1.83	3.20	1.25	4.68	0.58	0.79	0.62	0.64
	m eq%	34.67	23.89	19.46	32.82	27.23	32.59	13.03	18.42	13.36	14.61
NO ₃ ⁻	mg/l	1.07	0.64	0.60	136.19	18.71	24.16	0.00	0.00	33.49	24.90
	m eq/l	0.02	0.01	0.00	2.20	0.30	0.41	0.00	0.00	0.54	0.04
	m eq%	0.14	0.09	0.00	22.56	6.54	2.86	0.00	0.00	11.64	0.91
SO ₄ ^{..}	mg/l	117.46	42.75	68.25	40.80	16.20	*131.75*	19.69	1.92	5.76	14.40
	m eq/l	1.49	0.89	1.42	0.85	0.34	* 2.07*	0.41	0.04	0.12	0.30
	m eq%	10.33	7.79	15.35	8.72	7.41	* 19.73*	9.21	0.93	2.59	6.85
Total anions (m eq/l)			*****	copy of table cut off			*****				
T.D.S. (mg/l)			*****	copy of table cut off			*****				

Table continued

Sample Number		Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain		Spring No. 7	Ain-Ba'boul	Ain-Sombal
Date		9/9/80	21/7/79	20/7/80	21/7/79	20/7/80	6/9/80	6/9/80	6/9/80
Source Type		Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring
Temperature °C		24.0	-	-	-	-	22.50	23.00	23.00
pH		6.8	-	-	-	-	6.80	6.80	6.80
Ca ⁺⁺	mg/l	68.14	60.92	66.13	52.10	63.73	104.21	128.26	110.22
	m eq/l	3.40	3.04	3.30	2.60	3.18	5.20	6.40	5.50
	m eq%	67.73	52.96	-	-	-	-	-	-
Mg ⁺⁺	mg/l	7.30	11.68	14.59	10.46	13.62	23.10	41.34	20.67
	m eq/l	0.60	0.96	1.20	0.86	1.12	1.90	3.40	1.70
	m eq%	11.95	16.73	-	-	-	-	-	-
Na ⁺	mg/l	22.99	39.08	42.76	57.48	62.99	22.99	41.38	22.07
	m eq/l	1.00	1.70	1.86	2.50	2.74	1.00	1.80	0.96
	m eq%	5.02	29.62	-	-	-	-	-	-
K ⁺	mg/l	0.78	1.56	3.13	1.56	3.91	2.74	2.35	3.13
	m eq/l	0.02	0.04	0.08	0.04	0.10	0.07	0.06	0.08
	m eq%	0.40	0.70	-	-	-	-	-	-
Total cations (m eq/l)		5.02	5.74	-	6.00	7.14	8.17	11.66	8.24

Table continued

Sample Number	Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain	Spring No. 7	Ain-Ba'boul	Ain-Sombal		
CO ₃ ^{..}	mg/l	0.00	10.20	0.00	2.40	0.00	0.00	0.00	
	m eq/l	0.00	0.84	0.00	0.08	0.00	0.00	0.00	
	m eq%	0.00	5.87	0.00	1.37	0.00	0.00	0.00	
HCO ₃ ⁻	mg/l	225.77	183.06	223.33	147.67	237.98	378.32	390.53	372.22
	m eq/l	3.70	3.00	3.66	2.42	3.90	6.30	6.40	6.10
	m eq%	76.61	51.81	-	41.44	52.07	-	-	-
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	22.68	54.25	61.35	81.56	82.98	39.18	79.39	61.86
	m eq/l	0.64	1.53	1.73	2.30	2.34	1.11	2.24	1.75
	m eq%	13.25	26.43	-	39.39	31.24	-	-	-
NO ₃ ⁻	mg/l	22.30	32.34	46.51	39.69	56.43	6.69	6.40	11.46
	m eq/l	0.36	0.52	0.75	0.64	0.91	0.18	0.10	0.19
	m eq%	7.45	8.98	-	10.96	12.15	-	-	-
SO ₄ ^{..}	mg/l	6.45	19.21	16.33	31.70	5.76	62.69	111.91	28.82
	m eq/l	0.13	0.40	0.34	0.66	0.12	1.31	2.33	0.60
	m eq%	2.69	6.91	*****	copy cut off	*****			
Total anions (m eq/l)	*****	*****	*****	*****	*****	*****	*****	*****	
T.D.S. (mg/l)	*****	*****	*****	*****	*****	*****	*****	*****	

Table: Trace Metal Composition of the Springs Water

Location	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Spring No. 4	6.9	746.55	5.32	17.81	7.22	15.65	0.01	18.60	0.063	9.60	2.34	N.D.
Spring No. 9	6.8	573.02	5.53	6.30	3.44	12.99	0.02	21.70	0.123	13.29	1.64	N.D.
Spring No. 2	6.8	484.69	4.68	20.27	3.44	13.65	0.02	N.D.	0.076	5.91	2.44	N.D.
Spring No. 3	6.8	479.36	5.96	5.21	7.22	10.99	0.03	14.03	0.116	6.65	N.D.	N.D.
Spring No. 3	6.8	326.85	3.39	7.22	15.57	8.97	0.03	12.31	0.396	10.13	1.55	N.D.
Quseir	8.5	589.86	13.65	25.02	3.09	15.55	0.09	23.81	0.371	N.D.	1.51	N.D.
Ghazabah	6.8	247.74	2.58	4.83	7.20	8.11	0.02	15.87	0.180	N.D.	1.00	*8.??*
Spring No. 7	6.8	450.76	6.46	3.78	6.18	29.65	0.03	19.16	0.086	9.94	1.79	N.D.
Ba'boul	6.8	606.40	8.07	25.08	19.27	7.41	0.02	27.67	0.196	N.D.	1.79	20.89
Sombal	6.8	444.34	6.68	4.85	4.00	31.17	0.04	17.03	0.080	N.D.	2.93	*8.8?*
El-Trab	6.8	502.86	6.93	5.12	2.74	12.17	0.02	12.27	0.052	5.94	0.97	N.D.
Quelba	6.8	258.68	8.89	9.01	4.31	19.61	1.59	55.91	0.122	12.46	2.17	N.D.
Murdahia	6.8	796.57	8.67	20.23	12.00	19.77	0.03	24.48	0.266	18.41	2.28	N.D.

N.D. = not detected

Table: Location of Sampling Sites Not Plotted on the Map

Sampling Site	Coordinates	
	N	E
Spring No. 4	237,799.2	232,676.9
Ain El Merdashia	236,451.49	233,397.96
Spring No. 7		
Ain Ba'boul	234,380.0	233,402.2
Ain Sombal	235,118.8	233,229.0
Ain et Trab	229.900	226.900
Ain el Quseir	Springs issue from the basalts in the Syrian side.	
NRA-Saham Exp. 234.000	234.000	222.000
Travertine Zone Seepage	236,981.7	232.739,96
Ain Quelbe	231.600	231.000
Ain Shelaq	221.000	238.400
Ain Um Jrain	221.200	240.100

Table: Chemical Composition of High pH Water
Upper Portion of B-3/Bituminous Marl Formation (compare columnar section)

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
Date		5/8/80	16/8/80	5/8/80	5/9/77	6/9/77	5/8/80	1/81	12/3/81	22/4/81
Source Type		Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage
Temperature °C		24.5	-	24.5	-	-	29.0	-	-	-
pH		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Ca ⁺⁺	mg/l	923.84	735.47	679.36	710.10	310.62	815.63	545.29	456.91	454.91
	m eq/l	46.10	36.70	33.90	35.43	15.50	40.70	27.21	22.80	22.70
	m eq%	94.82	83.33	92.55	91.81	79.61	94.78	91.90	89.59	91.72
Mg ⁺⁺	mg/l	0.00	6.08	3.65	0.00	7.30	0.00	0.00	1.22	0.00
	m eq/l	0.00	0.50	0.30	0.00	0.60	0.00	0.00	0.10	0.00
	m eq%	0.00	1.14	0.82	0.00	3.08	0.00	0.00	0.39	0.00
Na ⁺	mg/l	45.98	124.15	50.58	59.77	68.97	39.08	45.98	48.28	39.08
	m eq/l	2.00	5.40	2.20	2.60	3.00	1.70	2.00	2.10	1.70
	m eq%	4.11	-	6.01	6.74	15.41	3.96	6.76	8.25	6.87
K ⁺	mg/l	20.33	75.85	20.72	21.90	14.47	21.11	15.69	17.60	13.69
	m eq/l	0.52	1.94	0.53	0.56	0.37	0.54	0.40	0.45	0.35
	m eq%	1.07	12.26	1.45	1.45	1.90	1.26	1.35	1.77	1.41
Total cations (m eq/l)		48.62	44.04	36.63	38.59	19.47	42.94	29.61	25.45	24.75

Table continued

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
CO ₃ ⁻⁻	mg/l	36.01	162.05	60.02	42.33	18.31	108.04	30.01	66.02	36.01
	m eq/l	1.20	5.46	2.00	1.41	0.61	3.60	1.00	2.20	1.20
	m eq%	2.47	12.58	5.50	3.33	3.09	8.55	3.28	8.71	4.83
HCO ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH ⁻	mg/l	682.10	435.46	474.58	523.06	175.88	523.91	365.72	243.24	284.41
	m eq/l	40.10	25.60	27.90	30.75	10.34	30.80	21.50	14.30	16.70
	m eq%	82.44	59.62	76.69	72.51	52.51	73.18	70.58	56.63	67.20
Cl ⁻	mg/l	101.04	253.63	74.23	95.74	92.91	91.76	90.23	87.13	69.71
	m eq/l	2.85	7.15	2.09	2.70	2.62	2.59	2.55	2.46	1.96
	m eq%	5.86	16.65	5.75	6.37	13.25	6.15	8.37	9.74	7.89
NO ₃ ⁻	mg/l	2.25	32.94	8.18	7.75	2.86	8.86	10.65	10.75	6.66
	m eq/l	0.04	0.53	0.13	0.13	0.05	0.14	0.17	0.17	0.11
	m eq%	0.08	1.23	0.36	0.31	0.25	0.33	0.56	0.67	0.44
SO ₄ ⁻⁻	mg/l	223.34	204.61	204.61	356.38	286.26	238.23	260.30	293.94	321.39
	m eq/l	4.65	4.26	4.26	7.42	5.96	4.96	5.42	6.12	4.88
	m eq%	9.56	8.78	11.71	17.50	30.15	11.78	17.79	24.24	19.64
Total anions (m eq/l)		48.64	42.94	36.38	42.41	19.77	42.09	30.64	25.25	24.85
T.D.S. (mg/l)		2068.17	2030.00	1575.93	1774.70	977.58	1866.94	1363.84	1225.08	1110.89

Table continued

Sample Number		W.S. seepage	W.S. seepage
Date		23/6/81	14/2/77
Source Type		seepage	seepage
Temperature °C		-	-
pH		12.5	12.5
Ca ⁺⁺	mg/l	795.59	611.22
	m eq/l	39.70	30.50
	m eq%	39.63	89.13
Mg ⁺⁺	mg/l	0.00	7.30
	m eq/l	0.00	0.60
	m eq%	0.00	1.75
Na ⁺	mg/l	47.46	59.77
	m eq/l	2.07	2.60
	m eq%	4.88	7.60
K ⁺	mg/l	24.53	20.33
	m eq/l	0.63	0.52
	m eq%	1.49	1.52
Total cations (m eq/l)		42.40	34.2

Table continued

Sample Number		W.S. seepage	W.S. seepage
CO ₃ ^{..}	mg/l	24.01	15.61
	m eq/l	0.80	0.52
	m eq%	1.93	1.44
HCO ₃ [.]	mg/l	0.00	0.00
	m eq/l	0.00	0.00
	m eq%	0.00	0.00
OH [.]	mg/l	534.11	395.31
	m eq/l	31.40	23.24
	m eq%	75.74	64.16
Cl [.]	mg/l	93.07	108.51
	m eq/l	2.63	3.06
	m eq%	6.34	8.45
NO ₃ [.]	mg/l	7.44	0.00
	m eq/l	0.12	0.00
	m eq%	0.29	0.00
SO ₄ ^{..}	mg/l	321.43	451.48
	m eq/l	6.69	9.40
	m eq%	16.14	25.95
Total anions (m eq/l)		41.46	36.22
T.D.S. (mg/l)		1847.64	1668.53

Table: Trace Metal Composition of High pH Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Adits for construct. of Maqarin Dam, left side of Yarmuk R.	10/1/81 10/1/81 12/3/81 22/4/81 25/5/81 23/6/81	12.5 12.5 12.5 12.5 12.5 12.5	- 1289.62 1175.97 1226.06 1285.02 1127.87	11.97 5.51 5.58 6.18 8.62 6.79	8.90 7.83 4.33 7.38 6.21 2.76	415.82 467.81 425.12 437.35 419.48 400.70	39.88 27.61 22.21 25.62 20.07 18.79	0.03 0.08 0.03 0.05 0.02 0.02	49.09 47.32 31.02 55.97 38.56 41.97	0.085 0.184 0.056 0.120 0.133 0.125	24.37 38.20 37.94 33.51 38.96 47.53	5.04 6.54 5.96 5.89 6.93 6.35	42.69 32.30 32.39 28.42 28.42 27.63
W.S.- seepages	5/8/80 10/1/81 12/3/81 22/4/81 23/6/81	12.5 12.5 12.5 12.5 12.5	1866.94 1363.86 1225.08 1140.89 1847.46	17.54 - 8.37 8.17 7.52	6.38 7.99 5.39 8.18 10.01	523.32 466.05 348.76 383.98 635.78	67.41 31.43 24.64 21.35 29.47	0.10 0.11 3.06 0.02 0.05	95.79 59.40 48.13 43.85 73.72	0.081 0.139 0.113 0.090 0.125	39.65 41.52 36.39 31.74 52.21	9.76 7.46 5.97 6.54 10.06	49.62 44.17 39.02 26.50 26.84
Tr. Zone FS-1 Adit-AFS	16/8/80 5/8/80 25/8/80	12.5 12.5 12.5	2030.24 2868.94 1575.93	33.13 16.71 14.48	14.02 19.42 16.18	422.74 161.08 265.46	66.00 75.53 59.65	0.13 0.10 0.10	81.96 81.15 69.19	0.113 0.161 0.096	38.94 50.22 36.81	8.54 9.91 9.76	38.07 80.77 46.35

Table: Chemical Composition of Amman Formation Waters

Sample Number	FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35	
Date	9/12/80	22/4/81	25/5/81	23/6/81	4/8/80	22/4/81	9/9/80	12/3/81	22/4/81	
Source Type	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	
Temperature °C	-	-	-	-	26.5	-	30.0	-	-	
pH	6.80	-	7.20	7.10	6.50	-	7.10	6.80	-	
Ca ⁺⁺	mg/l	96.19	86.17	92.18	90.18	76.15	52.10	33.06	58.12	50.10
	m eq/l	4.80	4.30	4.60	4.50	3.80	2.60	1.60	2.90	2.50
	m eq%	48.39	43.66	46.23	45.32	35.58	35.23	32.85	33.68	34.82
Mg ⁺⁺	mg/l	27.97	34.05	30.40	32.82	40.13	24.36	3.65	35.26	32.26
	m eq/l	2.30	2.50	2.50	2.70	3.30	2.00	0.30	2.90	2.70
	m eq%	23.19	28.43	25.13	27.19	30.90	*27.1?*	6.16	33.68	37.60
Na ⁺	mg/l	63.91	62.07	63.28	60.81	75.87	62.07	64.37	62.07	43.91
	m eq/l	2.78	2.70	2.75	2.65	3.30	2.70	2.80	2.70	1.91
	m eq%	28.02	27.41	27.64	26.69	30.90	36.59	57.50	31.36	26.60
K ⁺	mg/l	1.56	1.96	3.83	3.07	10.95	3.13	6.65	4.30	2.74
	m eq/l	0.04	0.08	0.10	0.08	0.28	0.08	0.17	0.11	0.07
	m eq%	0.40	0.81	1.01	0.81	2.62	1.08	3.49	1.28	0.98
Total cations (m eq/l)	9.92	9.85	9.95	9.93	10.68	7.38	4.87	8.61	7.18	

Table continued

Sample Number		FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35
CO ₃ ^{''}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	36.01	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	25.32	0.00	0.00
HCO ₃ [']	mg/l	402.73	390.53	378.53	409.33	256.28	250.18	67.12	305.10	323.41
	m eq/l	6.60	6.40	6.20	6.60	4.20	4.10	1.10	5.00	5.30
	m eq%	67.76	65.11	63.46	62.44	41.26	54.16	23.21	59.45	78.99
OH [']	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl [']	mg/l	79.39	76.24	79.21	80.20	109.29	74.26	80.42	77.33	40.59
	m eq/l	2.24	2.15	2.23	2.26	3.08	2.09	2.27	2.18	1.15
	m eq%	23.00	21.87	22.83	21.38	30.26	27.61	47.89	25.92	17.14
NO ₃ [']	mg/l	1.00	0.20	0.00	0.00	0.75	2.22	2.18	0.90	0.11
	m eq/l	0.20	0.00	0.00	0.00	0.01	0.04	0.04	0.02	0.00
	m eq%	0.21	0.00	0.00	0.00	0.10	0.53	0.84	0.24	0.00
SO ₄ ^{''}	mg/l	42.48	61.62	64.12	82.14	138.09	64.20	6.45	58.12	12.50
	m eq/l	0.88	1.20	1.34	1.71	2.89	1.34	0.13	1.21	0.26
	m eq%	9.04	12.21	13.72	16.18	28.39	17.70	2.70	14.39	3.88
Total anions (m eq/l)		9.74	9.83	9.77	10.57	10.18	7.57	4.70	8.41	6.71
T.D.S. (mg/l)		512.31	517.54	522.18	553.90	580.17	407.43	256.45	448.65	349.49

Table continued

Sample Number	Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34	
Date	7/9/80	12/3/81	25/5/81	24/9/80	10/9/80	12/3/81	10/8/80	12/3/81	9/9/80	
Source Type	G.W.	G.W.	G.W.	-	G.W.	G.W.	G.W.	G.W.	G.W.	
Temperature °C	26.0	-	-	-	29.0	-	29.0	-	26.5	
pH	6.8	6.8	7.4	6.9	7.0	7.3	6.8	6.8	12.0	
Ca ⁺⁺	mg/l	106.21	70.14	96.17	24.05	14.03	8.02	90.18	66.13	206.41
	m eq/l	5.30	3.40	4.80	1.20	0.70	0.40	3.90	3.30	10.30
	m eq%	41.31	29.80	39.15	15.06	11.09	8.55	43.67	51.40	43.22
Mg ⁺⁺	mg/l	32.83	49.86	55.94	26.75	9.73	0.00	30.40	21.89	3.65
	m eq/l	4.10	4.60	4.10	2.20	0.80	0.00	2.50	1.80	0.30
	m eq%	31.96	40.32	33.44	-	12.68	0.00	28.00	28.03	1.26
Na ⁺	mg/l	71.27	69.86	69.21	91.96	105.29	24.81	41.38	28.44	108.05
	m eq/l	3.10	3.04	3.01	4.00	4.58	4.12	2.30	1.24	4.70
	m eq%	24.16	26.64	24.55	27.58	88.03	25.76	19.32	-	19.72
K ⁺	mg/l	2.90	14.86	13.80	22.25	7.42	6.26	5.87	3.11	333.52
	m eq/l	0.33	0.36	0.35	0.57	0.23	0.16	0.23	0.08	8.53
	m eq%	2.57	3.16	-	7.15	3.65	3.42	2.58	1.25	35.80
Total cations (m eq/l)	12.83	11.41	12.26	7.97	6.31	4.68	8.93	6.42	23.83	

Table continued

Sample Number	Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34	
CO ₃ ^{''}	mg/l	0.00	0.00	0.00	18.01	12.00	12.00	0.00	0.00	66.02
	m eq/l	0.00	0.00	0.00	0.60	0.40	0.40	0.00	0.00	2.20
	m eq%	0.00	0.00	0.00	-	6.53	8.49	0.00	0.00	9.37
HCO ₃ [']	mg/l	292.90	280.69	280.69	201.37	42.71	24.41	366.14	274.59	0.00
	m eq/l	4.80	4.60	4.60	3.30	0.70	0.40	6.00	4.60	0.00
	m eq%	39.80	39.76	39.18	-	11.42	8.49	65.95	61.07	0.00
OH [']	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.93
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.50
Cl [']	mg/l	143.31	144.56	133.66	118.57	168.03	137.62	64.95	45.36	90.73
	m eq/l	4.04	4.56	3.77	3.34	4.74	3.88	1.85	1.23	2.56
	m eq%	33.50	39.41	32.11	40.19	77.33	82.38	20.33	19.22	10.91
NO ₃ [']	mg/l	2.46	1.80	1.35	4.50	2.60	1.85	0.60	1.45	10.97
	m eq/l	0.04	0.03	0.02	0.07	0.04	0.03	0.06	1.45	0.18
	m eq%	0.33	0.26	0.17	0.84	0.65	0.64	0.66	0.30	0.77
SO ₄ ^{''}	mg/l	152.74	114.05	160.71	62.40	12.00	5.00	68.25	36.40	760.32
	m eq/l	3.18	2.38	3.35	1.30	0.25	0.10	1.19	0.76	15.83
	m eq%	26.37	20.57	28.55	15.64	4.08	2.12	13.08	11.41	67.54
Total anions (m eq/l)	12.06	11.57	11.74	8.31	6.13	4.71	9.10	6.66	23.47	
T.D.S. (mg/l)	685.20	611.56	665.11	469.22	352.46	277.77	484.69	340.09	1625.50	

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
Date		9/12/80	1/81	4/8/80	8/9/80	9/9/80	9/9/80	2/10/80	9/9/80	7/9/80	9/9/80
Source Type		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		-	-	26.5	27.0	25.0	26.0	24.5	25.0	25.5	28.0
pH		12.0	6.8	6.8	7.5	12.0	7.1	8.2	6.8	8.5	7.1
Ca ⁺⁺	mg/l	96.19	90.18	104.21	68.14	44.09	42.08	22.04	60.12	44.09	49.09
	m eq/l	4.80	4.50	5.20	3.40	2.20	2.10	1.10	3.00	2.20	2.30
	m eq%	23.08	46.06	44.94	41.87	35.03	34.04	21.87	38.66	31.56	31.59
Mg ⁺⁺	mg/l	18.24	35.26	37.70	6.08	3.65	9.73	10.94	36.48	3.65	25.04
	m eq/l	1.50	2.90	3.10	0.50	0.30	0.80	0.90	3.00	0.30	2.10
	m eq%	7.21	29.68	26.79	6.16	4.78	12.97	17.89	38.66	4.30	28.85
Na ⁺	mg/l	117.94	52.88	72.85	101.16	78.17	71.27	64.87	39.08	91.96	61.84
	m eq/l	5.13	2.30	3.17	4.04	3.40	3.10	2.82	1.70	4.00	2.69
	m eq%	24.66	23.54	27.40	49.75	54.14	50.24	56.06	21.91	57.39	36.95
K ⁺	mg/l	366.37	2.74	4.69	7.04	14.86	6.65	8.29	2.35	16.42	7.43
	m eq/l	9.37	0.07	3.71	0.18	0.38	0.17	0.21	0.06	0.47	0.19
	m eq%	45.05	0.72	0.86	2.22	6.05	2.76	4.18	0.77	6.74	2.61
Total cations (m eq/l)		20.80	9.77	11.57	8.12	6.28	6.17	5.03	7.76	6.97	7.28

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
CO ₃ ^{''}	mg/l	42.01	0.00	0.00	24.00	36.01	24.01	24.01	0.00	30.01	12.00
	m eq/l	1.40	0.00	0.00	0.80	1.20	0.80	0.80	0.00	1.00	0.10
	m eq%	6.27	0.00	0.00	10.30	19.14	13.84	17.06	0.00	13.95	1.45
HCO ₃ [']	mg/l	0.00	421.00	463.75	42.71	0.00	79.33	54.92	341.71	0.00	36.61
	m eq/l	0.00	6.90	7.60	0.70	0.00	1.30	0.40	5.60	0.00	4.70
	m eq%	0.00	68.66	66.55	9.01	0.00	22.49	19.19	77.56	0.00	68.12
OH [']	mg/l	69.01	0.00	0.00	0.00	8.51	0.00	0.00	0.00	1.70	0.00
	m eq/l	4.10	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.10	0.00
	m eq%	18.37	0.00	0.00	0.00	7.97	0.00	0.00	0.00	1.40	0.00
Cl [']	mg/l	84.54	77.33	86.60	113.41	113.41	79.39	59.80	39.18	117.53	68.05
	m eq/l	4.10	2.18	2.44	3.20	3.20	2.24	1.69	1.11	3.32	1.92
	m eq%	18.10	21.69	21.37	41.18	51.04	38.75	36.03	15.37	46.30	27.83
NO ₃ [']	mg/l	5.85	1.00	0.89	3.52	3.80	5.28	5.84	1.90	1.96	3.31
	m eq/l	0.09	0.02	0.01	0.06	0.06	0.09	0.09	0.03	0.02	0.05
	m eq%	0.40	0.20	0.09	0.77	0.96	1.56	1.92	0.42	0.28	0.73
SO ₄ ^{''}	mg/l	606.62	45.59	65.87	144.57	84.60	69.00	58.20	22.80	130.95	6.24
	m eq/l	12.63	0.95	1.37	3.01	1.76	1.44	1.21	0.48	2.73	0.13
	m eq%	56.59	9.45	12.00	38.79	28.07	24.91	25.80	6.65	38.08	1.88
Total anions (m eq/l)		22.32	10.05	11.42	7.77	6.27	5.78	4.69	7.22	7.17	6.90
T.D.S. (mg/l)		1407.49	515.48	603.71	489.29	387.10	347.08	281.45	372.77	438.27	238.77

Table: Trace Metal Concentration of Amman Formation Waters

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
FS-36	Aug 80	6.5	-	5.11	16.99	2.06	23.31	8.20	24.80	0.146	N.D.	1.95	N.D.
FS-36	Nov 80	6.8	-	4.20	20.92	10.78	25.35	8.29	21.96	0.613	14.12	2.43	6.10
FS-36	Jun 81	6.8	512.31	3.88	19.74	N.D.	16.57	4.14	16.10	0.682	13.29	1.76	7.36
FS-36	Apr 81	-	517.58	2.59	13.15	12.23	17.08	0.14	20.15	0.153	17.14	2.04	10.26
FS-36	May 81	7.2	522.18	2.39	29.82	187.46	83.27	0.24	32.51	0.835	21.82	3.19	15.79
FS-36	Jun 81	7.4	553.90	4.95	15.01	8.10	13.24	1.18	13.61	0.107	17.14	2.97	N.D.
FS-35	Sep 80	7.1	265.45	18.67	11.65	6.87	17.51	3.19	53.18	0.361	N.D.	1.77	19.86
FS-35	Dec 80	8.0	-	5.19	N.D.	2.87	9.80	0.23	16.97	0.047	N.D.	N.D.	20.57
FS-35	Mar 81	6.8	448.65	1.84	8.15	N.D.	14.44	2.81	32.22	0.111	8.52	N.D.	10.31
FS-35	Apr 81	-	349.49	1.79	7.22	N.D.	6.41	0.76	16.79	0.125	12.39	1.55	6.36
NRA-W.S.	Sep 80	6.8	685.20	9.70	22.75	6.51	21.51	1.11	54.67	0.316	13.45	1.86	14.07
NRA-W.S.	Mar 81	6.8	611.56	2.59	N.D.	N.D.	10.68	0.19	23.53	0.056	17.03	1.55	14.72
NRA-W.S.	May 81	7.4	665.11	2.75	21.74	19.15	17.51	0.29	43.66	0.271	8.57	3.03	10.26
HV-11	Sep 80	7.0	352.46	11.33	19.05	17.14	10.82	4.82	37.70	0.633	N.D.	3.43	11.43
HV-11	Mar 81	7.3	277.77	2.25	2.35	N.D.	9.79	1.91	N.D.	0.078	14.71	N.D.	6.63
HV-11	Apr 81	-	-	7.38	7.05	N.D.	8.97	1.26	42.54	0.304	13.16	1.47	N.D.
FS-37	Aug 80	6.8	-	6.38	13.48	5.46	24.71	3.70	24.04	0.147	11.82	2.60	9.23
FS-37	Jun 81	6.8	515.48	3.47	14.73	4.64	13.17	7.49	15.10	0.443	12.39	1.93	11.04
FS-37	Mar 81	6.8	-	4.69	14.57	N.D.	4.67	11.38	20.13	0.051	6.97	N.D.	11.04
FS-52	Aug 80	6.5	580.17	5.01	25.35	5.09	14.82	0.02	22.04	0.121	8.86	N.D.	N.D.
FS-52	Apr 81	-	407.43	3.59	14.11	9.64	13.24	0.06	19.25	0.137	19.35	1.88	N.D.
FS-74	Sep 80	6.9	469.22	8.50	20.05	3.59	18.59	1.16	22.96	0.196	N.D.	1.00	10.97
FS-74	Dec 80	6.8	-	18.52	9.59	3.59	17.58	0.54	52.91	0.100	12.46	N.D.	14.48
FS-74	Mar 81	6.8	391.82	14.08	6.42	10.32	16.72	1.14	N.D.	0.107	11.61	N.D.	11.04
FS-34		12.0	1625.60	13.60	11.65	8.31	48.51	5.87	527.73	0.268	34.18	22.98	40.55
FS-34		12.0	1407.49	23.46	6.68	7.19	45.30	0.83	534.09	0.032	36.54	3.04	54.10

Table continued

Location	Date	pH	T.D.S.	Cu	Mn	Cr	Ni	Zn	Pb	Fe	Co	Cd	Mo
			p.p.m.	p.p.b.	p.p.b.	p.p.b.	p.p.b.	p.p.m.	p.p.b.	p.p.m.	p.p.b.	p.p.b.	p.p.b.
FS-4	Aug 80	6.8	458.60	6.17	15.62	5.16	19.31	1.72	N.D.	0.199	13.29	2.44	36.00
FS-4	Mar 81	6.8	359.48	1.63	7.21	32.44	23.36	0.88	36.24	0.331	17.81	7.88	12.50
FS-17		6.8	603.70	6.60	34.25	5.85	17.31	4.31	14.47	0.529	5.91	2.73	N.D.
NRA-B		11.5	-	9.75	30.61	71.27	28.09	0.05	37.17	1.054	13.45	2.42	14.90
NRA-A		8.5	438.27	11.73	21.40	6.87	22.25	3.00	171.65	0.206	9.91	N.D.	N.D.
FS-26 ²		7.5	489.29	16.27	87.95	7.95	22.61	6.06	162.91	0.613	N.D.	0.97	11.59
FS-25		9.5	-	20.27	9.75	9.76	25.17	1.00	59.04	0.261	N.D.	1.94	18.21
FS-10		6.8	-	10.40	7.04	7.59	18.61	4.04	44.83	0.610	10.62	2.26	14.07
FS-63		12.0	387.10	16.53	41.45	2.12	19.33	7.05	281.25	0.420	11.15	1.77	23.17
FS-62		7.0	347.08	13.60	5.96	1.45	16.78	3.80	43.98	0.233	N.D.	N.D.	10.76
FS-21		7.5	432.71	16.00	14.36	3.25	15.68	15.28	227.05	2.636	N.D.	3.22	N.D.
FS-18		7.1	238.81	21.07	17.92	4.80	29.07	6.15	150.34	0.527	N.D.	3.46	8.28
NRA-Saham Exp.		6.8	372.77	48.53	5.40	2.40	17.24	0.01	18.41	0.151	N.D.	N.D.	N.D.
FS-22		7.4	-	41.72	23.61	7.20	30.42	10.51	169.64	0.338	26.01	2.42	48.00
FS-32		8.2	281.45	21.48	6.97	4.67	24.00	2.55	125.79	0.160	N.D.	N.D.	10.67
NRA-A ₁		6.8	-	25.34	32.24	8.68	21.89	15.82	557.60	1.034	4.96	5.33	N.D.

N.D. = not detected

Table: Chemical Composition of the Bituminous Marl Formation
Compare columnar section of the area

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70
Date		31/8/77	3/8/80	12/3/81	22/4/81	25/5/81	23/6/81	10/9/80	22/4/81	20/9/80	24/9/80
Source Type		Borehole	Borehole	Borehole	Borehole	Borehole	Borehole				
Temperature °C		-	26.0	-	-	-	-	28.5	-	28.0	25.0
pH		8.02	6.5	6.8	6.8	6.9	6.8	7.2	-	8.5	6.9
Ca ⁺⁺	mg/l	83.97	86.17	82.16	88.17	84.17	88.18	20.04	14.03	26.05	122.24
	m eq/l	4.19	4.30	4.10	4.40	4.20	4.40	1.00	0.70	1.30	3.90
	m eq%	49.53	40.76	40.84	42.59	41.58	43.96	14.93	11.82	26.59	36.93
Mg ⁺⁺	mg/l	17.88	35.26	36.48	36.48	36.48	34.05	14.59	7.30	9.73	31.62
	m eq/l	1.47	3.30	3.00	3.00	3.00	2.80	1.20	0.60	0.80	1.80
	m eq%	17.38	31.28	29.88	29.04	29.70	27.97	17.91	16.14	16.36	17.05
Na ⁺	mg/l	62.07	64.37	64.37	64.37	63.77	61.55	93.34	94.26	57.48	108.28
	m eq/l	2.07	2.80	2.80	2.80	2.77	2.68	4.06	4.10	2.50	4.71
	m eq%	31.48	26.54	27.89	27.11	27.43	26.77	60.60	69.26	51.13	44.60
K ⁺	mg/l	4.69	5.87	5.47	5.08	5.11	4.85	17.20	20.33	11.34	5.81
	m eq/l	0.12	0.15	0.14	0.13	0.13	0.13	0.44	0.52	0.29	0.15
	m eq%	1.27	1.42	1.39	1.26	1.29	1.30	5.57	8.78	5.93	1.42
Total cations (m eq/l)		8.48	10.55	10.04	10.33	10.10	10.01	6.70	5.92	4.89	10.56

Table continued

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70
CO ₃ ^{''}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	12.00	18.07	12.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.60	0.40	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	5.95	9.67	8.49	0.00
HCO ₃ [']	mg/l	383.85	475.96	421.04	445.45	427.14	433.24	48.82	0.00	61.02	231.88
	m eq/l	6.19	7.80	6.90	7.30	7.00	7.10	0.80	0.00	1.00	3.80
	m eq%	64.75	68.78	65.28	69.92	68.16	68.01	11.91	0.00	21.23	33.51
OH [']	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl [']	mg/l	75.18	84.54	83.17	77.23	82.18	84.16	105.16	105.94	67.02	103.10
	m eq/l	2.12	2.38	2.35	2.18	2.32	2.37	2.97	2.99	1.89	2.91
	m eq%	22.18	20.99	22.23	20.88	22.59	22.70	44.20	47.69	40.13	25.66
NO ₃ [']	mg/l	2.86	0.96	1.40	1.20	0.85	1.24	3.31	1.55	2.96	3.38
	m eq/l	0.05	0.02	0.02	0.02	0.01	0.02	0.05	0.03	0.05	0.06
	m eq%	0.52	0.18	0.19	0.19	0.10	0.19	0.74	0.48	1.66	0.59
SO ₄ ^{''}	mg/l	57.64	54.76	53.63	45.32	44.94	45.54	120.08	127.26	66.00	219.50
	m eq/l	1.20	1.14	1.12	0.94	0.94	0.95	2.50	2.65	1.37	4.57
	m eq%	12.55	10.05	10.60	9.00	9.15	9.10	37.20	42.27	29.09	40.30
Total anions (m eq/l)		9.86	11.34	10.57	10.44	10.27	10.44	6.72	6.27	4.71	11.34
T.D.S. (mg/l)		576.00	569.91	532.20	540.58	531.07	536.19	410.13	388.68	283.09	709.87

Table continued

Sample Number	BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2	
Date	25/9/80	10/9/80	19/5/78	3/8/80	3/6/81	24/9/80	12/3/81	12/3/81	3/8/80	12/3/81	
Source Type			Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	
Temperature °C	26.0	28.0	-	29.0	-	27.5	-	-	24.5	-	
pH	8.5	7.0	7.25	6.5	6.8	6.9	6.8	6.8	6.8	6.8	
Ca ⁺⁺	mg/l	18.04	14.03	72.34	78.15	74.80	100.20	88.18	98.20	76.15	66.13
	m eq/l	0.90	0.70	3.64	3.90	3.70	5.00	4.40	4.80	3.30	3.30
	m eq%	25.35	13.59	47.82	50.98	49.87	49.70	43.56	47.81	49.16	44.24
Mg ⁺⁺	mg/l	8.51	13.38	24.20	24.32	25.54	30.40	35.26	34.05	27.97	29.18
	m eq/l	0.70	1.10	1.99	2.00	2.10	2.50	2.90	2.80	2.30	2.40
	m eq%	19.72	21.36	26.36	26.14	28.30	24.85	28.71	27.80	29.75	32.17
Na ⁺	mg/l	38.62	71.27	41.38	36.78	34.72	53.89	63.54	52.88	34.43	36.78
	m eq/l	1.68	3.10	1.80	1.60	1.51	2.34	2.76	2.30	1.50	1.60
	m eq%	47.32	60.19	23.84	20.92	20.35	23.26	27.33	22.91	19.41	21.45
K ⁺	mg/l	10.56	9.78	5.87	5.87	4.30	8.41	1.56	5.47	5.19	6.26
	m eq/l	0.27	0.25	0.15	0.15	0.11	0.22	0.04	0.14	0.13	0.16
	m eq%	7.61	4.85	1.99	1.96	1.48	2.19	0.40	1.39	1.68	2.15
Total cations (m eq/l)	3.55	5.15	7.55	7.65	7.42	10.06	10.10	10.04	7.73	7.46	

Table continued

Sample Number		BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2
CO ₃ ^{''}	mg/l	30.01	12.00	0.00	0.00	0.00	0.00	0.00	0.00	24.01	0.00
	m eq/l	1.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00
	m eq%	29.67	8.25	0.00	0.00	0.00	0.00	0.00	0.00	10.97	0.00
HCO ₃ [']	mg/l	36.61	36.61	321.83	341.71	303.90	262.39	292.90	280.69	280.69	305.10
	m eq/l	0.60	0.60	5.19	5.60	4.90	4.30	4.80	4.60	3.60	5.00
	m eq%	17.80	12.42	68.29	68.54	66.13	44.75	51.01	48.68	49.38	69.25
OH [']	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl [']	mg/l	57.74	89.70	51.06	50.52	47.53	98.98	83.51	86.14	45.36	48.52
	m eq/l	1.58	2.53	1.44	1.42	1.34	2.79	2.36	2.44	1.28	1.73
	m eq%	46.88	52.38	18.95	17.38	18.08	29.03	25.08	25.82	17.56	
NO ₃ [']	mg/l	3.38	2.53	2.17	0.29	0.00	1.42	1.05	1.00	0.71	0.95
	m eq/l	0.06	0.04	0.04	0.00	0.00	0.02	0.02	0.02	0.01	0.02
	m eq%	1.78	0.83	0.53	0.00	0.00	0.21	0.21	0.21	0.14	0.28
SO ₄ ^{''}	mg/l	6.24	60.60	44.67	55.23	56.20	120.00	106.43	114.62	28.57	39.90
	m eq/l	0.13	1.26	0.93	1.15	1.17	2.50	2.23	2.39	0.60	0.83
	m eq%	3.86	26.09	12.24	14.08	15.79	26.02	23.70	25.29	8.23	11.50
Total anions (m eq/l)		3.37	4.83	7.60	8.17	7.41	9.61	9.41	9.45	7.29	7.22

Table continued

Sample Number	S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2	
Date	4/8/80	4/8/80		23/8/80	12/3/81	25/5/81	23/6/81	25/5/81	23/6/81	31/8/77	
Source Type	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	
Temperature °C	26.0	29.5	-	28.0	-	-	-	-	-	-	
pH	6.8	6.8	-	6.8	6.8	6.9	6.8	7.4	6.8	7.3	
Ca ⁺⁺	mg/l	104.21	68.14	68.14	84.17	84.17	78.16	82.16	70.14	70.14	80.16
	m eq/l	5.20	3.40	3.40	4.20	4.20	3.90	4.10	3.50	3.50	4.00
	m eq%	58.56	46.26	41.87	44.21	51.41	52.56	51.57	45.81	54.26	53.41
Mg ⁺⁺	mg/l	8.51	25.54	6.08	25.54	30.40	23.47	27.97	29.18	17.02	23.10
	m eq/l	0.70	2.10	0.50	2.10	2.50	1.93	2.30	2.40	1.40	1.90
	m eq%	7.88	28.57	6.16	22.11	30.60	26.01	28.93	31.41	21.71	25.37
Na ⁺	mg/l	64.37	39.08	101.16	68.97	29.89	32.13	31.14	37.08	32.63	34.49
	m eq/l	2.80	1.70	4.04	3.00	1.30	1.40	1.36	1.61	1.42	1.50
	m eq%	31.53	23.13	49.75	31.58	15.91	18.87	17.11	21.07	22.01	20.03
K ⁺	mg/l	7.04	5.87	7.04	7.82	6.65	7.40	7.41	5.11	4.85	5.45
	m eq/l	0.18	0.15	0.18	0.20	0.17	0.19	0.19	0.13	0.13	0.14
	m eq%	2.03	2.04	0.22	2.11	2.08	2.56	2.39	1.70	4.65	1.34
Total cations (m eq/l)	8.88	7.35	8.12	9.50	8.17	7.42	7.95	7.64	6.45	7.49	

Table continued

Sample Number		S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2
CO ₃ ^{..}	mg/l	0.00	0.00	24.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	353.92	341.71	42.71	378.32	317.30	311.20	317.30	311.20	274.59	321.21
	m eq/l	5.80	5.60	0.70	6.20	5.20	5.10	5.20	5.10	4.50	5.18
	m eq%	61.44	72.26	9.00	67.39	66.67	68.64	65.16	67.11	70.31	69.34
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	46.40	41.24	113.41	43.30	44.56	46.54	43.56	45.55	47.53	45.39
	m eq/l	1.31	1.16	3.20	1.22	1.26	1.31	1.23	1.29	1.35	1.22
	m eq%	13.88	14.97	41.18	13.26	16.15	17.63	15.41	16.97	21.09	17.14
NO ₃ ⁻	mg/l	0.55	0.60	3.52	1.57	2.45	1.46	1.86	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.06	0.03	0.04	0.02	0.03	0.00	0.00	0.00
	m eq%	0.00	0.00	0.77	0.33	0.51	0.27	0.38	0.00	0.00	0.00
SO ₄ ^{..}	mg/l	111.91	47.62	144.57	84.13	63.45	68.70	73.21	58.23	41.07	48.51
	m eq/l	2.33	0.99	3.01	***		copy unreadable			***	1.01
	m eq%	24.68	12.77	38.74	***		copy unreadable			***	13.52
Total anions (m eq/l)		9.44	7.75	7.77	9.20	7.82	7.43	7.98	7.60	6.40	7.47
T.D.S. (mg/l)		*** copy	cut off	***	504.66	420.22	413.46	425.96	379.89	350.54	* cut *

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
Date		3/8/80	12/3/80	22/3/81	25/5/81
Source Type		Borehole	Borehole	Borehole	Borehole
Temperature °C		28.2	-	-	-
pH		6.5	6.8	6.8	6.8
Ca ⁺⁺	mg/l	102.20	86.17	84.17	102.20
	m eq/l	5.10	4.30	4.20	5.10
	m eq%	56.67	56.21	54.40	67.55
Mg ⁺⁺	mg/l	24.32	23.10	26.75	12.16
	m eq/l	2.00	1.90	2.20	1.00
	m eq%	22.22	24.84	28.50	13.25
Na ⁺	mg/l	39.08	29.94	27.59	29.66
	m eq/l	1.70	1.30	1.20	1.29
	m eq%	18.89	16.99	15.54	17.09
K ⁺	mg/l	7.82	14.35	4.69	6.13
	m eq/l	0.20	0.15	0.12	0.16
	m eq%	2.22	1.96	1.55	2.12
Total cations (m eq/l)		9.00	7.65	7.72	7.55

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
CO ₃ ²⁻	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	366.12	311.20	317.30	392.51
	m eq/l	6.00	5.10	5.20	5.40
	m eq%	69.61	70.25	68.06	69.23
OH ⁻	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	44.33	43.56	40.59	41.58
	m eq/l	1.25	1.23	1.15	1.17
	m eq%	14.50	16.94	15.05	15.00
NO ₃ ⁻	mg/l	1.03	1.45	0.32	0.00
	m eq/l	0.02	0.02	0.00	0.00
	m eq%	0.23	0.28	0.00	0.00
SO ₄ ²⁻	mg/l	64.29	43.73	61.44	58.93
	m eq/l	1.34	0.91	1.29	1.23
	m eq%	15.55	12.53	16.88	15.77
Total anions (m eq/l)		8.62	7.62	7.64	7.80
T.D.S. (mg/l)		***	copy cut off	***	***

Table: Trace Metal Composition of the Bituminous Marl Formation

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
HV-5A	Aug 77	-	576.0	-	-	-	-	-	-	-	-	-	-
HV-5A	Aug 80	6.5	570.0	6.81	41.37	8.25	17.98	0.04	20.67	0.360	5.91	2.89	25.38
HV-5A	Nov 80	6.8	-	1.98	40.93	4.31	18.24	0.01	15.95	0.065	10.80	1.39	N.D.
HV-5A	Mar 81	6.8	537.0	4.29	40.11	N.D.	9.77	0.03	9.63	0.907	20.13	1.23	15.46
HV-5A	Apr 81	6.8	540.0	4.59	27.42	3.34	8.54	0.03	14.97	0.304	18.58	2.13	N.D.
HV-5A	May 81	6.9	531.0	4.22	43.48	39.04	11.53	0.02	13.61	0.347	16.36	2.64	11.05
HV-5A	Jun 81	6.8	536.0	3.85	46.93	11.79	12.38	0.01	20.42	0.187	15.58	3.13	N.D.
AV-2	Aug 80	6.8	505.0	4.47	36.44	4.13	22.64	0.09	17.57	0.446	88.12	2.27	28.85
AV-2	Mar 81	6.8	420.0	5.18	26.94	4.45	19.64	0.10	11.77	0.350	21.08	1.88	9.57
AV-2	May 81	6.9	413.0	2.75	18.98	7.73	14.95	0.18	22.39	0.607	19.48	1.96	17.37
AV-2	Jun 81	6.8	426.0	5.51	10.52	9.21	19.64	0.27	13.60	0.263	19.25	2.64	N.D.
BV-2	Aug 80	6.5	466.0	8.51	14.80	5.85	3.33	0.04	17.57	0.249	7.39	2.19	27.69
BV-2	Mar 81	6.8	398.0	1.63	1.25	N.D.	12.32	0.02	N.D.	0.042	13.94	N.D.	16.93
BV-2	Apr 81	6.8	407.0	4.98	13.95	N.D.	21.78	0.03	14.97	0.153	13.16	1.96	9.57
BV-2	May 81	7.2	383.0	N.D.	9.83	6.63	6.41	0.02	19.03	0.404	16.36	2.70	15.00
BV-2	Jun 81	6.8	447.0	3.12	34.33	11.79	7.69	0.01	N.D.	0.355	16.36	2.23	N.D.
HV-10	Aug 80	6.5	421.3	9.36	14.52	3.10	16.32	0.04	16.53	0.120	N.D.	1.02	17.21
HV-10	Jan 81	6.8	394.0	3.49	13.11	12.52	13.67	0.01	22.63	0.131	20.26	2.89	13.42
HV-8	Sep 80	6.8	545.0	7.47	48.81	7.19	24.68	11.76	86.35	0.505	N.D.	1.59	13.71
HV-8	Jan 81	6.8	526.0	2.44	18.96	N.D.	12.38	0.59	19.13	0.329	40.69	2.35	19.88
HV-8	Mar 81	6.8	533.0	3.47	6.27	10.32	21.24	0.11	N.D.	0.129	19.36	1.43	15.46
AV-1	May 81	7.4	381.0	2.75	28.64	19.52	15.37	3.16	31.35	0.857	11.69	1.39	N.D.
AV-1	Jun 81	6.8	394.0	4.40	24.84	9.21	18.54	1.80	N.D.	0.200	16.36	2.14	N.D.
HV-2	Aug 80	6.8	383.0	10.00	13.15	7.22	20.64	3.59	21.70	0.325	N.D.	3.90	N.D.
HV-2		6.8	380.0	6.78	49.70	8.15	8.54	0.73	13.90	0.183	12.39	0.98	10.31

Table continued

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
S-29	Aug 80	6.8	520.0	5.32	11.51	2.75	13.65	1.41	14.03	0.088	8.86	1.46	N.D.
HV-7	Aug 80	6.8	394.0	5.53	30.14	2.06	11.99	0.24	N.D.	0.393	19.94	1.71	13.85
FS-47		6.8	-	48.27	74.49	17.71	69.67	19.05	84.19	0.227	31.15	5.09	62.07
FS-70		6.8	466.0	11.47	70.43	3.25	12.77	0.33	33.89	0.477	6.37	N.D.	N.D.
FS-26		7.4	489.0	16.27	87.95	7.95	22.61	6.60	162.91	0.613	N.D.	0.97	11.59
S-20		8.0	-	16.09	14.09	15.18	26.63	6.44	159.63	0.673	12.74	2.42	16.55
S-8		12.5	1009.9	19.57	13.65	12.69	37.52	4.21	102.18	0.623	23.78	4.35	135.00
S-26		7.0	1078.83	15.45	28.44	7.54	61.52	8.80	117.06	0.931	26.75	3.26	54.10
FS-71		7.2	410.13	26.27	36.68	5.49	20.96	15.32	136.86	1.876	N.D.	1.50	N.D.
S-18		7.0	291.57	12.10	14.22	10.63	12.17	-	39.68	0.593	N.D.	1.00	N.D.
S-41		8.5	283.09	15.19	16.49	2.74	10.17	6.87	101.19	0.423	N.D.	N.D.	N.D.
S-70		6.9	709.87	9.01	46.64	6.17	23.66	3.69	48.61	0.250	N.D.	1.51	24.30
AV-5		8.2	-	21.37	13.08	7.90	19.94	14.91	754.84	0.512	N.D.	1.51	N.D.
BV-4		8.5	224.97	24.98	24.70	8.62	13.18	14.60	1119.04	0.710	N.D.	1.22	6.10
BV-5		6.8	-	20.99	61.02	13.65	40.56	12.38	560.53	0.781	13.29	4.51	8.38
FS-5		8.5	-	15.80	21.50	6.83	27.38	17.96	1001.03	0.781	N.D.	2.52	41.11

N.D. = not detected

Table: Duration of the Discharge at Station AD5

Discharge m ³ /sec.	68/69 days	69/70 days	70/71 days	71/72 days	74/75 days	75/76 days	76/77 days	77/78 days	78/79 days	79/80 days
18	60	12	14	3	-	5	2	7	-	42
17	63	13	15	3	-	5	3	7	-	45
16	68	14	17	4	-	5	3	8	-	65
15	76	14	17	4	-	7	5	9	-	69
14	83	15	17	5	-	7	6	10	-	74
13	99	16	19	5	-	8	6	12	-	78
12	106	19	21	5	1	11	7	14	-	81
11	112	19	24	7	1	16	10	22	-	91
10	124	26	25	8	5	23	15	33	-	95
9	140	47	27	10	13	29	18	59	1	111
8	148	59	33	10	19	38	37	79	5	131
7	168	105	75	47	43	74	107	124	14	138
6	206	170	100	145	106	148	151	156	63	161
5	292	231	155	162	149	184	182	211	140	193
4	364	364	358	360	330	316	326	301	202	355
3	364	364	365	366	365	366	365	364	362	365
2	364	364	365	366	365	366	365	365	364	365

Table: Historic Discharge (in Mcm)

<u>Year</u>	<u>AD5</u>	<u>AD2</u>	<u>Year</u>	<u>AD5</u>	<u>AD2</u>	<u>Year</u>	<u>AD5</u>	<u>AD2</u>
1930	306	402	1946	245	353	1962	245	389
1931	460	572	1947	219	315	1963	221	327
1932	277	377	1948	305	420	1964	252	412
1933	156	248	1949	354	476	1965	289	447
1934	257	354	1950	291	404	1966	189	258
1935	464	577	1951	283	387	1967	421	613
1936	217	319	1952	542	652	1968	203	138
1937	352	458	1953	496	615	1969	532	123
1938	427	544	1954	348	664	1970	224	76
1939	311	436	1955	190	289	1971	269	92
1940	338	451	1956	282	457	1972	182	280
1941	315	426	1957	266	360	1973	-	244
1942	367	477	1958	240	373	1974	-	-
1943	478	599	1959	201	302	1975	156	298
1944	366	490	1960	205	244	1976	131	-
1945	550	670	1961	232	289			

Table: Measured Streamflow (in Mcm)
Gauging Station - AD5 Y. Maqarin

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	15.0	16.0	19.0	55.0	110.0	33.0	25.0	15.0	14.0	15.0	15.0	16.0	258.0	90.0	348.0
54/55	19.0	20.0	22.0	21.0	15.0	16.0	14.0	13.0	11.0	12.0	13.0	14.0	108.0	82.0	190.0
55/56	15.0	24.0	31.0	42.0	31.0	26.0	21.0	18.0	17.0	19.0	19.0	19.0	175.0	107.0	282.0
56/57	19.0	19.0	23.0	23.0	30.0	41.0	20.0	18.0	17.0	19.0	19.0	18.0	156.0	110.0	266.0
57/58	19.0	20.0	24.0	31.0	23.0	20.0	18.0	16.0	16.0	18.0	18.0	17.0	136.0	104.0	240.0
58/59	17.0	16.0	17.0	17.0	16.0	19.0	16.0	17.0	16.0	16.0	17.0	17.0	101.0	100.0	201.0
59/60	17.0	16.0	17.0	18.0	17.0	18.0	18.0	18.0	17.0	16.0	17.0	16.0	104.0	101.0	205.0
60/61	17.0	18.0	19.0	23.0	27.0	23.0	19.0	20.0	17.0	16.0	16.0	17.0	129.0	103.0	232.0
61/62	19.3	18.9	86.4	27.6	31.0	20.6	14.3	14.5	13.7	14.5	16.1	18.1	148.8	96.2	245.0
62/63	20.3	11.5	21.5	21.4	26.2	25.8	17.1	16.3	13.9	14.4	16.2	17.2	123.5	98.3	221.8
63/64	17.4	17.1	22.1	19.7	45.9	34.8	17.9	16.1	14.7	14.4	16.0	16.6	157.5	95.2	252.7
64/65	16.1	17.2	28.1	58.5	51.1	22.3	18.6	15.9	14.5	15.5	15.8	15.5	195.8	93.3	289.1
65/66	16.9	15.8	17.7	17.2	17.8	24.2	15.1	12.0	11.9	12.4	13.0	14.8	107.8	81.0	188.8
66/67	20.4	18.8	41.8	34.2	62.3	98.6	31.3	19.6	20.4	22.7	25.4	25.4	287.0	133.9	420.9
67/68	7.8	9.2	11.7	69.4	37.8	9.0	8.1	8.5	9.8	9.3	10.6	11.7	145.2	57.8	203.0
68/69	16.6	17.2	61.9	142.0	81.8	113.0	31.0	17.0	12.4	12.8	13.4	13.2	446.9	85.4	532.3
69/70	16.7	19.6	17.5	27.3	21.5	44.2	15.4	13.9	11.8	12.2	12.2	11.8	145.5	78.6	224.1
70/71	12.2	11.8	12.2	20.3	22.8	24.6	103.0	14.9	11.9	11.4	11.9	11.6	194.7	73.9	268.6
71/72	12.2	11.8	13.2	19.7	24.7	18.8	18.1	17.2	12.0	10.8	11.8	11.6	106.3	75.6	181.9
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	53.3	71.2	62.4	-	13.9	11.7	11.2	11.7	12.1	-	60.6	-
74/75	-	8.0	17.2	15.4	21.8	24.1	11.3	11.3	11.5	13.0	10.7	11.3	97.8	57.8	155.6
75/76	12.9	14.0	16.7	17.1	22.5	29.9	18.0	0.0	0.0	0.0	0.0	0.0	118.2	12.9	131.1
Averages															
	15.6	16.2	23.3	34.3	35.1	32.7	22.4	14.9	13.5	14.0	14.6	14.9	163.9	87.5	251.4

Table: Measured Streamflow (in Mcm)
Gauging Station - A3 Jord Wahadneh

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Wet	Dry	Total
50/51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51/52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52/53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53/54	-	-	-	-	380.0	240.0	160.0	130.0	80.0	68.0	67.0	66.0	-	411.0	-
54/55	84.0	74.0	96.0	66.0*	32.0	44.0*	-	-	-	-	-	-	-	-	-
55/56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56/57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57/58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58/59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59/60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60/61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61/62	-	-	-	157.0	180.0	58.9	22.5	21.7	18.6	21.7	22.4	27.3	-	111.7	-
62/63	40.0*	75.3	55.1	64.4	116.0	124.0	50.6	69.1	26.3	19.4	13.5	17.5	485.4	185.8	671.2
63/64	26.4	45.3	179.0	61.0	239.0	216.0	96.4	49.4	21.5	16.0	16.3	15.6	836.7	145.2	981.9
64/65	21.1	102.0	148.0	224.0	239.0	47.7	34.8	17.3	19.7	14.5	12.2	16.0	795.5	100.8	896.3
65/66	27.4	25.1	33.6	41.6	57.4	47.4	23.3	12.4	12.0	9.9	10.3	13.4	228.4	85.4	313.8
66/67	23.3	21.5	76.1	100.0	162.0	332.0	146.0	36.4	16.2	13.0	10.4	13.7	837.6	113.0	950.6
67/68	18.1	24.1	99.1	361.0	-	-	-	-	-	-	-	-	-	-	-
68/69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69/70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70/71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71/72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72/73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73/74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74/75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75/76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Averages

27.6 53.8 98.4 98.2 162.7 153.4 70.2 36.9 19.1 14.6 12.5 15.2 636.7 126.0 762.8

* The figures are estimated for only a few days

(Station was closed after war 1967)

Table: Chemical Composition of the Yarmuk River Water

Sample Number	Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3	
Date	3/8/80	16/8/80	1/10/80	16/8/80	12/3/81	22/4/81	9/12/80	25/5/81	4/8/80	22/4/81	
Source Type	River	River	River	River	River	River	River	River	Spring	Spring	
Temperature °C	24.5	25.0	23.0	26.0	-	-	-	-	27.0	-	
pH	6.5	6.8	6.8	6.8	6.8	-	6.5	9.0	6.8	6.8	
Ca ⁺⁺	mg/l	30.06	46.09	50.10	32.06	30.60	28.06	26.05	38.08	62.12	38.08
	m eq/l	1.50	2.30	2.50	1.60	1.50	1.40	1.30	1.90	3.10	1.90
	m eq%	18.87	26.41	30.53	21.53	30.86	20.12	27.96	24.87	36.91	32.93
Mg ⁺⁺	mg/l	32.83	30.40	25.54	24.32	13.38	26.75	19.46	24.36	17.02	18.24
	m eq/l	2.70	2.50	2.10	2.00	1.10	2.20	1.66	2.00	1.40	1.50
	m eq%	33.96	28.70	25.64	26.92	22.63	31.61	34.41	26.18	16.67	26.00
Na ⁺	mg/l	83.83	87.36	80.47	86.44	49.40	75.87	39.08	83.55	85.06	52.88
	m eq/l	3.65	3.80	3.50	3.76	2.15	3.30	1.70	3.63	3.70	2.30
	m eq%	45.91	43.63	42.74	50.61	44.24	47.41	36.56	47.51	44.05	39.86
K ⁺	mg/l	3.96	4.30	3.52	2.74	4.82	2.35	1.96	4.09	7.82	2.74
	m eq/l	0.10	0.11	0.09	0.07	0.11	0.06	0.05	0.11	0.20	0.07
	m eq%	1.26	1.26	1.10	0.94	2.26	0.86	1.08	1.44	2.38	1.21
Total cations (m eq/l)	7.95	8.71	8.19	7.43	4.86	6.96	4.65	7.64	8.40	5.77	

Table continued

Sample Number		Yarmuk River	Wach-Maddana	Wadi Ehrer	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Yarmuk River	Spring No. 3	Spring No. 3
CO ₃ ^{..}	mg/l	24.01	18.02	18.02	12.00	0.00	12.00	0.00	24.01	0.00	0.00
	m eq/l	0.80	0.60	0.60	0.40	0.00	0.40	0.00	0.80	0.00	0.00
	m eq%	9.49	7.02	7.59	5.26	0.00	0.40	0.00	9.70	0.00	0.00
HCO ₃ ⁻	mg/l	207.47	207.47	195.26	189.19	158.65	176.96	152.55	175.96	256.28	195.24
	m eq/l	3.40	3.40	3.20	2.10	2.60	2.90	2.40	2.90	4.20	3.20
	m eq%	40.33	39.77	40.46	40.74	51.08	40.79	47.34	35.15	49.41	53.33
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	88.67	80.42	80.42	82.48	54.46	75.25	57.33	86.14	85.57	55.45
	m eq/l	2.50	2.27	2.27	2.23	1.54	2.12	1.63	2.43	2.41	1.56
	m eq%	29.66	26.55	28.70	29.30	30.26	29.82	32.15	24.46	28.35	26.00
NO ₃ ⁻	mg/l	14.55	12.91	15.62	16.81	11.10	14.52	13.10	16.58	11.88	10.57
	m eq/l	0.24	0.21	0.25	0.27	0.18	0.23	0.21	0.27	0.19	0.17
	m eq%	2.85	2.56	3.16	3.55	3.54	3.24	4.14	3.27	2.24	2.83
SO ₄ ^{..}	mg/l	71.43	99.42	76.19	77.40	36.73	70.27	39.87	88.77	81.75	51.27
	m eq/l	1.49	2.07	1.59	1.61	0.77	1.46	0.83	1.85	1.70	1.07
	m eq%	17.68	24.21	20.10	21.16	15.13	20.54	16.37	22.42	20.00	17.83
Total anions (m eq/l)		8.43	8.55	7.91	7.61	5.09	7.11	5.07	8.25	8.50	6.00
T.D.S. (mg/l)		* figures missing from copy *						273.53	454.06	479.36	326.85

Table: Trace Metal Composition Yarmuk River Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Yarmuk R.	3/8/80	6.5	421.11	7.23	4.93	11.35	11.32	0.05	19.63	0.194	5.17	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	482.66	7.24	12.14	18.55	13.06	0.02	20.22	0.170	15.58	1.22	18.21
Yarmuk R.	16/8/80	6.8	447.51	5.86	7.55	10.18	11.29	0.22	21.29	0.178	14.16	N.D.	N.D.
Yarmuk R.	16/8/80	6.8	-	4.18	5.93	10.91	9.88	0.41	21.29	0.213	9.91	N.D.	N.D.
Yarmuk R.	1/10/80	6.8	428.85	6.91	8.72	12.22	16.56	5.25	46.89	0.305	N.D.	1.65	8.38
Yarmuk R.		6.5	-	3.95	5.23	9.70	14.87	0.02	N.D.	0.039	13.29	N.D.	N.D.
Yarmuk R.		6.8	-	3.46	2.91	12.58	13.18	0.02	11.98	0.052	N.D.	N.D.	N.D.
Yarmuk R.	9/12/80	6.5	273.53	11.63	13.63	29.12	18.27	0.02	21.14	0.497	12.39	N.D.	14.72
Yarmuk R.	12/3/81	6.8	279.76	7.55	2.04	11.80	15.29	0.02	N.D.	0.147	10.84	N.D.	15.46
Yarmuk R.	22/4/81	-	393.55	6.58	4.97	17.42	14.04	0.05	20.15	0.151	14.03	1.64	12.63
Yarmuk R.	25/5/81	9.0	454.06	2.75	6.56	20.99	6.83	0.01	12.48	0.297	17.92	1.81	15.05
Yarmuk R.	23/6/81	6.8	468.09	7.71	6.56	18.78	6.41	0.02	18.15	0.204	11.69	2.89	N.D.

N.D. = not detected

Table: Chemical Composition of the Spring Water

These springs issue from B4,5 and their overlying recent rocks of basalts and soils. (Lower Tertiary and pleistocene). It includes Lower chalky unit, chalky unit, upper chalky unit. Basalts and Soils. Compare columnar section.

Sample Number	Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba	
Date	4/8/80	4/8/80	4/8/80	24/9/80	24/9/80	9/8/80	8/3/72	14/12/77	7/5/80	10/11/80	
Source Type	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	
Temperature °C	34.5	32.0	32.0	20.5	20.5	23.0	-	-	-	-	
pH	6.9	6.8	6.8	8.5	6.8	6.8	-	-	-	-	
Ca ⁺⁺	mg/l	88.18	72.14	90.18	78.16	20.04	94.19	70.54	68.14	70.54	68.14
	m eq/l	4.40	3.60	4.50	3.90	1.00	4.70	3.52	3.40	3.52	3.40
	m eq%	34.06	35.33	50.28	39.80	4.45	30.92	80.09	71.88	77.88	72.03
Mg ⁺⁺	mg/l	52.29	42.56	30.40	25.54	15.81	71.74	4.38	6.06	4.74	7.30
	m eq/l	4.30	3.50	2.50	2.10	1.30	5.90	0.36	0.50	0.39	0.60
	m eq%	33.28	34.35	27.93	21.43	29.35	38.82	8.24	10.57	8.63	12.71
Na ⁺	mg/l	91.96	66.90	41.38	85.06	46.91	103.46	10.35	18.39	13.79	15.17
	m eq/l	4.00	2.91	1.80	3.70	2.05	4.50	0.45	0.80	0.60	0.66
	m eq%	30.95	28.56	20.11	37.76	46.05	29.61	10.30	16.91	13.27	13.98
K ⁺	mg/l	4.69	7.84	5.87	3.91	5.46	3.91	2.35	1.17	0.39	2.35
	m eq/l	0.12	0.18	0.15	0.10	0.09	0.10	0.06	0.03	0.01	0.06
	m eq%	0.93	1.77	1.68	1.02	2.03	0.66	1.37	0.63	0.22	1.27
Total cations (m eq/l)	12.82	10.19	8.95	9.80	4.43	15.20	4.37	4.73	4.52	4.72	

Table continued

Sample Number		Spring No. 4	Spring No. 9	Spring No. 2	Ein el Quseir	Ein Ghazala	Ein el Mardash	Ain Quelba	Ain Quelba	Ain Quelba	Ain Quelba
CO ₃ ^{..}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	427.14	488.16	366.12	213.57	152.55	390.53	211.13	211.13	205.03	207.47
	m eq/l	7.00	7.80	6.00	3.50	2.21	6.40	3.46	3.46	3.36	3.40
	m eq%	48.54	68.24	64.87	35.90	48.15	44.57	77.75	80.65	72.41	77.63
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	177.33	96.91	64.95	113.41	44.33	165.99	20.56	28.01	21.99	22.68
	m eq/l	5.00	2.73	1.83	3.20	1.25	4.68	0.58	0.79	0.62	0.64
	m eq%	34.67	23.89	19.46	32.82	27.23	32.59	13.03	18.42	13.36	14.61
NO ₃ ⁻	mg/l	1.07	0.64	0.60	136.19	18.71	24.16	0.00	0.00	33.49	24.90
	m eq/l	0.02	0.01	0.00	2.20	0.30	0.41	0.00	0.00	0.54	0.04
	m eq%	0.14	0.09	0.00	22.56	6.54	2.86	0.00	0.00	11.64	0.91
SO ₄ ^{..}	mg/l	117.46	42.75	68.25	40.80	16.20	*131.75*	19.69	1.92	5.76	14.40
	m eq/l	1.49	0.89	1.42	0.85	0.34	* 2.07*	0.41	0.04	0.12	0.30
	m eq%	10.33	7.79	15.35	8.72	7.41	* 19.73*	9.21	0.93	2.59	6.85
Total anions (m eq/l)			*****	copy of table cut off			*****				
T.D.S. (mg/l)			*****	copy of table cut off			*****				

Table continued

Sample Number	Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain		Spring No. 7	Ain-Ba'boul	Ain-Sombal	
Date	9/9/80	21/7/79	20/7/80	21/7/79	20/7/80	6/9/80	6/9/80	6/9/80	
Source Type	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring	
Temperature °C	24.0	-	-	-	-	22.50	23.00	23.00	
pH	6.8	-	-	-	-	6.80	6.80	6.80	
Ca ⁺⁺	mg/l	68.14	60.92	66.13	52.10	63.73	104.21	128.26	110.22
	m eq/l	3.40	3.04	3.30	2.60	3.18	5.20	6.40	5.50
	m eq%	67.73	52.96	-	-	-	-	-	-
Mg ⁺⁺	mg/l	7.30	11.68	14.59	10.46	13.62	23.10	41.34	20.67
	m eq/l	0.60	0.96	1.20	0.86	1.12	1.90	3.40	1.70
	m eq%	11.95	16.73	-	-	-	-	-	-
Na ⁺	mg/l	22.99	39.08	42.76	57.48	62.99	22.99	41.38	22.07
	m eq/l	1.00	1.70	1.86	2.50	2.74	1.00	1.80	0.96
	m eq%	5.02	29.62	-	-	-	-	-	-
K ⁺	mg/l	0.78	1.56	3.13	1.56	3.91	2.74	2.35	3.13
	m eq/l	0.02	0.04	0.08	0.04	0.10	0.07	0.06	0.08
	m eq%	0.40	0.70	-	-	-	-	-	-
Total cations (m eq/l)	5.02	5.74	-	6.00	7.14	8.17	11.66	8.24	

Table continued

Sample Number		Ain et Trab	Ain Shalaq	Ain-Shalaq	Ain-Um Jrain		Spring No. 7	Ain-Ba'boul	Ain-Sombal
CO ₃ ^{..}	mg/l	0.00	10.20	0.00	2.40	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.84	0.00	0.08	0.00	0.00	0.00	0.00
	m eq%	0.00	5.87	0.00	1.37	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	225.77	183.06	223.33	147.67	237.98	378.32	390.53	372.22
	m eq/l	3.70	3.00	3.66	2.42	3.90	6.30	6.40	6.10
	m eq%	76.61	51.81	-	41.44	52.07	-	-	-
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	22.68	54.25	61.35	81.56	82.98	39.18	79.39	61.86
	m eq/l	0.64	1.53	1.73	2.30	2.34	1.11	2.24	1.75
	m eq%	13.25	26.43	-	39.39	31.24	-	-	-
NO ₃ ⁻	mg/l	22.30	32.34	46.51	39.69	56.43	6.69	6.40	11.46
	m eq/l	0.36	0.52	0.75	0.64	0.91	0.18	0.10	0.19
	m eq%	7.45	8.98	-	10.96	12.15	-	-	-
SO ₄ ^{..}	mg/l	6.45	19.21	16.33	31.70	5.76	62.69	111.91	28.82
	m eq/l	0.13	0.40	0.34	0.66	0.12	1.31	2.33	0.60
	m eq%	2.69	6.91	*****	copy cut off	*****	*****		
Total anions (m eq/l)		*****	*****	*****	*****	*****	*****	*****	*****
T.D.S. (mg/l)		*****	*****	*****	*****	*****	*****	*****	*****

Table: Trace Metal Composition of the Springs Water

Location	pH	T.D.S.	Cu	Mn	Cr	Ni	Zn	Pb	Fe	Co	Cd	Mo
		p.p.m.	p.p.b.	p.p.b.	p.p.b.	p.p.b.	p.p.m.	p.p.b.	p.p.m.	p.p.b.	p.p.b.	p.p.b.
Spring No. 4	6.9	746.55	5.32	17.81	7.22	15.65	0.01	18.60	0.063	9.60	2.34	N.D.
Spring No. 9	6.8	573.02	5.53	6.30	3.44	12.99	0.02	21.70	0.123	13.29	1.64	N.D.
Spring No. 2	6.8	484.69	4.68	20.27	3.44	13.65	0.02	N.D.	0.076	5.91	2.44	N.D.
Spring No. 3	6.8	479.36	5.96	5.21	7.22	10.99	0.03	14.03	0.116	6.65	N.D.	N.D.
Spring No. 3	6.8	326.85	3.39	7.22	15.57	8.97	0.03	12.31	0.396	10.13	1.55	N.D.
Quseir	8.5	589.86	13.65	25.02	3.09	15.55	0.09	23.81	0.371	N.D.	1.51	N.D.
Ghazabah	6.8	247.74	2.58	4.83	7.20	8.11	0.02	15.87	0.180	N.D.	1.00	*8.??*
Spring No. 7	6.8	450.76	6.46	3.78	6.18	29.65	0.03	19.16	0.086	9.94	1.79	N.D.
Ba'boul	6.8	606.40	8.07	25.08	19.27	7.41	0.02	27.67	0.196	N.D.	1.79	20.89
Sombal	6.8	444.34	6.68	4.85	4.00	31.17	0.04	17.03	0.080	N.D.	2.93	*8.8?*
El-Trab	6.8	502.86	6.93	5.12	2.74	12.17	0.02	12.27	0.052	5.94	0.97	N.D.
Quelba	6.8	258.68	8.89	9.01	4.31	19.61	1.59	55.91	0.122	12.46	2.17	N.D.
Murdahia	6.8	796.57	8.67	20.23	12.00	19.77	0.03	24.48	0.266	18.41	2.28	N.D.

N.D. = not detected

Table: Location of Sampling Sites Not Plotted on the Map

Sampling Site	Coordinates	
	N	E
Spring No. 4	237,799.2	232,676.9
Ain El Merdashia	236,451.49	233,397.96
Spring No. 7		
Ain Ba'bul	234,380.0	233,402.2
Ain Sombal	235,118.8	233,229.0
Ain et Trab	229.900	226.900
Ain el Quseir	Springs issue from the basalts in the Syrian side.	
NRA-Saham Exp. 234.000	234.000	222.000
Travertine Zone Seepage	236,981.7	232.739,96
Ain Quelbe	231.600	231.000
Ain Shelaq	221.000	238.400
Ain Um Jrain	221.200	240.100

Table: Chemical Composition of High pH Water
Upper Portion of B-3/Bituminous Marl Formation (compare columnar section)

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
Date		5/8/80	16/8/80	5/8/80	5/9/77	6/9/77	5/8/80	1/81	12/3/81	22/4/81
Source Type		Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage	Seepage
Temperature °C		24.5	-	24.5	-	-	29.0	-	-	-
pH		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Ca ⁺⁺	mg/l	923.84	735.47	679.36	710.10	310.62	815.63	545.29	456.91	454.91
	m eq/l	46.10	36.70	33.90	35.43	15.50	40.70	27.21	22.80	22.70
	m eq%	94.82	83.33	92.55	91.81	79.61	94.78	91.90	89.59	91.72
Mg ⁺⁺	mg/l	0.00	6.08	3.65	0.00	7.30	0.00	0.00	1.22	0.00
	m eq/l	0.00	0.50	0.30	0.00	0.60	0.00	0.00	0.10	0.00
	m eq%	0.00	1.14	0.82	0.00	3.08	0.00	0.00	0.39	0.00
Na ⁺	mg/l	45.98	124.15	50.58	59.77	68.97	39.08	45.98	48.28	39.08
	m eq/l	2.00	5.40	2.20	2.60	3.00	1.70	2.00	2.10	1.70
	m eq%	4.11	-	6.01	6.74	15.41	3.96	6.76	8.25	6.87
K ⁺	mg/l	20.33	75.85	20.72	21.90	14.47	21.11	15.69	17.60	13.69
	m eq/l	0.52	1.94	0.53	0.56	0.37	0.54	0.40	0.45	0.35
	m eq%	1.07	12.26	1.45	1.45	1.90	1.26	1.35	1.77	1.41
Total cations (m eq/l)		48.62	44.04	36.63	38.59	19.47	42.94	29.61	25.45	24.75

Table continued

Sample Number		FS-1	Travertine Zone	AFS-2	A-1	A-4	W.S. seepage	W.S. seepage	W.S. seepage	W.S. seepage
CO ₃ ^{..}	mg/l	36.01	162.05	60.02	42.33	18.31	108.04	30.01	66.02	36.01
	m eq/l	1.20	5.46	2.00	1.41	0.61	3.60	1.00	2.20	1.20
	m eq%	2.47	12.58	5.50	3.33	3.09	8.55	3.28	8.71	4.83
HCO ₃ ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OH ⁻	mg/l	682.10	435.46	474.58	523.06	175.88	523.91	365.72	243.24	284.41
	m eq/l	40.10	25.60	27.90	30.75	10.34	30.80	21.50	14.30	16.70
	m eq%	82.44	59.62	76.69	72.51	52.51	73.18	70.58	56.63	67.20
Cl ⁻	mg/l	101.04	253.63	74.23	95.74	92.91	91.76	90.23	87.13	69.71
	m eq/l	2.85	7.15	2.09	2.70	2.62	2.59	2.55	2.46	1.96
	m eq%	5.86	16.65	5.75	6.37	13.25	6.15	8.37	9.74	7.89
NO ₃ ⁻	mg/l	2.25	32.94	8.18	7.75	2.86	8.86	10.65	10.75	6.66
	m eq/l	0.04	0.53	0.13	0.13	0.05	0.14	0.17	0.17	0.11
	m eq%	0.08	1.23	0.36	0.31	0.25	0.33	0.56	0.67	0.44
SO ₄ ^{..}	mg/l	223.34	204.61	204.61	356.38	286.26	238.23	260.30	293.94	321.39
	m eq/l	4.65	4.26	4.26	7.42	5.96	4.96	5.42	6.12	4.88
	m eq%	9.56	8.78	11.71	17.50	30.15	11.78	17.79	24.24	19.64
Total anions (m eq/l)		48.64	42.94	36.38	42.41	19.77	42.09	30.64	25.25	24.85
T.D.S. (mg/l)		2068.17	2030.00	1575.93	1774.70	977.58	1866.94	1363.84	1225.08	1110.89

Table continued

Sample Number		W.S. seepage	W.S. seepage
Date		23/6/81	14/2/77
Source Type		seepage	seepage
Temperature °C		-	-
pH		12.5	12.5
Ca ⁺⁺	mg/l	795.59	611.22
	m eq/l	39.70	30.50
	m eq%	39.63	89.13
Mg ⁺⁺	mg/l	0.00	7.30
	m eq/l	0.00	0.60
	m eq%	0.00	1.75
Na ⁺	mg/l	47.46	59.77
	m eq/l	2.07	2.60
	m eq%	4.88	7.60
K ⁺	mg/l	24.53	20.33
	m eq/l	0.63	0.52
	m eq%	1.49	1.52
Total cations (m eq/l)		42.40	34.2

Table continued

Sample Number		W.S. seepage	W.S. seepage
CO ₃ ^{''}	mg/l	24.01	15.61
	m eq/l	0.80	0.52
	m eq%	1.93	1.44
HCO ₃ [']	mg/l	0.00	0.00
	m eq/l	0.00	0.00
	m eq%	0.00	0.00
OH [']	mg/l	534.11	395.31
	m eq/l	31.40	23.24
	m eq%	75.74	64.16
Cl [']	mg/l	93.07	108.51
	m eq/l	2.63	3.06
	m eq%	6.34	8.45
NO ₃ [']	mg/l	7.44	0.00
	m eq/l	0.12	0.00
	m eq%	0.29	0.00
SO ₄ ^{''}	mg/l	321.43	451.48
	m eq/l	6.69	9.40
	m eq%	16.14	25.95
Total anions (m eq/l)		41.46	36.22
T.D.S. (mg/l)		1847.64	1668.53

Table: Trace Metal Composition of High pH Water

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
Adits for construct. of Maqarin Dam, left side of Yarmuk R.	10/1/81 10/1/81 12/3/81 22/4/81 25/5/81 23/6/81	12.5 12.5 12.5 12.5 12.5 12.5	- 1289.62 1175.97 1226.06 1285.02 1127.87	11.97 5.51 5.58 6.18 8.62 6.79	8.90 7.83 4.33 7.38 6.21 2.76	415.82 467.81 425.12 437.35 419.48 400.70	39.88 27.61 22.21 25.62 20.07 18.79	0.03 0.08 0.03 0.05 0.02 0.02	49.09 47.32 31.02 55.97 38.56 41.97	0.085 0.184 0.056 0.120 0.133 0.125	24.37 38.20 37.94 33.51 38.96 47.53	5.04 6.54 5.96 5.89 6.93 6.35	42.69 32.30 32.39 28.42 28.42 27.63
W.S.- seepages	5/8/80 10/1/81 12/3/81 22/4/81 23/6/81	12.5 12.5 12.5 12.5 12.5	1866.94 1363.86 1225.08 1140.89 1847.46	17.54 - 8.37 8.17 7.52	6.38 7.99 5.39 8.18 10.01	523.32 466.05 348.76 383.98 635.78	67.41 31.43 24.64 21.35 29.47	0.10 0.11 3.06 0.02 0.05	95.79 59.40 48.13 43.85 73.72	0.081 0.139 0.113 0.090 0.125	39.65 41.52 36.39 31.74 52.21	9.76 7.46 5.97 6.54 10.06	49.62 44.17 39.02 26.50 26.84
Tr. Zone FS-1 Adit-AFS	16/8/80 5/8/80 25/8/80	12.5 12.5 12.5	2030.24 2868.94 1575.93	33.13 16.71 14.48	14.02 19.42 16.18	422.74 161.08 265.46	66.00 75.53 59.65	0.13 0.10 0.10	81.96 81.15 69.19	0.113 0.161 0.096	38.94 50.22 36.81	8.54 9.91 9.76	38.07 80.77 46.35

Table: Chemical Composition of Amman Formation Waters

Sample Number	FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35	
Date	9/12/80	22/4/81	25/5/81	23/6/81	4/8/80	22/4/81	9/9/80	12/3/81	22/4/81	
Source Type	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	
Temperature °C	-	-	-	-	26.5	-	30.0	-	-	
pH	6.80	-	7.20	7.10	6.50	-	7.10	6.80	-	
Ca ⁺⁺	mg/l	96.19	86.17	92.18	90.18	76.15	52.10	33.06	58.12	50.10
	m eq/l	4.80	4.30	4.60	4.50	3.80	2.60	1.60	2.90	2.50
	m eq%	48.39	43.66	46.23	45.32	35.58	35.23	32.85	33.68	34.82
Mg ⁺⁺	mg/l	27.97	34.05	30.40	32.82	40.13	24.36	3.65	35.26	32.26
	m eq/l	2.30	2.50	2.50	2.70	3.30	2.00	0.30	2.90	2.70
	m eq%	23.19	28.43	25.13	27.19	30.90	*27.1?*	6.16	33.68	37.60
Na ⁺	mg/l	63.91	62.07	63.28	60.81	75.87	62.07	64.37	62.07	43.91
	m eq/l	2.78	2.70	2.75	2.65	3.30	2.70	2.80	2.70	1.91
	m eq%	28.02	27.41	27.64	26.69	30.90	36.59	57.50	31.36	26.60
K ⁺	mg/l	1.56	1.96	3.83	3.07	10.95	3.13	6.65	4.30	2.74
	m eq/l	0.04	0.08	0.10	0.08	0.28	0.08	0.17	0.11	0.07
	m eq%	0.40	0.81	1.01	0.81	2.62	1.08	3.49	1.28	0.98
Total cations (m eq/l)	9.92	9.85	9.95	9.93	10.68	7.38	4.87	8.61	7.18	

Table continued

Sample Number		FS-36	FS-36	FS-36	FS-36	FS-52	FS-52	Borehole FS-35	Borehole FS-35	Borehole FS-35
CO ₃ ²⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	36.01	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	25.32	0.00	0.00
HCO ₃ ⁻	mg/l	402.73	390.53	378.53	409.33	256.28	250.18	67.12	305.10	323.41
	m eq/l	6.60	6.40	6.20	6.60	4.20	4.10	1.10	5.00	5.30
	m eq%	67.76	65.11	63.46	62.44	41.26	54.16	23.21	59.45	78.99
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	79.39	76.24	79.21	80.20	109.29	74.26	80.42	77.33	40.59
	m eq/l	2.24	2.15	2.23	2.26	3.08	2.09	2.27	2.18	1.15
	m eq%	23.00	21.87	22.83	21.38	30.26	27.61	47.89	25.92	17.14
NO ₃ ⁻	mg/l	1.00	0.20	0.00	0.00	0.75	2.22	2.18	0.90	0.11
	m eq/l	0.20	0.00	0.00	0.00	0.01	0.04	0.04	0.02	0.00
	m eq%	0.21	0.00	0.00	0.00	0.10	0.53	0.84	0.24	0.00
SO ₄ ²⁻	mg/l	42.48	61.62	64.12	82.14	138.09	64.20	6.45	58.12	12.50
	m eq/l	0.88	1.20	1.34	1.71	2.89	1.34	0.13	1.21	0.26
	m eq%	9.04	12.21	13.72	16.18	28.39	17.70	2.70	14.39	3.88
Total anions (m eq/l)		9.74	9.83	9.77	10.57	10.18	7.57	4.70	8.41	6.71
T.D.S. (mg/l)		512.31	517.54	522.18	553.90	580.17	407.43	256.45	448.65	349.49

Table continued

Sample Number	Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34	
Date	7/9/80	12/3/81	25/5/81	24/9/80	10/9/80	12/3/81	10/8/80	12/3/81	9/9/80	
Source Type	G.W.	G.W.	G.W.	-	G.W.	G.W.	G.W.	G.W.	G.W.	
Temperature °C	26.0	-	-	-	29.0	-	29.0	-	26.5	
pH	6.8	6.8	7.4	6.9	7.0	7.3	6.8	6.8	12.0	
Ca ⁺⁺	mg/l	106.21	70.14	96.17	24.05	14.03	8.02	90.18	66.13	206.41
	m eq/l	5.30	3.40	4.80	1.20	0.70	0.40	3.90	3.30	10.30
	m eq%	41.31	29.80	39.15	15.06	11.09	8.55	43.67	51.40	43.22
Mg ⁺⁺	mg/l	32.83	49.86	55.94	26.75	9.73	0.00	30.40	21.89	3.65
	m eq/l	4.10	4.60	4.10	2.20	0.80	0.00	2.50	1.80	0.30
	m eq%	31.96	40.32	33.44	-	12.68	0.00	28.00	28.03	1.26
Na ⁺	mg/l	71.27	69.86	69.21	91.96	105.29	24.81	41.38	28.44	108.05
	m eq/l	3.10	3.04	3.01	4.00	4.58	4.12	2.30	1.24	4.70
	m eq%	24.16	26.64	24.55	27.58	88.03	25.76	19.32	-	19.72
K ⁺	mg/l	2.90	14.86	13.80	22.25	7.42	6.26	5.87	3.11	333.52
	m eq/l	0.33	0.36	0.35	0.57	0.23	0.16	0.23	0.08	8.53
	m eq%	2.57	3.16	-	7.15	3.65	3.42	2.58	1.25	35.80
Total cations (m eq/l)	12.83	11.41	12.26	7.97	6.31	4.68	8.93	6.42	23.83	

Table continued

Sample Number	Well NRA-W.S.	Well NRA-W.S.	Well NRA-W.S.	FS-74	HV-11	HV-11	FS-4	FS-4	FS-34	
CO ₃ ²⁻	mg/l	0.00	0.00	0.00	18.01	12.00	12.00	0.00	0.00	66.02
	m eq/l	0.00	0.00	0.00	0.60	0.40	0.40	0.00	0.00	2.20
	m eq%	0.00	0.00	0.00	-	6.53	8.49	0.00	0.00	9.37
HCO ₃ ⁻	mg/l	292.90	280.69	280.69	201.37	42.71	24.41	366.14	274.59	0.00
	m eq/l	4.80	4.60	4.60	3.30	0.70	0.40	6.00	4.60	0.00
	m eq%	39.80	39.76	39.18	-	11.42	8.49	65.95	61.07	0.00
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.93
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.50
Cl ⁻	mg/l	143.31	144.56	133.66	118.57	168.03	137.62	64.95	45.36	90.73
	m eq/l	4.04	4.56	3.77	3.34	4.74	3.88	1.85	1.23	2.56
	m eq%	33.50	39.41	32.11	40.19	77.33	82.38	20.33	19.22	10.91
NO ₃ ⁻	mg/l	2.46	1.80	1.35	4.50	2.60	1.85	0.60	1.45	10.97
	m eq/l	0.04	0.03	0.02	0.07	0.04	0.03	0.06	1.45	0.18
	m eq%	0.33	0.26	0.17	0.84	0.65	0.64	0.66	0.30	0.77
SO ₄ ²⁻	mg/l	152.74	114.05	160.71	62.40	12.00	5.00	68.25	36.40	760.32
	m eq/l	3.18	2.38	3.35	1.30	0.25	0.10	1.19	0.76	15.83
	m eq%	26.37	20.57	28.55	15.64	4.08	2.12	13.08	11.41	67.54
Total anions (m eq/l)	12.06	11.57	11.74	8.31	6.13	4.71	9.10	6.66	23.47	
T.D.S. (mg/l)	685.20	611.56	665.11	469.22	352.46	277.77	484.69	340.09	1625.50	

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
Date		9/12/80	1/81	4/8/80	8/9/80	9/9/80	9/9/80	2/10/80	9/9/80	7/9/80	9/9/80
Source Type		G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.	G.W.
Temperature °C		-	-	26.5	27.0	25.0	26.0	24.5	25.0	25.5	28.0
pH		12.0	6.8	6.8	7.5	12.0	7.1	8.2	6.8	8.5	7.1
Ca ⁺⁺	mg/l	96.19	90.18	104.21	68.14	44.09	42.08	22.04	60.12	44.09	49.09
	m eq/l	4.80	4.50	5.20	3.40	2.20	2.10	1.10	3.00	2.20	2.30
	m eq%	23.08	46.06	44.94	41.87	35.03	34.04	21.87	38.66	31.56	31.59
Mg ⁺⁺	mg/l	18.24	35.26	37.70	6.08	3.65	9.73	10.94	36.48	3.65	25.04
	m eq/l	1.50	2.90	3.10	0.50	0.30	0.80	0.90	3.00	0.30	2.10
	m eq%	7.21	29.68	26.79	6.16	4.78	12.97	17.89	38.66	4.30	28.85
Na ⁺	mg/l	117.94	52.88	72.85	101.16	78.17	71.27	64.87	39.08	91.96	61.84
	m eq/l	5.13	2.30	3.17	4.04	3.40	3.10	2.82	1.70	4.00	2.69
	m eq%	24.66	23.54	27.40	49.75	54.14	50.24	56.06	21.91	57.39	36.95
K ⁺	mg/l	366.37	2.74	4.69	7.04	14.86	6.65	8.29	2.35	16.42	7.43
	m eq/l	9.37	0.07	3.71	0.18	0.38	0.17	0.21	0.06	0.47	0.19
	m eq%	45.05	0.72	0.86	2.22	6.05	2.76	4.18	0.77	6.74	2.61
Total cations (m eq/l)		20.80	9.77	11.57	8.12	6.28	6.17	5.03	7.76	6.97	7.28

Table continued

Sample Number		FS-34	FS-37	FS-17	FS-26	FS-63	FS-62	FS-32	Exp.	NRA-A(2)	FS-18
CO ₃ ^{..}	mg/l	42.01	0.00	0.00	24.00	36.01	24.01	24.01	0.00	30.01	12.00
	m eq/l	1.40	0.00	0.00	0.80	1.20	0.80	0.80	0.00	1.00	0.10
	m eq%	6.27	0.00	0.00	10.30	19.14	13.84	17.06	0.00	13.95	1.45
HCO ₃ [']	mg/l	0.00	421.00	463.75	42.71	0.00	79.33	54.92	341.71	0.00	36.61
	m eq/l	0.00	6.90	7.60	0.70	0.00	1.30	0.40	5.60	0.00	4.70
	m eq%	0.00	68.66	66.55	9.01	0.00	22.49	19.19	77.56	0.00	68.12
OH ⁻	mg/l	69.01	0.00	0.00	0.00	8.51	0.00	0.00	0.00	1.70	0.00
	m eq/l	4.10	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.10	0.00
	m eq%	18.37	0.00	0.00	0.00	7.97	0.00	0.00	0.00	1.40	0.00
Cl ⁻	mg/l	84.54	77.33	86.60	113.41	113.41	79.39	59.80	39.18	117.53	68.05
	m eq/l	4.10	2.18	2.44	3.20	3.20	2.24	1.69	1.11	3.32	1.92
	m eq%	18.10	21.69	21.37	41.18	51.04	38.75	36.03	15.37	46.30	27.83
NO ₃ [']	mg/l	5.85	1.00	0.89	3.52	3.80	5.28	5.84	1.90	1.96	3.31
	m eq/l	0.09	0.02	0.01	0.06	0.06	0.09	0.09	0.03	0.02	0.05
	m eq%	0.40	0.20	0.09	0.77	0.96	1.56	1.92	0.42	0.28	0.73
SO ₄ ^{..}	mg/l	606.62	45.59	65.87	144.57	84.60	69.00	58.20	22.80	130.95	6.24
	m eq/l	12.63	0.95	1.37	3.01	1.76	1.44	1.21	0.48	2.73	0.13
	m eq%	56.59	9.45	12.00	38.79	28.07	24.91	25.80	6.65	38.08	1.88
Total anions (m eq/l)		22.32	10.05	11.42	7.77	6.27	5.78	4.69	7.22	7.17	6.90
T.D.S. (mg/l)		1407.49	515.48	603.71	489.29	387.10	347.08	281.45	372.77	438.27	238.77

Table: Trace Metal Concentration of Amman Formation Waters

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
FS-36	Aug 80	6.5	-	5.11	16.99	2.06	23.31	8.20	24.80	0.146	N.D.	1.95	N.D.
FS-36	Nov 80	6.8	-	4.20	20.92	10.78	25.35	8.29	21.96	0.613	14.12	2.43	6.10
FS-36	Jun 81	6.8	512.31	3.88	19.74	N.D.	16.57	4.14	16.10	0.682	13.29	1.76	7.36
FS-36	Apr 81	-	517.58	2.59	13.15	12.23	17.08	0.14	20.15	0.153	17.14	2.04	10.26
FS-36	May 81	7.2	522.18	2.39	29.82	187.46	83.27	0.24	32.51	0.835	21.82	3.19	15.79
FS-36	Jun 81	7.4	553.90	4.95	15.01	8.10	13.24	1.18	13.61	0.107	17.14	2.97	N.D.
FS-35	Sep 80	7.1	265.45	18.67	11.65	6.87	17.51	3.19	53.18	0.361	N.D.	1.77	19.86
FS-35	Dec 80	8.0	-	5.19	N.D.	2.87	9.80	0.23	16.97	0.047	N.D.	N.D.	20.57
FS-35	Mar 81	6.8	448.65	1.84	8.15	N.D.	14.44	2.81	32.22	0.111	8.52	N.D.	10.31
FS-35	Apr 81	-	349.49	1.79	7.22	N.D.	6.41	0.76	16.79	0.125	12.39	1.55	6.36
NRA-W.S.	Sep 80	6.8	685.20	9.70	22.75	6.51	21.51	1.11	54.67	0.316	13.45	1.86	14.07
NRA-W.S.	Mar 81	6.8	611.56	2.59	N.D.	N.D.	10.68	0.19	23.53	0.056	17.03	1.55	14.72
NRA-W.S.	May 81	7.4	665.11	2.75	21.74	19.15	17.51	0.29	43.66	0.271	8.57	3.03	10.26
HV-11	Sep 80	7.0	352.46	11.33	19.05	17.14	10.82	4.82	37.70	0.633	N.D.	3.43	11.43
HV-11	Mar 81	7.3	277.77	2.25	2.35	N.D.	9.79	1.91	N.D.	0.078	14.71	N.D.	6.63
HV-11	Apr 81	-	-	7.38	7.05	N.D.	8.97	1.26	42.54	0.304	13.16	1.47	N.D.
FS-37	Aug 80	6.8	-	6.38	13.48	5.46	24.71	3.70	24.04	0.147	11.82	2.60	9.23
FS-37	Jun 81	6.8	515.48	3.47	14.73	4.64	13.17	7.49	15.10	0.443	12.39	1.93	11.04
FS-37	Mar 81	6.8	-	4.69	14.57	N.D.	4.67	11.38	20.13	0.051	6.97	N.D.	11.04
FS-52	Aug 80	6.5	580.17	5.01	25.35	5.09	14.82	0.02	22.04	0.121	8.86	N.D.	N.D.
FS-52	Apr 81	-	407.43	3.59	14.11	9.64	13.24	0.06	19.25	0.137	19.35	1.88	N.D.
FS-74	Sep 80	6.9	469.22	8.50	20.05	3.59	18.59	1.16	22.96	0.196	N.D.	1.00	10.97
FS-74	Dec 80	6.8	-	18.52	9.59	3.59	17.58	0.54	52.91	0.100	12.46	N.D.	14.48
FS-74	Mar 81	6.8	391.82	14.08	6.42	10.32	16.72	1.14	N.D.	0.107	11.61	N.D.	11.04
FS-34		12.0	1625.60	13.60	11.65	8.31	48.51	5.87	527.73	0.268	34.18	22.98	40.55
FS-34		12.0	1407.49	23.46	6.68	7.19	45.30	0.83	534.09	0.032	36.54	3.04	54.10

Table continued

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
FS-4	Aug 80	6.8	458.60	6.17	15.62	5.16	19.31	1.72	N.D.	0.199	13.29	2.44	36.00
FS-4	Mar 81	6.8	359.48	1.63	7.21	32.44	23.36	0.88	36.24	0.331	17.81	7.88	12.50
FS-17		6.8	603.70	6.60	34.25	5.85	17.31	4.31	14.47	0.529	5.91	2.73	N.D.
NRA-B		11.5	-	9.75	30.61	71.27	28.09	0.05	37.17	1.054	13.45	2.42	14.90
NRA-A ₂		8.5	438.27	11.73	21.40	6.87	22.25	3.00	171.65	0.206	9.91	N.D.	N.D.
FS-26 ²		7.5	489.29	16.27	87.95	7.95	22.61	6.06	162.91	0.613	N.D.	0.97	11.59
FS-25		9.5	-	20.27	9.75	9.76	25.17	1.00	59.04	0.261	N.D.	1.94	18.21
FS-10		6.8	-	10.40	7.04	7.59	18.61	4.04	44.83	0.610	10.62	2.26	14.07
FS-63		12.0	387.10	16.53	41.45	2.12	19.33	7.05	281.25	0.420	11.15	1.77	23.17
FS-62		7.0	347.08	13.60	5.96	1.45	16.78	3.80	43.98	0.233	N.D.	N.D.	10.76
FS-21		7.5	432.71	16.00	14.36	3.25	15.68	15.28	227.05	2.636	N.D.	3.22	N.D.
FS-18		7.1	238.81	21.07	17.92	4.80	29.07	6.15	150.34	0.527	N.D.	3.46	8.28
NRA-Saham Exp.		6.8	372.77	48.53	5.40	2.40	17.24	0.01	18.41	0.151	N.D.	N.D.	N.D.
FS-22		7.4	-	41.72	23.61	7.20	30.42	10.51	169.64	0.338	26.01	2.42	48.00
FS-32		8.2	281.45	21.48	6.97	4.67	24.00	2.55	125.79	0.160	N.D.	N.D.	10.67
NRA-A ₁		6.8	-	25.34	32.24	8.68	21.89	15.82	557.60	1.034	4.96	5.33	N.D.

N.D. = not detected

Table: Chemical Composition of the Bituminous Marl Formation
 Compare columnar section of the area

Sample Number	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70	
Date	31/8/77	3/8/80	12/3/81	22/4/81	25/5/81	23/6/81	10/9/80	22/4/81	20/9/80	24/9/80	
Source Type	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole					
Temperature °C	-	26.0	-	-	-	-	28.5	-	28.0	25.0	
pH	8.02	6.5	6.8	6.8	6.9	6.8	7.2	-	8.5	6.9	
Ca ⁺⁺	mg/l	83.97	86.17	82.16	88.17	84.17	88.18	20.04	14.03	26.05	122.24
	m eq/l	4.19	4.30	4.10	4.40	4.20	4.40	1.00	0.70	1.30	3.90
	m eq%	49.53	40.76	40.84	42.59	41.58	43.96	14.93	11.82	26.59	36.93
Mg ⁺⁺	mg/l	17.88	35.26	36.48	36.48	36.48	34.05	14.59	7.30	9.73	31.62
	m eq/l	1.47	3.30	3.00	3.00	3.00	2.80	1.20	0.60	0.80	1.80
	m eq%	17.38	31.28	29.88	29.04	29.70	27.97	17.91	16.14	16.36	17.05
Na ⁺	mg/l	62.07	64.37	64.37	64.37	63.77	61.55	93.34	94.26	57.48	108.28
	m eq/l	2.07	2.80	2.80	2.80	2.77	2.68	4.06	4.10	2.50	4.71
	m eq%	31.48	26.54	27.89	27.11	27.43	26.77	60.60	69.26	51.13	44.60
K ⁺	mg/l	4.69	5.87	5.47	5.08	5.11	4.85	17.20	20.33	11.34	5.81
	m eq/l	0.12	0.15	0.14	0.13	0.13	0.13	0.44	0.52	0.29	0.15
	m eq%	1.27	1.42	1.39	1.26	1.29	1.30	5.57	8.78	5.93	1.42
Total cations (m eq/l)	8.48	10.55	10.04	10.33	10.10	10.01	6.70	5.92	4.89	10.56	

Table continued

Sample Number		HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	HV-5A	FS-71	FS-71	S-41	S-70
CO ₃ ^{''}	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	12.00	18.07	12.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.60	0.40	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	5.95	9.67	8.49	0.00
HCO ₃ [']	mg/l	383.85	475.96	421.04	445.45	427.14	433.24	48.82	0.00	61.02	231.88
	m eq/l	6.19	7.80	6.90	7.30	7.00	7.10	0.80	0.00	1.00	3.80
	m eq%	64.75	68.78	65.28	69.92	68.16	68.01	11.91	0.00	21.23	33.51
OH [']	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl [']	mg/l	75.18	84.54	83.17	77.23	82.18	84.16	105.16	105.94	67.02	103.10
	m eq/l	2.12	2.38	2.35	2.18	2.32	2.37	2.97	2.99	1.89	2.91
	m eq%	22.18	20.99	22.23	20.88	22.59	22.70	44.20	47.69	40.13	25.66
NO ₃ [']	mg/l	2.86	0.96	1.40	1.20	0.85	1.24	3.31	1.55	2.96	3.38
	m eq/l	0.05	0.02	0.02	0.02	0.01	0.02	0.05	0.03	0.05	0.06
	m eq%	0.52	0.18	0.19	0.19	0.10	0.19	0.74	0.48	1.66	0.59
SO ₄ ^{''}	mg/l	57.64	54.76	53.63	45.32	44.94	45.54	120.08	127.26	66.00	219.50
	m eq/l	1.20	1.14	1.12	0.94	0.94	0.95	2.50	2.65	1.37	4.57
	m eq%	12.55	10.05	10.60	9.00	9.15	9.10	37.20	42.27	29.09	40.30
Total anions (m eq/l)		9.86	11.34	10.57	10.44	10.27	10.44	6.72	6.27	4.71	11.34
T.D.S. (mg/l)		576.00	569.91	532.20	540.58	531.07	536.19	410.13	388.68	283.09	709.87

Table continued

Sample Number	BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2	
Date	25/9/80	10/9/80	19/5/78	3/8/80	3/6/81	24/9/80	12/3/81	12/3/81	3/8/80	12/3/81	
Source Type			Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	
Temperature °C	26.0	28.0	-	29.0	-	27.5	-	-	24.5	-	
pH	8.5	7.0	7.25	6.5	6.8	6.9	6.8	6.8	6.8	6.8	
Ca ⁺⁺	mg/l	18.04	14.03	72.34	78.15	74.80	100.20	88.18	98.20	76.15	66.13
	m eq/l	0.90	0.70	3.64	3.90	3.70	5.00	4.40	4.80	3.30	3.30
	m eq%	25.35	13.59	47.82	50.98	49.87	49.70	43.56	47.81	49.16	44.24
Mg ⁺⁺	mg/l	8.51	13.38	24.20	24.32	25.54	30.40	35.26	34.05	27.97	29.18
	m eq/l	0.70	1.10	1.99	2.00	2.10	2.50	2.90	2.80	2.30	2.40
	m eq%	19.72	21.36	26.36	26.14	28.30	24.85	28.71	27.80	29.75	32.17
Na ⁺	mg/l	38.62	71.27	41.38	36.78	34.72	53.89	63.54	52.88	34.43	36.78
	m eq/l	1.68	3.10	1.80	1.60	1.51	2.34	2.76	2.30	1.50	1.60
	m eq%	47.32	60.19	23.84	20.92	20.35	23.26	27.33	22.91	19.41	21.45
K ⁺	mg/l	10.56	9.78	5.87	5.87	4.30	8.41	1.56	5.47	5.19	6.26
	m eq/l	0.27	0.25	0.15	0.15	0.11	0.22	0.04	0.14	0.13	0.16
	m eq%	7.61	4.85	1.99	1.96	1.48	2.19	0.40	1.39	1.68	2.15
Total cations (m eq/l)	3.55	5.15	7.55	7.65	7.42	10.06	10.10	10.04	7.73	7.46	

Table continued

Sample Number		BV-4	S-18	HV-10	HV-10	HV-10	HV-8	HV-8	HV-8	HV-2	HV-2
CO ₃ ^{..}	mg/l	30.01	12.00	0.00	0.00	0.00	0.00	0.00	0.00	24.01	0.00
	m eq/l	1.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00
	m eq%	29.67	8.25	0.00	0.00	0.00	0.00	0.00	0.00	10.97	0.00
HCO ₃ [.]	mg/l	36.61	36.61	321.83	341.71	303.90	262.39	292.90	280.69	280.69	305.10
	m eq/l	0.60	0.60	5.19	5.60	4.90	4.30	4.80	4.60	3.60	5.00
	m eq%	17.80	12.42	68.29	68.54	66.13	44.75	51.01	48.68	49.38	69.25
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	57.74	89.70	51.06	50.52	47.53	98.98	83.51	86.14	45.36	48.52
	m eq/l	1.58	2.53	1.44	1.42	1.34	2.79	2.36	2.44	1.28	1.73
	m eq%	46.88	52.38	18.95	17.38	18.08	29.03	25.08	25.82	17.56	
NO ₃ [.]	mg/l	3.38	2.53	2.17	0.29	0.00	1.42	1.05	1.00	0.71	0.95
	m eq/l	0.06	0.04	0.04	0.00	0.00	0.02	0.02	0.02	0.01	0.02
	m eq%	1.78	0.83	0.53	0.00	0.00	0.21	0.21	0.21	0.14	0.28
SO ₄ ^{..}	mg/l	6.24	60.60	44.67	55.23	56.20	120.00	106.43	114.62	28.57	39.90
	m eq/l	0.13	1.26	0.93	1.15	1.17	2.50	2.23	2.39	0.60	0.83
	m eq%	3.86	26.09	12.24	14.08	15.79	26.02	23.70	25.29	8.23	11.50
Total anions (m eq/l)		3.37	4.83	7.60	8.17	7.41	9.61	9.41	9.45	7.29	7.22

Table continued

Sample Number	S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2	
Date	4/8/80	4/8/80		23/8/80	12/3/81	25/5/81	23/6/81	25/5/81	23/6/81	31/8/77	
Source Type	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	Borehole	
Temperature °C	26.0	29.5	-	28.0	-	-	-	-	-	-	
pH	6.8	6.8	-	6.8	6.8	6.9	6.8	7.4	6.8	7.3	
Ca ⁺⁺	mg/l	104.21	68.14	68.14	84.17	84.17	78.16	82.16	70.14	70.14	80.16
	m eq/l	5.20	3.40	3.40	4.20	4.20	3.90	4.10	3.50	3.50	4.00
	m eq%	58.56	46.26	41.87	44.21	51.41	52.56	51.57	45.81	54.26	53.41
Mg ⁺⁺	mg/l	8.51	25.54	6.08	25.54	30.40	23.47	27.97	29.18	17.02	23.10
	m eq/l	0.70	2.10	0.50	2.10	2.50	1.93	2.30	2.40	1.40	1.90
	m eq%	7.88	28.57	6.16	22.11	30.60	26.01	28.93	31.41	21.71	25.37
Na ⁺	mg/l	64.37	39.08	101.16	68.97	29.89	32.13	31.14	37.08	32.63	34.49
	m eq/l	2.80	1.70	4.04	3.00	1.30	1.40	1.36	1.61	1.42	1.50
	m eq%	31.53	23.13	49.75	31.58	15.91	18.87	17.11	21.07	22.01	20.03
K ⁺	mg/l	7.04	5.87	7.04	7.82	6.65	7.40	7.41	5.11	4.85	5.45
	m eq/l	0.18	0.15	0.18	0.20	0.17	0.19	0.19	0.13	0.13	0.14
	m eq%	2.03	2.04	0.22	2.11	2.08	2.56	2.39	1.70	4.65	1.34
Total cations (m eq/l)	8.88	7.35	8.12	9.50	8.17	7.42	7.95	7.64	6.45	7.49	

Table continued

Sample Number		S-29	HV-7	FS-26	AV-2	AV-2	AV-2	AV-2	AV-1	AV-1	BV-2
CO ₃ ⁻⁻	mg/l	0.00	0.00	24.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	353.92	341.71	42.71	378.32	317.30	311.20	317.30	311.20	274.59	321.21
	m eq/l	5.80	5.60	0.70	6.20	5.20	5.10	5.20	5.10	4.50	5.18
	m eq%	61.44	72.26	9.00	67.39	66.67	68.64	65.16	67.11	70.31	69.34
OH ⁻	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	46.40	41.24	113.41	43.30	44.56	46.54	43.56	45.55	47.53	45.39
	m eq/l	1.31	1.16	3.20	1.22	1.26	1.31	1.23	1.29	1.35	1.22
	m eq%	13.88	14.97	41.18	13.26	16.15	17.63	15.41	16.97	21.09	17.14
NO ₃ ⁻	mg/l	0.55	0.60	3.52	1.57	2.45	1.46	1.86	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.06	0.03	0.04	0.02	0.03	0.00	0.00	0.00
	m eq%	0.00	0.00	0.77	0.33	0.51	0.27	0.38	0.00	0.00	0.00
SO ₄ ⁻⁻	mg/l	111.91	47.62	144.57	84.13	63.45	68.70	73.21	58.23	41.07	48.51
	m eq/l	2.33	0.99	3.01	***		copy unreadable			***	1.01
	m eq%	24.68	12.77	38.74	***		copy unreadable			***	13.52
Total anions (m eq/l)		9.44	7.75	7.77	9.20	7.82	7.43	7.98	7.60	6.40	7.47
T.D.S. (mg/l)		*** copy cut off ***			504.66	420.22	413.46	425.96	379.89	350.54	* cut *

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
Date		3/8/80	12/3/80	22/3/81	25/5/81
Source Type		Borehole	Borehole	Borehole	Borehole
Temperature °C		28.2	-	-	-
pH		6.5	6.8	6.8	6.8
Ca ⁺⁺	mg/l	102.20	86.17	84.17	102.20
	m eq/l	5.10	4.30	4.20	5.10
	m eq%	56.67	56.21	54.40	67.55
Mg ⁺⁺	mg/l	24.32	23.10	26.75	12.16
	m eq/l	2.00	1.90	2.20	1.00
	m eq%	22.22	24.84	28.50	13.25
Na ⁺	mg/l	39.08	29.94	27.59	29.66
	m eq/l	1.70	1.30	1.20	1.29
	m eq%	18.89	16.99	15.54	17.09
K ⁺	mg/l	7.82	14.35	4.69	6.13
	m eq/l	0.20	0.15	0.12	0.16
	m eq%	2.22	1.96	1.55	2.12
Total cations (m eq/l)		9.00	7.65	7.72	7.55

Table continued

Sample Number		BV-2	BV-2	BV-2	BV-2
CO ₃ ^{..}	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
HCO ₃ ⁻	mg/l	366.12	311.20	317.30	392.51
	m eq/l	6.00	5.10	5.20	5.40
	m eq%	69.61	70.25	68.06	69.23
OH ⁻	mg/l	0.00	0.00	0.00	0.00
	m eq/l	0.00	0.00	0.00	0.00
	m eq%	0.00	0.00	0.00	0.00
Cl ⁻	mg/l	44.33	43.56	40.59	41.58
	m eq/l	1.25	1.23	1.15	1.17
	m eq%	14.50	16.94	15.05	15.00
NO ₃ ⁻	mg/l	1.03	1.45	0.32	0.00
	m eq/l	0.02	0.02	0.00	0.00
	m eq%	0.23	0.28	0.00	0.00
SO ₄ ^{..}	mg/l	64.29	43.73	61.44	58.93
	m eq/l	1.34	0.91	1.29	1.23
	m eq%	15.55	12.53	16.88	15.77
Total anions (m eq/l)		8.62	7.62	7.64	7.80
T.D.S. (mg/l)		***	copy cut off	***	***

Table: Trace Metal Composition of the Bituminous Marl Formation

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
HV-5A	Aug 77	-	576.0	-	-	-	-	-	-	-	-	-	-
HV-5A	Aug 80	6.5	570.0	6.81	41.37	8.25	17.98	0.04	20.67	0.360	5.91	2.89	25.38
HV-5A	Nov 80	6.8	-	1.98	40.93	4.31	18.24	0.01	15.95	0.065	10.80	1.39	N.D.
HV-5A	Mar 81	6.8	537.0	4.29	40.11	N.D.	9.77	0.03	9.63	0.907	20.13	1.23	15.46
HV-5A	Apr 81	6.8	540.0	4.59	27.42	3.34	8.54	0.03	14.97	0.304	18.58	2.13	N.D.
HV-5A	May 81	6.9	531.0	4.22	43.48	39.04	11.53	0.02	13.61	0.347	16.36	2.64	11.05
HV-5A	Jun 81	6.8	536.0	3.85	46.93	11.79	12.38	0.01	20.42	0.187	15.58	3.13	N.D.
AV-2	Aug 80	6.8	505.0	4.47	36.44	4.13	22.64	0.09	17.57	0.446	88.12	2.27	28.85
AV-2	Mar 81	6.8	420.0	5.18	26.94	4.45	19.64	0.10	11.77	0.350	21.08	1.88	9.57
AV-2	May 81	6.9	413.0	2.75	18.98	7.73	14.95	0.18	22.39	0.607	19.48	1.96	17.37
AV-2	Jun 81	6.8	426.0	5.51	10.52	9.21	19.64	0.27	13.60	0.263	19.25	2.64	N.D.
BV-2	Aug 80	6.5	466.0	8.51	14.80	5.85	3.33	0.04	17.57	0.249	7.39	2.19	27.69
BV-2	Mar 81	6.8	398.0	1.63	1.25	N.D.	12.32	0.02	N.D.	0.042	13.94	N.D.	16.93
BV-2	Apr 81	6.8	407.0	4.98	13.95	N.D.	21.78	0.03	14.97	0.153	13.16	1.96	9.57
BV-2	May 81	7.2	383.0	N.D.	9.83	6.63	6.41	0.02	19.03	0.404	16.36	2.70	15.00
BV-2	Jun 81	6.8	447.0	3.12	34.33	11.79	7.69	0.01	N.D.	0.355	16.36	2.23	N.D.
HV-10	Aug 80	6.5	421.3	9.36	14.52	3.10	16.32	0.04	16.53	0.120	N.D.	1.02	17.21
HV-10	Jan 81	6.8	394.0	3.49	13.11	12.52	13.67	0.01	22.63	0.131	20.26	2.89	13.42
HV-8	Sep 80	6.8	545.0	7.47	48.81	7.19	24.68	11.76	86.35	0.505	N.D.	1.59	13.71
HV-8	Jan 81	6.8	526.0	2.44	18.96	N.D.	12.38	0.59	19.13	0.329	40.69	2.35	19.88
HV-8	Mar 81	6.8	533.0	3.47	6.27	10.32	21.24	0.11	N.D.	0.129	19.36	1.43	15.46
AV-1	May 81	7.4	381.0	2.75	28.64	19.52	15.37	3.16	31.35	0.857	11.69	1.39	N.D.
AV-1	Jun 81	6.8	394.0	4.40	24.84	9.21	18.54	1.80	N.D.	0.200	16.36	2.14	N.D.
HV-2	Aug 80	6.8	383.0	10.00	13.15	7.22	20.64	3.59	21.70	0.325	N.D.	3.90	N.D.
HV-2		6.8	380.0	6.78	49.70	8.15	8.54	0.73	13.90	0.183	12.39	0.98	10.31

Table continued

Location	Date	pH	T.D.S. p.p.m.	Cu p.p.b.	Mn p.p.b.	Cr p.p.b.	Ni p.p.b.	Zn p.p.m.	Pb p.p.b.	Fe p.p.m.	Co p.p.b.	Cd p.p.b.	Mo p.p.b.
S-29	Aug 80	6.8	520.0	5.32	11.51	2.75	13.65	1.41	14.03	0.088	8.86	1.46	N.D.
HV-7	Aug 80	6.8	394.0	5.53	30.14	2.06	11.99	0.24	N.D.	0.393	19.94	1.71	13.85
FS-47		6.8	-	48.27	74.49	17.71	69.67	19.05	84.19	0.227	31.15	5.09	62.07
FS-70		6.8	466.0	11.47	70.43	3.25	12.77	0.33	33.89	0.477	6.37	N.D.	N.D.
FS-26		7.4	489.0	16.27	87.95	7.95	22.61	6.60	162.91	0.613	N.D.	0.97	11.59
S-20		8.0	-	16.09	14.09	15.18	26.63	6.44	159.63	0.673	12.74	2.42	16.55
S-8		12.5	1009.9	19.57	13.65	12.69	37.52	4.21	102.18	0.623	23.78	4.35	135.00
S-26		7.0	1078.83	15.45	28.44	7.54	61.52	8.80	117.06	0.931	26.75	3.26	54.10
FS-71		7.2	410.13	26.27	36.68	5.49	20.96	15.32	136.86	1.876	N.D.	1.50	N.D.
S-18		7.0	291.57	12.10	14.22	10.63	12.17	-	39.68	0.593	N.D.	1.00	N.D.
S-41		8.5	283.09	15.19	16.49	2.74	10.17	6.87	101.19	0.423	N.D.	N.D.	N.D.
S-70		6.9	709.87	9.01	46.64	6.17	23.66	3.69	48.61	0.250	N.D.	1.51	24.30
AV-5		8.2	-	21.37	13.08	7.90	19.94	14.91	754.84	0.512	N.D.	1.51	N.D.
BV-4		8.5	224.97	24.98	24.70	8.62	13.18	14.60	1119.04	0.710	N.D.	1.22	6.10
BV-5		6.8	-	20.99	61.02	13.65	40.56	12.38	560.53	0.781	13.29	4.51	8.38
FS-5		8.5	-	15.80	21.50	6.83	27.38	17.96	1001.03	0.781	N.D.	2.52	41.11

N.D. = not detected