THE UNITED ARAB EMIRATES
THE MINISTRY OF AGRICULTURE AND FISHERIES
WATER AND SOIL DIRECTORATE

WADI AL BASSIERAH BASIN WATER RESOURCES DEVELOPMENT PROJECT

REPORT ON FEASIBILITY STUDY

VOL. I

SUMMARY

JAPAN INTERNATIONAL COOPERATION AGENCY

NOVEMBER, 1981

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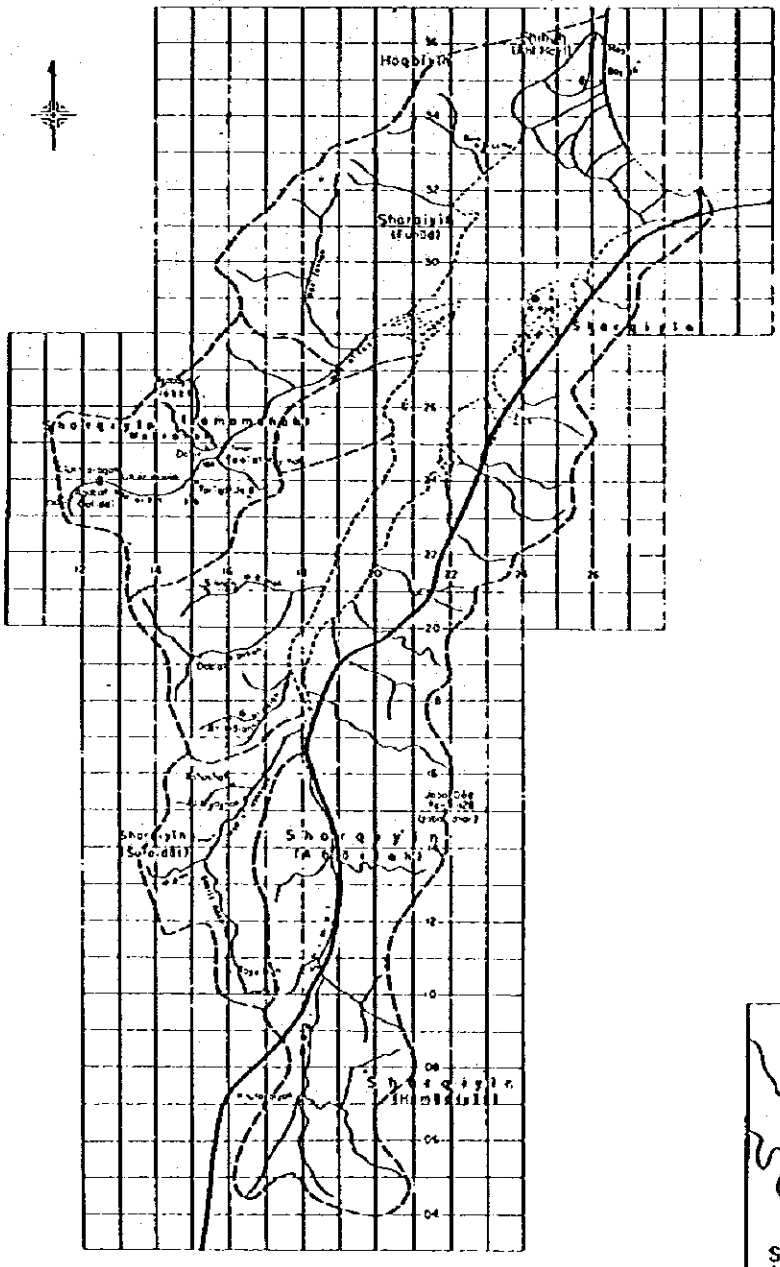
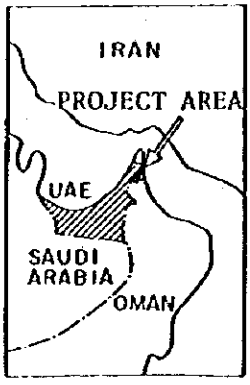
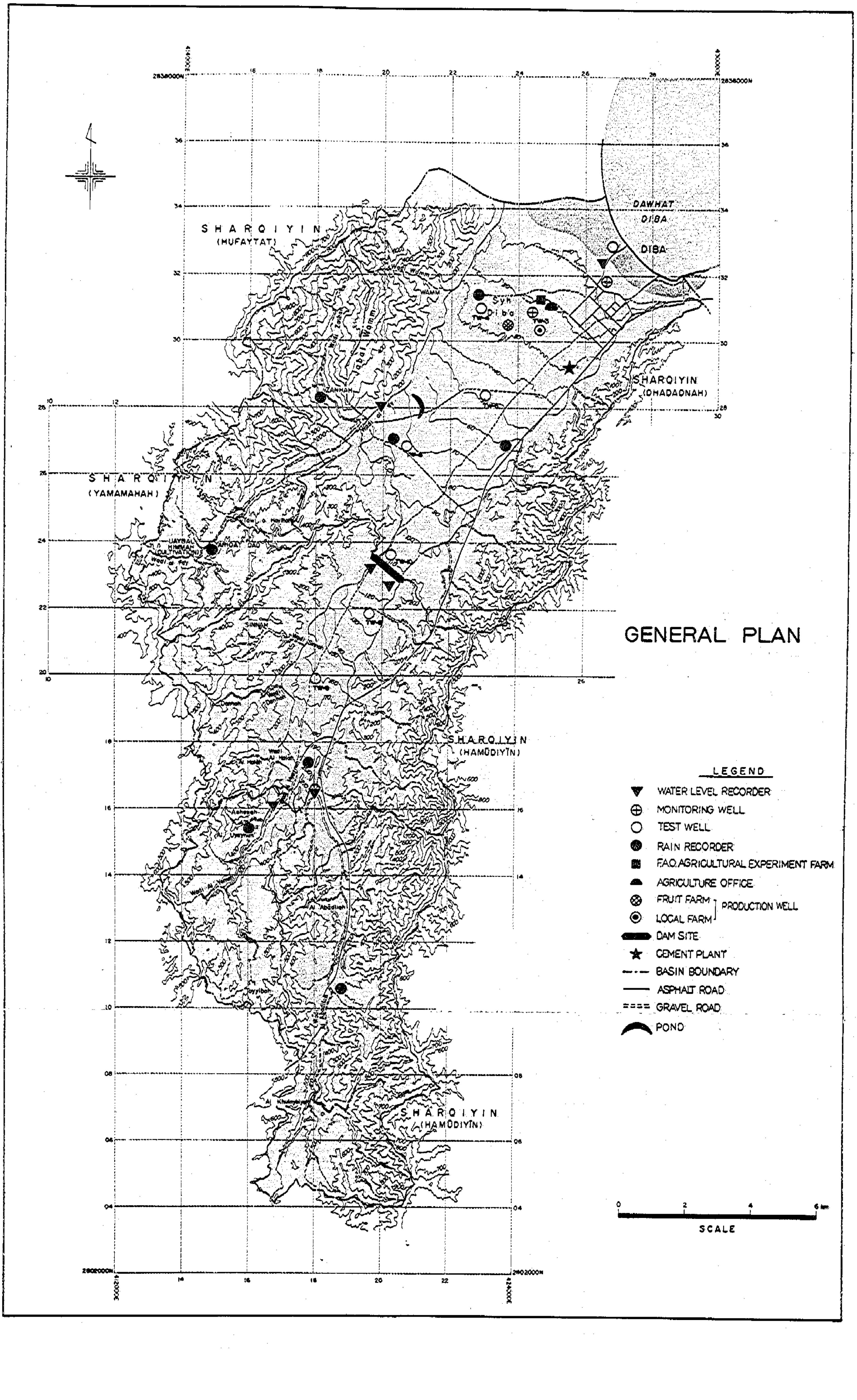
LOCATION OF THE PROJECT






GENERAL PLAN
DAWHAT DIBA
DIBA
SHARQIYIN (HUFAYTAT)
SHARQIYIN (DHADADNAH)
SHARQIYIN (YAMAMAHAH)
SHARQIYIN (HAMŪDIYĪN)
SHARQIYIN (HAMŪDIYĪN)
LEGEND
WATER LEVEL RECORDER
MONITORING WELL
TEST WELL
RAIN RECORDER
F.A.O. AGRICULTURAL EXPERIMENT FARM
AGRICULTURE OFFICE
FRUIT FARM
LOCAL FARM
PRODUCTION WELL
DAM SITE
CEMENT PLANT
BASIN BOUNDARY
ASPHALT ROAD
GRAVEL ROAD
POND
0 2 4 6 km
SCALE
2838000N
2802000N

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1. Outline of the Wadi Al Bassierah Basin Water Resources Development Project

(1) Objectives of the Project

In compliance with a request of the Government of the United Arab Emirates (UAE) made in January 1979 for technical cooperation in a study on water resources development in the country, the Government of Japan dispatched a feasibility study team for the AL Bassierah water resources development to the UAE in December, 1979, through Japan International Cooperation Agency. Since then, the team conducted field works in the UAE and home office works in Japan to work out a development strategy for the Project, and prepared a progress report in December 1980. Furthermore, the team verified supplemental hydrological data and reviewed the development strategy in October, 1981. This report prepared in November, 1981, presents a project development plan formulated, based on the above-mentioned review of the former development strategy, so as to secure industrial and agricultural water in the basin through groundwater recharging and to increase the agricultural production in the basin through intensive use of it.

To materialize the objectives, it is proposed to construct Bassierah dam near the center of the Wadi Al Bassierah basin a and groundwater recharging pond in the lower Al Fay basin, and in this development plan attentions have been paid to the maintenance of groundwater quality.Moreover, the Project aims to reduce water losses through soil improvement and introduction of modernized irrigation facilities. Furthermore, crops with a high productivity and marketability have been selected to be raised. Under the situations, three alternative plans for agricultural development have been formulated, that is, i) 75 ha vegetable farm plan, ii) 65 ha orchard plan and iii) 30 ha vegetable farm and 40 ha orchard plan (totally 70 ha). The existing farm land in the project area is 490 ha.

Therefore, the form lands will total 570 ha approximately after the implementation of Project.

(2) Project Benefits

The project will supply a domestic and industrial water of 0.70 MCM per year to the inhabitants as well as an irrigation water amounting to 3.10 MCM per year to a farm area of 570 ha, totaling 3.80 MCM. As regards the agricultural production, tomato, cucumber, egg plant and cabbage will be grown as winter crops whereas melon will be raised as summer crop. In addition, fruits such as citrus, mango and date palm will be harvested. The vegetable production is expected to reach about 6,590 tons per year in total, amounting to a gross income of DH 20.5 million in monetary terms. The raw water cost in the project is estimated at DH 4.6 per cubic meter which is reasonable in comparison with the fresh water production cost at the sea water desalination plant presently under construction in the UAE which ranges from DH 1.3 to 6.4 per one cubic meter.

(3) Major Works

° Al Bassierah Dam

Location:	The middle stream of the Wadi Al Bassierah main flow about 10 km upstream of Dibba
Dam type:	Fill type dam with sand, gravel and rock
Capacity:	2.5 MCM
Dam height:	19.5 m
Dam length:	900 m
Embankment volume;	0.64 MCM

° Al Fay Pond

Location:	Gravel plain in the lower Wadi Al Fay basin
Type:	Pond (one place with a storage capacity of 1.5 MCM)

° Irrigation Facilities and Farms

New farms:	Plan A:	Vegetable farm of 75 ha
	Plan B:	Orchard of 65 ha
	Plan C:	Vegetable farm of 30 ha and orchard of 40 ha, totalling 70 ha

(4) Project Cost

(Unit: 1,000 DH)

Construction Works	Construction Cost	
° Al Bassierah Dam	19,800	(1,200)
° Al Fay Pond	12,200	(720)
° Irrigation Facilities & Farms	4,800	(290)
° Administrative Expenses	5,500	(330)
° Contingency	5,500	(330)
Total	47,800	(2,870)

Note: Figures with parenthesis are expressed in million Japanese yen.

II. Summary

2-1. Background

Two ways of approach have been employed for water resources development in the UAE, that is, the desalination of sea or brackish water and the utilization of surface runoff and groundwater derived from the annual rainfall of some 100 mm in the eastern mountain area and the gravel plain. The former has been carried out for domestic and industrial use of water in the western coastal area, the growing economic center of this country with a rapid population increase due to the development petro-related industries. The latter, is for domestic water supply for the local people and for irrigation.

The Government of the UAE has been recently making efforts to urbanize and to industrialize the country in parallel with the modernization of agriculture and fishery for which the water resources development is vitally important. In this view, the UAE authorities concerned initiated investigations and studies on the Wadi Bhi and the Wadi Ham projects for water resources development in the region both of which have come to the construction stage of various facilities at present.The Project is also a part of the comprehensive water resources development program in the region.

The cropping area of the UAE increased by 1.7 times for the five years from 1973 to 1978, and reached 21,550 ha in total, that is, 3,000 ha in the central region, 3,700 ha in the eastern region, 7,000 ha in the southern region and 7,800 ha in the northern region. The major crops are of vegetables, fruits and other upland crops. The agricultural production in 1978 was 146,200 tons per annum which were comprised of 49 per cent of vegetables, 32 per cent of fruits and 19 per cent of the other upland crops.

A yield per hectare in the eastern region is as high as 17 tons per hectare as compared with that in the other regions in the UAE

since the region is blessed with the natural conditions such as rainfalls and soil conditions. The vegetable consumption per capita is almost equal to the world average of 220 grams per day. However, the national demand for vegetables exceeds the production, judging from the fact that the markets in Dubai and Abu Dhabi abound with imported vegetables. Thereby, an increase in self-sufficiency rate of vegetables is one of the urgent needs of the nation.

2-2. The Wadi Al Bassierah Basin

(1) Geographical Conditions

Being situated in the north-eastern part of the UAE, the Wadi Al Bassierah of 260 sq.km extends about 30 km in longitudinal direction centering about the main flow of the Wadi Al Bassierah, and about 6 to 10 km in crossing direction of the main flow, shaping a strip with the upper part toward NS and the lower part toward NE. The mountain area around the basin is about 500 m in elevation whereas the gravel plain extending in the middle basin ranges from 20 m to EL 100 m in elevation.

The major road networks in the basin consist of the coastal road of the Oman gulf connecting Dubai and Fujeirah and a link road running through the basin to Masafi through Dibba in the lower basin.

(2) Topography and Geology

In terms of topography and geology, the basin is roughly classified into four parts; the north-western part underlain by limestones, the mountain areas in the upstream part and the south-eastern part consisting of serpentinites and schists and the middle stream plain characterized by gravels and the sandy coastal beach zone. The gravel plain is about 100 m in elevation. The area dips topographically by 1/85 in the upper basin and by 1/105 in the lower basin. The mountain areas have little vegetations whereas the

gravel plain are dotted by acacia bushes of some three meters in tree height.

(3) Wadi System

The main stream of the Wadi Al Bassierah has a flow length of about 30 km in total with two main tributaries of Wadi Uyaynah and Wadi Al Fay in the left catchment area and many other small wadis joining the main stream from the both banks. These wadis, running in the mountain area, form river courses in trace. Along some tributary wadis having a little base flow, some farmers grow date palms and vegetables in a small scale. The wadi system consists of the main stream of the Wadi Al Bassierah and many tributary wadis run through the central gravel plain to the coast of the Oman gulf after joining into the main flow.

(4) General Social Conditions

The lower right basin of the Wadi Al Bassierah of which left bank is a territory of Oman belongs to Sharja and Fujeirah of the UAE. The town of Dibba extends along the coast, and about ten villages are scattered in the middle and upper basins. The population of the basin was some 13,200 persons in September, 1980, of which 3,700 persons (28 %) were resident aliens. The number of households was 1,340 in total, and the population of farmers and fishermen were 1,240 persons, that is, nine per cent of the total population in the same year. The Government of the UAE has been promoting the urban modernization of the Oman gulf coastal area of Fujeirah through scrap-and-build of houses and constructing new houses in the upstream areas to meet the growing population under the housing projects of the Ministry of Public Works and Housing. A cement factory is also presently under construction. In Dibba a public hospital having 45 bed was established in 1969, and has been operated under the supervision of foreign doctors. The major endemic

is malaria. The international telephone communication is available in Dibba by direct dialing.

(5) Water and Agriculture

Groundwater is lifted through three tube wells at a rate of about 1,300 cu.m/day for domestic water supply in urban areas (100 lit/day/capita) whereas domestic water supply to the mountain villages is made by tank lorries.

Electric power is generated by diesel generators and gas turbines provided in Dibba, and supplied to Dibba and its vicinity. Furthermore, a power generation plant and a sea water desalination plant are now under construction around Qadfa so as to secure stabilized power and domestic water supply to Batina coastal area in Fujeirah.

Agriculture in the basin is comprised of 280 ha of farms in the UAE, which consists of 230 ha date palm and 50 ha vegetable farms, and date palm plantations of 210 ha in Oman. A greater part of these farms and plantations is located in the coastal area. The farming is extensively practiced with irrigation water supply from shallow wells or by utilizing wadi waters derived from rainfalls in winter. Presently tomato, cucumber, egg plant, cabbage, etc., are mainly raised. Recently a FAO's experimental farm has been established in the basin for various experiments of cropping by vinyl-covered green houses inclusive of fruit tree growing. It is expected that this farm will greatly contribute to the improvement of farming in the basin inclusive of the project area.

2-3. Development Plans for Water Resources and Agriculture

(1) Basic Strategy

The water resources in the basin depend upon the annual rainfall amounting to 130 mm on an average some of which function to recharge groundwater in the basin wheres the other flows down to the Oman as a surface runoff. The surface runoff is divided into a small quantity of base flows in the upstream Wadi Al Bassierah system and flood that takes place once or twice a year rushing to the Oman gulf. A greater part of the domestic and irrigation water depends on groundwater.

Under the circumstances, a positive development strategy has been formulated to store both the surface runoff and groundwater flowing down to the Oman gulf through the basin for effective utilization of them. Furthermore, it has been planned to provide a monitoring well in the coastal area to preuent the sea water intrusion and to preserve water quality through total control of pumping-up of groundwater in the basin.

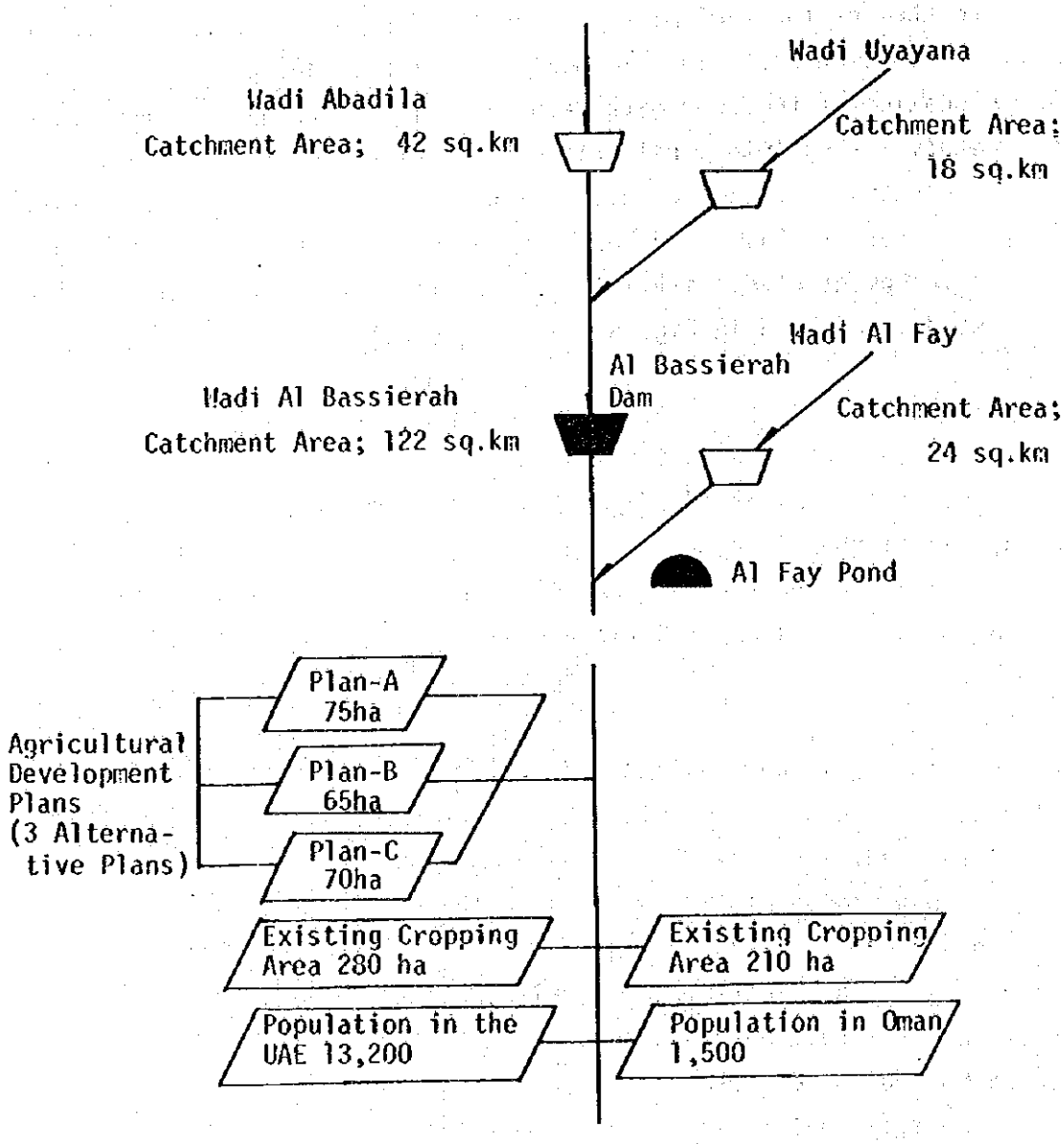
To put it in the concrete, the construction of the dam and the pond has been planned across the main flow of the Wadi Al Bassierah and in the gravel plain on the downstream reaches of the Wadi Al Fay, respectively, so as to temporary storage surface runoff and to recharge groundwater. A water to be newly developed under the Project and the existing water resources available shall be allocated to domestic use for local people, industrial and irrigation uses. The water allocated to irrigation will be utilized for upgrading of agricultural productivity through improvement of the existing facilities and the establishment of a new irrigation system.

(2) Water Resources Development Plan

Along with the above-mentioned development strategy, surface

and groundwater runoff discharges were analyzed based on rainfall and flood data observed during 21 years from 1960 to 1981. Based on the analysis, it has been planned to construct a low dam across the Wadi Al Bassierah main flow and a pond in the gravel plain on the lower reaches of the Wadi Al Fay so as to recharge groundwater through the combination operation of these facilities. The dam site and the location of the pond have been determined through an alternative study taking into consideration the influence of topographic, geological and wadi conditions on the function of these facilities. As a result, Case C'-9 has been selected as the most recommendable development plan. The major comparative items in the alternative study are shown in Fig. S-1 and Table S-1.

Figure S-1 Majar Facilities, Cropping Area and Population



Notes:

Plan A: Vegetable Farm 75 ha

Plan B: Orchard 65 ha

Plan C: Vegetable Farm 30 ha and Orchard 40 ha (total 70 ha)

Table S-1 Alternative Plans of Water Resources Development Plan

Case	Facilities	Direct Construction Cost (MDH)	Rechargeable Groundwater (MCM)	Cost of Low Water (DH/m^3)
C' - 8	BD: 1.5MCM BP: 1.0MCM AP: 1.5MCM	Dam: 15.6 Pond: 12.8 Pond: 12.2 Total: 40.6	0.9	4.5
C' - 9	BD: 2.5MCM AP: 1.5MCM	Dam: 19.8 Pond: 12.2 Total: 32.0	0.9	3.6
C' -10	BD: 2.0MCM AP: 1.5MCM	Dam: 18.2 Pond: 12.2 Total: 30.4	0.8	3.8

Note) Figure S-1 indicates the location of the above-mentioned facilities.

BD: Al Bassierah Dam
BP: Al Bassierah Pond
AP: Al Fay Pond

(3) Water Allocation

Out of a rechargeable groundwater of 0.9 MCM per annuam, a water of 0.1 MCM per annum will be used for industrial purpose, and the remaining 0.8 MCM per annum for agricultural purpose. For agricultural use of groundwater, the following three alternative plans have been formulated;

Plan A: New upland field (vegetable farm) of 75 ha and FAO experimental farm of 5 ha

Plan B: New upland field (orchard) of 65 ha and FAO experimental farm of 5 ha

Plan C: New upland field (vegetable farm of 30 ha and fruit tree plantation of 40 ha) and FAO experimental farm (of 5 ha)

The breakdown of the above-mentioned alternative plans is shown in Table S-2.

Table S-2. Allocation of Rechargeable Groundwater

Description	Use		Alternative Plans Plan A	Plan B	Plan C
Industrial Water	UAE Cement plant		0.10	0.10	0.10
Irrigation Water	Vegetable	75 ha	0.73	-	-
	"	30 ha	-	-	0.30
	Fruit	65 ha	-	0.73	-
	"	40 ha	-	-	0.43
	FAO farm	5 ha	0.07	0.07	0.07
Sub-total			0.80	0.80	0.80
Total			0.90	0.90	0.90

The water use plan in the basin is shown in Table S-3.

Table S-3. Water Use Plan

(Unit: MCM/annum)

Region	Item	Objectives	Area (ha)	Present Use	Proposed Use A	Proposed Use B	Proposed Use C
UAE	Domestic Water			0.48 (MCM)	0.48	0.48	0.48
	Industrial Water	Marble Factory		0.07	0.07	0.07	0.07
		Sub-total (1)		(0.55)	(0.55)	(0.55)	(0.55)
		Cement Factory		-	0.10*	0.10*	0.10*
		Sub-total (2)		-	(0.10)	(0.10)	(0.10)
	Total (1)			((0.55))	((0.65))	((0.65))	((0.65))
	Agricultural Water	Existing Vegetable Farms	50	0.30	0.30	0.30	0.30
		Existing Date Farms	230	1.04	1.04	1.04	1.04
		Sub-total (3)		(1.34)	(1.34)	(1.34)	(1.34)
		FAO Farm	5	-	0.07*	0.07*	0.07*
		Proposed Vegetable Farm	30	-	-	-	0.30*
		"	75	-	0.73*	-	-
		Proposed Orchards	40	-	-	-	0.43*
		"	65	-	-	0.73*	-
		Sub-total (4)			(0.80)	(0.80)	(0.80)*
	Total (2)	(3) + (4)		((1.34))	((2.14))	((2.14))	((2.14))
	Grand Total (I)			[1.89]	[2.79]	[2.79]	[2.79]
OMAN	Domostic Water			0.05	0.05	0.05	0.05
	Agricultural Water	Existing Date Farm	210	0.96	0.96	0.96	0.96
		Sub-total (5)		((1.01))	((1.01))	((1.01))	((1.01))
	Grand Total (II)			[1.01]	[1.01]	[1.01]	[1.01]
	Grand Total (I) + (II)			2.90 (2.9)	3.80 (3.8)	3.80 (3.8)	3.80 (3.8)

[Note] * Allocation of groundwater to be developed under the Project.

The water distribution plan in consideration of the present use of groundwater naturally recharged is shown in Table S-3. However, the water allocation shown in the said table premises the population of 14,700 as of 1980, and the domestic water demand is expected to increase inevitably in parallel with a sharp population growth. Therefore, the demand of domestic water in 1990 (10 years later) and in 2000 (20 years later) was forecast, and a case study on water allocation was made taking into account the demand increase in domestic and industrial water (new cement plant) on one hand and the supply increase by provision of sea water desalination plants. As a result, it has been revealed that the population would be 26,600 persons in the year 2000, and that the water demand would reach 1.94 MCM based on a daily consumption of 200 lit/capita in consideration of an increase in domestic water consumption per capita. The figures suggest that the water demand in the year 2000 would be 3.6 times as much as at present. The details of the case study are shown in Table S-3.

Table S-3. Water Demand Forecast (1980 to 2000)

	Domestic Use	Industrial Use	Irrigation Use			Total
Year	(population)		UAE	Oman	Proposed	(MCM)
1980	14,700					
	(100 lit/day/capita)		280ha	210ha	75ha	
	0.53	0.17	1.34	0.96	0.80	3.80
1990	19,800					
	(150 lit/day/capita)		160ha	210ha	200ha	
	1.10	0.27	1.03	0.96	1.91	5.30
2000	26,600					
	(200 lit/day/capita)		70ha	210ha	300ha	
	1.94	0.35	0.61	0.96	2.86	6.70

Note: (1) A yearly population increase rate of three per cent and a increase in domestic water demand per capita of

50 lit per 10-year period are assumed.

(2) As regards the industrial water, the peak water demand after 20 years at the cement plant presently under construction is estimated at 250,000 tons per annum.

(3) As regards the agricultural lands, it is assumed that the present date palm planting area will decrease to 70 % of the present area after 10 years, and to 30 % after 20 years.

(4) Agricultural Development Plan

It is expected that the proposed agricultural development plan having been formulated based on the agricultural production as of 1980 will increase the present production to the following;

Item	Yield (ton)	Price (DH 1,000) : Plan-A
° Vegetables	4,290	8,237
° Fruit crops	2,300	12,226
Total	6,500	20,463

The proposed agricultural development basically premises the field improvement, land improvement in the gravel plain, upgrading of the existing irrigation facilities and introduction of pipeline system and drip irrigation method for minimizing the water conveyance loss. The proposed crops have been selected in due consideration of the marketability and popularity of crops in the basin such as tomato, cucumber, egg plant and cabbage as winter crops and melon as summer crop.

The future agriculture in the basin will never be free from the critical water utilization conditions currently imposed. Hence, it

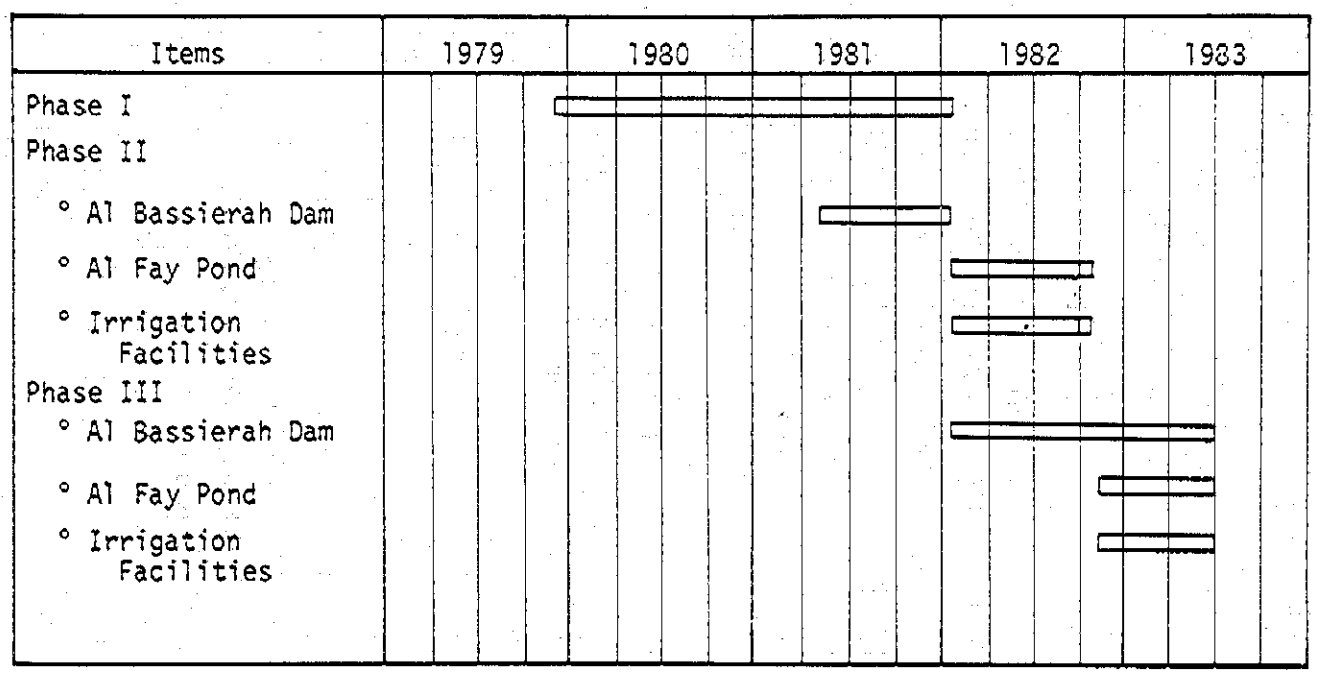
has been planned to covert the water used in the date palm plantations as much as possible to vegetable farms for high productivity. This comes from the fact that the annual water requirements of the date cropping is 900 to 1,300 mm for one cropping per annum whereas the vegetable cropping requires only a half of that, that is, 250 to 500 mm. In other words, the water requirements for the date cropping will permit the vegetable cropping to have two crops per year or to be double in its cropping acreage.

2-4. Project Schedule

An execution schedule of about 3.5 years has been established for the Project inclusive of the feasibility study that started in December, 1979. The Project cost is estimated at DH 47.8 millions in total based on the unit prices in the UAE as of October, 1980, as its breakdown is shown in the above (4) of I.

The entire Project works inclusive of the feasibility study have been scheduled to be completed in three phases, that is, necessary studies and the Project planning in Phase-I of a 25-month period from December, 1979 to January, 1982, the detailed design and preparation of tender documents in Phase-II (the works for Al Bassierah dam from April to November, 1981, and these for Al Fay pond from February to October, 1982) and the construction works in Phase-III (the construction of Al Bassierah dam in a 16-month period from March, 1982, to June, 1983 and that for Al Fay pond and irrigation facilities from November, 1982 to June, 1983.)

Fig. S-2 Project Schedule for Wadi Al Bassierah Basin Water Resources Development Project



III. Recommendations

(1) Al Bassierah dam will be firstly constructed in the implementation schedule of the Project, followed by the construction of Al Fay pond, a facility to further strengthen the recharge of groundwater in the basin. The final design and construction of these facilities will be carried out based on the related descriptions in this feasibility study report for which the relevant topographic maps and the cross sectional and longitudinal drawings are essentially required.

(2) This feasibility study presents a trial allocation of water resources within the basin to domestic water for the population of 14,700 persons and agricultural water to meet the water requirements in existing farms of 50 ha, dates palm plantations and proposed farms. However, the increasing population will naturally result in a greater demand of domestic water as well as perishable vegetables than the present ones. To cope with the increasing demand of water, the desalination of sea water will be inevitably required. As regards the agricultural water use in future, irrigation water presently supplied to the dates palm plantations of 230 ha will be saved as much as possible for the stabilized water supply to the proposed fruit-tree plantations and vegetable farms since the water consumption of vegetables amounting to 250 mm to 500 mm is nearly a half of that of dates palm amounting to 900 mm to 1,300 mm (single cropping a year), that is, if irrigation water presently supplied to dates palm is used for raising vegetables, the double cropping of vegetables a year or cropping of vegetables in an area about two times as large as the present cropping area will become possible. In consideration of the shortage of water that will become more serious in future, pipeline systems should be employed for water conveyance and irrigation to minimize the water conveyance loss. It will be necessary to replace the existing earth canals, which connect the existing pumps and vegetable farms of 50 ha dotted in the lowest basin with pipelines. The existing production wells in the coastal

specially these located in the existing farms should be integrated. Instead of them, integrated production wells should be constructed by three kilometers inland from the coastal line to supply irrigation water to the zone.

(3) The hydrological and hydrogeological data employed in the study are not fully reliable from the statistic point of view. Therefore, it is recommended to continue the hydrological observation at least a 10-year period in future with the observation network established by the JICA study team, and a similar hydrological study to what is indicated in the feasibility study should be conducted to recofirm and verify the quantity of water resources evaluated in this report when the observation data of several years are collected in future. In this aspect, it is desirable to replace the present one-week gauges with long-term automatic gauges of about three months since the present gauges require much labor force for data collection. After the construction of Al Bassierah dam, the discharge data at this dam will be essentially important to judge the effect produced by the dam, and the observation itself will be easily made. Therefore, it is specially recommended to install three-month automatic gauges to observe the storage water level and water levels at the spillway and at the floodway of this dam. To observe the storage water level, a tower of about 16 m high or a pit excavated on one of the abutments will be required.

(4) Concentrated over-pumping of groundwater that exceeds the groundwater recharge has caused the sea water intrusion into the coastal area, and brought about damages on agricultural production. It is necessary to control groundwater in order to prevent water contamination and damages of saline water caused by sea water intrusion and to preserve the groundwater resources. The principles and methods of controlling groundwater can be said in short to keep the groundwater table higher than a certain elevation. For controlling groundwater, the groundwater table at the observation wells No. TW-3 and BH-1 having been installed by the study team

should be observed, and the groundwater lifting at all the production wells should be restricted, if necessary, in order to keep the groundwater table at TW-3 higher than 1.5 m in elevation. The observation well No. TW-3 has been located near to the production well for FAO experimental farm, therefore, it should be removed somewhere free from the interference caused by groundwater lifing through this production well.

(5) In addition to the facilities for recharging groundwater such as dams and ponds that will be constructed in future, many hydrological observation equipment will be required for the comprehensive management of water use in the basin. Therefore, these observation equipment should be always carefully checked and fixed so that they will present highly reliable data. A comprehensive water utilization schedule will be established based on the data summed up every year. The competent authorities of water management consists of the MAF and MEW of the UAE. On the other hand, inhabitants using water administratively belong emirates of Sharja, Fujeirah in the UAE and Oman. Under the situations, it is recommended to establish the water utilization committee, a coordinating organization among administrative units concerned, for comprehensive utilization, operation and management of water resources in the basin.