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Report on the Activities of
Water Division. 4th May 1970.
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REPORT ON THE ACTIVITIES OF THE WATER DIVISION
OF THE PUBLIC WORKS DEPARTMENT

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6th May 1970

INTRODUCTION

1. In 1965 Sir William Halcrow & Partners were appointed to organize and carry out a Water Resources Survey of the Trucial States including the preparation of reports and year-books and recommendations for further studies and works. It was originally envisaged that this survey would be completed by September 1967 but by that time the nature and scope of the survey had changed radically; as a result of the early findings and in response to popular demand the survey team were required, in addition, to establish a rural water development programme operated by a direct labour organisation for the drilling and sinking of water wells, construction of water reservoirs and pipelines, cleaning and development of falages and springs, repairs and construction of irrigation channels and such similar works. Concurrently the survey and the embryonic P.W.D. organisation carried out studies and development works for urban water supplies including Ajman, Umm al Qawain, Ras al Khaimah, Fujairah, Kalba and Khor Fakkan. Clearly exploration had become exploitation.

2. For these reasons the survey period was extended first to September 1968 and subsequently for further year, its responsibilities eventually being handed over from the Consultants to the Public Works Department on 1st September 1969. At this time the survey organisation in addition to professional and administrative personnel, comprised expert surveyors, recorders, drillers, pump fitters, pipe layers, drivers, operators and totalled over 150 staff with plant which included three drilling rigs, concrete mixers excavators, blockmaking machines and miscellaneous equipment together with a transport fleet of 5 lorries and 9 Land Rovers. This relatively large operation had been administered wholly within the Consultant's Organisation and one of the first difficulties after the Council take-over was to reassess the operation in terms of overall P.W.D. management and to ensure its proper integration with the Departmental organisation. This eventually has led to some savings in labour and transport to the benefit of the department as a whole.

3. In February 1969 the Consultants published their final report, "Water Resources of the Trucial States" which sets out their findings from the four year study together with recommendations for future action, much of the Division's present work follows along the lines of these recommendations although in certain details changes are desirable and these are discussed at greater length below. In addition, the Division is increasingly involved in the rapid expansion of certain urban water supply systems on a scale which puts a heavy load on a technical and supervisory staff that is actually somewhat smaller and more thinly spread than the original Survey organisation.

4. In summary, the present operations of the Division may be scheduled as follows:-

Capital (a) Rural Water Development -Community and garden development including boreholes, wells, fallaj, testing, pump and engine installation, water tanks, pipelines, irrigation channels etc. both vote chargeable and repayment.

(b) Town and Village Water Supplies-Similar works for large communities.

(c) Irrigation Development - Boreholes, irrigation works for Council projects mainly at Hamraniyah and Milciha.

Recurrent (d) Maintenance and Improvement of Rural Water Supplies

(e) Maintenance and Improvement of Urban Water Supplies

(f) Water Research and Records: -The continuation and

development of the original Water Resources Survey.

RURAL WATER DEVELOPMENT

5. Originally the drilling rigs were employed to sink holes for providing hydrological data; needless to say this led to a demand for pump and engine installation to convert the holes into productive wells. Similarly cleaning and development of certain falajs and springs for hydraulic measurement has led to a demand for this work for purely water production purposes. At present these requirements far outstrip our capabilities and while valuable hydrological data is being collected in the process it is rarely that a rig or falaj crew can be engaged on work directly governed by hydrological considerations. In general the operations fall into two main categories:-

- a) Community Development: for small village supplies and communal supplies to an area of gardens where the community is in need of financial help. This work is chargeable to Vote No.3H Rural Water Development.
- b) Garden Development: works for individual privately owned gardens. These works, mainly borehole drilling are, since October 1969 carried out on a repayment basis.

6. Drilling

A total of 252 boreholes have been drilled since the commencement of the Survey until the present day. Details of those are given in Appendix I and the boreholes fall into the following categories:-

Undeveloped	(Survey bores	..	50
	(Abandoned or dry bores	..	35
Developed or	(Rural community bores	..	17
Developable	(Urban Water Supplies	..	21
	(TSC Irrigation development	..	46
	(Private garden wells (prior to Oct. '69)	..	73
	(Repayment	..	10
	Total No of bores	..	<u>252</u>
	Total depth drilled	..	<u>1502.2 met</u> ^{g.s.}
			15,822'

The distribution by States is as follows:-

Abu Dhabi	-
Dubai	4
Sharjah	83
Ajman	13
Umm al Qawain	42
Ras al Khaimah	85
Fujairah	25
	<u>252</u>

of these 94 were drilled in the year 1969 and 56 have been drilled since The Council take over on 11th September, 1969.

As indicated on the accompanying map.

The three rigs originally purchased for the Survey are still operated. While they remain basically satisfactory equipment little repair or overhaul was carried out during the Consultant's administration and no spares were obtained, consequently with increasing age the burden of overhaul is falling on this organisation and in recent months there has been a significant increase in down time due to repairs, some of

which await the receipt of spares from abroad. When these immediate difficulties are overcome the operation will regain to its former efficiency.

The Ras al Khaimah government have had difficulties with the rig which they have been operating; this has now been taken over by the Public Works Department and the total output of drilling by the Division will therefore increase.

All repairs and maintenance are now being undertaken by the Mechanical Division or the Public Works Department and costs are significantly less than previously when such work was carried out by private engineering firms.

All wells drilled by Public Works Department rigs are subsequently pump tested for 72 hours and yield, drawdown and water quality records maintained.

The costs for drilling including transport, repairs and capital depreciation were estimated by the Consultants during the period of their administration as follows:-

September 1966 - September 1967	QDR. 110 per metre
October 1967 - September 1968	" 94 " "
October 1968 - July 1969	" 67 " "

Since the Council takeover last September the operation has been modified as outlined above some costs being reduced but down time for repair being proportionately high. The Consultants methods of accounts makes it difficult to determine the precise reasons for the variability in drilling costs and the Council accounts since the takeover are in a similar position. A proper cost account record and analysis programme has been prepared and goes into operation on the 1st May this year and more accurate figures will then become available.

7. Repayment wells

The Council have directed that all wells drilled for private gardens shall be carried out on the basis of repayment by installments for all successful wells. Allowing for the variability of costs according to ground conditions, a proportion of unsuccessful wells not directly rechargeable and for test pumping each well it was considered that a standard charge of QDR.100/- per metre or approx. QDR.30/- per foot would be reasonable. In general it would be expected that privately operated rigs might offer a slightly lower price, but without well testing, in known and easy drilling areas in the gravel plain but the Council's price would be attractive in the more difficult areas bordering the mountains and on the East Coast; this would go some way towards easing the pressure on the Council rigs.

An application form for drilling a repayment well is illustrated in Appendix II. On completion of drilling and testing a report is prepared in English and Arabic for the information of the garden owner (see Appendices III and IV).

At present, particularly due to shortage of funds there is no similar arrangement for the provision of pumping equipment etc. on a repayment basis, such machinery having to be purchased by the owner himself.

8. Falajs, Springs and Hand-dug wells

Before the advent of borcholes and mechanical pumps, water was entirely obtained from hand dug wells, artificial falajs and natural springs. Modern methods of abstraction are generally easier to arrange and control but falajs and springs have the advantage of consuming no fuel and are most valuable in the more isolated and inaccessible areas, where it is impossible at the moment to transport our drilling rigs. Many of the falajs and springs yield a consistent flow of water but others have fallen into disrepair, are blocked or have seasonal or

other unexplained variations in yield. In 1967 a programme for rehabilitation of falajs was commenced and we now have two crews experienced in the work. Installations so far completed include
 Falaj al Mu'alla
 Falaj Dhaid
 Falaj Manama
 Falaj Fili
 Falaj Hadf.

Dams at ^{natural} springs have been completed at Bithna and Hadf and hand dug well improvements at Wadi Sidr and Wadi Bih.

In October last year heavy rains caused extensive damage to existing falajs in the area of Masfut and Hatta and since that time our crews have ^{been} almost continuously employed in rehabilitation works in these locations so that development in other areas have been delayed. It is hoped to recommence this work in the immediate future.

9. Pumps, Water Tank and Distribution Installation

As outlined in (7) above, the Division does not now pay for pump machinery for private gardens but our crews are still intensively employed on abstraction and distribution installations for community development in the rural areas, in addition to coping with the increasing demand for installation and maintenance of town and village supplies. Rural installations so far completed include:-

Ghayl	Massafi	Masfut
Idha	W.Siji	Manama
Sayh Fahlayn	Biata	Hulaywa

10. Irrigation Development

During the Consultant's administration irrigation works for about half the projected development area were installed at Mileiha and the Council have now approved the completion of the scheme; these works are to be undertaken by the Water Division.

Twenty five boreholes have so far been completed and pump tested for the Hamraniyah Irrigation Project and eight more remain to be drilled.

URBAN WATER SUPPLIES

11. Ajman

The water supply is obtained from Sharjah mains at low pressure; a booster station operated by the Public Works Department transfer the water into the existing elevated tank south west of the town whence it is distributed within Ajman via an incomplete reticulation system. The Water Division is presently engaged on water mains laying both to reinforce the present system and to extend the supply to newly developing areas.

Umm al Qawain

The water supply and distribution system was originally installed with Council funds; subsequent extensions have been carried out by the State.

Ras al Khaimah

An overall water main system has been designed to supply Ras al Khaimah town, Jezirat Za'ab and Rams; the Department has completed part of the 8" main in Old Ras al Khaimah and is presently engaged on laying a 10" supply main from the wellfield, a 6" supply connection to, and distribution mains within Jezirat, as well as 6" mains reinforcement to

to the new hospital at Hodeiba.

The existing well field at Burayrat is being rehabilitated under the control of the department. A drilling rig and crew obtained from the Royal Engineers have sunk one additional well to a depth of 300 feet and this has proved the best yielding bore to date; this team is now in the process of deepening other wells in the field. When this work is completed the complete field will be tested and a comprehensive design prepared for the electrification and automatic control of water abstraction. Meanwhile the supply continues to be lifted by diesel power and a departmental fitter is on duty at the station to maintain the engines and pumps.

Southern Ras al Khaimah Villages

Outline designs are being prepared for village water supplies for Khouran, Fahlain and Digdaga; finalising of these designs is being delayed until the results of the deep drilling project at Khatt (see below) are available.

A first phase scheme for Idhn has commenced and other projects are about to start in Ghayl and Asima.

Masfut and Hatta

An exploratory survey is now in hand to locate the most suitable sources of supply.

Fujairah and Churfa

Two small supply systems have been installed in this area but extension and reinforcement will become necessary in the near future; it is hoped to electrify the pumps when the new power station is in operation.

Dibba and Other Fujairah Villages

Mains laying and storage tank construction is in progress at Dibba, work on supply wells for Qarawayyah and Squmqam is in hand.

Khor Fakkan

A skeletal water distribution system was installed by the Council and is operated by the State authorities. Demand is increasing and further supply wells are shortly to be drilled. Some extension to the distribution system will be required together with a new storage tank.

Kalba

A supply system for Kalba and an extension to Khor Kalba were completed in 1969. Tankage to improve the pressure at Khor Kalba is to be provided this year.

WATER RESEARCH AND RECORDS

12. In simplified terms the object of this work is to find out:-

1. Where the water is
2. How much there is.

To date the Survey and subsequently the water division of Public Works Department have gone some way in some areas to answer the first question; the gravel plain from Ras al Khaimah to Jabal Fayah has, in general been well covered, although further detailed exploration is required in the area between Hamraniyah and Manama, between Falaj Mu'alla and Dhaid, south of Mileiha and along the mountain flank. Further work is also necessary in the wadi gravels within the mountains and in

tracing fresh water leads across the desert.

Very much less is, at present, known about the second question and what is in the end more important, the maximum safe abstraction rate to avoid depletion of reserves. Certain conclusions can be drawn from observations at drilled wells but in the end a detailed investigation is required in the areas from which the water is derived viz. the mountains. In this respect the Consultant's report and recommendations must be considered deficient; in particular an expansion of meteorological stations in the mountain areas is urgently required to assess the total incidence of rainfall, which is believed to be significantly higher than that recorded on the plains, and also gauging stations to measure the surface and subsurface flow and hence the proportion of rainfall entering the aquifer and eventually available for exploitation.

13. The Division operates four full meteorological stations at:

Falaj al Mu'alla
Digdaga
Milciha and
Kalba.

and regularly records observations at 16 rain gauges, 6 flood record stations, 13 falaj's and springs and 107 observation wells. Since the Council takeover the last named has been increased to 700 wells. The department publishes this information in the form of a Year Book based upon the Hydrological Year of October - September (the Year book for 1968-69 is at present in the hands of the printers)

Before the commencement of the next Hydrological Year in October, it is hoped that, in cooperation with the Agricultural Department, a full register of all water supply installations, boreholes, hand dug wells, and falaj's whether TSC, State or privately owned, will be finalised. It is also proposed that the operation of the existing meteorological stations should be integrated with the adjacent agricultural stations and that additional meteorological parameters e.g. soil temperatures and evaporation, of particular interest to the agriculturalists should be recorded.

As and when staff become available a programme of hydrological well testing specifically designed to determine aquifer characteristics is envisaged, together with a detailed study of the hydrological conditions in areas of intensive development such as Digdaga and Dhaid which may be expected to the first to suffer from overpumping.

14. Deep Drilling Project

Virtually all the water at present abstracted in the northern Trucial States is derived from relatively shallow quaternary gravel aquifers fed from surface flow off the mountain wadis. On the mountain flanks and in the gravel plain this water is still relatively fresh with an electrical conductivity less than 2000 micromhos/cc. but in flowing seawards the water picks up increasing quantities of salts from the aquifer and very high salinities are encountered near the sea where evaporation from shallow aquifers can indeed raise salinities even higher than sea water. It is extremely unlikely that under these conditions (illustrated in Fig. I of Appendix V) good quality water will be encountered at greater depths.

Variations from this general pattern do, however, occur in such configurations as to suggest that deep drilling in these areas might be more promising. Two such areas are in the neighbourhoods of Al Khatt and the Jabal Fayah range and accordingly a deep drilling operation has been put in hand to explore these formations.

15. Al Khatt (see Fig. II of Appendix V and Appendix VI)

These two settlements derive their water from hot springs issuing

from lower cretaceous limestone bands on the edge of the main limestone massif. The temperature differential between this water and that normally encountered in the gravel plain suggest that the source for these springs is at least 300 metres below ground level. The original intention was therefore to sink a bore to this depth along the spring line between the two settlements to locate the source and to provide information which might lead to proposals for increasing the yield from this aquifer.

In the event, we were unable to proceed with the site selected on geological grounds due to State boundary disputes and we have accordingly arranged to drill two bores, one - south of Habhab and one - north of Al Khatt.

The Habhab borehole has been sunk to a depth of 78 metres after a great deal of technical difficulty in drilling through fissured limestone without an adequate supply of water for the rig. The hole was therefore completed at this depth after providing 13 metres of well casing. Two aquifers were encountered, the first at 8 metres was almost certainly the same aquifer as that supplying the existing hot springs in the area; the second at a depth of 54 metres had a rest water level $\frac{1}{2}$ metre lower than the more shallow source and must therefore be constructed as being a geologically separate supply zone. Pump testing to date indicates a yield of at least 16,000 gallons per hour from the lower zone which is clearly a valuable aquifer previously untapped.

To avoid water supply difficulties in the second borehole at Al Khatt, a separate water well has been drilled to provide drilling water for sinking what is hoped will be a bore down to the main source depth of 900 feet. The water well has yielded valuable geological data itself and while revealing an unexpectedly large thickness of clay overburden appears to confirm that the major aquiclude takes the form of a massive limestone band on the outside flank of the formation. The yield of this well remains to be determined by pumping test but qualitatively it is of the same order as the Habhab well.

Without prejudging the outcome of the whole operation it would appear that the lower cretaceous limestone in this area may have great possibilities as a source of water quite separate from the usual gravel plain aquifers presently tapped for irrigation in the Digdaga-Hamranayah area though there may be leakage into this latter zone which only long term records are likely to prove. If further exploratory/production wells were to be considered suitable sites would be:-

1. Behind Sayh Shawji
2. Between Qawn Herf and the mountains
3. Near W. Muleyhah as illustrated in Appendix VI

16. Jebel Fayah Range (see Appendix V fig. III)

An out-thrust of Maestrichtian limestone beyond the main mountain range and culminating in the Jebel Fayah range suggests that underlying the gravel plain between aquicludes formed from a caliche horizon and the main body of serpentinite this limestone might possibly be a source of sub-artesian fresh water.

An exploratory bore is therefore proposed in the area south of Mileiha with casing to prevent connection to and possible contamination of the gravel plain aquifer. If this proved successful a further exploratory bore might be deemed desirable between Jebel Fayah and Qawn where somewhat similar geological conditions may exist.

17. Miscellaneous Research:

- i. Two experimental salt-pans have been constructed adjacent to the main highway bordering a lagoon near Umm al Qawain. With the approach of hot weather an observation station is being set up with a view to collecting experimental data relating to rates of evaporation

and salt production correlated with ambient temperature, humidity and wind speeds; operational procedures will also be investigated as there is a distinct possibility that a two stage process decanting partially evaporated water will yield a more refined product.

11. On completion of the well deepening operations at Ras al Khaimah the Army drilling unit is to be employed firstly in investigating the subsurface conditions in the mouth of the Wadi Bih which may lend itself to the formation of an underground reservoir, and secondly in exploration of a possible fresh water lead and falaj to the rear of Sharjah Town and the Army Camp.

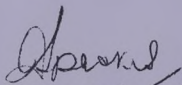
CONCLUSION

18. Future Programme of Works: For information, the programme for works to be undertaken in the immediate future is summarised in Appendix VII.

19. From the foregoing it will be apparent that the activities of the Water Division of the Public Works Department are of an increasingly complex and widespread nature. Since the takeover of the Survey operation from Consultants in September of last year this increasing amount of work has been maintained with an overall reduction in staff for reasons of general economy, for the purposes of revealing which personnel are capable of accepting a greater degree of responsibility and, in general, to accustom all the staff to working under continuous pressure; this is necessary for the economic management of any rapidly expanding development programme.

However, it is increasingly clear that few further economies can be made and that additional development will be reflected in the need for additional staff and backup organization. There is a sense in which the rate of development, or the demand for it, is less a function of deliberate decision making but more an outcome of its own previous success; in common with other Divisions of the P. W. D., financial provisions, organisation, staffing and the general acceptance of its role are running some 18 months to 2 years behind the present level of development required.

In urban water supplies a greater degree of supply reliability must accompany the expansion of source and distribution installations and the increasing amount of both T.S.C. and private drilling in the rural areas makes more urgent the detailed study of resources available and the prediction of ultimate yields. Here the wheel comes full circle as the oldest of the world's civilisations, out of which present civilised life grew, had its beginnings in the need for development, control, distribution and allocation of limited supplies of water on which in the end, all life depends.


(K.F. Sparke)
DY. DIRECTOR OF PUBLIC WORKS

Date: 4th May, 1970

APPENDIX 1

LIST OF BOREHOLES COMPLETED BY WATER RESOURCES SURVEY
AND PUBLIC WORKS DEPARTMENT

HYDROLOGICAL ZONE

ZONE - 1 CENTRAL MOUNTAINS

Ref No.	Pump & Engine	Location	Drilling Date	E.C. Value	Yield g.p.h.	Depth (m)	Draw-down (m)
1WRO01	P/E/T	Idhn	7/66	1600	6100	80.2	9.2
1WRO02		Masafi (F)	9/66	1100	8500	51.2	8.0
1WRO03		Masafi (TOS)	9/66	460	220	62.4	5.6
1WRO04		Sayh Mudayrah	1/67	1500	-	20.1	-
1WRO05		Sayh Mudayrah	1/67	600	1300	28.9	16.5
1WRO06	P/E/T	Sayh Mudayrah		650	6100	28.0	8.9
1WRO07	P/E/T	Sayh Mudayrah	4/67	970	8800	35.0	14.2
1WRO08	P/E/T	Masafi (F)	6/67	500	1600	Engine replaced 11/68	
						66.21	21.2
1WRO09		Masafi (F)	9/67	2000	6100	45.0	6.7
1WRO10		Masafi	-	-	-	-	-
1WRO11	P/E	Masafi (RAK)	11/67	450	4750	30.0	7.2
1WRO12		Masafi (RAK)	12/67	1700	440	40.0	10.0
1WRO13		Masafi (F)	1/68	1700	-	36.6	-
1WRO14		Masafi (RAK)	3/68	400	18000	44.0	4.4
1WRO15	P/E	Idhn	4/68	1150	8140	61.0	8.8
1WRO16		Masafi (F)	4/68	410	-	49.1	-
1WRO17		Idhn	5/68	1740	400	69.0	32.3
1WRO18	P/E	Masafi (F)	5/68	1150	3000	61.0	19.0
1WRO19	P/E	Idhn	5/68	1000	12100	61.0	8.2
1WRO20	P/E	Masfut	6/68	480	5830	34.0	5.2
1WRO21	P/E	Idhn	6/68	1300	11660	39.0	3.2
1WRO22	P/E	Sayh Mudayrah	6/68	870	-	30.0	-
1WRO23		Idhn	7/68	1170	1800	43.1	22.6
1WRO24		Masfut	7/68	-	-	-	-
1WRO25		Masfut	8/68	2220	-	-	-
1WRO26	P/E	Idhn	8/68	1590	4700	54.4	17.3
1WRO27	P/E	Masfut	9/68	600	1200	39.6	30.6
1WRO28		Idhn	10/68	1500	950	61.0	-
1WRO29		Ghayl	10/68	-	-	-	-
1WRO30		Idhn	10/68	2600	Not tested	-	-
1WRO31	P/E	Idhn	11/68	980	2530	60.5	24.2
1WRO32	P/E	Masafi (F)	12/68	1500	1430	61.0	25.3
1WRO33		W.Shawkah	12/68	880	286	61.0	22.3
1WRO34	P/E	Idhn	12/68	870	15000	61.0	4.1
1WRO35		W.Shawkah	12/68	940	3200	60.0	22.1
1WRO36		Masafi (F)	1/69	-	-	-	-
1WRO37		Idhn	1/69	-	132	60.0	-
1WRO38	P/E	Masafi/Fuj.	2/69	420	7200	18.3	6.8
1WRO39		Masafi (RAK)	3/69	-	-	-	-
1WRO40		Masafi (RAK)	3/69	-	-	-	-
1WRO41		Masafi (RAK)	3/69	-	-	-	-
1WRO42		Masafi (Fuj)	3/69	480	7200	45.7	16.4
1WRO43	P/E	Masafi (RAK)	4/69	590	13500	45.7	16.25
1WRO44		Masafi (Fuj)	4/69	1330	300	30.1	-
1WRO45		Masafi (F)	5/69	910	3100	49.3	23.0
1WRO46		Masafi (F)	5/69	910	-	33.3	27.5
1WRO47		Masafi (F)	5/69	890	3600	56.5	19.5
RE2	P/E	Ghayl	5/69	930	14630	61.0	4.1

COUNCIL TAKE OVER

1WRO48

Masafi (F)

4/70

Ref.No.	Pump & Engine	Location	Drilling Date	E.C. Value	Yield g.p.h.	Depth (m)	Draw-down (m)
ZONE - 4 CENTRAL GRAVEL PLAIN							
4WRO01		Mileiha	10/66	1300	800A	70.5	-
4WRO02	P/E/T	Buhays	11/66	1920	6000	61.2	18.6
4WRO03		Mileiha	11/66	1160	11440	71.0	12.61
4WRO04		Mileiha	12/66	6400	2550	31.0	17.8
4WRO05		Mileiha	12/66	1150	9600	59.2	4.5
4WRO06		Mileiha	1/67	1180	4700	53.0	18.6
4WRO07		Mileiha	1/67	1130	15600	46.5	3.3
4WRO08		Mileiha	2/67	2400	-	-	-
4WRO09		Falaj al Mu'alla	4/67	1570	2300	65.0	1.9
4WRO10		Falaj al Mu'alla	5/67	2500	2840	64.5	8.20
4WRO11		Mileiha	7/67	1300	5400	45.7	13.8
4WRO12	P/E	Mileiha	7/67	1400	6640	45.7	7.4
4WRO13	P/E	Mileiha	8/67	4080	12000	45.7	6.9
4WRO14	P/E	Mileiha	4/67	1150	7300	45.7	11.4
4WRO15		Mileiha	9/67	1240	1300	46.5	24.3
4WRO16	P/E	Mileiha	9/67	1110	12300	46.0	2.5
4WRO17	P/E	Mileiha	9/67	1100	6666	46.0	11.4
4WRO18		Mileiha	10/67	1500	3300	46.5	21.7
4WRO19		Mileiha	10/67	1620	4000	46.0	16.3
4WRO20	P/E	Mileiha	10/67	1120	11800	45.7	3.0
4WRO21		Mileiha	11/67	1350	6700	45.7	15.3
4WRO22		Mileiha	4/67	1690	6000	46.0	13.4
4WRO23	P/E	Mileiha	11/67	1850	8360	46.5	14.6
4WRO24		Mileiha	12/67	1620	4200	46.0	22.8
4WRO25	P/E	Mileiha	12/67	1150	10450	46.5	8.9
4WRO26		J.Fayya	1/68	7300	550	47.7	23.0
4WRO27	P/E	Buhays	2/68	2500	5760	54.9	27.0
4WRO28		Sayah Falaj al Sheikh	3/68	1580	2800	61.0	19.1
4WRO29	P/E/T	Sayah Falaj al Sheikh	3/68	1250	11175	61.0	4.7
4WRO30		Manama	5/68	1910	-	50.9	-
4WRO31		Manama	7/68	1030	-	52.0	-
4WRO32	P/E	Falaj al Mu'alla	7/68	2650	2222	54.0	20.6
4WRO33	P/E	Falaj al Mu'alla	7/68	2780	11000	-	-
4WRO34	P/E	Nabkha	7/68	1030	6000	50.4	12.1
4WRO35	P/E	Nabkha	8/68	1040	5400	45.7	6.4
4WRO36	P/E/T	Wadi Siji	8/68	600	6000	47.3	3.7
4WRO37	P/E	Nabkha	9/68	1100	3000	45.7	20.7
4WRO38	P/E	Nabkha	9/68	1330	13500	45.7	10.6
4WRO39	P/E	Nabkha	9/68	3000	8000	42.7	23.5
4WRO40	P/E	Nabkha	10/68	910	11000	47.0	17.3
4WRO41	P/E	Buhays	10/68	1700	7200	61.0	9.2
4WRO42	P/E	Nabkha	10/68	810	12000	51.8	20.3
4WRO43	P/E	Nabkha	10/68	800	2400	54.9	25.8
4WRO44	P/E	Nabkha	10/68	780	12000	45.7	18.6
4WRO45	P/E	Nabkha	11/68	850	8000	54.8	23.0
4WRO46	P/E	Nabkha	11/68	920	12000	46.8	21.0
4WRO47		Dhaid	11/68	600	12400	61.0	16.6
4WRO48		T.Hamdah	11/68	650	2530	61.0	26.5
-	P/E	Mileiha					
493	P/E/T	Falaj al Mu'alla	11/68	2240	5830	45.7	10.9
481	P/E/T	Dhaid Airstrip					
471	P/E	Manama		3400	5000	51.6	6.5
4WRO49		T.Hamdah	1/69	700	-	-	-
4WRO50	P/E	Mileiha	1/69	1380	12460	-	-
4WRO51		Madam I	2/69	1200	13800	45.8	9.6
4WRO52		Zubeida II	2/69	850	4000	61.0	28.6
4WRO53	P	Madam II	2/69	1100	5650	45.7	20.2
4WRO54		Zubeida II	2/69	850	9000	61.1	28.8
4WRO55		" III	3/69	850	5520	61.0	19.1
4WRO56		Dhaid	3/69	705	5000	61.0	21.2
4WRO57		Dhaid	3/69	576	12500	61.0	1.1
4WRO58		Dhaid	3/69	620	14400	61.0	1.3

Ref.No.	Pump & Engine	Location	Drilling Date	E.o.G. Value	Yield g.p.h.	Depth (m)	Draw-down (m)
4WRO59		Dhaid	3/69	530	14400	61.0	1.5
4WRO60		Dhaid	3/69	-	-	-	-
4WRO61		Dhaid	4/69	1270	5000	61.0	22.0
4WRO62		Manama NW Frontier	4/69	670	6000	-	-
4WRO63		Manama (T.Huwairah)	4/69	640	4620	45.7	17.6
4WRO64		Manama (N.W.)	5/69	-	dry	36.0	-
4WRO65		Manama	5/69	1960	3000	57.5	29.8
4WRO66		Manama (N. of camp)	5/69	800	-	49.3	-
4WRO67		Manama Sand dunes	6/69	800	4550	45.8	18.6
4WRO68		Dhaid	6/69	620	-	47.4	-
4WRO69		Dhaid (50 mm fr.68)	6/69	780	14400	58.0	1.70
4WRO70		Shamai (Madam)	-	1400	9650	51.8	7.50
4WRO71		Dhaid	6/69	1500	11650	51.8	3.6
4WRO72		Dhaid	7/69	500	14400	51.8	1.74
4WRO73		Dhaid (North of 72)	8/69	450	-	30.5	-
4WRO74		Dhaid	8/69	800	9650	42.7	2.8
4WRO75		Dhaid (Near 71)	8/69	1000	13902	42.7	6.1
4WRO76		Dhaid (30 m fr.74)	8/69	930	14000	48.8	2.07

COUNCIL TAKE OVER

4WRO77		Dhaid	9/69	800	7700	61.0	8.2
4WRO78		Dhaid (½ km fr.76)	9/69	1310	-	54.9	-
4WRO79		Al Hayna	9/69	-	-	24.4	-
4WRO80		Dhaid	10/69	790	-	61.0	-
4WRO81		Al Hagna (F)(50m S 79)	10/69	-	-	48.8	-
4WRO82		Al Hagna (F)(W of 81)	10/69	2700	3000	61.0	-
4WRO83		Jabal Wabla (RAK)	11/69	-	-	45.7	-
4WRO84		Jabal Wabla (RAK) II	11/69	-	-	45.7	-
4WRO85		" " III	12/69	-	-	16.8	-
4WRO86		Mileiha (East of Garden)	12/69	900	1000	45.7	20.36
4WRO87	P/E	Mileiha (S.W. of Garden)	12/69	1200	6600	45.7	6.02
4WRO88		Jabal Wabla (RAK) IV	12/69	-	-	30.5	-
4WRO89		" " V	1/70	500	-	45.7	-
4WRO90		Dhaid	1/70	1000	3900	45.7	6.90
4WRO91		Jari Harrsa	1/70	-	-	45.7	-
4WRO92		Dhaid	2/70	550	12150	45.7	2.40
4WRO93		Jarri Harrsa II	2/70	5250	-	45.7	-
4WRO94		" " III	2/70	3900	3000	45.7	15.71
4WRO95		" " IV	2/70	5000	1000	45.7	-
4WRO96		" " V	2/70	-	-	30.5	-
4WRO97		Dhaid	3/70	2900	1400	45.7	19.77
4WRO98		Jabal Wabla (RAK) VI	3/70	-	-	45.7	-
4WRO99		Al Barat (Sharjah)	3/70	2050	16650	45.7	6.80
4WR100		Al Barat (II)	4/70	4200	-	45.7	-
4WR101		Jabal Wabla (VII)	4/70	-	-	45.7	-
4WR102	P/E	Dhaid	4/70	1700	12000	45.7	5.2
4WR103		Al-Barat III	4/70	850	16000	45.7	7.20

ZONE - 6 RAS AL KHAIMAH -JIRI PLAIN

6WRO01		Wadi Mahani	8/66	-	-	18.2	-
6WRO02		Khatt	9/66	2400	-	71.3	-
6WRO03		Khatt	12/66	2300	-	39.9	-
6WRO04		Sayh Fahlain	2/67	2380	4775	67.0	7.6
6WRO05	P/E	Hamraniyah (Haramil)	3/67	2500	4160	65.5	7.9
6WRO06	P/E	Sayh Fahlain	3/67	2400	9400	65.5	5.0
6WRO07		Hamraniyah	4/67	1880	13600	65.5	6.5
6WRO08		Hamraniyah	4/67	1200	2200	61.0	6.0
6WRO09		Wadi Naqab	-	1200	5000	61.0	6.5
6WRO10		Hamraniyah	6/67	1200	5000	61.0	6.1
6WRO11		W.Naqab	-	-	-	-	-
6WRO12	P/E	Sayh Fahlain	5/68	2350	8000	61.0	3.2
6WRO13	P/E/T	"	2/68	2300	9500	61.0	6.1
6WRO14	P/E	Digdaga	3/68	3680	11000	45.7	4.4
6WRO15		Haremla	5/68	3050	6200	82.3	3.9

Ref.No.	Pump & Engine	Location	Drilling Date	E.C. Value	Yield g.p.h.	Depth (m)	Drawdown (m)
6WRO16		Haremle		13500	-	49.8	-
6WRO17		Haremle	1/68	6000	7600	61.0	4.4
6WRO18	P/E	W.Ghalilah	7/68	1240	2660	61.0	14.3
6WRO19		Shemal	7/68	1575	8140	33.0	6.5
6WRO20		Hamraniyah	3/69	1210	10800	42.7	6.5
6WRO21		Hamraniyah	4/69	1260	12000	61.0	4.1
6WRO22		Hamraniyah	4/69	1740	12000	57.9	3.6
6WRO23		Hamraniyah	5/69	1080	9000	61.0	1.9
6WRO24		Hamraniyah	5/69	1070	6700	57.5	4.6
6WRO25		Hamraniyah	5/69	1030		54.9	
6WRO26		Buzayrat	6/69	1970	-	76.2	-
6WRO27		Hamraniyah	7/69	1300	8500	61.0	3.3
6WRO28		Hamraniyah	7/69	950	7550	61.0	2.4
6WRO29		Hamraniyah	7/69	1020		61.0	
6WRO30		Hamraniyah	8/69	1200	11500	61.0	3.6
6WRO31		Hamraniyah	8/69	1100		61.0	

COUNCIL TAKE OVER

6WRO32		Hamraniyah	9/69	1050		61.0	
6WRO33		Hamraniyah	9/69	1200	9200	61.0	7.8
6WRO34		Hamraniyah	9/69	1010	12000	61.0	2.5
6WRO35		Hamraniyah	9/69	1300	11520	61.0	4.4
6WRO36		Hamraniyah	10/69	1190	8300	61.0	12.8
6WRO37		Hamraniyah	10/69	1150	12000	61.0	3.7
6WRO38		Hamraniyah	10/69	1170	11660	54.9	3.6
6WRO39		Hamraniyah	10/69	1050	10350	61.0	1.3
6WRO40		Hamraniyah	11/69	1250	8000	61.0	9.8
6WRO41		Hamraniyah	11/69	1350	6000	61.0	2.3
6WRO42		Hamraniyah	11/69	1000	10280	50.3	2.5
6WRO43		Hamraniyah	12/69	1020	8280	61.0	2.6
6WRO44		Hamraniyah	12/69	1000	9000	61.0	1.0
6WRO45		Al-Moyahiha	1/70	1900	10800	61.0	10.7
6WRO46		"	1/70	1700	7200	61.0	12.1
6WRO47		Hamraniyah	2/70	2000	7300	51.2	10.8
6WRO48		Yahili (RAK)	2/70	1850	600	61.0	40.0
6WRO49		Saghi (RAK)	2/70	2200	1500	61.0	30.0
6WRO50		" "	3/70	1900	6000	61.0	8.8
6WRO51		" "	3/70	2000	1000	61.0	40.2
6WRO52		" "		-	-	-	-

ZONE - 7 DESERT FORELAND

7WRO01		T.Saif	4/68	1375	2550		
7WRO02		Bidaya'	4/68	2050	16800		
7WRO03		"	5/68	1820	16650		
7WRO04		Moweilha	5/68	3400	11900		
7WRO05		Gharad	5/68	9550	11000		
7WRO06		Khili Tel Aba'adi	5/68	10400	10400		
7WRO07		Dhaid road	6/68	3900	8800		
7WRO08		Riqa Hamra	6/68	5800	10500		
7WRO09		Limha	8/68	1870	2000		
7WRO10		Murarat Ghanum	9/68	6400	-		
7WRO11		Bidaya'	4/69	1980	9000	61.0	2.77
7WRO12		"	4/69	1940	9000	61.0	2.80
7WRO13		Wadi Lamaha	7/69	4230	1800	61.0	10.0
7WRO14		Dhaid Road (17 km from Dhaid)	6/69	4000	1700	45.7	9.40
7WRO15		Dhaid(20 km fr.Dhaid)	7/69	7000		45.7	
7WRO16		W.Lamaha Borehole 2	7/69	4200	3600	61.0	11.10
7WRO17		" " 3	8/69	3000	3650	61.0	8.50
7WRO18		" " 4	8/69	3025	2500	61.0	11.75
7WRO19		Dhaid Road (14 km from Sharjah)	8/69	4000	7000	47.2	5.55

Ref.No.	Pump & Engine	Location	Drilling Date	E.C. Value	Yield g.p.h.	Depth (m)	Drawdown (m)
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COUNCIL TAKE OVER

7WRO20		Dhaid road	10/69	3800	7100	45.7	14.7
7WRO21		"	10/69	3100	5850	45.7	5.9
7WRO22		"	10/69	4200	6200	45.2	11.3
7WRO23		"	11/69	3570	5065	45.7	8.0
7WRO24		"	11/69	3200	4590	45.7	9.2
7WRO25		" (B/hole No.1 Sharjah Falaj)	12/69	7200		45.7	
7WRO26		Dhaid road(Sh.Falaj)	12/69	12000		10.2	
7WRO27		" "	12/69	3500		10.2	

UMM AL QAIWAIN SERIES

UQ1	P/E/T	Sirrah	10/65	4000	7530		
UQ2		T.Muadhab	10/65	5600	-		
UQ3		T.Harib	10/65	7000	-		
UQ4		Libsah	11/65	7000	-		
UQ5		Sayh Biatah	11/65	5000	-		
UQ6		Limahah	11/65	2500	1760		
UQ7		Batha al Ali	12/65	4500	-		
UQ8		" "	12/65	6000	-		
UQ9		" "	1/66	3800	-		
UQ10		" "	1/66	8000	-		
UQ11		Libsah "	2/66	3800	-		
UQ12		" "	2/66	3500	-		
UQ13		" "	3/66	5000	-		
UQ14		Limahah	3/66	4500	-		
UQ15		Limahah	4/66	2100	1275		
UA16		Limahah	5/66	2150	-		
UQ17		"	6/66	2200	1670		
UA18		"	5/66	5000	-		
UA19		"	4/68	2300	1300		
19a		"		1300	1800		
WR7113		Khawanij	10/67	3500	-		
UQ20							
UA21		Limahah		2900	1100		
UQ22		"		1800	1320		

11

Year	Month	Day	Time	Location	Remarks
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1911	Jan	1	10:00
1911	Jan	2	10:00
1911	Jan	3	10:00
1911	Jan	4	10:00
1911	Jan	5	10:00
1911	Jan	6	10:00
1911	Jan	7	10:00	...	...
1911	Jan	8	10:00	...	...
1911	Jan	9	10:00	...	...
1911	Jan	10	10:00	...	...
1911	Jan	11	10:00	...	...
1911	Jan	12	10:00	...	...
1911	Jan	13	10:00	...	...
1911	Jan	14	10:00	...	...
1911	Jan	15	10:00	...	...
1911	Jan	16	10:00	...	...
1911	Jan	17	10:00	...	...
1911	Jan	18	10:00	...	...
1911	Jan	19	10:00	...	...
1911	Jan	20	10:00	...	...
1911	Jan	21	10:00	...	...
1911	Jan	22	10:00	...	...
1911	Jan	23	10:00	...	...
1911	Jan	24	10:00	...	...
1911	Jan	25	10:00	...	...
1911	Jan	26	10:00	...	...
1911	Jan	27	10:00	...	...
1911	Jan	28	10:00	...	...
1911	Jan	29	10:00	...	...
1911	Jan	30	10:00	...	...
1911	Jan	31	10:00	...	...