THE SULTANATE OF OMAN

THE DETAILED DESIGN REPORT
ON

THE WADI JIZZI AGRICULTURAL DEVELOPMENT PROJECT

MAIN REPORT

JUNE 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of The Sultanate of Oman, the Japanese Government decided to conduct a Detailed Design Survey on The Wadi Jizzi Agricultural Development Project and entrusted the survey to the Japan International Cooperation Agency.

J.I.C.A. sent to Oman a survey team headed by Mr. Koichi INOUE three times during a period from March, 1985 to March, 1986.

The team exchanged views with the officials concerned of the Government of Oman and conducted a survey on the implementation of the Project.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

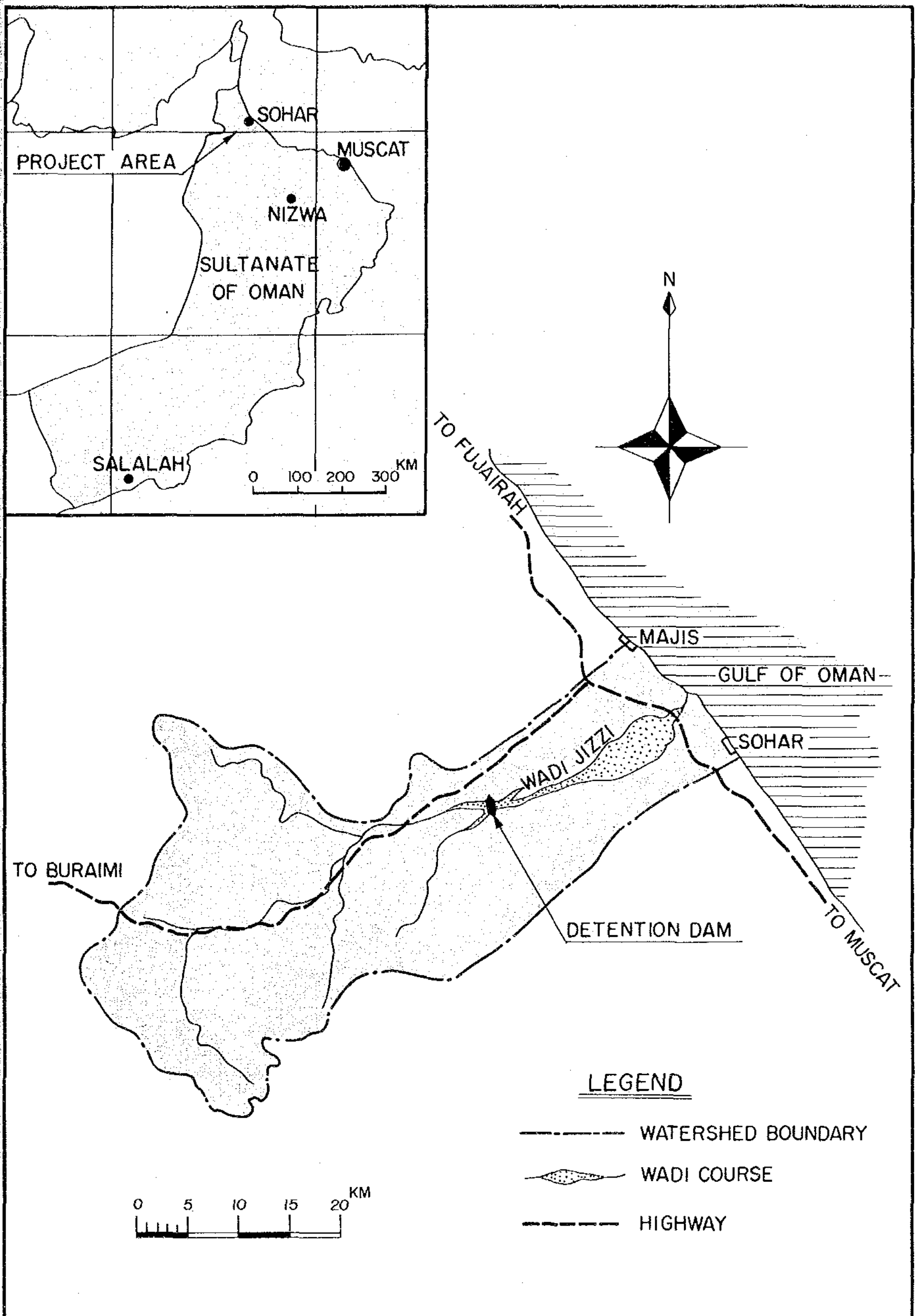
I wish to express my deep appreciation to the officials concerned of the Government of The Sultanate of Oman for their close cooperation extended to the team.

June, 1986

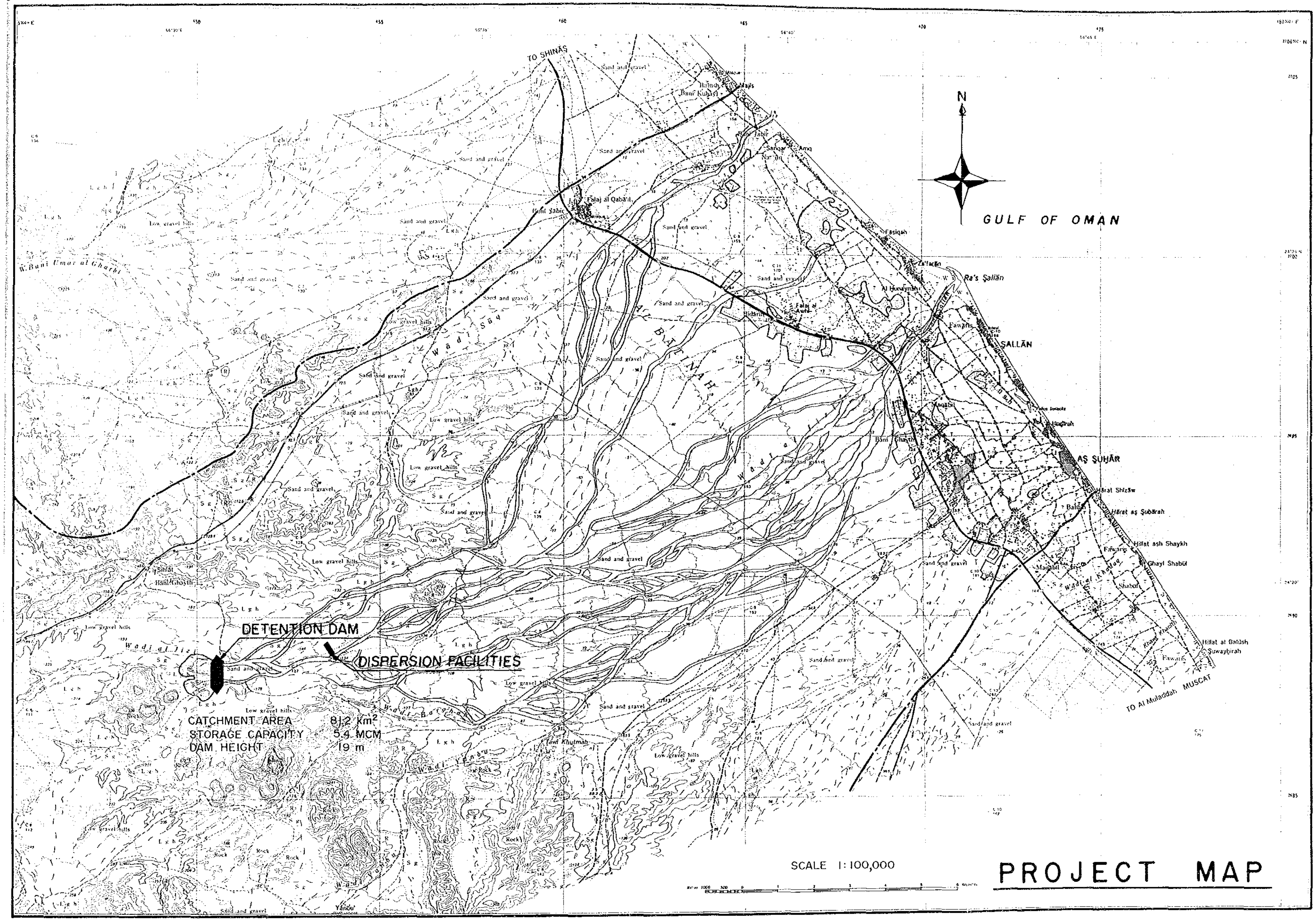
Keisuke ARITA

President

Japan International Cooperation Agency



PROJECT LOCATION



TO SHINAS
GULF OF OMAN
N
Ra's Sallan
SALLAN
AS SUHAR
W. Buni Umar al Gharbi
Wadi Suq
DETENTION DAM
DISPERSION FACILITIES
CATCHMENT AREA 81.2 Km²
STORAGE CAPACITY 5.4 MCM
DAM HEIGHT 19 m
TO Al Muladdah MUSCAT
SCALE 1:100,000

PROJECT MAP

WADI JIZZI AGRICULTURAL DEVELOPMENT PROJECT

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GLOSSARY

MEASUREMENTS

Length

mm	Millimeter
cm	Centimeter
m	Meter
km	Kilometer

Area

sq.cm, cm^2	Square centimeter
sq.m, m^2	Square meter
sq.km, km^2	Square kilometer
ha	Hectare
MSM, 10^6m^2	Million square meter
MCM, 10^6m^3	Million cubic meter

Capacity

l, lit	Liter
cu.m, m^3	Million cubic meter
barrel	31.5 gallon (U.S.), or 36 gallon (U.K.)
gallon	3.785 l (U.S.), or 4.564 l (U.K.)

Weight

g	Gram
Kg	Kilogram
ton, m.t	Metric ton

Others

EL	Elevation above mean sea level
FWL	Full water level
HWL	High water level
mamsl	Meter above mean sea level
mbmsl	Meter below mean sea level
mbgs	Meter below ground surface
sec	Second
min	Minute
hr	Hour
min	Minimum
max	Maximum
°C	Degree Centigrade
°F	Degree Fahrenheit
EC	Electric Conductivity
mho	Reciprocal ohm
mmho	Millimho
µmho	Micromho
mg/lit	Milligram of solid per liter of solution
ppm	Parts per million
%	Percent
FY	Fiscal Year

Conversion

R.O.	Omani Rial, 1 R.O. = 2.924 USD (1985)
	= 1,000 Baiza
U.S.D	U.S. Dollar, 1 USD. = 0.342 R.O. (1985)
Feddan	Omani unit of area measurement = 0.42 ha

ABBREVIATIONS

ADB	Asian Development Bank
FAO	Food and Agricultural Organization
IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
MAF	Ministry of Agriculture and Fisheries
MEW	Ministry of Electricity and Water
MLAM	Ministry of Land Affairs and Municipalities
MPM	Ministry of Petroleum and Minerals
MPW	Ministry of Public Works
PAWR	Public Authority of Water Resources
MC	Ministry of Communication

OMANI TERMINOLOGY

Ain	Spring
Aflaj	Plural from of Falaj
Falaj	Water distribution system under or above ground
Wadi	Dry river valley
Wali	Local Governor of an area
Wilaya	Local Governorate
Wilayat	Plural from of Wilaya

CHAPTER I INTRODUCTION

1.1 Background of the Project

The water resources represent a vital element in the economic development of the Sultanate of Oman. They are relatively limited since the rainfall ranges only from 100 mm to 200 mm per annum in an average. The agriculture in Oman does not rely on direct rainfall, but rather on underground water. For this purpose the Falaj systems were developed some hundred years ago.

Recently, an increasing number of farmers have been using the wells with pumps to meet the local conditions. This tendency has resulted in the over-pumping of water beyond the level of water table permitted.

The rapid development and remarkable improvement in the standard of living in the region have brought about a very substantial increase in water consumption. The shortage in irrigation water is the major constraint in the expansion of agricultural lands. In Batinah coast, the uncontrolled pumping of groundwater from production wells has caused a high salinity of soils and groundwater, and helped lower the fertility of the existing arable lands.

1.2 Objectives of the Project

The agriculture in the Sultanate of Oman is the major source of income for the majority of the population besides oil income. However the agricultural production has been stagnating for recent years mainly because of the insufficient investment in water resources development.

The total cultivation area in the Sultanate of Oman has not changed significantly in recent years. The shortage of irrigation water is the major constraint in the expansion of agricultural lands, moreover, the uncontrolled pumping of groundwater from production wells has caused a high salinity of soils and groundwater.

Under above-mentioned circumstances, the Wadi Jizzi Agricultural Development Project will serve as the initial project, direct aims 1) to increase the agricultural production through the water resources development by constructing the Wadi Jizzi detention dam, indirectly 2) to improve the existing farm lands for suitable production of crops and the living environment of farmers to better circumstance, 3) to stabilize the Wadi Jizzi groundwater for various purposes of irrigation, industry and domestic water supply.

The water resources to be developed in the basin is flood water flowing uselessly into the sea at present. A flood sporadically takes place due to heavy rainfall in a short time. In order to utilize such flood water, a detention dam is planned. The flood water is temporarily retained in the reservoir and released in such a manner as to augment recharge to the groundwater aquifer.

1.3 Background of the Study

For the implementation of the Second Five-Year Plan, the highest priority is accorded to the development of water resources and agriculture, and the Government of the Sultanate of Oman has requested the Government of Japan for technical cooperation in the study of technical matters as well as in the formulation of plans required for the implementation of the Project in February 1980.

The Government of Japan, in response to the request of the Government of the Sultanate of Oman, has subsequently dispatched study teams through JICA twice to the Sultanate of Oman, once during March-May 1981 for about two months and another during November 1981-March 1982 for feasibility study of the Project. The team has carried out relevant studies and presented feasibility study report to the Government of the Sultanate of Oman.

The Government of the Sultanate of Oman has also requested the Government of Japan for cooperation in implementation of the Project.

and the Government of Japan has accepted the request and decided to conduct the detailed design survey (hereinafter refer to as "the Survey") accordingly.

JICA, in accordance with the decision, has dispatched a preliminary survey team in July 1984 to the Sultanate of Oman for discussion on implementation of the Survey. A plan on implementation in terms of Record of Discussion (R/D) has duly been agreed by both parties in December 1984, and the commencement of the Survey has therein been set-up in March 1985. The objectives of the Survey were:

1) to review the Feasibility Study;
2) to prepare the detailed design and tender documents; and,
3) to undertake on-the-job training of the Omani counterpart personnel in the course of the Survey.

1.4 Project Description

(1) Project Area

The Wadi Jizzi baisn, the Project area to be studied for water resources development in this plan, is located in the north Batinah region, forming one of the large alluvial fan near Sohar with the catchment area of about 1,300 sq.km. Sohar is one of eleven Wilayats in the Batinah region, and Sohar town lies on the Batinah coast of northern Oman, some 220 km north-west of the Muscat capital area.

The Project area, located in the downstream Wadi Jizzi basin, has a rectangular shape of about 3,830 ha, lying between the coastal line and the inland line of about 17 km long that runs in parallel with the coastal line and connects Majis with Wadi Khadag. The distance between the two lines is about 9.5 km.

(2) Climate

The Project area is situated in the arid zone. There are two distinct seasons in a year, i.e. the winter (November to March) and the summer (May to September). April and October are transitional period between the two seasons. A greater part of the annual rain falls in the winter.

The annual rainfall varies remarkably from season to season and from year to year amounting to 102 mm as an average in the past 11 years at Sohar. The annual mean temperature observed at Sohar is 25.7°C, July is the hottest month with a mean average of 32.6°C and January the coldest with that of 18.2°C.

(3) Geology

The Wadi Jizzi basin is geologically composed of the Hawasina group of the sedimentary rocks, the metamorphic rocks, the Semail ophiolite of the igneous rocks, and the quaternary deposits.

Geology of the dam site consists of recent river deposits, middle terrace deposits, upper terrace deposits and bed rocks. The surface terrace deposit is weathered and weakly cemented, so that the deposit shows high permeability at the abutment.

(4) Water Resource

A part of the rainfall concentrates through river channels as surface runoff or infiltrates into deep soil, and flows down by gravity to reach stream channel forming a base flow. A greater part of rain water is lost through evapo-transpiration. Among many complicated factors affecting volume and duration of direct surface runoff and base flow, hourly rainfall and hydrograph are available only since 1981.

The water resources available in the basin are classified into the surface water and the groundwater. A flood discharge which is the surface water, mostly takes place in winter from November to March. It runs down the Wadi course to the sea in a short time, and its effective use is difficult at present. On the other hand, the groundwater in the basin is the major water source for irrigation, domestic and industrial water use. The annual consumption of the groundwater in the basin was estimated at 11.23 MCM comprising 11.03 MCM for irrigation, and 0.2 MCM for domestic use.

The Wadi Jizzi basin is composed of the impervious formations, terrace deposits, and alluvial deposits. The alluvial deposits are mainly developed in the coastal strip, forming an excellent unconfirmed aquifer thicker than 100 m and about eight(8) kilometers wide.

(5) Agricultural Condition

Presently, the Project area of 3,830 ha is roughly divided into 2,340 ha of orchards, 495 ha of upland fields and 995 ha of non-farm lands.

Almost the entire cropping in the Sohar area is from groundwater through wells. Dates are the major crop in the Project area, and other tree-crops such as lime, banana, mango, etc are also grown. The major upland crops are vegetables and fodder crops. The livestock breeding in Wilaya Sohar is ranked high in this country.

Irrigation in the Project area depends on the groundwater pumped up though wells. The prevailing irrigation methods are classified into basin irrigation, border-strip irrigation and furrow irrigation. Over draft of the groundwater in the coastal plain for various purposes has recently caused sea water intrusion into the aquifers in the coastal strip. Some existing cultivation areas have suffered from salinity in irrigation water. Under the circumstances, the water resources development through groundwater recharging is a vital and urgent requirement in the Wadi Jizzi basin.

(6) Project Component

The Project directly aims at 1) water resources development through groundwater recharging and indirectly at 2) improvement of agricultural production in the existing land and of living environment through flood control and prevention of sea water intrusion into the coastal strip and 3) stabilization of groundwater production for the domestic and industrial water use.

The Project components consist of 1) water resources development in the Wadi Jizzi basin through the construction of a flood detention dam for groundwater recharging and 2) establishment of monitoring system which survey the discharge of Wadi Jizzi and the variation of groundwater level.

(7) Annual Regulated Flood Volume

One or two floods occur in a year following very heavy rains. These floods rush down the Wadi in a short time and presently only a limited volume of flood water seeps into the aquifer. In order to use effectively its flood discharge as the water resources, annually regulated flood value of 6.63 MCM was adopted. In this case, the maximum volume of single flood to be regulated (max. dam capacity) is estimated at 5.4 MCM.

(8) Water Resources Development Plan

The groundwater recharge plan with the detention dam and dispersion facilities was recommended. The potential groundwater recharge capacity of the gravel plain was estimated at 13 cu.m/sec based on its actual measurement in flooding time.

Flood discharge presently flowing uselessly into the sea could be converted into the exploitable water resources for the Project. The water volume to be recharged was estimated at 3.47 MCM per annum based on the water balance computation. The groundwater would be effectively recharged if the reservoir water is released in proportion to the recharging capacity of the downstream gravel plain.

Allocation of the above-mentioned groundwater to be recharged in the Project would be as follows:

. Groundwater to be recharged;	3.47 MCM
. Groundwater to be used	
Supplemental water to cover the shortage of the present water balance;	1.02 MCM
Domestic and industrial water;	1.06 MCM
Use for farmer's lands distributed from 1983 up to date;	1.39 MCM
Total	3.47 MCM

(9) Proposed Facilities

The facilities to be constructed under the Project consist of the detention dam and dispersion facilities.

The major features of the detention dam and dispersion facilities are summarized below;

Detention Dam

. Catchment Area; 812 sq.km

. Mean Annual Inflow;	6.63 MCM
. Detention capacity;	5.40 MCM
. Specific sediment volume;	53 cu.m/sq.km/year
. Full water surface;	EL 163.90 m
. Reservoir water surface area as full water level:	1.25 MSM
. Design flood discharge for service spillway	4,700 cu.m/sec
. Max. probable flood discharge;	7,800 "
. Flood discharge for emergency spillway;	3,100 "
. Water level at design flood discharge;	EL 169.20 m
. Max. rate of released flow:	13 cu.m/sec

Dam Body

. Dam crest elevation	EL 170.0 m
. Lowest elevation of foundation	EL 149.6 m
. Max. height of dam	20.4 m
. Length of dam	1,234.0 m (including spillway crest length of 462.4 m)
. Volume of dam	600,000 cu.m
. Dam type	Zone type fill dam

Spillway

. Service spillway type	non-control open type spillway
. Crest elevation	EL 163.90 m
. Crest length	184.2 m
. Crest height	2.0 m
. Emergency spillway type	non-control open type spillway
. Crest elevation	EL 165.70 m
. Crest length	278.2 m
. Crest height	1.8 m

Conduit

Type (for Service)	Non control steel pipe Diameter 1500 mm)
Length	114.0 m
Released discharge (Max.)	13 cu.m/sec
Type (for Emergency)	Steel pipe with gate control (D=1500 mm)
Length	66.0 m
Released discharge (Max.)	10.19 cu.m/sec

Dispersion Facilities

Location	3.3 km downstream of the detention dam
. Type	Gabion dike
. Height	3.7 m
. Length	243 m
. Connection channel	Open type; non-lining canal
. Bottom width	12.5 m
. Length	469 m
. Max. depth	1.59 m
. Side slope	1 : 2.0

Monitoring Facilities

. Automatic water level gauge	1 gauge (in the reservoir area)
. Observation well (with automatic gauges)	5 wells (at the downstream of the dispersion facility for 4

wells and upstream
of dam for 1
well.)

3 wells 70 m deep, diameter 100 mm
1 well 40 m " "
1 well 20 m " "

(10) Monitoring System

Parallel with the implementation of the Project, a monitoring system of the surface water, groundwater and environmental pollution shall be incorporated for the control of groundwater and the appreciate maintenance of the Project facilities. The maintenance will be managed under the responsibility of MAF.

In order to find out the hydrological equilibrium of the catchment area, the following facilities shall be installed for the study of the surface water hydrology.

° Self-recording water level gauges shall be installed in the reservoir in order to measure and analyse the direct inflow into the reservoir, overflows from the spillways and discharges of the outlet conduits.

° In addition to the above, it is desirable that the existing rain gauges and the wadi water level gauges be controlled directly by the said center.

Purposes of the monitoring system for groundwater are 1) evaluation of the effect of groundwater recharging, 2) control of the groundwater quality of each production well. The content of work items for the accomplishment of these purposes shall be as follows:

- Evaluations of the effect of groundwater recharging:

  To analyse the hydrograph data obtained by observations of the groundwater tables of the newly constructed observation wells and the existing production wells, and to evaluate the effect of the groundwater recharging brought in by the Project.
  To control the pump-up volume of the groundwater, if necessary.

- Control of the groundwater quality of each production well;
  To prevent the sea water intrusion into the groundwater layer, and to prevent chemical pollution of the groundwater by the copper mine.

(11) Project Implementation

The Director General of W.R.I who is fully responsible for overall planning, programming and execution of the major water resources and irrigation projects in the Sultanate of Oman will be the executing agency of the Project. Assistances and cooperations of the other governmental agencies will be provided to this executing agency during the implementation period of the Project.

The implementation period of three (3) years from June 1986 to August 1988 is proposed inclusive of about 8 months of tendering and contract period, and the construction period is 17 months.

Concerning the selection of a contractor, the tendering shall be conducted in two stages, i.e., first by prequalification of applicants, and thereafter by limited competitive tendering among the prequalified applicants. The successful tender will be awarded the construction contract.

(12) Cost Estimate

The total Project cost, inclusive of the compensation, consulting services and contingencies was estimated at 8.1 million R.O. or US$ 22.8 million based on the unit prices as of June, 1985. The breakdown of the Project cost is as follows:

Items	Cost (R.O.)
Civil Works	7,050,058
Compensation	15,000
Consulting Services	326,000
Subtotal	7,391,058
Contingency	705,942
Total	8,097,000

(13) Project Evaluation

The direct and indirect benefits could be expected from the Project after its completion. The measurable direct benefits will be derived from the incremental agricultural production, the prevention of flood damages, the protection of dates from salt damage, and the domestic and industrial water supply to Sohar and to the copper mining industry.

The economic internal rate of return (EIRR) is computed at 12.2 percent.

Besides the direct benefits, the Project would create the indirect benefits, and give the socio-economic impacts on the farm economy as well as the regional and national economy.

from acidic water, heavy metals contained in acidic water, alkaline water, various minerals in tailings, salt, and gas and fume in smoke.

The prevention of environmental pollution should be made through 1) chemical and physical treatment of exhaust water and smoke and 2) organizational arrangement for monitoring the treatment methods and consequent effect.

1.5 Personnel Assigned to the Project

Followings are the Supervisory Group Members, Team Members and Counterparts personnel assigned to the Project.

(1) Supervisory Group

1. Chief Advisor (Mr. Shiro HIRATA)	Director, Project Planning, Department, Kanto Regional Adminitrative Office, Ministry of Agriculture, Forestry and Fisheries (M.A.F.F.)
2. Advisor (Mr. Kuniaki ANMA)	Middle East Division Loan Department II The Export-Import Bank of Japan
3. Advisor (Mr. Kenjiro NAKAJIMA)	Chief, Study of No. 2 -- Construction Engineering, Department of Construction Engineer National Research Institute of Agricultural Engineering, M.A.F.F.
4. Advisor (Mr. Shin TAMURA)	Director, Land Development Division, Construction Department,

Tohoku Regional Administrative Office, M.A.F.F.

(2) Team Member

1.	Mr. Koichi INOUE	Team Leader
2.	Mr. Yasuhiro AMATSUJI	Meteorology and Hydrology
3.	Mr. Yoshiaki KIMURA	Flood Analysis
4.	Mr. Hidemasa ENDO	Groundwater
5.	Mr. Haruhiko NAKAMURA	Geology
6.	Mr. Tsuneyoshi KIMURA	Construction Materials
7.	Mr. Hironori TAKAHASHI	Dam Design (A)
8.	Mr. Tetsuro HORI	Dam Design (B)
9.	Mr. Toshio KAMIYA	Construction Planning & Cost Estimation
10.	Mr. Kensaku IRIYA	Project Evaluation
11.	Mr. Koki MITSUNOBU	Specifications
12.	Mr. Kazuki MUTA	Tender Document
13.	Mr. Toshiro URABE	Survey (A)
14.	Mr. Tsutomu KURIBAYASHI	Survey (B)

(3) Counterpart Personnel

1.	Mr. Zakariya Yahya Al Riyawi	Director of Water Resources and Irrigation, Ministry of Agriculture and Fisheries (MAF)
2.	Mr. Majid Bilarab Al-Batashi	Chief of Technical Assistant W.R.I., MAF
3.	Mr. Rifat Aboul Magd	Hydrologist, W.R.I., M.A.F.
4.	Mr. Abdel Salam Morsi	Hydrologist, W.R.I., M.A.F.

CHAPTER II HYDROLOGY AND AGRICULTURE

2.1 Surface Water Hydrology

2.1.1 River Basin

The Wadi Jizzi river, originating from Al-Garbi Mountains and joining a number of affluents; traverses the North Batinah region extending to a length of about 75 km from west to east and stretching over the catchment area of about 1,300 sq.km within a range from latitudes 24°03' to 24°27' N and from longitudes 56°06' to 45°45' E, and empties into the Gulf of Oman at the point near Sohar.

From topographic point of view the catchment area is divided into two zones; namely hilly area and alluvial coastal plain area. The hilly area extends from the southwest to the ranges of mountain with an elevation up to 800 m above mean sea level, and from the northwest and southeast to the divide of mountains with an elevation ranging from 1,400 m to 1,600 m. The alluvial plain area stretches along the lower reaches of the river as well as along the Batinah coast. The slope of the Wadi is surveyed considerably steep having average bed slopes of 1/100 and 1/150 in the upper and lower stream reaches, respectively.

2.1.2 Meteorology

Being located in the arid homoclimatic zone, the Project area is under severe climate conditions. There are two distinct seasons in a year; the winter season and the summer season.

The winter season, from November to March, is characterized by series of tropical depressions which bring heavy rainfalls in the catchment of rivers causing occasional high flood in them. April is transitional period between the winter and summer. The months, May to September, are characterized by extreme continentality with hot and dry climates. In April weather becomes progressively warmer and drier. May and June are usually the hottest and driest with the maximum temperatures rising up to 45°C, and relative humidity during these two months falls below 60% as a daily average.

October is also the transitional period with weather becoming increasingly cool. November and December become again cold with occasional rainfalls.

The annual rainfall ranges remarkably from season to season and from year to year amounting to 102 mm as an average in the past 11 years at Sohar, of which about 97% concentrates during the winter season and transitional period from October to April. In other words, the summer season from May to September receives only 3% of annual rainfall. The daily mean temperature varies from 32.6°C in July to 18.2°C in January with an annual average of 25.7°C at Sohar. Major climatic elements, in terms of monthly averages observed at Sohar, are summarized as shown in Table 2-1.

2.1.3 Hydro-meteorological Observations

The perennial flow in the river are observed in the upper reaches and tributaries where river deposits are shallow and hard rock material reaches as far as the river bed. Several floods a year are usually caused by storms not only making the plain area in a state of emergency but also wasting a considerable amount of surface water into the sea.

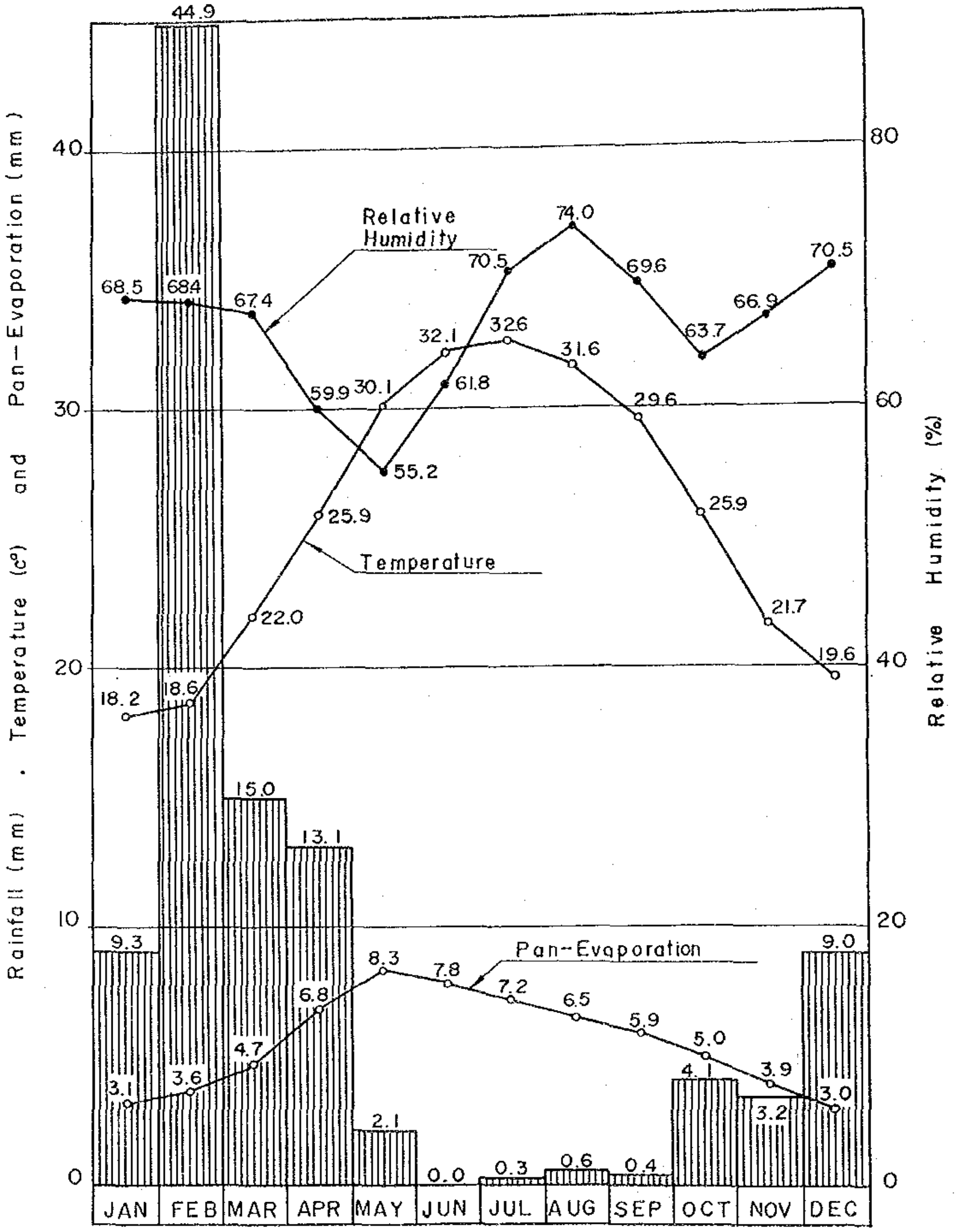
The surface water discharge of the Wadi Jizzi has been observed monthly by the Department of Water Resources and Irrigation at the point of Mulayyinah since 1977. Automatic level gauges have been operated by the government since 1977, however, some records unavailable for the study were included in the data obtained from the gauges. In 1982, during the course of feasibility study for the project, four automatic Wadi gauges were installed on the river at S-1, S-2, S-3 and S-4. Mulayyinah was selected as the most suitable site for flood discharge measurement. Gauges No. 1 (S-1) and No. 2 (S-2) were so installed as to

Table 2-1 Major Climatic Elements at Sohar

Major Climatic Elements at Sohar

Climatic Element	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct	Nov.	Dec.	Annual
Rainfall (mm: 1974 - 1984)													
	9.3	44.9	15.0	13.1	2.1	0.0	0.3	0.6	0.4	4.1	3.2	9.0	102.0
Temperature (°C: 1973 - 1984)													
Maximum	24.4	24.5	28.2	33.4	38.0	38.8	37.6	36.4	35.6	33.7	29.4	26.0	32.2
Minimum	11.9	12.6	15.7	18.4	22.2	25.4	27.6	26.7	23.5	18.1	14.0	13.2	19.1
Mean	18.2	18.6	22.0	25.9	30.1	32.1	32.6	31.6	29.6	25.9	21.7	19.6	25.7
Relative Humidity (%: 1973 - 1984)													
Maximum	95.4	94.8	94.3	92.5	88.3	93.5	95.6	96.7	96.1	95.1	95.8	96.7	94.6
Minimum	41.6	41.9	40.5	27.2	22.0	30.0	45.4	51.2	43.1	32.2	37.9	44.3	38.1
Mean	68.5	68.4	67.4	59.9	55.2	61.8	70.5	74.0	69.6	63.7	66.9	70.5	66.4
Pan-Evaporation (mm/day: 1976 - 1984)													
	3.1	3.6	4.7	6.8	8.3	7.8	7.2	6.5	5.9	5.0	3.9	3.0	5.5
Sunshine Hours (hrs/day: 1973 - 1979)													
	7.2	7.7	8.1	8.7	10.3	9.9	8.7	8.5	9.3	9.1	8.4	7.6	8.6
Wind Velocity (Km/day: 1973 - 1984)													
	56.4	61.0	67.2	70.3	73.3	75.2	85.3	84.9	71.0	58.6	49.6	46.3	66.6

FIGURE 2-1 SEASONAL VARIATION OF RAINFALL, TEMPERATURE, RELATIVE HUMIDITY AND PAN-EVAPORATION



obtain highly accurate flood hydrograph, while the gauges of No. 3 (S-3) and No. 4 (S-4) were installed nearby and at the river mouth to measure amount of water wasted into the sea.

However the gauges No. 1 and No. 2 were badly damaged immediately after installation by the flood occurred in February 1982, and No. 4 gauge has not been functioning. To cope with such damages, two gauging stations were newly established during the first phase of the Survey at the bridge approximately 300 m upstream from the damaged No. 1 gauge and at a distance about 500 m downstream from the proposed damsite, whereas the No. 4 station was equipped with a new recording gauge.

In the Wadi Jizzi basin, there exist five rain gauge stations in the mountain area and daily records of rainfall are available since 1974. Five automatic rain gauges were also installed during the course of feasibility study at Daqiz, Kitnah, Hayl (Wadi Jizzi), Hayl (Wadi Hayl and Farfar. Among these, three recording gauges, such as Daqiq, Kitnah and Hayl (Wadi Hayl), have not been functioning and therefore those gauges were replaced by new automatic ones during the period of field survey for detailed design works.

Areal rainfalls have been calculated by using Thiessen Polygon Method. The amount of annual rain is as below;

Areal Rainfall

Basin and Area	Catchment (sq.km)	Area Rain (mm/yr)
1. Dam Site (Above Dam)	812	128
2. Residual (Below Dam)	471	110
3. River Mouth (Entire Basin)	1,283	121
4. At Sohar	-	102

Regarding sediment load of wadis, neither record of observation nor experimental values are available in the Sultanate of Oman. According to the FAO Field Document No. 7: "Runoff Measurement in Oman" by P.M. Horn and J.B. Nielson, small flood flow of less than 5 cu.m/sec remains remarkable clear. The larger flood causes muddy river water but subsides rapidly. These characteristics have also observed in the Wadi Jizzi on the occasion of the flood occurred in February, 1982. In qualitative and quantitative terms, it would be considered that silt transported to the Wadi Jizzi is not quite different from that in the most flash rivers in the arid homoclimate zone. As is employed in the Wadi Al-Khawd Aquifer Recharge Project, measured sediment deposits in arid states of the USA were used to estimate conditions for the Wadi Jizzi area. Use of data from Piute Reservoir in Utah, McMillan Reservoir and Elephant Butte Reservoir in New Mexico, Lake Mead in Nevada and Ericson Reservoir in Nebraska result in a preliminary prediction of 53 cubic meter per year of sediment for each square kilometer of drainage area[1/].

Thus an estimated average sediment load of approximately 43,000 cubic meters per year could be expected at the proposed dam site. Since the sediment deposits are to be removed annually, this preliminary figure would be revised depending on the actual quantity of sediment deposit after the completion of the dam.

2.1.4 Surface Water Hydrology

A part of rainfall concentrates to river channels as surface runoff or infiltrates into deep soils and flows down by gravity to reach stream channels forming a base flow. A greater part of rain water is lost through evapo-transpiration. Among many complicated factors affecting volume and duration of direct surface runoff (hereinafter referred to as "flood") and base flow, hourly rainfall and hydrograph are available since 1981. During the feasibility study period, hourly rainfall distribution and hydrograph at Mulayyinah and the river-mouth were recorded for three days from February 14, 1982. The

---

1/ Feasibility Report, the Wadi Al-Khawd Aquifer Recharge Project multiple regression method was applied to analyze the relationship between the rainfall and runoff. To formulate the Project, hydrological analyses were reviewed and updated on the basis of rainfall - runoff data that subsequently became availabe after completion of the feasibility study report, and concluded accumulating every aspect of hydrology inclusive of probable maximum rainfall analysis, flood runoff estimates, peak discharge analysis and base flow estimates.

1) Base Flow

The surface water discharge has been measured by current-meters since 1977 at Mulayyinah with a catchment area of 654 sq.km. The observed discharge records and the estimated base flow discharge are presented in Figure 2-3. The average base flow discharge is 85 lit/sec, which corresponds to 0.13 lit/sec/sq.km.

In order to grasp the total potential base flow discharge, the water used for the Falaj irrigation by the villages in the catchment area must be taken into consideration. The irrigated areas and the estimated Falaj discharge are provided in Table B-1, Appendix B-1. The average Falaj discharge in the catchment area is estimated at 78 lit/sec, which corresponds to 0.12 lit/sec/sq.km. The total potential base flow discharge, therefore, is 0.25 lit/sec/sq.km. The average specific base flow discharge per annum is 7.9 mm in depth. The ratio of the baseflow discharge to the average annual rainfall was calculated at 6.2 percent.

2) Flood Volume

During the course of the feasibility study, multiple regression method was employed to estimate the flood run-off at both proposed dam site and river mouth. A real rainfall and hydrograph obtained from the flood occurred on February 14, 1982 were mainly used to analyze the relationship between flood volume and amount of single event consecutive rainfall. Such a relation established at Mulayyinah was directly applied to estimate the probable flood amount which would pass through the river channel at the point of the proposed dam.

After the completion of the feasibility study report, several flood hydrographs have been observed at the No. 3 gauge (by Coast Road) as well as at No. 4 gauge (River Mouth) as under;

Additional Flood Observation at River-Mouth

Date	Areal Rainfall (mm)	Square Measure of Hydrograph No. 3 1/	Square Measure of Hydrograph No. 4/	Flood Volume at No. 4 (4.03) 4/6/
Feb. 14, 1982	89.7	119.59	89.70	3.14 5/
Feb. 27, 1982	49.3	253.30	87.15 3/	(3.92) 3.06
Mar. 13, 1982	15.1	208.34	71.68 3/	(3.22) 2.51
Mar. 30, 1982	20.6	189.96	13.71	(0.62) 0.48
Feb. 14, 1983	46.6	129.46	44.54 3/	(2.00) 1.56

Notes: 1/ No. 3 Gauge at Coast Road

2/ No. 4 Gauge at River-Mouth

3/ Interpolated as follows;

87.15 = 253.30 x C

71.68 = 208.34 x C

44.54 = 129.46 x C

where C = (89.70 + 13.71)/(119.59 + 189.96)

4/ Flood volume in MCM

5/ Flood volume in mm

6/ See Figure 2-7

The rainfall-flood runoff relation at the river-mouth was thus revised in consideration of additionally available data as above and shown in Figure 2-5. Areal rainfalls obtained for basins in and after 1982 were added to update estimates of average annual flood volume. As a consequence of the computations, 6.63 MCM and 3.47 MCM at the dam site and river mouth respectively were calculated. Accordingly the average specific flood runoff per annum is 8.2 mm in depth at the proposed dam site, and it means that the average ratio of surface runoff to annual rainfall is 6.4 percent. Consequently the average ratio of total runoff for annual rainfall is calculated at 12.6 percent.

The frequency of single flood volume derived from the multiple regression analysis is shown in Figure 2-6.

3) Flood Peak Discharge

A flood hydrograph has been observed by JICA study team during the second phase field investigation (Nov. 6, 1981-Mar. 31, 1982) at the point of Mulayyinah (S-1) situated about 500 m upstream from the point S-2. Figure 2-7 presents the observed data of rainfalls and discharges which are computed by use of Manning's formula on the basis of measured river stages and cross-section. Under the assumption that n = 0.038, which is commonly adopted in PAWR's estimates, the peak flood discharge has been estimated at 770 cu.m/sec. The following are reviewed from observations:

- No precedential rain has been observed in the drainage basin before 13th February, 1982. Accordingly, rains during Feb. 13 and up to 5 a.m of Feb. 14, 1982 are considered to be initial losses of rains, which are consumed to saturate surface layers of the drainage basin.

- After soil layers have been saturated with rain water, sudden floodings, characterized by a rapid rise, sharp peak and rapid recession, have been observed. Two peaks of the flood are likely

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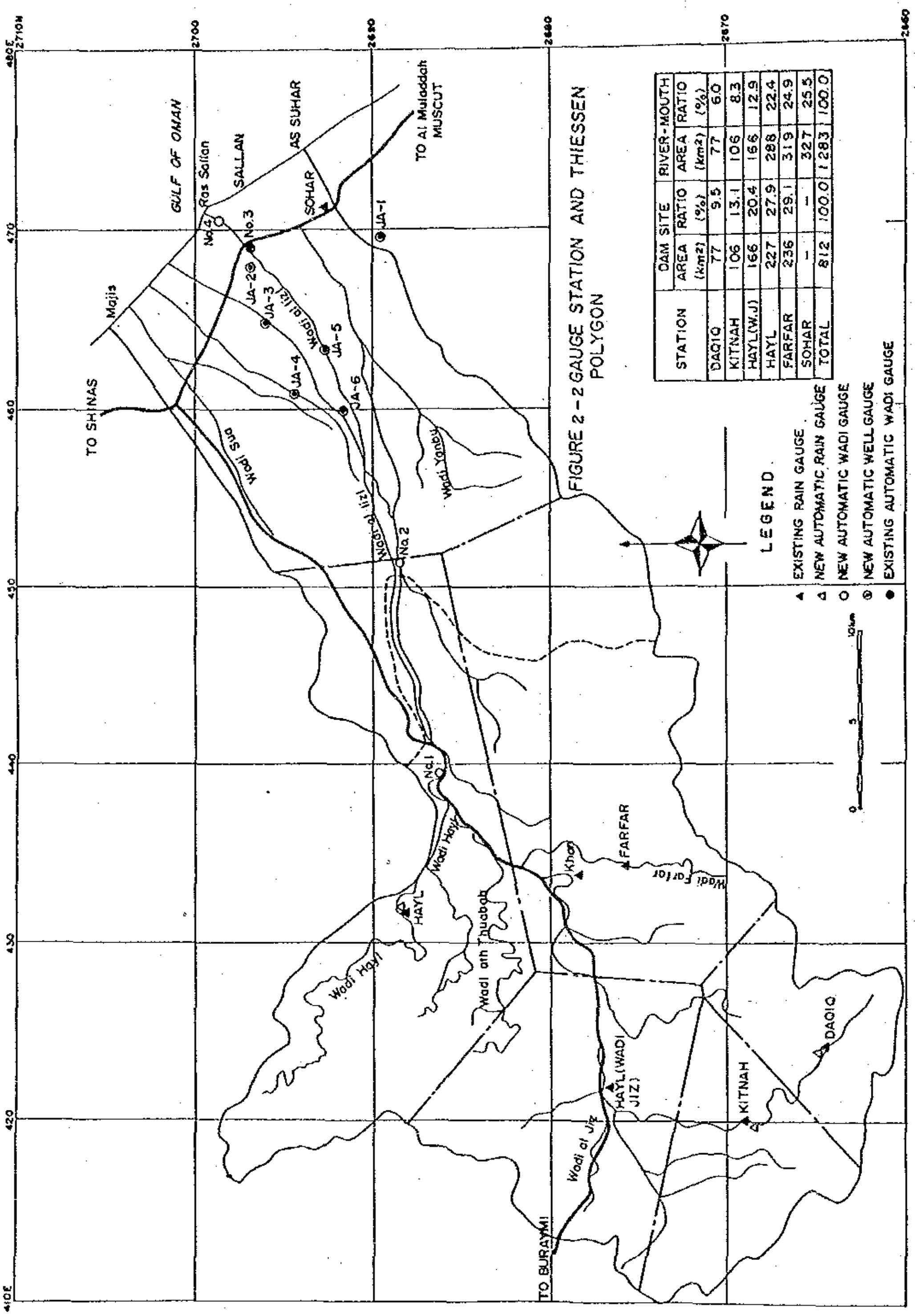
Table 2-3 Flood Runoff at River-Mouth

(Catchment = 1,283 sq.Km)

(Unit: MCM)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1974		1.76	-	-	-	-	-	-	-	-	-	-	1.76
		(0.05)											
		(2.04)											
1975	-	2.09	-	-	-	-	-	-	-	-	-	-	2.09
		(3.05)	(0.33)										
		(2.93)	(4.20)										
1976	0.51	5.98	4.53	1.87	-	-	-	-	-	-	-	-	12.89
1977	0.90	0.83	-	1.71	1.06	-	-	-	-	-	-	-	4.50
1978	-	1.45	-	-	-	-	-	-	-	-	-	-	1.45
1979	0.15	-	-	-	-	-	-	-	-	-	-	0.49	0.64
1980	-	-	0.31	-	-	-	-	-	-	-	-	-	0.31
1981	-	-	0.32	-	-	-	-	-	-	-	-	-	0.32
		(4.03)	(0.28)										
		(2.16)	(0.60)										
1982	-	6.18	0.89	-	-	-	-	-	-	-	-	-	7.07
				0.13									
				0.38									
1983	-	2.00	0.46	(0.51)	-	-	-	0.68	-	-	-	-	3.66
Total													34.69
Mean													3.47

FIGURE 2-2 HYDROLOGICAL MAP



STATION	DAM SITE		RIVER-MOUTH	
	AREA (km2)	RATIO (%)	AREA (km2)	RATIO (%)
DAQIQ	77	9.5	77	6.0
KITNAH	106	13.1	106	8.3
HAYL(W.J)	166	20.4	166	12.9
HAYL	227	27.9	288	22.4
FARFAR	236	29.1	319	24.9
SOHAR	–	–	327	25.5
TOTAL	812	100.0	1283	100.0

FIGURE 2-3 BASE-FLOW DISCHARGE AT MULAYYNAH

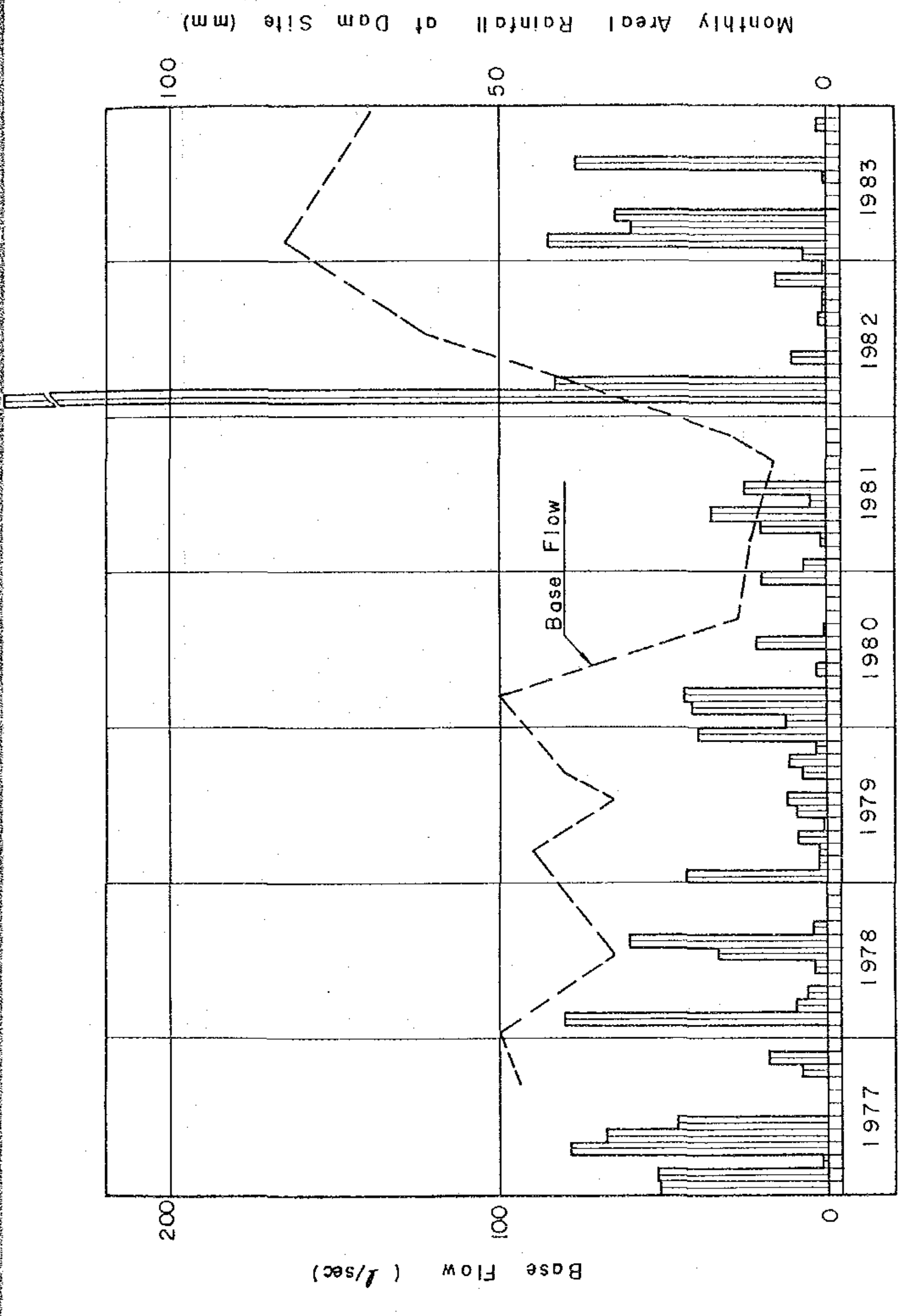


Figure 2-4 Rainfall-Runoff Relation at Dam Site

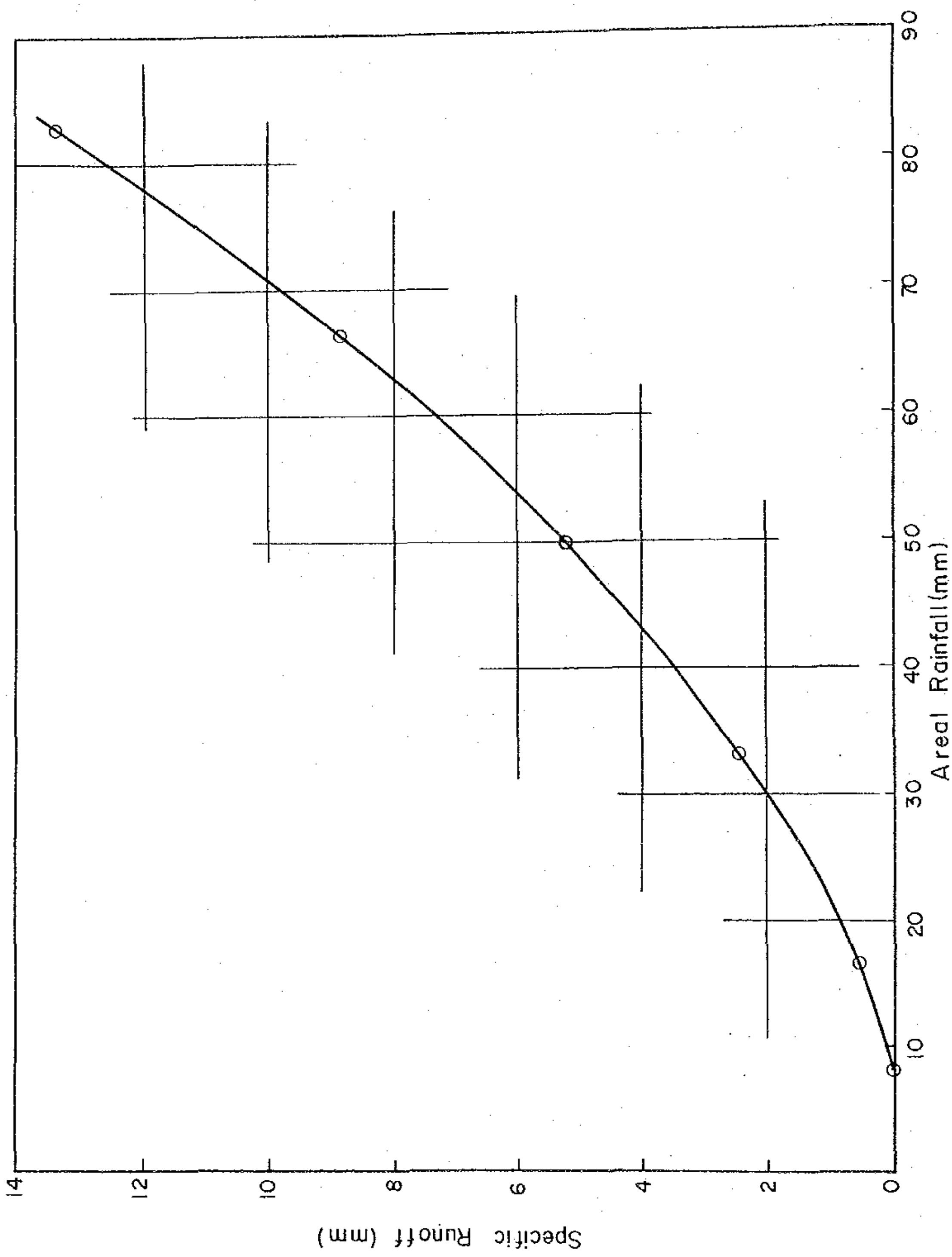
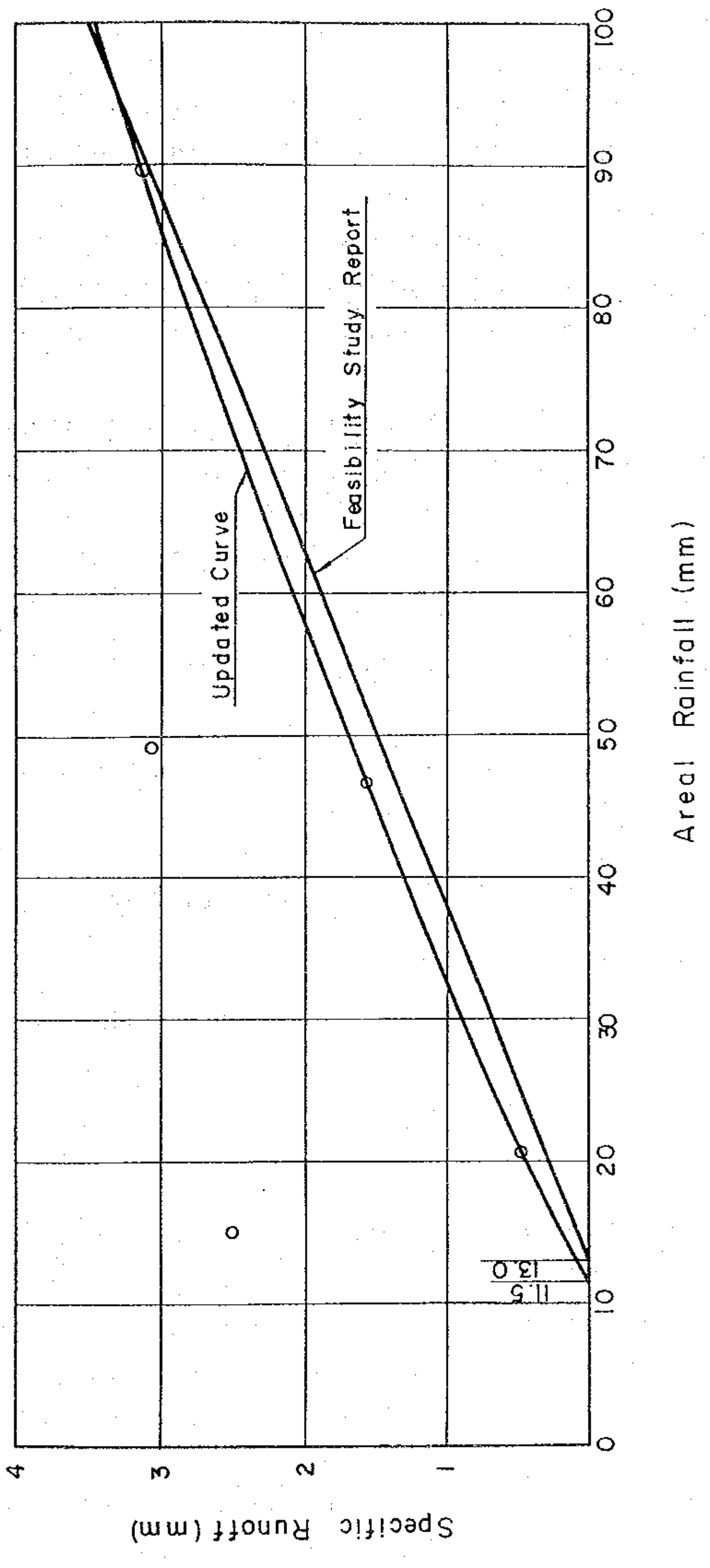


Figure 2-5 Rainfall-Runoff Relation at River Mouth



caused by series of rainfalls, those peaks were observed at 8 a.m and 2 to 3 p.m.

- Although large variations in rain intensity (and hence runoff rate) during a storm are reflected in the shape of the resulting hydrograph, the time scale of intensity variations depends mainly on basin size. Based on the conceptions of a unit hydrograph, flood concentration time of 3 hours as read on Figure 2-7 could be applicable to any other given intensity of storm rainfalls.

- If the former of two sharp peak hydrographs is extracted from observations so as to represent the typical shape of flood hydrograph within the drainage basin under consideration, a ratio of peak discharge for the volume of flood is given as:

$$\text{Ratio} = \frac{\text{Peak Discharge}}{\text{Flood Volue}} = \frac{770 \text{ cu.m/sec}}{7.7158 \text{ MCM}} = 9.9795 \times 10^{-5}(\text{sec}^{-4})$$

The same procedure was employed to calculate the ratio of peak discharge to flood volume at the river mouth:

$$\text{Ratio} = \frac{\text{Peak Discharge}}{\text{Flood Volume}} = \frac{163 \text{ cu.m/sec.}}{4.03 \text{ MCM}} = 4.045 \times 10^{-5}(\text{sec}^{-1})$$

4) Maximum Probable Flood

a) Maximum Probable Rainfall

As a long-term rain record, monthly rain data are obtainable from Muscat since the late 1800's for a relatively long period of about 90 years. To characterize the maximum probable rainfall of a relatively short duration, ratios of monthly maximum and daily maximum rains to annual rains are extracted from all of available data and plotted as shown in Figure 2-8. Envelope curves so drawn to enclose all the points would give the maximum probable monthly and daily rainfalls when a reasonable estimate of annual rainfall is made. Probability study on annual amount of rainfall at Muscat gives 255 mm with a recurrence period of 50 years. With regard to regional difference of annual rains, the drainage basin of the proposed dam has been receiving about 1.4 times of annual rainfall reported at Muscat.

The maximum probable daily rainfall at Muscat was accordingly estimated in consideration of a ratio of provisional estimate of the maximum probable rain and the 50-years return period rain, 1:0.6, as follows;

- 50 years frequency rainfall at Muscat = 255 mm/yr
- Maximum probable rainfall at Muscat = 255/0.6 = 425 ≑ 430 mm/yr
- Max. probable daily rain at Muscat = 430 x 0.4 = 172 mm/day (This is strongly supported by an observed rainfall intensity of 140 mm/day collected on May 2nd, 1981 at Quriyat, about 80 km south-east of Muscat)
- Max. probable daily rainfall within the proposed basin of the Wadi = 172 x 1.4 = 241 mm/day

b) Maximum Probable Flood

Based on the flood observation at Mulayyinah in February 1982, the coefficient of peak flood run-off, fp, was calculated as;

$$fp = \frac{770 \text{ cu.m/sec} \times 3.6}{654 \text{ sq.km} \times 10.5 \text{ mm/hr}} = 0.40$$

Where, a concentration time of peak flood was taken at 3 hours after inspection of observed pattern of rainfall and hydrograph, and the rainfall intensity during this period in terms of areal average was seen as 11.5 mm/hr in comparison with the second peak of rain and discharge (Refer to in Figure 2-7.)

Assuming that the maximum probable rainfall of 241 mm/day could be concentrated within a short duration of the concentration time, the average intensity of rainfall was then given as;

$$i = \frac{241}{3.0} = 80.3 \text{ mm/hr}$$

This figure is also strongly supported by an observed intensity of 36 mm falling in a storm at Sohar on October 30, 1979 measured within a period of 30 minutes.

The Rational formula, the most widely used design equation for peak flood estimation, was employed to compute the maximum probable flood discharge, Qp, as follows;

$$Qp = 1/3.6 \times fp \times i \times 812 \text{ sq.km}$$
$$= 1/3.6 \times 0.40 \times 80.3 \times 812 = 7,245 \text{ cu.m/sec}$$

A ratio of peak flood discharge to volume of flood run-off, as derived from actual measurement of flood hydrograph in February 1982, was applied to verify the reasonable estimate of maximum probable flood.

- Flood volume = 812 sq.km x 241 mm x 40%
  = 78.277 MCM
- Maximum Probable Flood = $78.277 \times 10^{6} \times 9.9795 \times 10^{-5}$
  = 7,828 cu.m/sec

The mentioned figures of maximum probable flood are so close upon that proposed by PAWR (i.e. 7,700 cu.m/sec), so that the estimate of 7,800 cu.m/sec was finally employed for the study.

Figure 2-6 Frequency Analysis on Flood Hight

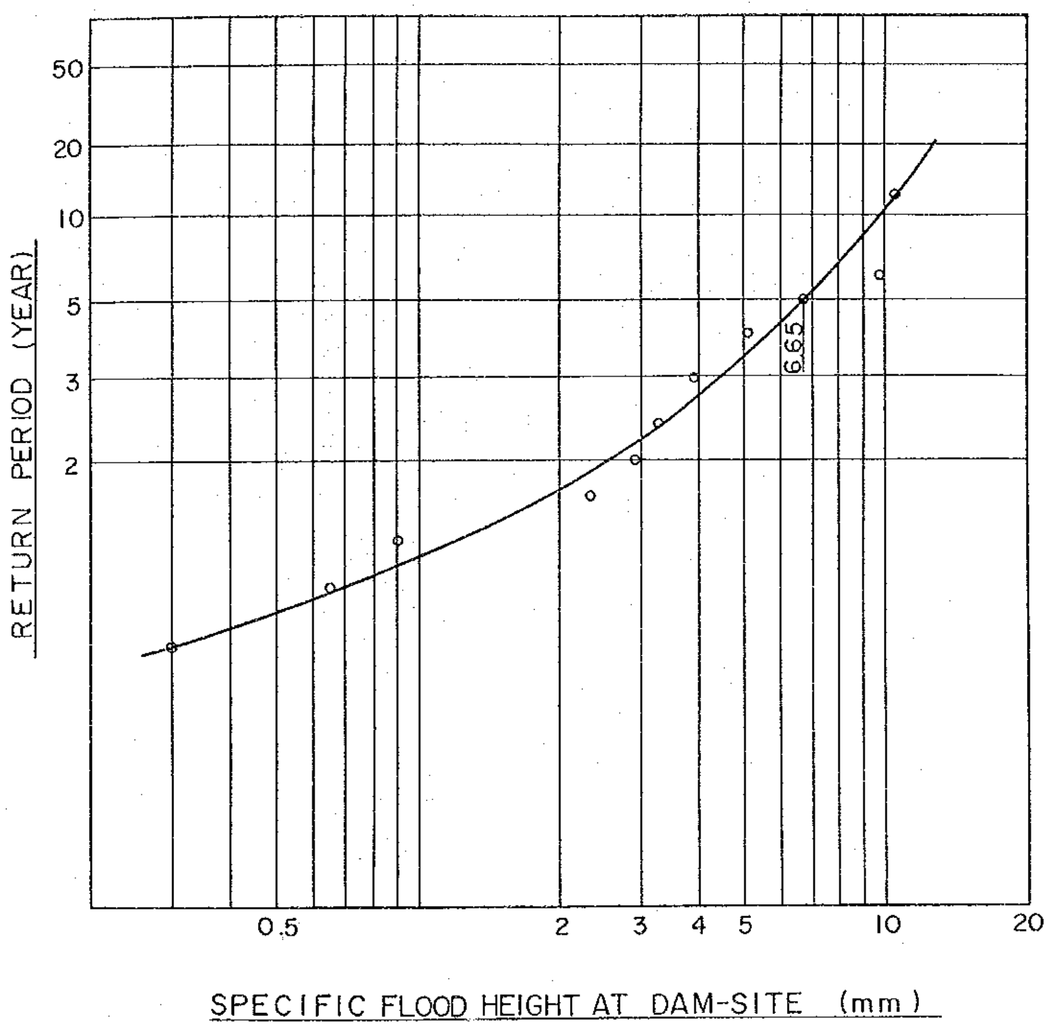


Figure 2-7 Observed Flood in February 1982

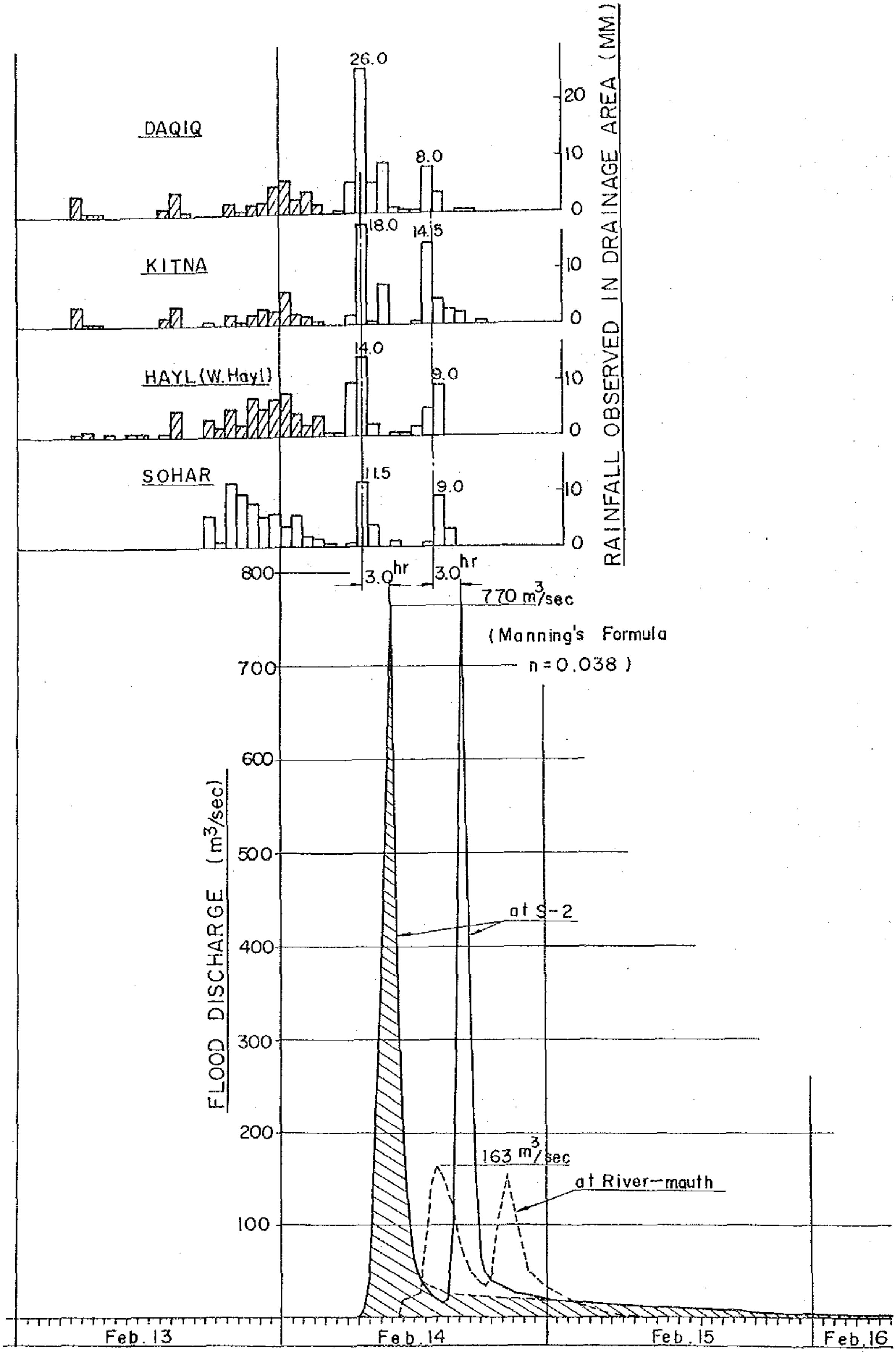


Figure 2-8 Envelope Curves for Maximum Rainfalls

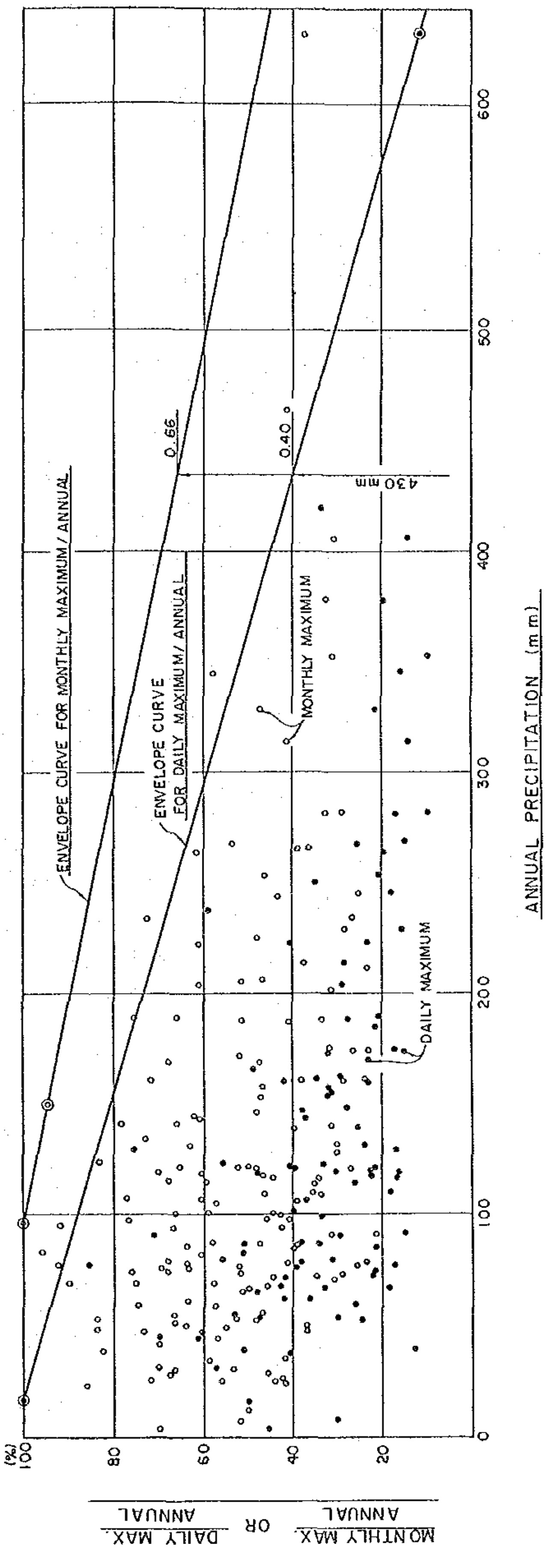
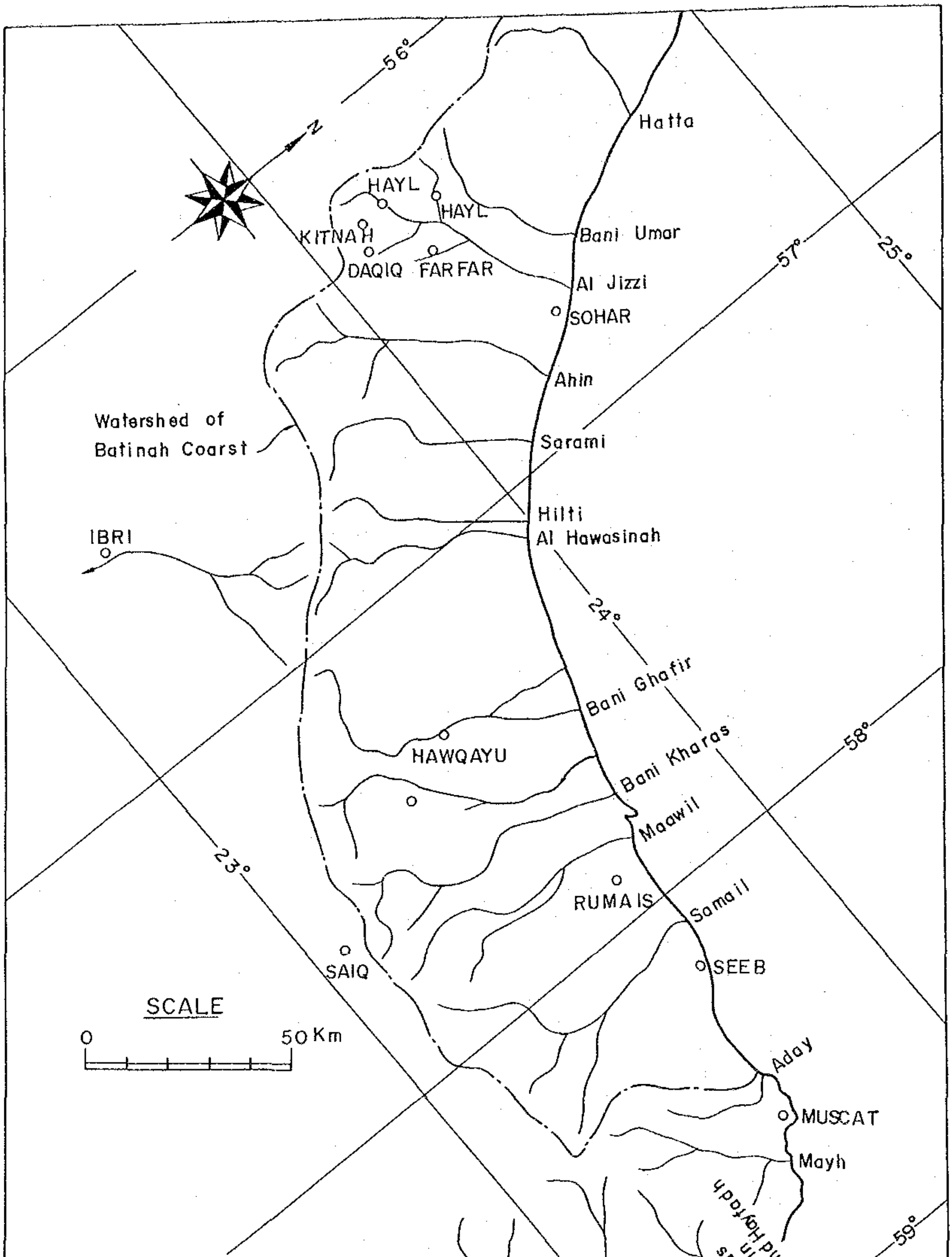


Figure 2-9 Location of Wadis and Rain Gauges



2.2 Groundwater Hydrology

1) Hydrogeological Unit

The Project area consists of the following three hydrogeological units; the impervious formations, terrace deposits and alluvial deposits. The impervious formations consist of the Hawasina group, basic volcanic rocks and tertiary sedimentary formations forming the main central ranges and their flanks in the upstream of the Wadi Jizzi.

The Hawasina group consists of silicified limestone, mudstone and chert. The basic volcanic rocks are mainly composed of Semail Ophiolite distributed in the mid-basin of the Wadi Jizzi. The teritary sedimentary formations spread in the west edge of the gravel plain. The terrace deposits have a large exposure in the middle stream of the Wadi Jizzi and the west edge of the gravel plain, but their distributions are limited to an upper stream of the Wadi. The deposits are composed of partially cemented sand and gravel of fluvial origin with various sizes of grains of the basic volcanic and sedimentary rocks. Although the deposits seem aquifuge, occasionally their uncemented thin layers of sand and granule among the deposits function as aquifers. The alluvial deposits are exposed in a limited area along the Wadi course in the catchment; however, they have a large exposure in the coastal plain. Thickness of the deposits ranges from several meters at the river beds in the catchment of 10 m in the mouth of gravel plain and more than 80 m in coastal plain where the deposits grow excellent as unconfined aquifers.

2) Aquifer Characteristics

The main aquifers in the Project area are restricted to the terrace deposits and alluvial deposits. Storativity obtained by aquifer tests at production well No. 1 of Sohar Expansion Farm was calculated at 0.05 in an average. Permeability coefficient has been estimated at 2.0×10^{-2} m/min in average by using the aquifer test data.

3) Hydrogeological Structure

The groundwater basin comprising the terrace deposits and alluvial deposits is enclosed by the impervous formations at the north and west edges with depth less than 40 m and its thickness to the east reaches more than 100 m at the coast. Location of the south end of the basin developing in the downstream of the Wadi Jizzi is estimated at the north of Wadi Kadaq where the groundwater table trench extends. An entire area of the groundwater basin extends about 10 km in length along the coast with 10 - 20 km width.

4) Movement of Groundwater

Groundwater levels in the Wadi Jizzi area are shown in Table 2-4. The transition of the groundwater level from 1974 to 1984 is drawn as shown in Figure 2-10. From the data, 1977 and 1978 are considered to be the high water years and the years from 1983 to 1985 are the low water years.

The groundwater contour lines in 1978 are shown in Figure 2-11. The contour lines run almost parallel with the coast line and groundwater level is kept over 1.0 m above mean sea level at the coast line. The average hydraulic gradient of groundwater is observed at 1:600. The average groundwater tables are given in Figure 2-12. The contour lines generally run in parallel with the coast line.

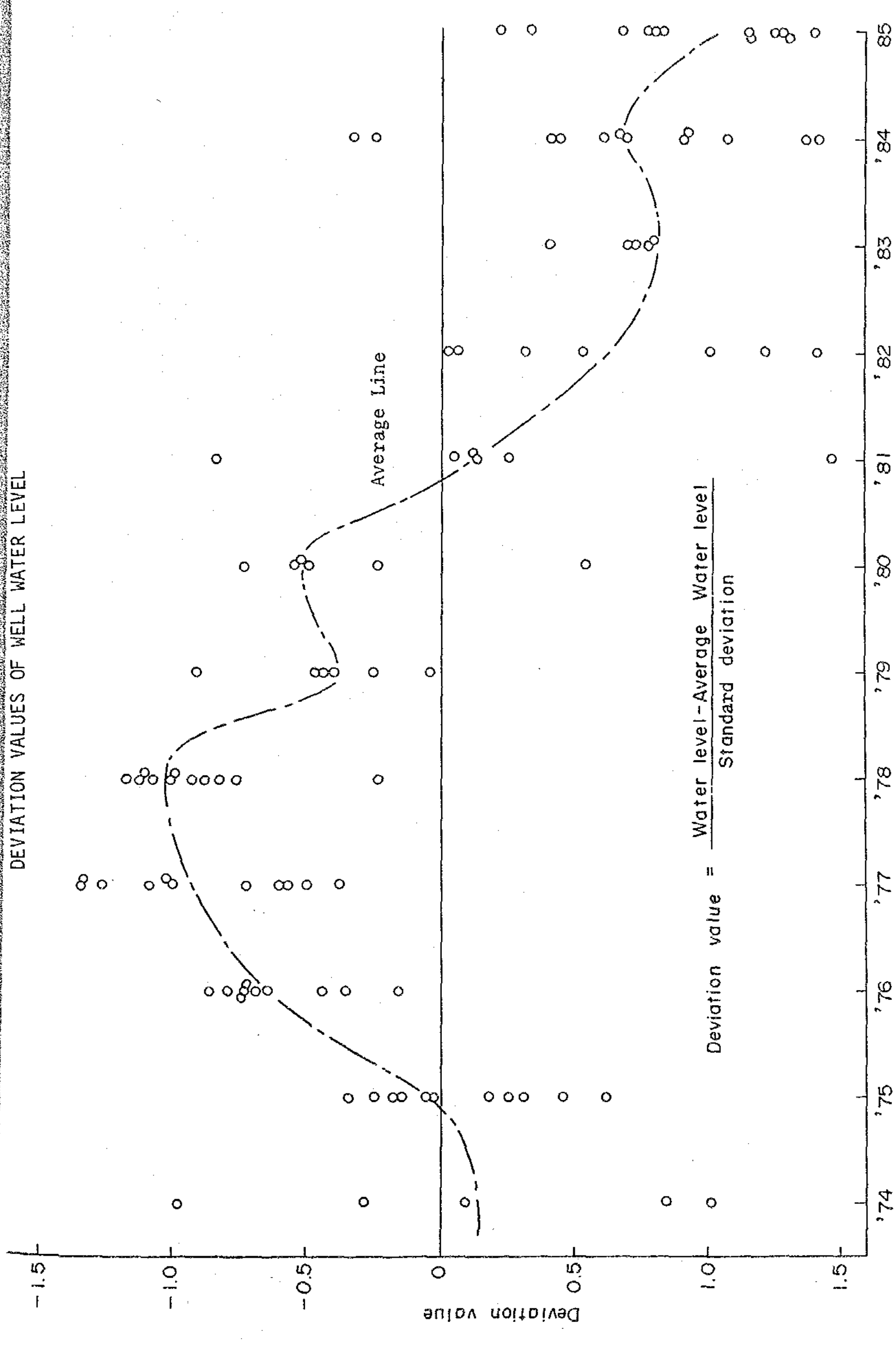
5) Groundwater Flow in View of Iso-EC Contour Lines

Distribution of Electric Conductivity (EC) at the surface layer of the groundwater along the Wadi Jizzi is drawn in Figure 2-13. The groundwater on the coast indicates conductivity ranging from 3000 to 5000 micro mho/cm, and EC of 500 micro mho/cm was measured at inland.

6) Chemical Quality of Groundwater

The result of chemical analysis of groundwater in 1982 and 1985 are

Figure 2-10 Deviation Values of Well Water Level



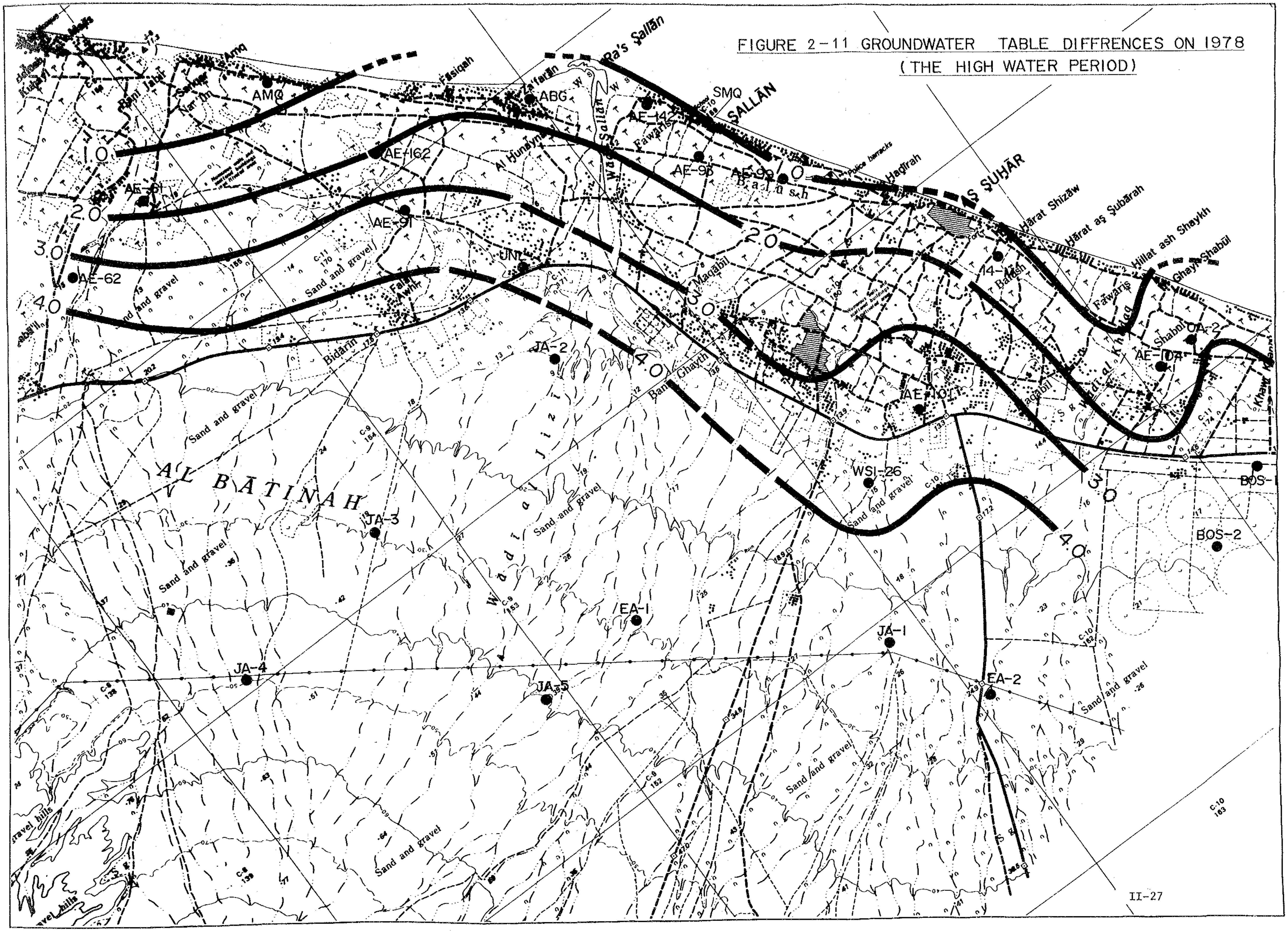
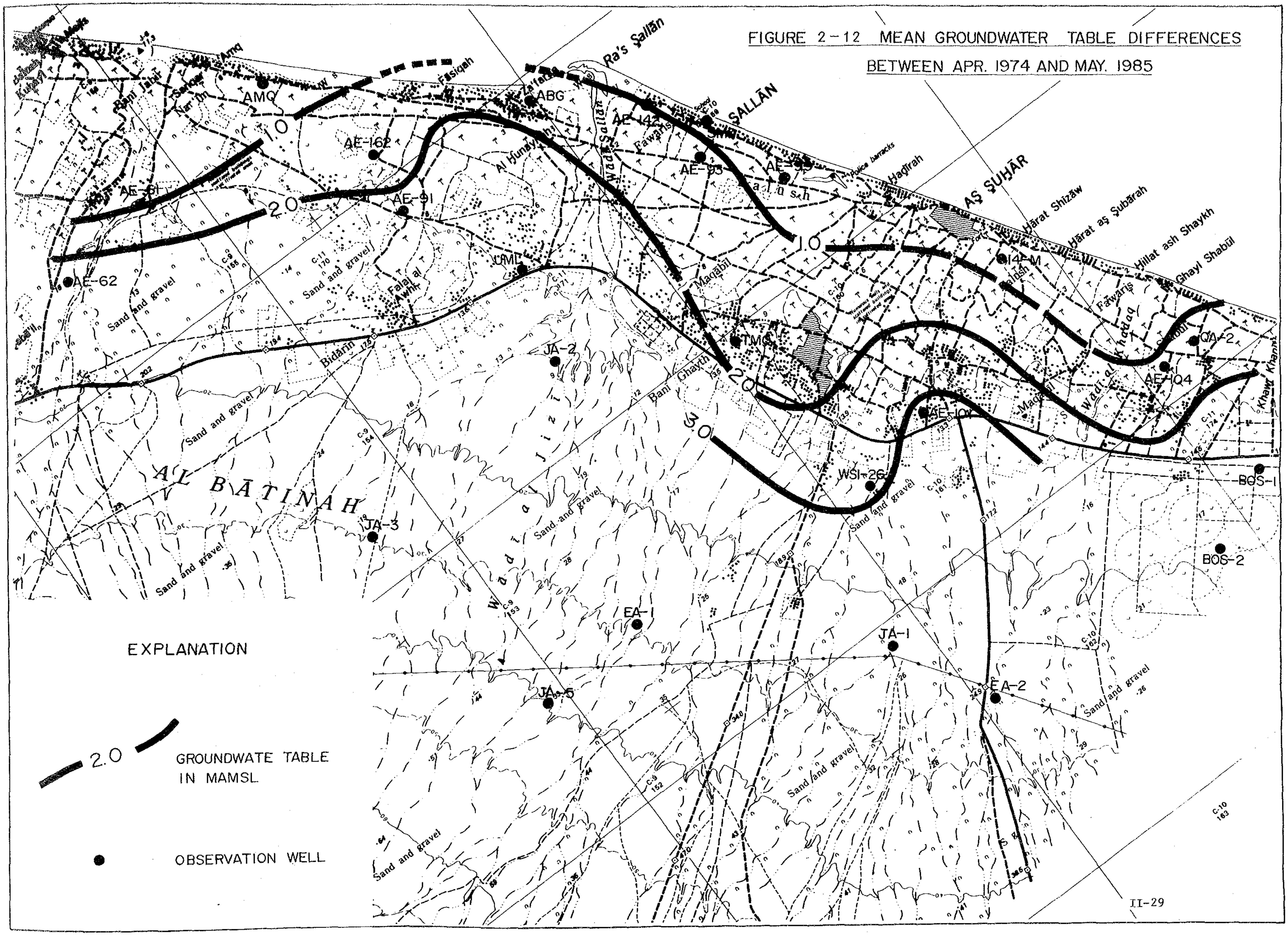


FIGURE 2-11 GROUNDWATER TABLE DIFFRENCES ON 1978 (THE HIGH WATER PERIOD)

FIGURE 2-12 MEAN GROUNDWATER TABLE DIFFERENCES BETWEEN APR. 1974 AND MAY. 1985



shown in Table 2-5, and was plotted on the key diagram of hydrochemistry in Figure 2-14.

The majority of groundwaters are categorized in I field indicating by hydrochemical signs of fresh water. Some groundwater samples at the coast are classified in III field indicating hydrochemical contamination caused by sea water intrusion.

7) Change of Groundwater Storage

An average change in groundwater levels from 1974 to 1984 was calculated at 43 mm in defect which is equivalent to a decrease of 1.02 MCM/annum.

Annual change of groundwater storage is shown in Table 2-6 as well as in Figure 2-15. As is shown in the said Table and Figure, maximum increase in groundwater storage change is calculated at 10.13 MCM/annum in the years 1975 and 1976, while maximum decrease is calculated at 11.64 MCM/annum in the years 1981 and 1982.

8) Groundwaer Run-off to the Sea

Groundwater run-off to the sea can be calculated by Darcy's formula. Darcy's formula is as follows;

$Q = K.A.I$

Q ; Flow volume (Groundwater run-off to the sea)

K ; Permeability coefficient (2.0×10^{-2} m/min)

A ; Flow area (1.85×10^{5} m^{2})

where A = L.H

L ; Length of the coast line (10 km)

H ; Depth of the first layer by EC logging (18.5 m)

I ; Hydraulic gradient

Hydraulic gradient of the groundwater table on the coast was calculated at 1.70×10^{-3} 1:590 as an average in the last 11 years. Ground water run-off to the sea is thus computed at 3.31 MCM per annum.

Table 2-4 Groundwater Level

Groundwater Level

	Mean Groundwater Level (Depth) (m)												Average	Standard
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	(m)	Deviation(m)
OA−1	−	21.32	11.42	17.42	22.30	−	−	−	−	−	−	−	−	−
AE−49	−	10.27	6.40	2.11	4.48	6.62	6.53	11.88	−	2.81	4.72	7.26	−	−
OA−2	6.49	6.15	6.05	6.07	5.79	6.12	6.03	6.25	6.26	6.45	6.47	6.60	6.23	0.35
EA−1	24.38	(24.35)	(22.33)	21.38	21.65	23.31	22.85	22.05	25.60	(24.67)	24.47	25.60	23.30	1.58
WSI−26	11.10	(10.95)	10.37	(10.11)	10.16	10.12	9.45	11.15	11.54	(11.82)	12.36	11.78	10.99	0.98
AE−61	(9.82)	9.88	9.57	9.49	8.57	(9.55)	(9.47)	(9.85)	(10.17)	10.18	10.70	9.99	9.77	0.59
AE−62	(9.07)	8.69	8.85	8.51	8.23	8.59	8.56	9.02	9.82	9.63	9.32	9.54	8.99	0.82
AE−91	(8.78)	8.29	7.70	7.28	7.29	(8.11)	(8.00)	(8.82)	9.06	9.07	9.91	10.41	8.56	1.37
AE−93	(1.78)	1.71	1.28	1.19	1.33	(1.52)	(1.46)	(1.79)	1.69	2.14	2.28	2.14	1.69	0.52
AE−99	(1.73)	1.82	1.52	1.54	1.47	(1.62)	1.58	(1.74)	(1.87)	1.89	1.86	2.02	1.72	0.24
AE−101	(9.69)	9.80	9.09	8.84	9.03	(9.34)	(9.03)	(9.71)	10.49	8.43	10.65	10.55	9.55	0.72
AE−104	5.85	6.16	6.35	5.74	5.82	5.87	6.29	6.56	(6.32)	(6.37)	6.00	6.37	6.14	0.29
AE−142	2.03	2.11	1.74	1.78	2.06	1.88	1.70	2.44	2.26	4.06	2.05	2.52	2.22	0.78
AE−162	(4.32)	4.37	4.11	3.96	4.01	(4.19)	(4.16)	(4.33)	(4.46)	4.77	4.21	4.58	4.29	0.25

Table 2-5 Chemical Analysis Data

Chemical Analysis Data

(1982)

Sample No.	Well No.	PH	EC Umbos/cm 25℃	Cations, me/L					Anions, me/L				
				Na^+	K^+	Ca^{++}	Mg^{++}	Total	$CO_3^=$	HCO_3^-	CL^-	SO_4^-	Total
1	JA-1	7.0	1,006	4.35	0.11	1.10	4.10	9.66	0.6	2.80	4.25	1.66	9.31
2	JA-2	7.4	367	1.74	0.06	—	2.50	3.74	0.6	1.45	1.10	0.16	3.31
3	JA-3	7.6	518	1.55	0.07	0.40	2.80	4.83	—	2.30	1.80	0.66	4.76
4	JA-4	7.7	489	1.30	0.07	0.20	3.45	5.02	0.6	2.30	1.30	0.42	4.62
5	JA-5	7.45	413	1.30	0.07	0.20	2.90	4.48	0.4	1.85	1.25	0.42	3.92

(1985)

Sample No.	Well No.	PH	EC Umbos/cm 25℃	Cations, me/L					Anions, me/L				
				Na^+	K^+	Ca^{++}	Mg^{++}	Total	$CO_3^=$	HCO_3^-	CL^-	SO_4^-	Total
1	JA-1	8.1	953	4.78	0.08	1.70	3.10	9.66	—	3.40	4.40	1.66	9.46
2	JA-2	7.9	379	1.35	0.04	0.26	2.14	3.84	—	2.30	1.20	0.16	3.66
3	JA-3	8.0	440	1.65	0.05	0.27	2.43	4.40	—	2.40	1.40	0.42	4.22
4	JA-4	8.0	562	2.22	0.05	0.55	3.05	5.87	—	2.80	2.05	0.66	5.51
5	JA-5	8.15	391	1.44	0.05	0.55	2.15	4.19	—	2.30	1.15	0.66	4.11
6	JA-6	8.05	367	1.27	0.10	1.48	0.97	3.82	—	2.30	0.60	0.66	3.56
7	OA-2	7.95	1,002	4.05	0.08	1.18	4.57	9.88	—	2.50	6.20	1.16	9.86
8	EA-1	7.90	416	1.99	0.08	0.58	1.57	4.22	—	2.40	1.75	—	4.15
9	WSI-26	8.15	623	2.93	0.06	1.07	2.48	6.54	—	3.50	2.35	0.66	6.51
10	AE-49	8.10	1,063	6.11	0.06	2.60	2.90	11.67	—	4.20	3.35	3.91	11.46
11	AE-62	8.05	966	3.15	0.08	1.05	5.65	9.93	—	2.80	5.20	1.91	9.91
12	AE-91	8.35	831	4.52	0.08	0.53	3.67	8.80	—	5.20	2.45	0.99	8.64
13	AE-93	8.05	1,467	10.67	0.09	1.05	3.60	15.43	—	2.40	11.40	0.99	14.74
14	AE-101	8.10	2,078	8.04	0.09	2.60	13.35	24.08	—	3.10	13.90	7.33	24.33
15	AE-2	8.15	574	2.37	0.08	1.05	2.20	5.70	—	2.60	3.05	—	5.65

Note;Analyzed by Rumais Agricultural Research Station

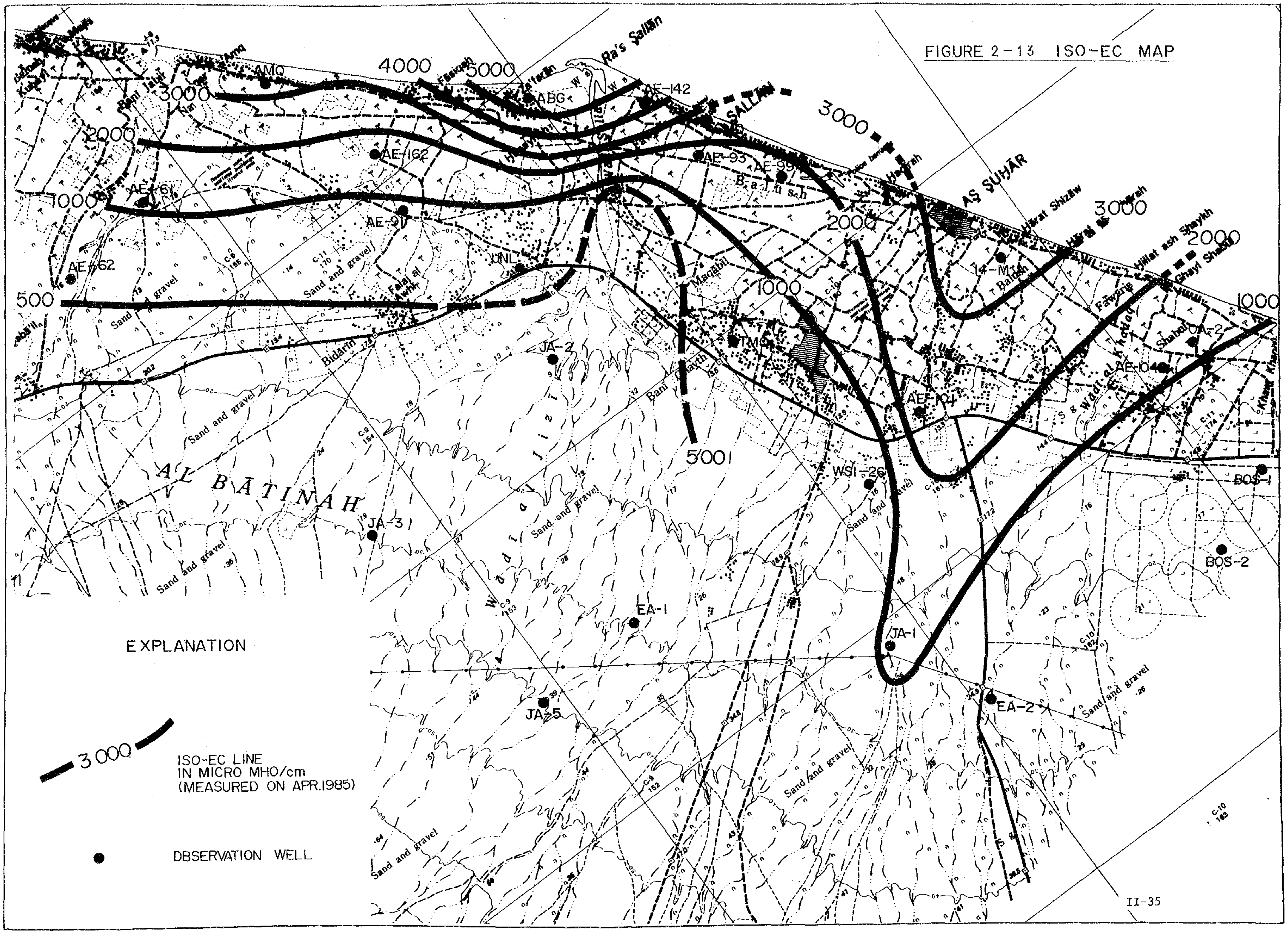
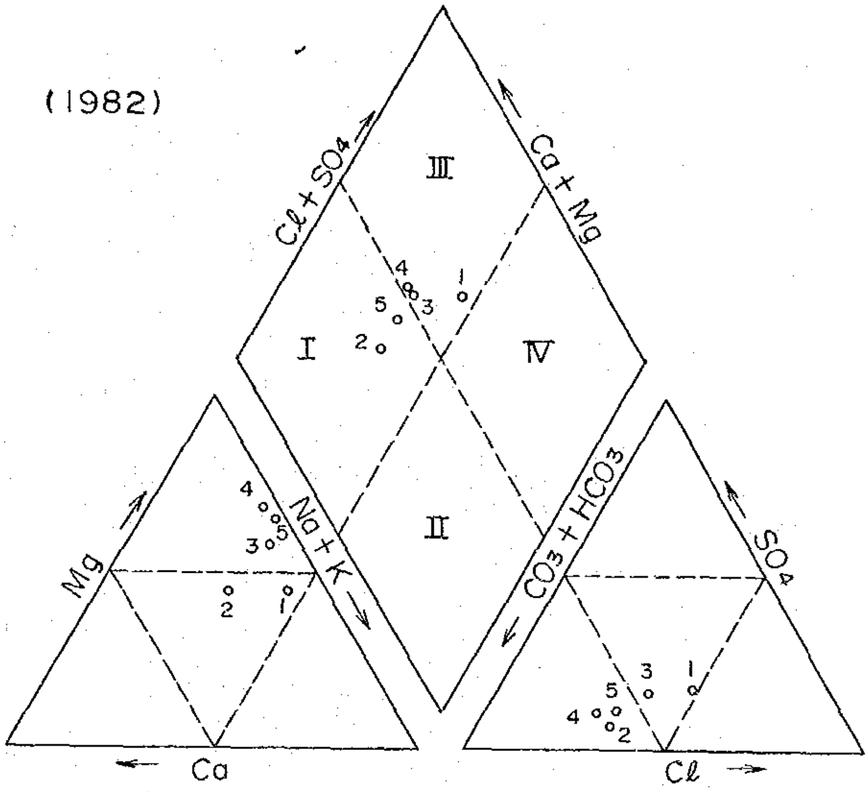


FIGURE 2-13 ISO-EC MAP

FIGERU 2-14 WATER ANALYSIS DIAGRM



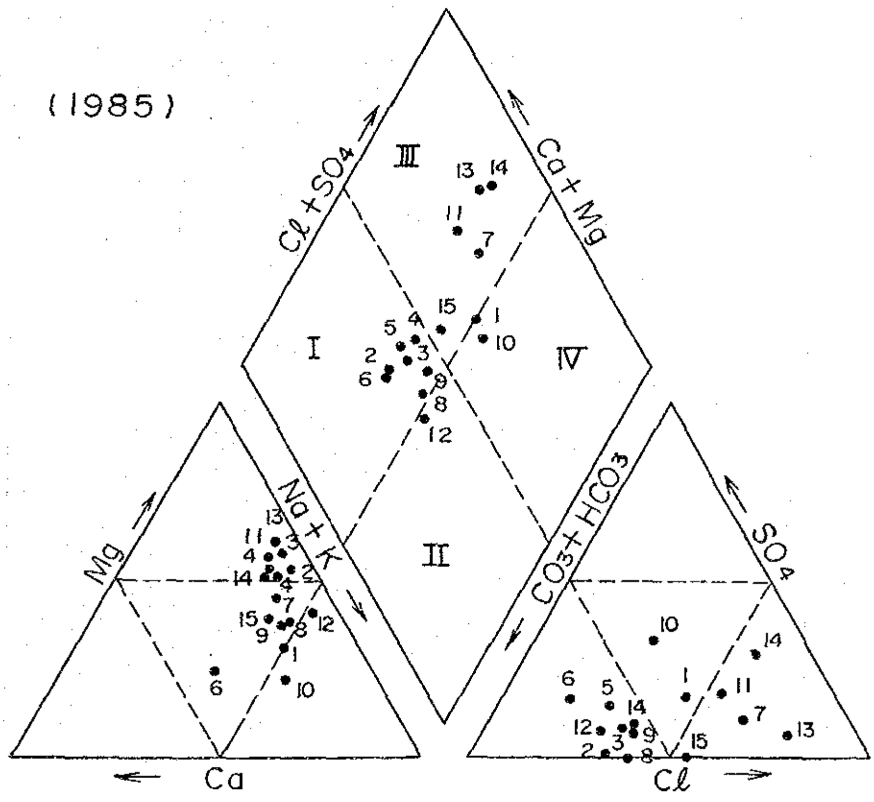
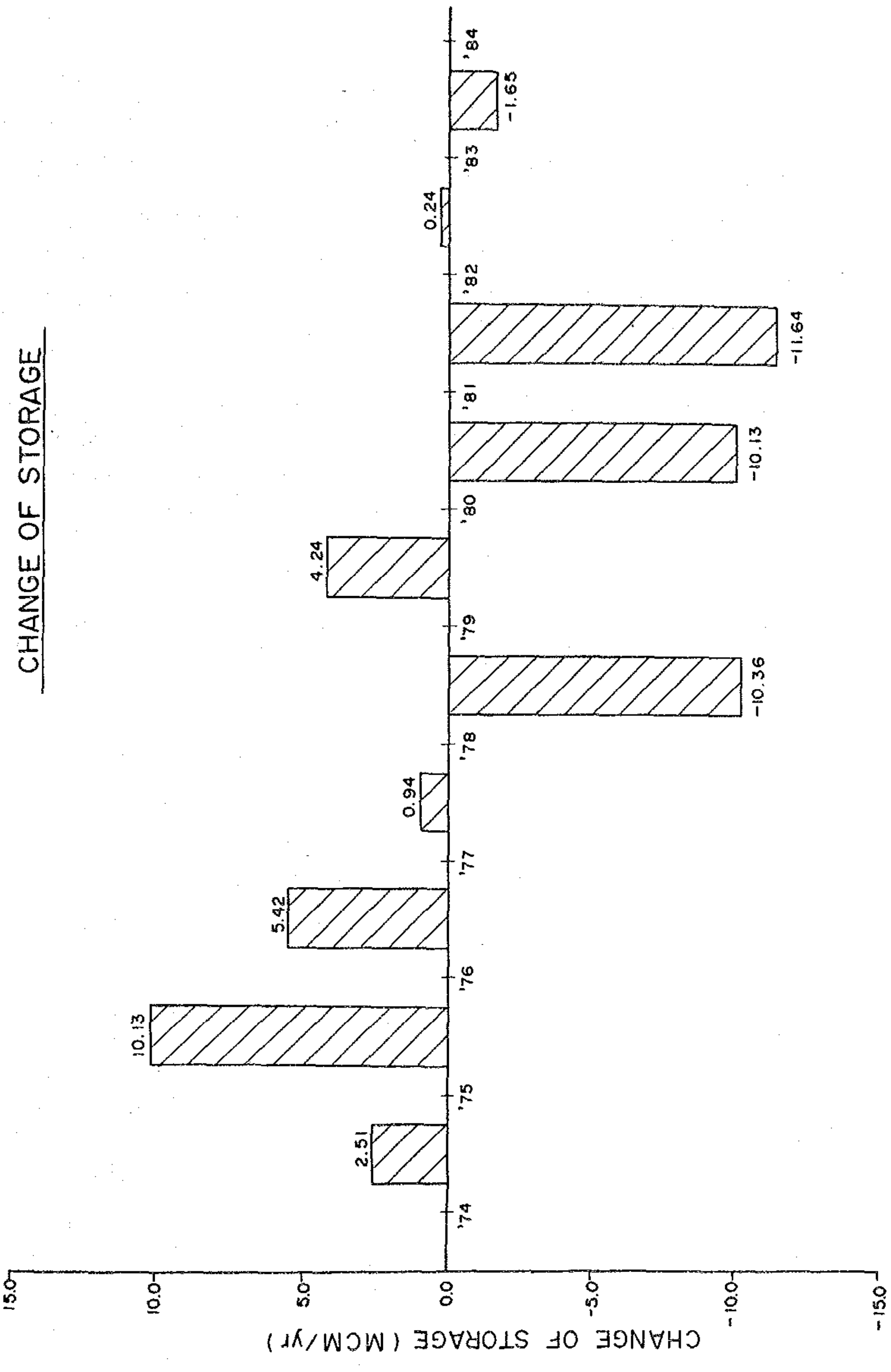


Table 2-6 Water Level Fluctuation and Change of Storage

Water Level Fluctuation and Change of Storage

		1974 ~1975	1975 ~1976	1976 ~1977	1977 ~1978	1978 ~1979	1979 ~1980	1980 ~1981	1981 ~1982	1982 ~1983	1983 ~1984	Average 1974~1984
Water Level Fluctuation (m/yr)	OA－2	+0.34	+0.10	-0.02	+0.28	-0.33	+0.19	-0.22	-0.01	-0.09	-0.02	
	EA－1	+0.03	+2.02	+0.95	-0.27	-1.66	+0.46	+0.80	-3.55	+0.93	+0.20	
	WSI-26	+0.15	+0.58	+0.27	-0.05	-0.46	+1.17	-1.70	-0.39	-0.28	-0.54	
	AE－61	-0.05	+0.31	+0.08	+0.92	-0.98	+0.08	-0.38	-0.32	-0.01	-0.52	
	AE－62	+0.38	-0.16	+0.34	+0.28	-0.36	+0.03	-0.46	-0.80	+0.19	+0.31	
	AE－91	+0.49	+0.59	+0.42	-0.01	-0.82	+0.11	-0.82	-0.24	-0.01	-0.84	
	AE－93	+0.07	+0.43	+0.09	-0.14	-0.19	+0.06	-0.33	+0.10	-0.45	-0.14	
	AE－99	+0.09	+0.30	-0.02	+0.07	-0.15	+0.04	-0.16	+0.13	-0.02	+0.03	
	AE－101	-0.11	+0.71	+0.25	-0.19	-0.31	+0.31	-0.68	-0.73	+2.06	-2.22	
	AE－104	-0.31	-0.19	+0.61	-0.08	-0.05	-0.42	-0.27	+0.24	-0.05	+0.37	
	AE－142	-0.08	+0.37	-0.04	-0.28	+0.18	+0.18	-0.74	+0.18	-1.80	+2.01	
	AE－162	-0.05	+0.26	-0.15	-0.05	-0.18	+0.03	-0.17	-0.13	-0.31	+0.56	
Average (m)		+0.11	+0.43	+0.23	+0.04	-0.44	+0.18	-0.43	-0.49	+0.01	-0.07	-0.04
Change of Storage (MCM/yr)		+1.88 (+2.51)	+10.13	+5.42	+0.94	-10.36	+4.24	-10.13	-11.64	+0.24	-1.65	-1.02

Figure 2-15 Change of Storage



2.3 Present Agriculture

2.3.1 Land Use

The Project area, with Sohar as a center of the area, comprises the farm lands extending 5 to 7 km wide and about 17 km long along the coastal line from Majis in the north to the Wadi Al Khadaq in the south including non-farm lands and proposed reclaimed lands. The Project area covers the land area of about 3,830 ha.

As for the present land use in the area, the land extending in strips between the coastal line and the highway running north to south is almost covered with date palm trees which have been growing for more than 30 years. Some farms have been growing vegetables in the spaces among these palm trees.

In the west side of the highway, there have been many new farm lands developed for growing vegetables and tree-crops.

2.3.2 Water Use

1) Irrigation Condition

The existing cultivated areas in the Project area were estimated at 2,835 ha out of the total cultivated area of about 4,420 ha in the Wilaya Sohar.

The prevailing irrigation methods in these area are classified into the following three 1) basin irrigation, 2) border-strip irrigation and iii) furrow irrigation. The basin irrigation is adopted for tree crops such as dates, limes and mangos, the border-strip irrigation for feed crops like alfalfa, misilba, and furrow irrigation for vegetable crops. Besides these surface irrigation systems, such as pipeline, drip and sprinkler irrigation method are partly used for the vegetables and feed crops in the limited small area along the highway.

Under these circumstances, low irrigation efficiency of 50 percent is estimated. Most of the losses occur through deep percolation and evaporation partly due to poor canal conveyance systems and to over-irrigation.

The annual irrigation demand for the areas of 2,835 ha was estimated at 11.01 MCM taking into account the present cropping pattern, cultivated area and crop consumptive use of the water estimated by a theoretical method known as the modified Penman method.

2) Water Quality

The groundwater quality sampled from 15 wells was tested at Rumais Agricultural Research Station, Ministry of Agriculture and Fisheries. The location of wells are illustrated in Figure B-1. From the result of chemical tests, similar values, as compared to those of the test conducted in 1981, have been obtained excepting pH values.

On the diagram of irrigation water classification, the sampled waters belong to the classification of C2-S1 and C3-S1 with an average of C2-S1 classification. (Refer to Annex-B, Figure B-10). While pH values were analyzed about 8 percent bigger than that of 1981. However, this value creates no problem for irrigation. Accordingly, it has been proved that the groundwater in the Wadi Jizzi basin can be used as irrigation water for most of crops.

2.3.3 Cropping Pattern and Water Requirement

On the basis of information collected in the field concerning the existing land use, the present irrigation intensities of cultivation are summarized as follows:

Present Irrigation Intensities

Cropping Intensity		100.0%	
Vegetable Crops	183 ha	(6.5%)	
Onion	96	(3.5)	Sep. to Jan.
Garlic	25	(0.9)	Sep. to May
Tomato	16	(0.6)	- do -
Potato	15	(0.5)	Nov. to Feb.
Okra	8	(0.3)	Feb. to June
Other	23	(0.8)	Nov. to Mar.
Fruit Crops	2,340	(82.5)	
Dates	1,820	(64.2)	Perennial
Lime	309	(10.9)	- do -
Banana	128	(4.5)	- do -
Mango	83	(2.9)	- do -
Feed Crops	312	(11.0	
Alfalfa	211	(7.4)	Perennial
Sorghum	101	(3.6)	- do -
Total	2,835	(100.0)	

In this connection, a cropping schedule and calendar are shown in Figure 2-16. In addition, it is noted here that about 500 ha of cropping area are mainly for vegetable crops and feed crops, and feed crops have increased during the recent three years.

Reference crops evapotranspirations by season were calculated based on the climatic conditions observed at Sohar Meteorological Station by applying Modified Penman Method through procedures given in FAO Technical Publication No. 24.

Reference Crop Evapotranspiration by Penman (ETo)

Month	ETo (mm/day)	ETo (mm/month)
January	2.9	89.9
February	3.6	100.8
March	4.7	145.7
April	6.0	180.0
May	7.7	238.7
June	7.6	228.0
July	7.1	220.1
August	6.7	207.7
September	6.3	189.0
October	5.0	155.0
November	3.5	105.0
December	2.9	89.9
Annual		1,949.8 mm/yr

The FAO method of developing crop growth stage coefficients (kc) and estimating effective rainfalls were also used to calculate crop water supply requirement. The following equation was employed in the study;

$$V = \frac{10}{EP}\left[\frac{A(ETc - RE)}{1 - LR}\right]$$

where;
- V: Crop water supply requirement (m^3)
- A: Cropping area (ha)
- ETc: Crop evapo-transpiration (mm)
- RE: Effective rainfall (mm)
- EP: Irrigation efficiency = 0.5
- LR: Leaching requirement

$$= \frac{EC\ (w)}{2\ Max.\ EC(E)} \cdot \frac{1}{LE}$$

- EC(w): Electric conductivity of irrigation water = 0.56 mm hos/cm
- Max.EC(E): Maximum tolerable electrical conductivity of soil saturation extract for crops, derived from FAO No.24 paper
- LE: Leaching efficiency = 0.8 (for sandy loam)

LE: Leaching efficiency = 0.8 (for sandy loam)

Water supply requirement for each crop was computed by use of the mentioned procedures as given in Table 2-7. Based upon these figures, present consumption of irrigation water was estimated at about 11.0 MCM, taking present status of irrigation water application into consideration.

With regard to quality of irrigation water, an analysis was made at the Rumais Agricultural Research Station with water samples taken at five sites. Table 2-8 summarizes the analysis accordingly proving that groundwater in the Wadi Jizzi plain can be used for irrigation of soils planted with most crops, with little likelihood of development of soil salinity unless some leaching be practised.

2.3.4 Cultivation and Cultivated Area

The Project area has extremely high temperatures with little precipitation in summer, while comparatively low temperatures with a little precipitation in winter. The annual precipitation is about 90 mm on an average. The soils of the farm lands consist of silty and sandy loam.

Agriculture in the Project area is under the administration of the North Batinah Office of the Department of Agriculture, and the extension division of this office is responsible for diffusion of the farming techniques. However, since an area as large as about 13,300 ha is under the office's jurisdiction, insufficient and inappropriate services for farmers are executed by the Office.

The pumps are most commonly used to lift groundwater for irrigation, and some Falaj are used as the irrigation water sources. The basin irrigation has been employed for tree-crops and alfalfa, while the furrow irrigation has been used for other crops with the exception of the drip irrigation for some of them.

Since a considerable amount of groundwater is required for the irrigation in the area, an improvement of the present irrigation method should be considered so as to meet the requirement including irrigation water in the expansion of agricultural land expected in the future.

FIGURE 2-16 PRESENT CROPPING PATTERN

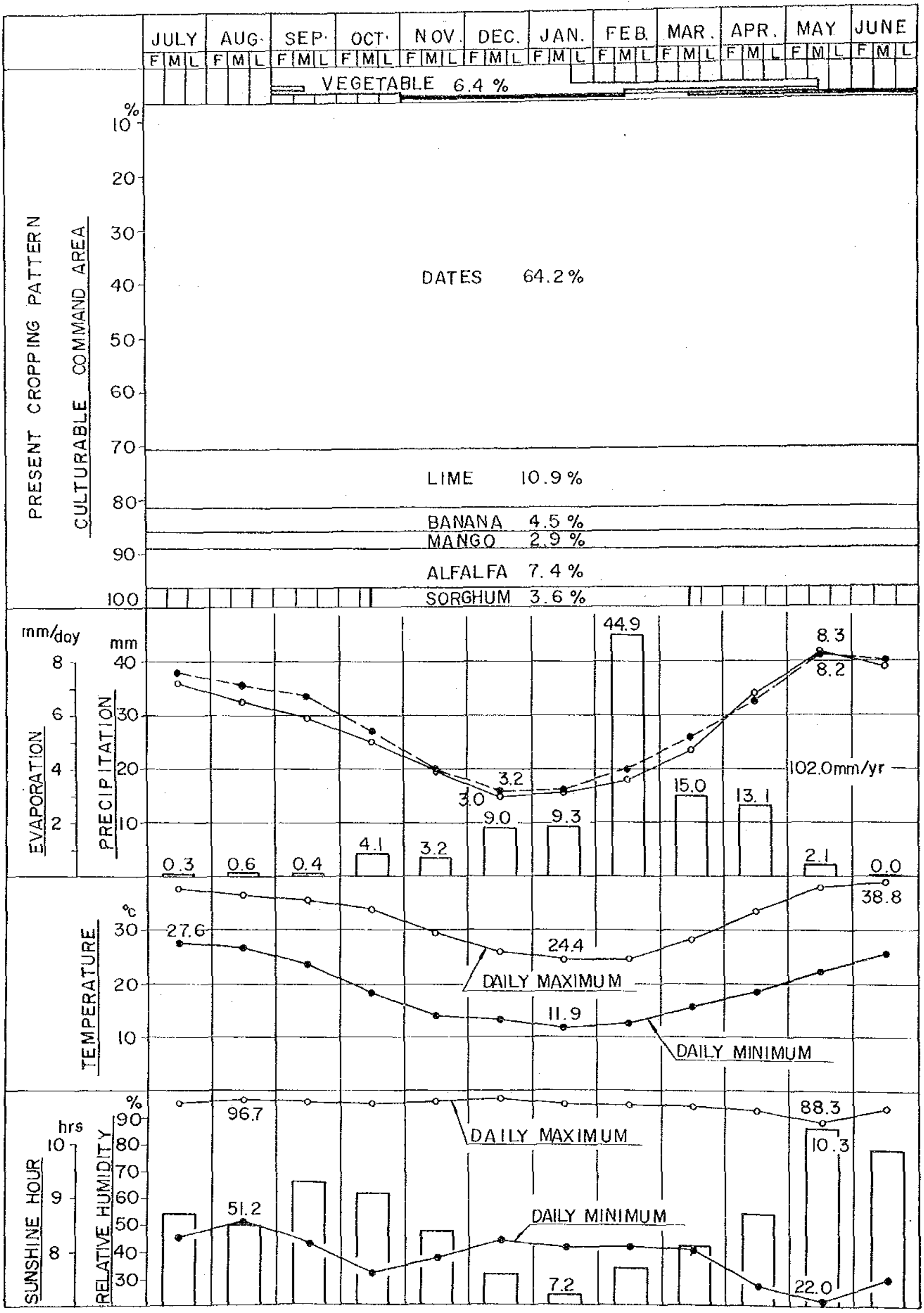


TABLE 2-7 UNIT IRRIGATION WATER SUPPLY REQUIREMENT BY CROPS

Average Monthly Water Supply Requirement per Hectar by Crops

(Unit: cu.m/ha)

Month	Vegetable							Fruit Crop					Feed Crop		
	Onion	Garlic	Tomato	Potato	Okra	Others	Average	Dates	Lime	Banana	Mango	Average	Alfalfa	Sorghum	Average
	96ha	25ha	16ha	15ha	8ha	23ha	183ha	1,820ha	309ha	128ha	83ha	2,340ha	211ha	101ha	312ha
Jan.	720	1,332	1,428	2,358		1,440	1,059	1,142	815	1,548	1,181	1,122	1,421	1,694	1,509
Feb.		983	1,383	937	105	995	462	779	420	1,207	806	756	1,081	880	1,016
Mar.		2,138	2,290		1,875	788	673	1,829	1,291	2,481	1,893	1,796	2,278	776	1,792
Apr.		2,356	2,366		2,941		657	2,328	1,677	3,149	2,408	2,290	2,902		1,963
May		1,206	1,585		3,947		476	3,359	2,465	4,477	3,475	3,306	4,143		2,802
Jun.					2,835		124	3,228	2,385	4,293	3,339	3,179	3,963		2,680
Jul.								3,116	2,302	4,144	3,223	3,069	3,826		2,587
Aug.								2,940	2,173	3,911	3,042	2,895	3,610		2,441
Sep.	395	677	388				334	2,675	1,977	3,559	2,767	2,634	3,285		2,222
Oct.	1,274	1,525	313				904	2,139	1,559	2,856	2,213	2,104	2,628	531	1,949
Nov.	1,489	1,457	942	949		837	1,246	1,439	1,068	1,939	1,489	1,419	1,785	1,246	1,611
Dec.	1,276	1,249	899	1,821		1,175	1,216	1,146	820	1,553	1,186	1,127	1,425	1,699	1,514
Total	5,154	12,923	11,594	6,066	11,704	5,236	7,151	26,120	18,951	35,117	27,021	25,697	32,348	6,825	24,086

Table 2-8 Water Quality Analysis

Results of Water Quality Analysis

Sampling site : Sohar

Laboratory : Rumais Agricultural Research Station

Analyzed date : 24/March, 1982

Sample	PH	EC µmhos/cm at 25°C	T.S.S.	Cations, me/ℓ Na	K	Ca	Mg	Total	S.A.R.	CO_3	HCO_3	Cl	SO_4	Total
JA-1	7.0	1,005.9	643.8	4.35	0.11	1.10	4.10	9.66	2.70	0.60	2.80	4.25	1.66	9.31
JA-2	7.4	367.0	234.9	1.17	0.06	-	2.50	3.73	1.05	0.60	1.45	1.10	0.16	3.31
JA-3	7.6	518.0	331.5	1.55	0.07	0.40	2.80	4.82	1.23	-	2.30	1.80	0.66	4.76
JA-4	7.7	489.4	313.2	1.30	0.07	0.20	3.45	5.02	0.97	0.60	2.30	1.30	0.42	4.62
JA-5	7.5	413.3	264.5	1.30	0.07	0.20	2.90	4.47	1.05	0.40	1.85	1.25	0.42	3.92
Average	7.4	558.7	357.6	1.93	0.08	0.38	3.15	5.54	1.40	0.55	2.14	1.94	0.66	5.18

CHAPTER III PROJECT FORMULATION

3.1 Project Components

The Project components are 1) to develop water resources in the Wadi Jizzi basin by constructing a detention dam and dispersion facilities and 2) to establish monitoring system in order to verify relationship between discharge from the detention dam and groundwater in the basin.

The detention dam and monitors include the following facilities:

- Detention dam body
- Spillways including emergency facility
- Outlets conduit including emergency conduit
- Dispersion facilities
- Water gauge in the reservoir of the detention dam
- Automatic groundwater level gauges.

3.2 Water Resources Development Plan

3.2.1 Development Plan

The basic concept of the water resources development is to augment the groundwater recharge to the alluvial aquifer by constructing a detention dam at D-2 site as stated in the previous paragraph.

1) Design Flood Volume

The continuous observation records of floods in the Project Area are not available. Only the rainfall records from 1974 to 1984 are available for estimating the frequency of floods. The 20 percent excess probability is adopted for the design flood volume. As already mentioned in the Section 2.1.4, the frequency analysis of single event flood volume was made. The flood volume with 20 percent excess probability was estimated at 5.4 MCM.

2) Capacity of Reservoir

A reservoir capacity should be so decided as to retain the run-off of the single design flood and is usually based on a water balance study on the inflow to and outflow from the reservoir through the conduit. However, the total design flood volume is adopted as a design capacity of the reservoir for the safety because of the lack of complete hydrograph. Thus, the storage capacity of the detention reservoir is decided at 5.4 MCM.

3) Design Peak Flood

In general, a design flood is determined, taking into consideration of economic and hydrologic factors. The design flood is usually selected by exercise of engineering judgment after consideration of the pertinent facts, which are represented by streamflow records of either computed from precipitation or by application of hydrologic principles to measured physical factors or directly observed and analyzed to the best apply to particular situation.

Major dams may be designed for a flood with a recurrence interval of several hundred years. If the dam is to be located immediately upstream from a large city where its failure could result in large loss of life or property, or if the dam structure is strictly to be protected from unforeseen even of large flood and economic and other circumstances allow, its design may even be based on the maximum probable (or possible) flood.

Frequency analyses of streamflow data are not satisfactory in such cases because: (1) they are of necessity based on the relatively short records, and the curves must be extrapolated considerably to estimate flood magnitudes for large recurrence intervals, and (2) they do not indicate whether the flood magnitudes estimated in this fashion are meteorologically or hydrologically possible.

The study is, therefore, based on hydro-meteorological procedures which analyse the basic factors of major floods inclusive of storm rainfalls. They are maximized to their upper physical limits consistent with current accepted meteorological and hydrologic knowledge and experience, and reassembled into more critical but meteorologically acceptable combinations or chronological sequences to provide the maximum probable flood.

"The Criteria and Practices Utilized in Determining the Required Capacity of Spillways" published in 1970 by United States Committee of International Commission on Large Dams states that (1) the Probable Maximum Flood (PMF) identifies estimates of hypothetical flood characteristics that are considered to be the most severe "reasonably possible" at a particular location, based on relatively comprehensive hydrometeorological analyses of critical runoff-producing precipitation (and snowmelt, if pertinent) and hydrologic factors favorable for the maximum flood run-off, and that (2) the Standard Project Flood (SPF) represents critical concentrations of run-off from the most severe combination of precipitation (and snowmelt, if pertinent) that is considered "reasonably characteristic" of the drainage basin involved. The SPF peak discharge and volume is usually equal to about 40% to 60% of the PMF estimate for the same drainage basin, when the comparison is related to rainfall concentrated in approximately 4 days or less.

In consequence for the Project, the spillway design discahrge was taken at 60% of the maximum probable flood as discussed in 2.1.4, and also analyzed value of 7,800 cu.m/sec was defined as the maximum probable flood with extremity of safety taking into account the great importance of the Project.

- Spillway Design Discharge = 7,800 cu.m/sec x 60%
  = 4,680 cu.m/sec
  ≑ 4,700 cu.m/sec
- Maximum Probable Flood with Extremity of Safety
  = 7,800 cu.m/sec

4) Annual Flood Inflow

The relationship between single flood volume and rainfall was as described in the Section 2.1.4 Surface Water. From this relation, a flood discharge volume was calculated based on the areal rainfall from 1974 to 1983. The annual flood inflow to the reservoir is shown in Table 2-2.

5) Design Discharge Rate of Release Flow

The discharge rate of release flow through the conduit of the dam should be so decided as to ensure the maximum possible infiltration in the downstream of the Wadi course. The maximum discharge rate was estimated at 13 cu.m/sec. Two steel lines (one is for emergency) of 1,500 mm in diameter will be constructed at the base of the dam body in order to use as outlet conduits. The conduits will function without any mechanical device.

Reservoir-emptying time was estimated on the assumption that there would be neither seepage loss nor evaporation loss. Starting from the full water elevation and neglecting further inflow above the spillway crest, estimated reservoir-emptying time through the conduit is illustrated in Figure 3-1. Stored flood water at the full water level will remain in the reservoir for seven days.

3.2.2 Water Balance in the Basin

(1) Present Water Balance

Combining every aspect obtainable from analyses of hydrology as well as groundwater, the present status of water balance in the entire Wadi Jizzi basin can be described briefly as visualized in Figure 3-2. Aiming at easy understandings, some short explanations for each item as given in the said figure are supplemented as under;

Item No.	Description
1	Average annual area rainfall at the dam (CA=812 km^2) as given in Tables A-3-4 (Annex A-3)
2	Total rain water: 128 mm/yr x 812 km^2 = 103.94 MCM/yr
3	Falaj use: 0.12 lit/sec/km^2 (Refer to Para. 2.2.4 1)) = 0.12 lit/sec/km^2 x 812 km^2 = 3.07 MCM/yr
4	Base flow: 0.13 lit/sec/km^2 (Para. 2.2.4 1)) x 812 km^2 = 3.33 MCM/yr
5	Surface runoff at the dam (See Table 2-2)
6	Loss due to evapotranspiration = 2 - (3+ 4 + 5)
7	Average annual area rainfall below dam (CA = 471 km^2) as given in Table A-3-4 (Annex A-3)
8	Total rain water: 110 mm/yr x 471 km^2 = 51.81 MCM/yr
9	Expected surface runoff below dam = Expected runoff at river mouth (Table A-3-10) - Surface runoff at the dam = 9.94 - 6.63 = 3.32 MCM/yr
10	Direct recharge of rain water = Average specific base flow discharge (7.9 mm/yr) x 471 km^2 = 3.72 MCM/yr
11	Surface runoff at river month (See Table 2-3)
12	Groundwater recharge from surface water = 6.63 + 3.31 - 3.47 = 6.47 MCM/yr
13	Present groundwater imbalance (Refer to Para 2.3 7))
14	Groundwater runoff to sea (Refer to Para. 2.3 8))
15	Irrigation water requirement after consideration of irrigation efficiency, application rate and effective rainfall (See Annex A-5)
16	Effective rainfall (involved in calculation of irrigation water requirement)
17	Present domestic use (rough estimation based onfield investigation)

18	Groundwater extraction = 11.03 + 0.20 = 11.23 MCM/yr
19	Loss due to evapotranspiration = 8 - (9 + 10 + 16)

(2) Projected Water Balance in 1987

Domestic water demands as of 1987 for the area between the Wadi Al Khadaq and Majis have been estimated at 0.95 MCM/annum as shown below;

Total number of inhabitants	: 20,800 persons
Water consumption per head	: 100 lit/day
Total demand	: 0.95 MCM 1/
Present Water Consumption	: 0.20 MCM
Increase	: 0.75 MCM

1/ inclusive of 25 percent of the water loss

In the above estimation, the following presumption has been made; 1) the population in the area will increase to about 20,800 by 1987 at an average growth rate of three percent, Agricultural Census, 1978/1979 reveals the population of about 16,000 and 2) water resources development exclusively for domestic water supply shall be undertaken before 1987.

With regard to industrial water demand, the Sohar Copper Project has been utilizing ground water with pumps of total capacity of 70 cu.m/hr at two sites in the Wadi Jizzi basin. The annual industrial water demand has been estimated at 0.31 MCM/annum as follows:

Plant Site	: 0.22 MCM (50 cu.m/hr x 12 hr x 365 days)
Town Site	: 0.09 MCM (20 cu.m/hr x 12 hr x 365 days)
Total	0.31 MCM

Thus, the water balance in the entire Wadi Jizzi basin as of the target year 1987 can be described as visualized in Figure 3-3. Some short explanations are also presented as in the following:

Item No.	Description
1	See Table A-3-4 (Annex A-3)
2	128 mm/yr x 812 km^2 = 103.94 MCM/yr
3	0.12 lit/sec/km^2 x 812 km^2 = 3.07 MCM/yr
4	0.13 lit/sec/km^2 x 812 km^2 = 3.33 MCM/yr
5	See Table 2-2
6	103.94 - (6.63 + 3.07 + 3.33) = 90.91 MCM/yr
7	6.63 - 0.73 = 5.90 MCM/yr (See Item No. 8)
8	Spillage from dam (Dam capacity = 5.4 MCM)

Date	Flood Volume in mm	Flood Volume in MCM	Spillage in MCM
Feb. 1976	8.60	7.0	1.6
Mar. 1976	9.85	8.0	2.6
Feb. 1982	10.50	8.5	3.1
Total			7.3
Average			0.73

Item No.	Description
9	See Table A-3-4 (Annex A-3)
10	110 mm/yr x 471 km^2 = 51.81 MCM/yr
11	9.94 (Table A-3-10) - 6.63 = 3.31 MCM/yr
12	7.9 mm/yr x 471 km^2 = 3.72 MCM/hr
13	Estimated at 0.0 under the assumption that construction of the detention dam and dispersion facilities would not allow the flood losses to be wasted to the sea on the condition that hydrologic figures not exceed analyzed averages in the past ten years.
14	8 + 11 - 13 = 0.73 + 3.31 - 0.0 = 4.04 MCM/yr
15	Present groundwater imbalance should be recovered by the Project
16	Refer to Para. 2.3 7)
17	Refer to Para. 2.3 8)
18	See Annex A-5
19	Effective rainfall which has been already involved in the calculation of irrigation water requirement
20	Present domestic water use

21	Future increase of domestic water use = 0.95 - 0.20 = 0.75 MCM/yr
22	Industrial water demand = 0.31 MCM/yr
23	Possible amount of groundwater development for unspecified purpose = 13.68 - (11.03 + 0.20 + 0.75 + 0.31)
24	Possible groundwater extraction = (4 + 7 + 12 + 14) - 17 = 3.33 + 5.90 + 3.72 + 4.04 - 3.31 = 13.68 MCM/yr
25	Loss due to evapotranspiration = 10 - (11 + 12 + 18) = 51.81 - (3.31 + 3.72 + 2.00) = 42.78 MCM/yr
26	Project Benefit = 16 + 21 + 22 + 23 = 1.02 + 0.75 + 0.31 + 1.39 = 3.47 MCM/yr

3.2.3 Water Allocation

Based upon the results of the present water balance study in the basin, the water resources developed by the Project and the proposed water demand for irrigation, domestic and industrial water uses, the water allocation in the basin is summarized as follows;

- Developed groundwater	:	(+) 3.47 MCM/annum
- Present groundwater imbalance	:	(-) 1.02
- Domestic water demand	:	(-) 0.75 1/
- Industrial water demand	:	(-) 0.31
- Water availability for unspecified purpose	:	(-) 1.39
- Water balance surplus	:	0.0

Notes: 1/ Increase of Sohar water supply as of 1987.

3.3 Monitoring System

3.3.1 Introduction

Safe yield of groundwater is defined as the amount of water which can be withdrawn annually from a groundwater basin without producing an undesired result. As the determination of safe yield is based upon specified hydrologic conditions, either existing or assumed, changes in these produce changes in the safe yield. Changes in pumping rates and locations will affect groundwater levels, which in turn modify inflow to the basin. Changes in land use could affect recharge rates. In practice, safe-yield calculations should be reexamined from time to time in terms of changing conditions within a basin and of more comprehensive hydrologic and geologic data being available.

To expect maximum beneficial use of groundwater, it will be essential to introduce monitoring system for the purpose of collecting necessary hydrologic data and information, analysing such data collected and of reflecting them in the management and administration of groundwater resources. In addition this sytem will be useful to prove possible increase of groundwater potentiality or safe yield from groundwater aquifer expected by the Project. Determination of safe yield is based upon solution of the equation of hydrologic equilibrium stating all waters entering and leaving the basin. The monitoring system is therefore to involve the following measures:

Entering Water : Surface Inflow + Subsurface Inflow + Precipitation + Imported Water + Decrease in Surface Storage + Decrease in Groundwater Storage

Leaving Water : Surface Outlfow + Subsurface Outflow + Consumptive Use + Exported Waer + Increase in Surface Storage + Increase in Groundwater Storage

To cope with the above-mentioned requirements, the monitoring system is to be facilitated by the following equipment:

(1) To measure and collect surface hydrologic data such as precipitation, evapo-transpiration and surface water discharge
(2) To monitor groundwater level and quality for the purpose of assessment of effect of recharge activities and of groundwater quality control.

The water management shall be executed under the responsibility of MAF, and, in a general term, such activities of groundwater management and monitoring are illustrated as shown in Figure 3-4.

1: The one who is constructing a new well or changing dimension of well facility in the area is requested to sbmit an application form to the responsible office not later than 60 days before construction stating location of well, depth, strainer depth, dimension of pump including capacity and proposed production of water.

2 to 4: The Office examines an application, modifies it if necessary and gives a reply. In the case when the application is approved, it will be required in view of optimal utilization of groundwater resources that installation of groundwater level gauge and/or water meter be put under obligation. In addition, methodology of observation should be unified.

5 to 6: Wells to which observation work is assigned execute measurements according to observation specification. Observation wells directly operated by the Office or Authorities concerned are also subject to the routine observation.

7: Items for observation depends upon the use of a well. Observation wells where usual operation of water pump is not expected only require observation of static water levels. On the contrary, observations of static and dynamic water levels and water production are usually requested for ordinary wells where frequent operation of pumps are needed.

8: Frequency of data sampling is recommended to be monthly by use of recording gauge. With regard to frequency of analysis of water quality, monthly interval is also recommendable. After once contamination of groundwater has been obvious, frequency should accordingly be increased. In order to maintain reliability of observed data, a staff of the Office is desirable to patrol the area and to check method of observation. The staff is also requested to exchange recording pads.

9: Observed data are submitted to the Office as soon as possible.

10: Data are arranged and analyzed by staffs of the Office, and provided so as to be utilized fully in view of optimal management of groundwater systems.

11, 12: To optimize groundwater utilization, not only management of wells but also numerical analyses of hydrologic equilibrium are needed to obtain reliable characteristics of groundwater recharge. It is therefore requested for the Office to cover observations of precipitation, discharge, percolation, evapotranspiration, etc..

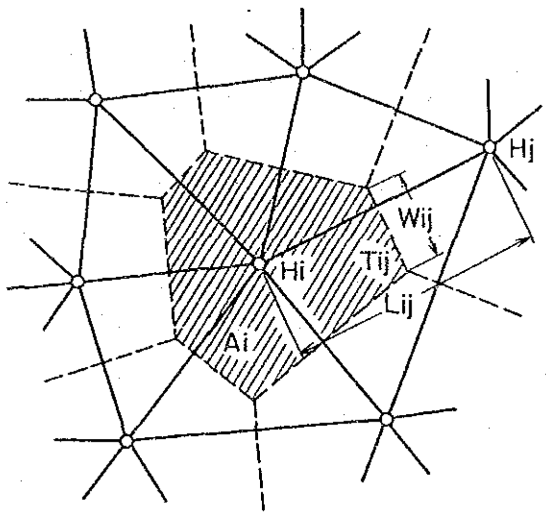
13, 14: Various observed data are investigated and analyzed by the Office. Based on this, the MAF executes administrative guidance on necessary controls regarding annual change of groundwater table, water production, available potentiality and water quality. Aiming at official announcement of information obtainable from investigation, the Office is desirable to publish monthly and annual groundwater reports.

15, 16: After operation and experience of the monitoring system over a number of years, allowable limits on depression rate of groundwater table, production of water and quality will be determined. Based on these figures, necessary guidance and control will be taken place.

3.3.2 Computer Simulation of Groundwater Basin

A general purpose digital computer is used in developing and testing a two-dimensional diffusion model of a ground-water basin, aiming at (1) the development of the model and (2) the use of the model for analyzing and predicting dynamic behavior of the basin under imposed conditions.

The groundwater basin is divided into small polygonal zones which enclose observation wells. The dynamic response of the portion of the model included within each zone is represented by a single water level elevation. The size of the zone is dependent on the variations in replenishment, extraction, transmission, storage and water level data. For purpose of testing the model against historical water level data, provision is made for the extraction or injection of time-varying flow rates from each of the zones.



Digital computer solution of the groundwater simulation system is given by an implicit numerical integration technique as under;

$$\sum_j (H_j^{t+1} - H_i^{t+1}) \cdot Y_{i,j} = \frac{Ai \cdot Si}{\Delta t}(H_i^{t+1} - H_i^t) + A_i \cdot Q_i^{t+1}$$

and $Y_{i,j} = \frac{W_{i,j} \cdot T_{i,j}}{L_{i,j}}$

In which Ai denotes the area associated with node i in sq.km, Yi,j is the conductance of pass between nodes i and j, in MCM per month per meter, Si is the storage coefficient of polygonal zone associated with node i, Qi is the volumetric flow rate per unit area at MCM per month per sq.km, Ti,j denotes the transmissibility at midpoint between nodes i and j, in MCM per month per meter, Li,j refers to the distance between nodes i and j, Wi,j describes the length of perpendicular bisector associated with nodes i and j, and t time.

Supplemental information and explanation on the technique used, as well as computer programs and other details, are presented in Annex B.

Based on the above conception, the groundwater basin is divided into a number of polygonal zones as shown in Figure 3-5 for the present (existing) condition of the basin before construction of a detention dam, as well as in Figure 3-6 for the proposed condition after project.

Among basic parameters to furnish the model, Falaj use and base flow run-off in and from the catchment of the proposed dam, direct run-off from the dam catchment as well as from residual area below dam, and direct recharge in the area are referred to in the hydrological investigations. These values are obtainable from the areal rainfall in the areas above and below the proposed dam, and hence the model requirs spot rainfall records at Daqiq, Kitnah, Hayl (Wadi Jizzi), Hayl (Wadi Hayl), Farfar and Sohar to be inputted. Groundwater recharge in each polygonal zone from the surface flow is estimated in proportion to the length of pass of percolation along the main course of the Wadi Jizzi.

Seasonal variation of irrigation water requirement to be extracted from the groundwater is obtained from the study made for evaluation of irrigation consumption. The FAO method of estimating effective rainfalls is also used to examine the balance of rain waters.

The initial water level in each observation well, permeabilities, storativity, and topographic parameters such as thickness of the permeable layers are also referred to in the findings of hydro-geological investigations.

3.3.3 Groundwater Simulation

The cases of groundwater simulation are as follows;

Case No.	Description of Simulation Condition
0	Present condition with water extraction of 11.0 MCM/yr for irrigation and 0.2 MCM/yr for domestic use.
1	Proposed condition with project, with extraction same as in the present condition.
2	In addition to the Case 1, additional water extraction of 1.06 MCM/yr for domestic use (in total 1.26 MCM/yr) is considered.
3	In addition to the Case 2, additional water extraction of 1.39 MCM/yr for irrigation purpose is considered.

All computations are made for the period of 11 years from 1974 up to 1984 on the monthly basis. The simulated results of the groundwater balance are presented in Tables 3-1, 3-2, 3-3 and 3-4 for the Cases 0, 1, 2 and 3 respectively. The simulated well water levels, in terms of summarized the simulated changes of groundwater storage for the respective cases by time, resulting in a conclusion that the Project would provide the required water demand (Case 3) without producing any undesired result on the groundwater resources.

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3	In addition to the Case 2, additional water extraction of 1.39 MCM/yr for irrigation purpose is considered.

All computations are made for the period of 11 years from 1974 up to 1984 on the monthly basis. The simulated results of the groundwater balance are presented in Tables 3-1, 3-2, 3-3 and 3-4 for the Cases 0, 1, 2 and 3, respectively. The simulated well water levels, in terms of the deviation values, are also shown in Figures 3-9 to 3-12. Figure 3-8 summarizes the simulated changes of groundwater storage for the respective cases by time, resulting in a conclusion that the Project would provide the required water demand (Case 3) without producing any undesired result on the groundwater resources.

FIGURE 3-1 RESERVOIR EMPTYING TIME

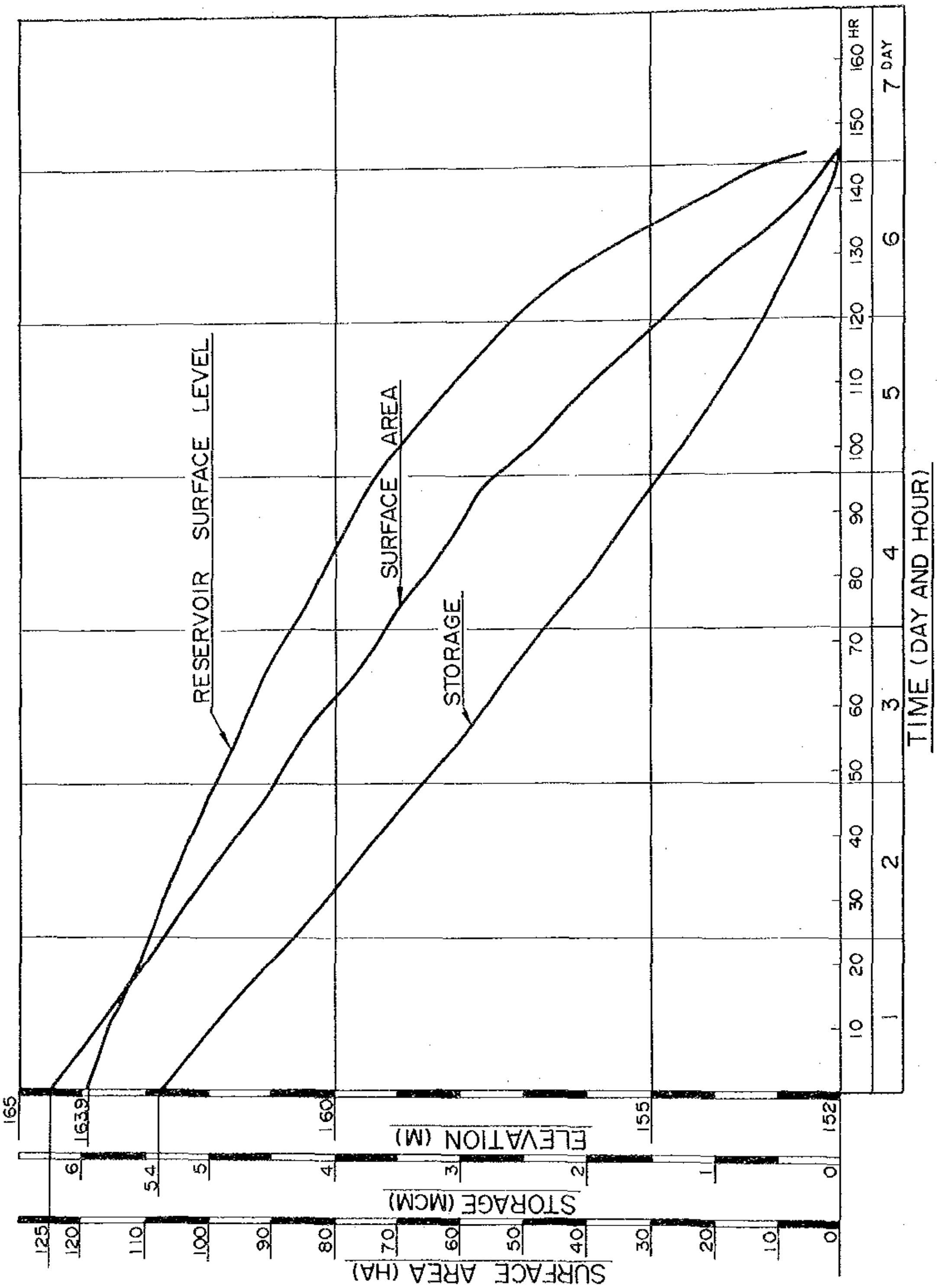


FIGURE 3-2 PRESENT WATER BALANCE (BEFORE PROJECT)

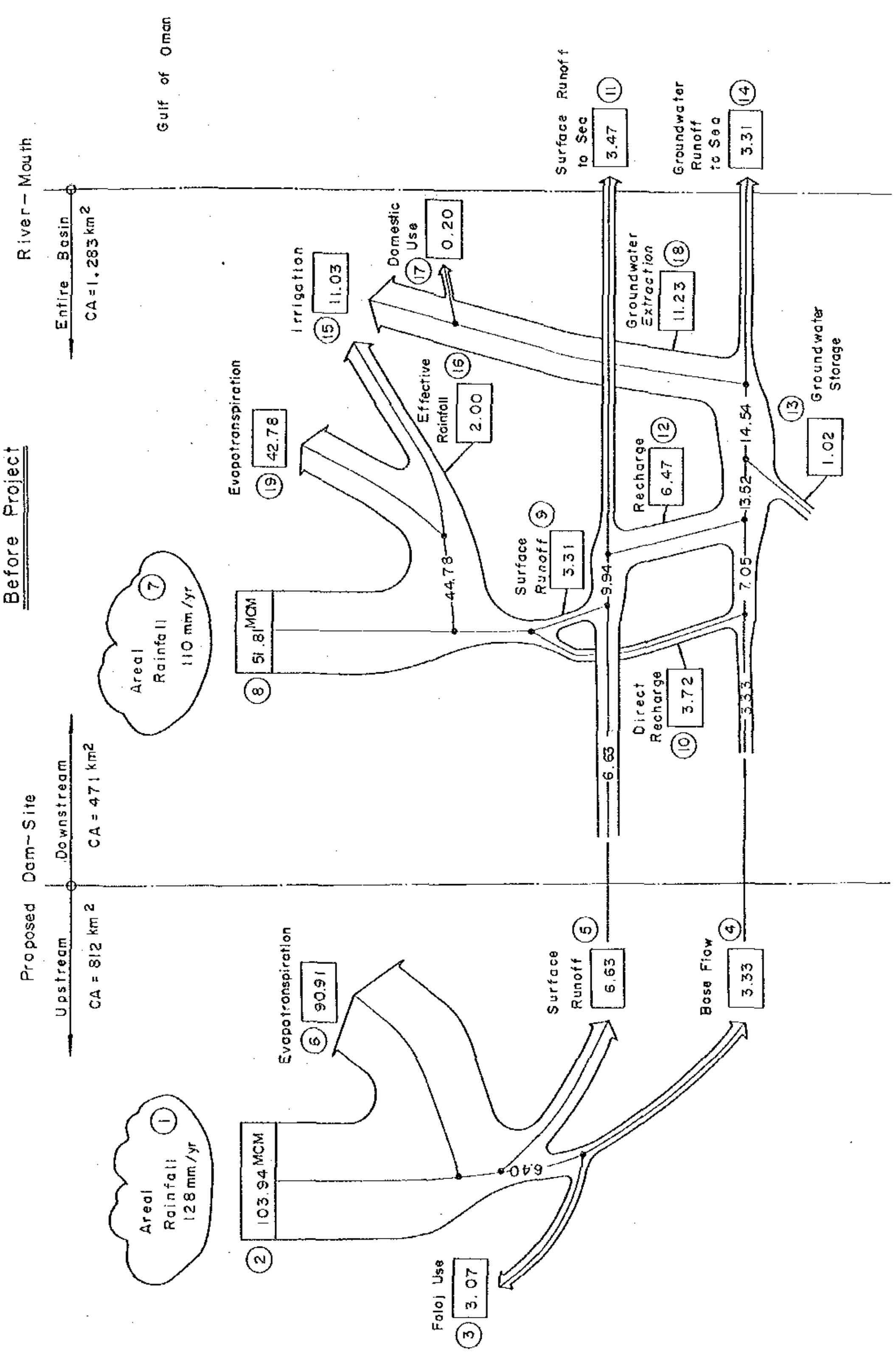


FIGURE 3-3 PROJECTED WATER BALANCE IN 1987

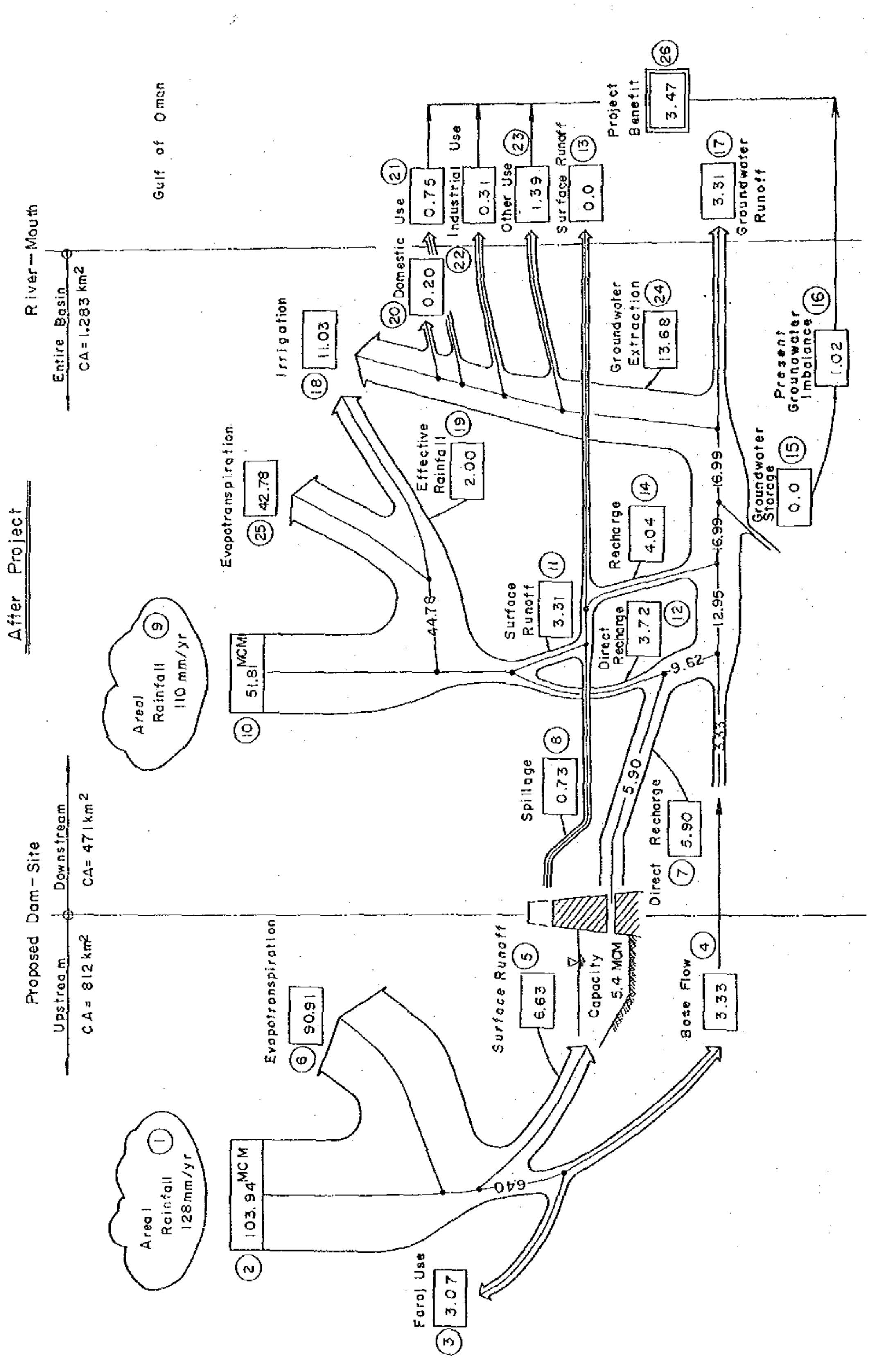


Figure 3-4 Diagram of Monitoring System

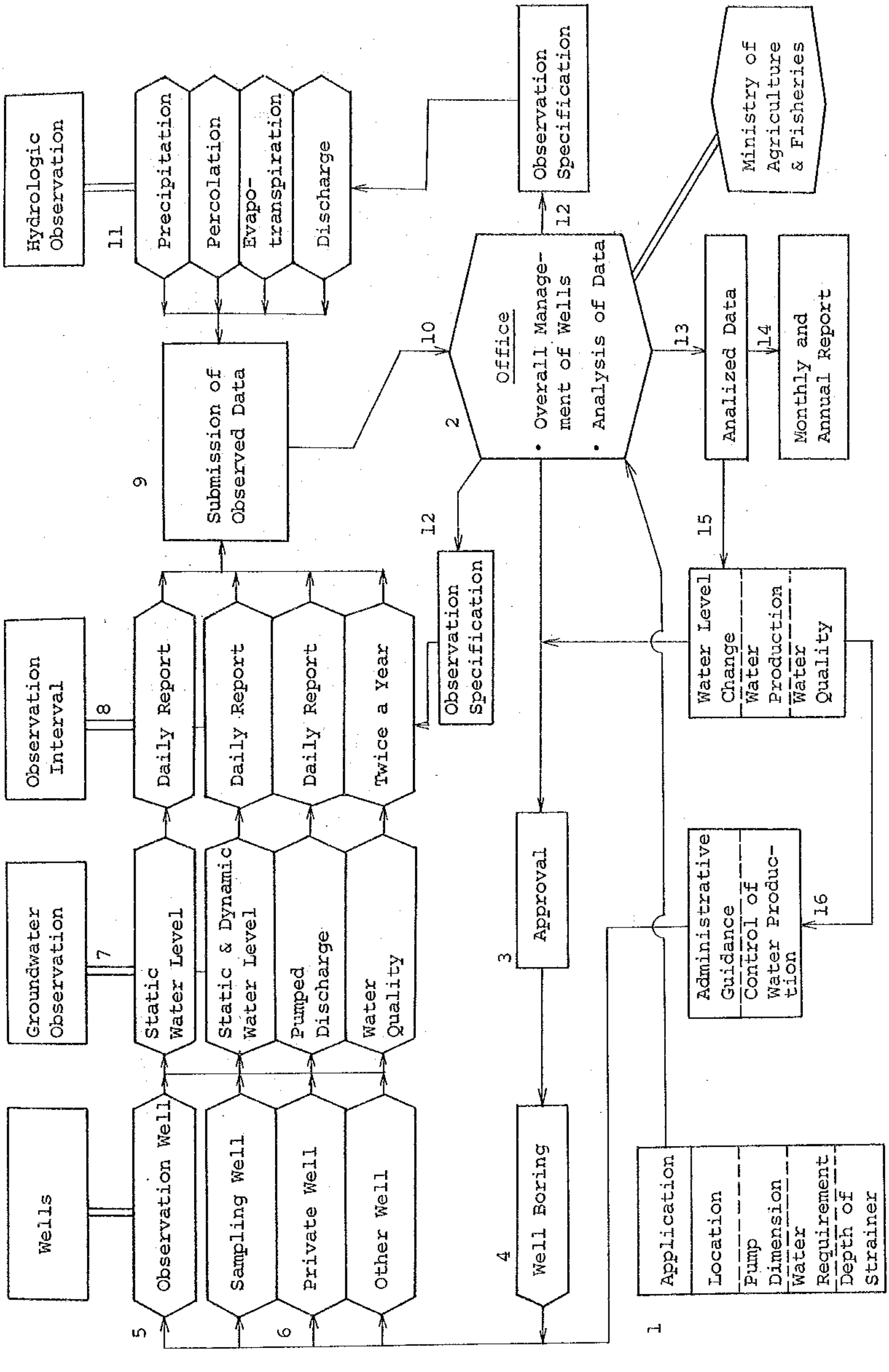


FIGURE 3-5 MODELING OF GROUNDWATER BASIN
(PRESENT CONDITION)

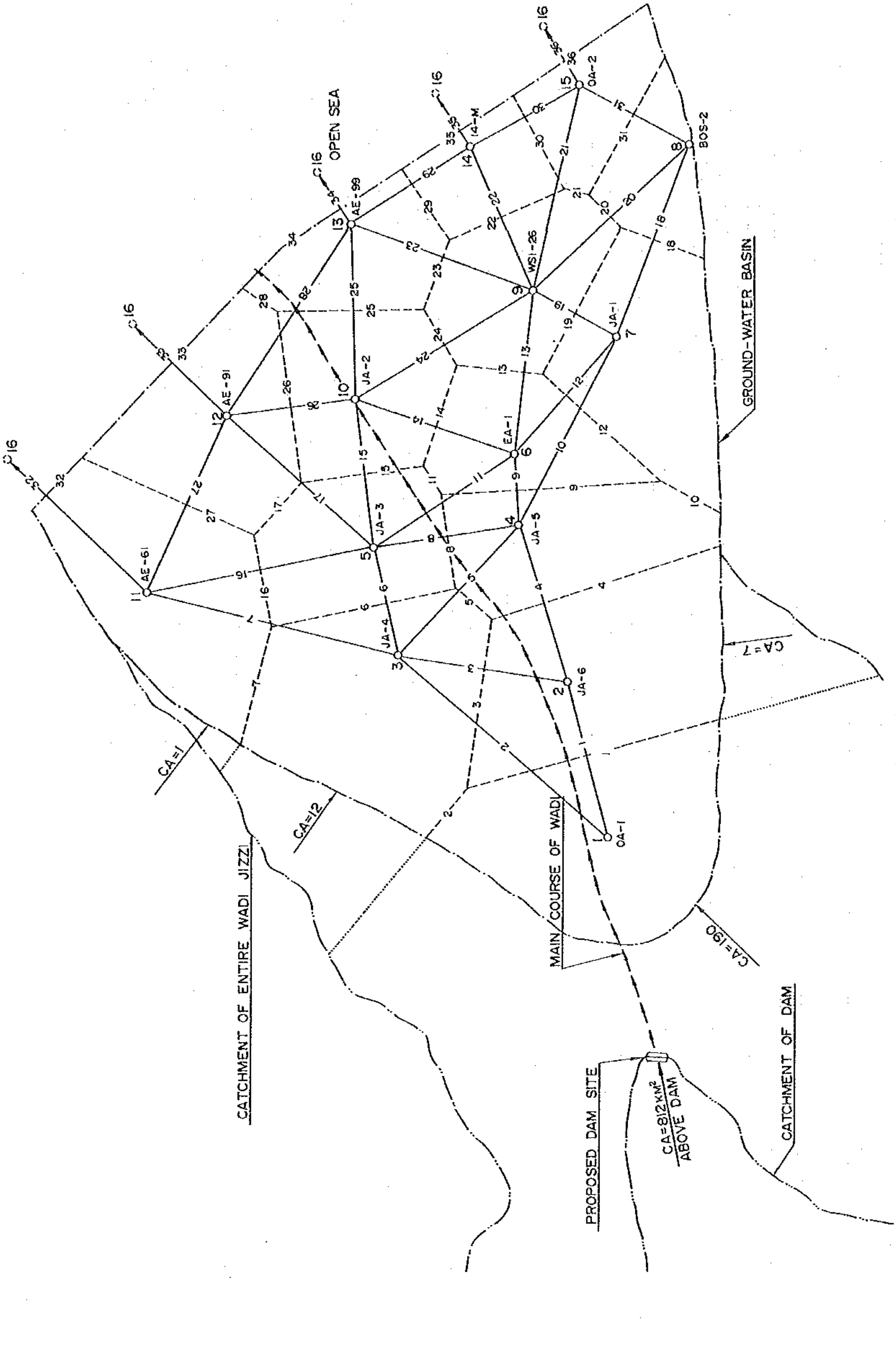


FIGURE 3-6 MODELING OF GROUNDWATER BASIN
(PROPOSED CONDITION)

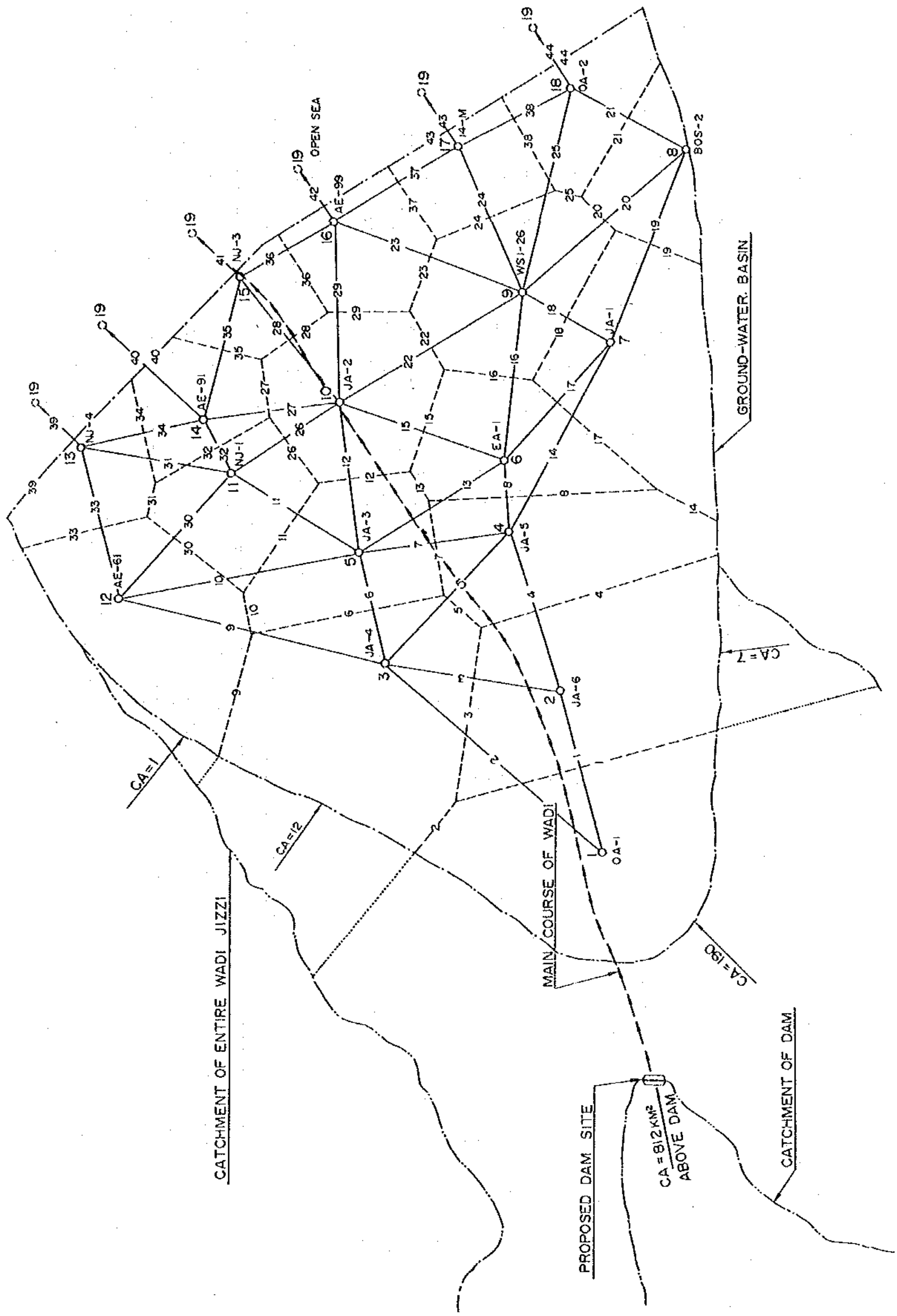


Figure 3-7 Simplified Flow Chart for Digital Computer Solution of Ground-Water Problem

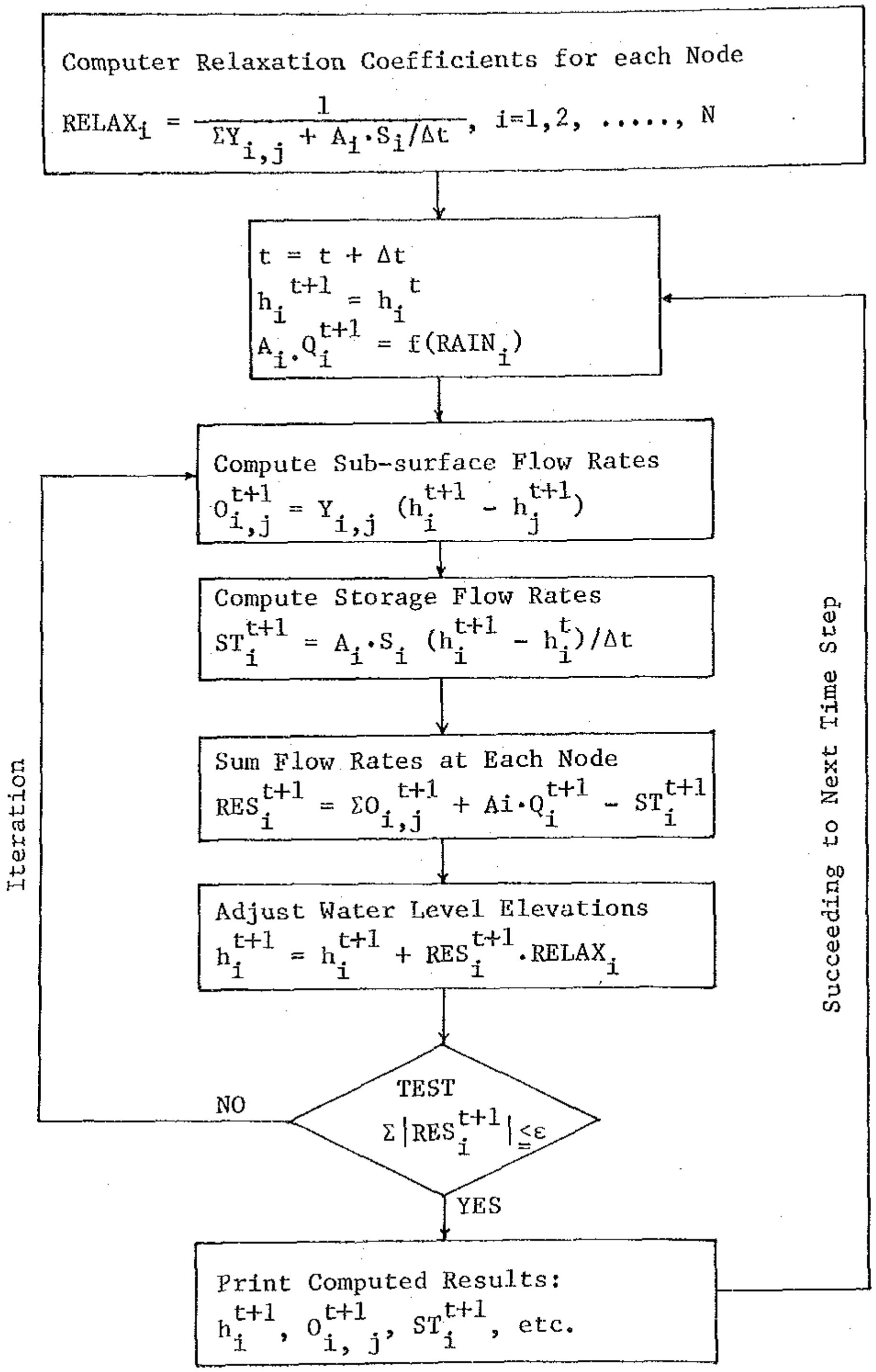
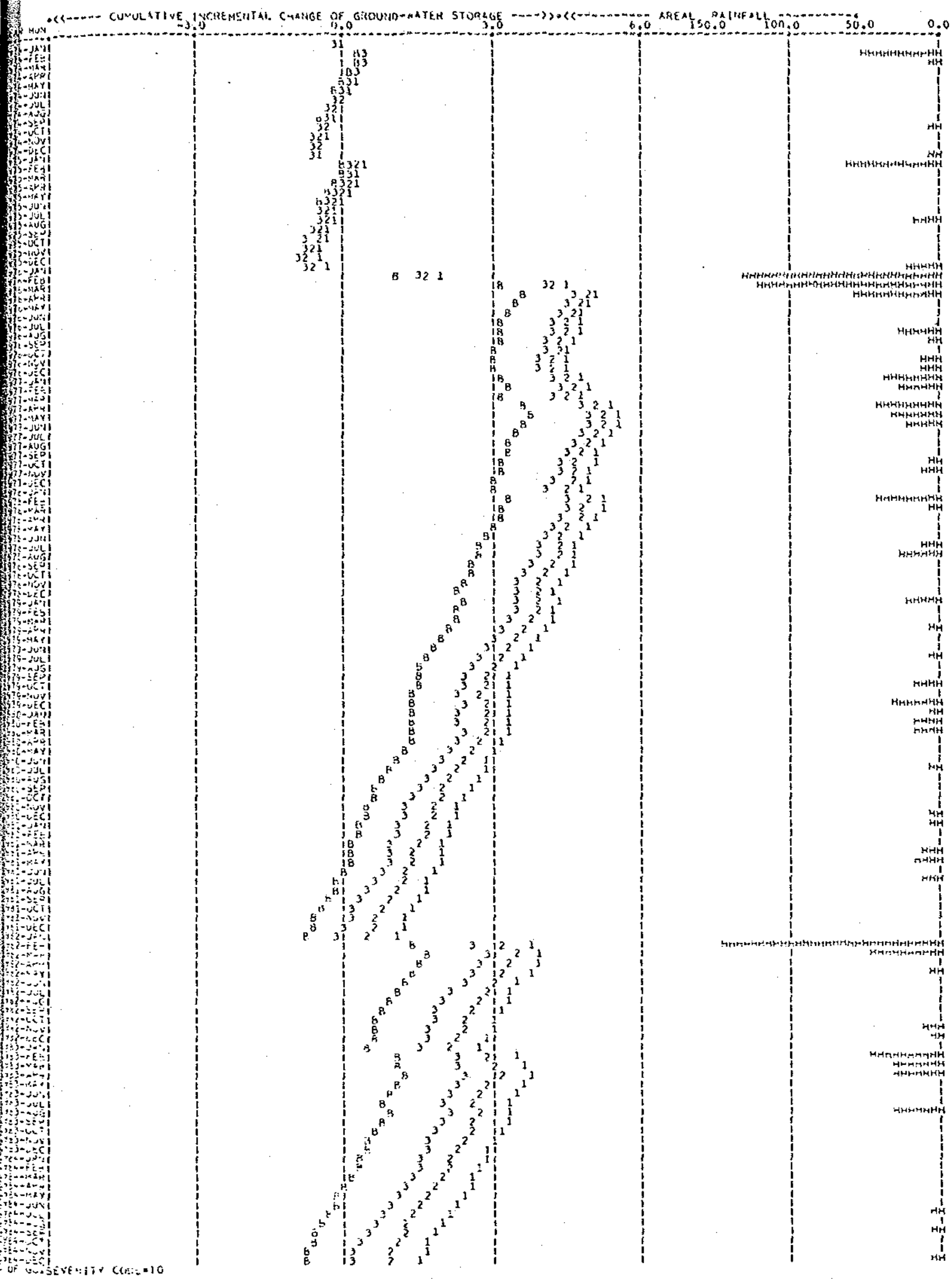
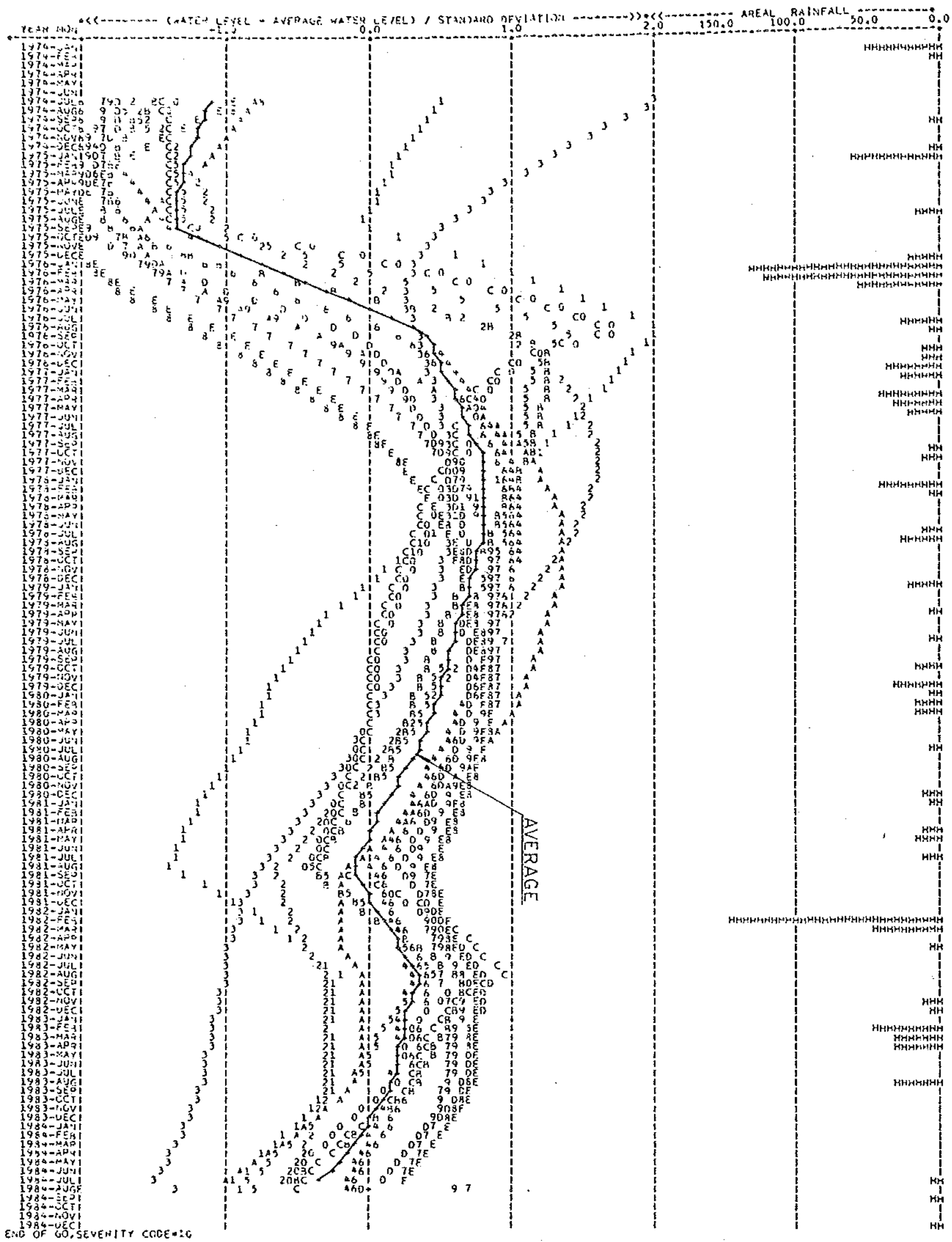


FIGURE 3-8 SIMULATED CHANGE OF GROUNDWATER STORAGE



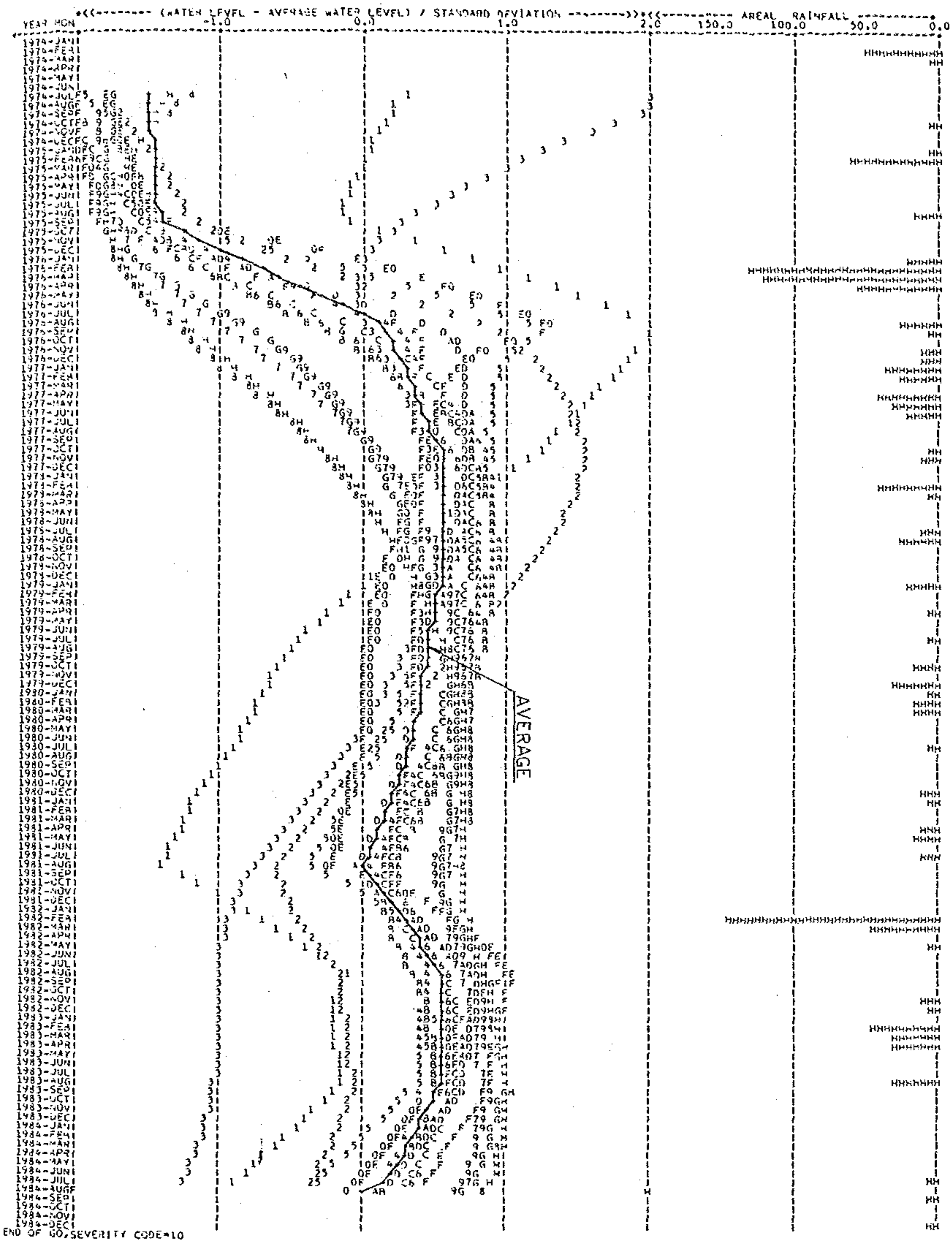
SYMBOL	DESCRIPTION
B	PRESENT CONDITION(BEFORE CONSTRUCTION OF DAM)
1	PROPOSED-1 (EXTRACTION SAME AS PRESENT)
2	PROPOSED-2 (PRESENT WATER USE + 1.26MCM/YEAR)
3	PROPOSED-3 (PRESENT USE + 1.26 + 1.39MCM/YEAR)
H	MONTHLY AREAL RAINFALL(MM)

FIGURE 3-9 DEVIATION OF GROUNDWATER LEVEL (CASE 0)
(12-MONTHS MOVING AVERAGE)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	OA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	BOS-2
9	WSI-26	0	JA-2	A	AE-61	B	AE-91
C	AE-99	D	14-M	E	OA-2	F	SEA

FIGURE 3-10 DEVIATION OF GROUNDWATER LEVEL (CASE 1) (12-MONTHS MOVING AVERAGE)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	DA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	BOS-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	DA-2	I	SEA		

*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY *** *** WADI JIZZI BASIN *** PRESENT CONDITION = BEFORE PROJECT ***

		<< ABOVE DAM					>>	<< BELOW DAM											>>
YEAR	MON	AREAL RAIN (MM)	AREAL RAIN (MCM)	FALAJ USE (MCM)	BASE FLOW (MCM)	RUN -OFF (MCM)	EVAPO -TRANS (MCM)	AREAL RAIN (MM)	AREAL RAIN (MCM)	RUN -OFF (MCM)	DRCT RECHR (MCM)	RUN -SFA (MCM)	RECHA -RGE (MCM)	STORA -GE (MCM)	G.W -SEA (MCM)	IRRIGA -TION (MCM)	OTHER USES (MCM)	EVAPO -TRANS (MCM)	EXTRAC -TION (MCM)
1974	JAN	2.9	2.35	0.07	0.08	0.0	2.20	1.4	0.64	0.0	0.05	0.0	0.0	-0.65	0.13	0.62	0.02	0.58	0.64
1974	FEB	39.7	32.25	0.95	1.03	1.92	28.34	62.9	29.63	1.77	2.13	1.74	1.95	4.53	0.17	0.40	0.02	24.58	0.41
1974	MAR	5.8	4.71	0.14	0.15	0.0	4.42	3.5	1.66	0.0	0.12	0.0	0.0	-0.73	0.19	0.80	0.02	1.49	0.82
1974	APR	2.3	1.85	0.05	0.06	0.0	1.74	0.8	0.36	0.0	0.03	0.0	0.0	-1.05	0.17	0.95	0.02	0.33	0.97
1974	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.50	0.15	1.33	0.02	0.0	1.34
1974	JUN	0.3	0.25	0.01	0.01	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.13	1.24	0.02	0.0	1.26
1974	JUL	2.0	1.61	0.05	0.05	0.0	1.51	0.0	0.0	0.0	0.0	0.0	0.0	-1.27	0.11	1.19	0.02	0.0	1.20
1974	AUG	4.0	3.21	0.09	0.10	0.0	3.01	1.1	0.53	0.0	0.04	0.0	0.0	-1.10	0.10	1.12	0.02	0.47	1.14
1974	SEP	2.1	1.68	0.05	0.05	0.0	1.57	1.0	0.45	0.0	0.03	0.0	0.0	-1.07	0.09	1.05	0.02	0.40	1.07
1974	OCT	9.6	7.81	0.23	0.25	0.0	7.32	5.0	2.33	0.0	0.17	0.0	0.0	-0.61	0.08	0.93	0.02	2.08	0.94
1974	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.83	0.08	0.73	0.02	0.0	0.75
1974	DEC	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.72	0.0	0.05	0.0	0.0	-0.69	0.09	0.64	0.02	0.65	0.66
*T		68.6	55.73	1.65	1.78	1.92	50.37	77.2	36.34	1.77	2.61	1.74	1.95	-6.35	1.49	11.00	0.20	30.58	11.20
1975	JAN	7.2	5.84	0.17	0.19	0.0	5.48	4.2	1.98	0.0	0.14	0.0	0.0	-0.40	0.09	0.62	0.02	1.77	0.64
1975	FEB	63.0	51.12	1.51	1.64	4.45	43.52	52.1	24.53	2.14	1.76	2.06	4.53	7.37	0.14	0.40	0.02	19.65	0.41
1975	MAR	0.7	0.57	0.02	0.02	0.0	0.54	0.0	0.0	0.0	0.0	0.0	0.0	-0.95	0.15	0.80	0.02	0.0	0.82
1975	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.10	0.13	0.95	0.02	0.0	0.97
1975	MAY	2.0	1.59	0.05	0.05	0.0	1.50	0.7	0.33	0.0	0.02	0.0	0.0	-1.39	0.12	1.33	0.02	0.31	1.34
1975	JUN	1.9	1.51	0.04	0.05	0.0	1.41	0.0	0.0	0.0	0.0	0.0	0.0	-1.30	0.09	1.24	0.02	0.0	1.26
1975	JUL	1.5	1.19	0.04	0.04	0.0	1.11	0.0	0.0	0.0	0.0	0.0	0.0	-1.25	0.08	1.19	0.02	0.0	1.20
1975	AUG	15.3	12.45	0.37	0.40	0.19	11.50	10.4	4.90	0.07	0.35	0.0	0.26	-0.20	0.08	1.12	0.02	4.24	1.14
1975	SEP	3.0	2.46	0.07	0.08	0.0	2.31	0.0	0.0	0.0	0.0	0.0	0.0	-1.05	0.06	1.05	0.02	0.0	1.07
1975	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.01	0.06	0.93	0.02	0.0	0.94
1975	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.81	0.06	0.73	0.02	0.0	0.75
1975	DEC	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	0.07	0.64	0.02	0.0	0.66
*T		94.5	76.72	2.27	2.46	4.64	67.36	67.4	31.74	2.21	2.28	2.06	4.79	-2.84	1.16	11.00	0.20	25.96	11.20
1976	JAN	26.8	21.79	0.64	0.70	1.06	19.38	9.5	4.47	0.22	0.32	0.48	0.80	1.09	0.09	0.62	0.02	3.75	0.64
1976	FEB	138.4	112.35	3.32	3.60	11.75	93.68	123.4	58.12	6.08	4.17	5.99	11.84	18.97	0.23	0.40	0.02	45.75	0.41
1976	MAR	142.5	115.70	3.42	3.71	17.42	91.15	77.9	36.69	5.53	2.64	4.50	18.44	23.52	0.45	0.80	0.02	27.10	0.82
1976	APR	53.6	43.52	1.29	1.39	3.40	37.44	58.6	27.60	2.16	1.98	1.87	3.68	5.62	0.47	0.95	0.02	22.30	0.97
1976	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.79	0.44	1.33	0.02	0.0	1.34
1976	JUN	1.7	1.41	0.04	0.05	0.0	1.32	0.0	0.0	0.0	0.0	0.0	0.0	-1.60	0.39	1.24	0.02	0.0	1.26
1976	JUL	4.4	3.58	0.11	0.11	0.0	3.36	0.5	0.25	0.0	0.02	0.0	0.0	-1.44	0.37	1.19	0.02	0.23	1.20
1976	AUG	29.5	23.94	0.71	0.77	0.45	22.02	12.1	5.71	0.11	0.41	0.0	0.55	0.24	0.36	1.12	0.02	4.92	1.14
1976	SEP	4.1	3.33	0.10	0.11	0.0	3.12	1.4	0.65	0.0	0.05	0.0	0.0	-1.24	0.32	1.05	0.02	0.57	1.07
1976	OCT	0.0	0.0	0.0	0.0	0.0	0.0	5.7	2.68	0.0	0.19	0.0	0.0	-1.07	0.32	0.93	0.02	2.38	0.94
1976	NOV	13.5	10.96	0.32	0.35	0.28	10.01	6.1	2.89	0.07	0.21	0.0	0.35	-0.15	0.31	0.73	0.02	2.49	0.75
1976	DEC	6.3	5.14	0.15	0.16	0.0	4.82	12.2	5.74	0.0	0.41	0.0	0.0	-0.40	0.32	0.64	0.02	5.09	0.66
*T		420.8	341.71	10.10	10.94	34.36	286.31	307.4	144.81	14.16	10.40	12.84	35.67	41.73	4.08	11.00	0.20	114.59	11.20
1977	JAN	25.5	20.73	0.61	0.66	0.56	18.89	56.1	26.44	0.72	1.90	0.92	0.36	1.94	0.34	0.62	0.02	22.79	0.64
1977	FEB	25.9	21.03	0.62	0.67	0.88	18.85	26.2	12.35	0.52	0.89	0.39	1.02	1.83	0.33	0.40	0.02	10.42	0.41
1977	MAR	0.8	0.64	0.02	0.02	0.0	0.60	1.8	0.85	0.0	0.06	0.0	0.0	-1.09	0.36	0.80	0.02	0.77	0.82
1977	APR	39.0	31.64	0.94	1.01	2.64	27.05	41.9	19.73	1.65	1.42	1.69	2.60	3.69	0.37	0.95	0.02	15.77	0.97
1977	MAY	33.8	27.43	0.81	0.88	2.06	23.68	22.0	10.36	0.78	0.74	1.07	1.77	1.67	0.38	1.33	0.02	8.32	1.34
1977	JUN	22.9	18.60	0.55	0.60	0.26	17.20	10.1	4.74	0.07	0.34	0.0	0.32	-0.35	0.35	1.24	0.02	4.11	1.26
1977	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.55	0.35	1.19	0.02	0.0	1.20
1977	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.47	0.33	1.12	0.02	0.0	1.14
1977	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.31	1.05	0.02	0.0	1.07
1977	OCT	3.9	3.19	0.09	0.10	0.0	2.99	1.9	0.91	0.0	0.07	0.0	0.0	-1.10	0.32	0.93	0.02	0.82	0.94
1977	NOV	8.9	7.25	0.21	0.23	0.05	6.75	16.9	7.97	0.05	0.57	0.0	0.10	-0.16	0.32	0.73	0.02	7.00	0.75
1977	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.07	0.0	0.00	0.0	0.0	-0.98	0.33	0.64	0.02	0.06	0.66
*T		160.7	130.51	3.86	4.18	6.46	116.01	177.1	83.43	3.78	5.99	4.07	6.17	1.04	4.10	11.00	0.20	70.06	11.20
1978	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.98	0.34	0.62	0.02	0.0	0.64
1978	FEB	39.9	32.42	0.96	1.04	2.35	28.07	37.4	17.60	1.28	1.26	1.44	2.18	3.73	0.34	0.40	0.02	14.31	0.41
1978	MAR	4.6	3.72	0.11	0.12	0.0	3.49	5.3	2.51	0.0	0.18	0.0	0.0	-0.90	0.38	0.80	0.02	2.24	0.82
1978	APR	3.0	2.41	0.07	0.08	0.0	2.26	3.0	1.40	0.0	0.10	0.0	0.0	-1.15	0.36	0.95	0.02	1.24	0.97
1978	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.70	0.35	1.33	0.02	0.0	1.34
1978	JUN	1.9	1.51	0.04	0.05	0.0	1.42	0.9	0.41	0.0	0.03	0.0	0.0	-1.50	0.32	1.24	0.02	0.38	1.26
1978	JUL	16.4	13.32	0.39	0.43	0.0	12.50	4.6	2.17	0.0	0.16	0.0	0.0	-0.95	0.32	1.19	0.02	1.92	1.20
1978	AUG	30.0	24.37	0.72	0.78	0.27	22.60	13.8	6.48	0.07	0.47	0.0	0.34	0.12	0.32	1.12	0.02	5.63	1.14
1978	SEP	2.1	1.70	0.05	0.05	0.0	1.59	0.0	0.0	0.0	0.0	0.0	0.0	-1.32	0.31	1.05	0.02	0.0	1.07
1978	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.26	0.31	0.93	0.02	0.0	0.94
1978	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.06	0.31	0.73	0.02	0.0	0.75
1978	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.10	0.0	0.01	0.0	0.0	-0.98	0.33	0.64	0.02	0.09	0.66
*T		97.8	79.44	2.35	2.54	2.62	71.93	65.1	30.67	1.35	2.20	1.44	2.52	-7.93	4.00	11.00	0.20	25.81	11.20
1979	JAN	21.6	17.52	0.52	0.56	0.24	16.20	20.3	9.56	0.13	0.69	0.17	0.20	0.46	0.34	0.62	0.02	8.35	0.64
1979	FEB	1.2	0.96	0.03	0.03	0.0	0.90	0.0	0.0	0.0	0.0	0.0	0.0	-0.70	0.32	0.40	0.02	0.0	0.41
1979	MAR	1.3	1.03	0.03	0.03	0.0	0.97	1.6	0.74	0.0	0.05	0.0	0.0	-1.09	0.35	0.80	0.02	0.68	0.82
1979	APR	4.3	3.50	0.10	0.11	0.0	3.28	3.8	1.80	0.0	0.13	0.0	0.0	-1.07	0.34	0.95	0.02	1.60	0.97

TABLE 3-1 SUMMARY OF GROUNDWATER SIMULATION (CASE 0)

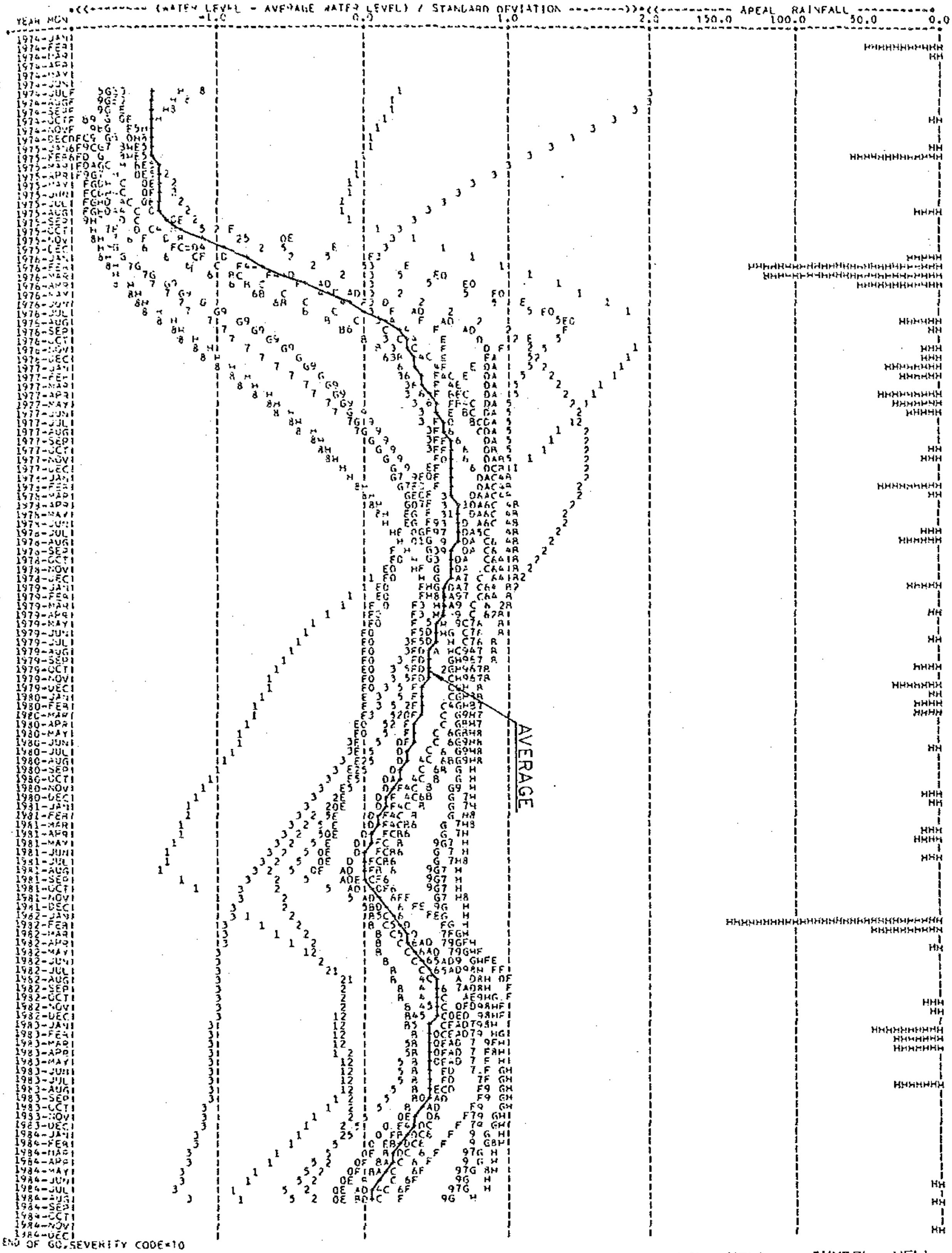
1974	APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1974	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1974	JUN	0.3	0.25	0.01	0.01	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.13	1.24	0.02	0.0	1.26
1974	JUL	2.0	1.61	0.05	0.05	0.0	1.51	0.0	0.0	0.0	0.0	0.0	0.0	-1.27	0.11	1.19	0.02	0.0	1.20
1974	AUG	4.0	3.21	0.09	0.10	0.0	3.01	1.1	0.53	0.0	0.04	0.0	0.0	-1.10	0.10	1.12	0.02	0.47	1.14
1974	SEP	2.1	1.68	0.05	0.05	0.0	1.57	1.0	0.45	0.0	0.03	0.0	0.0	-1.07	0.09	1.05	0.02	0.40	1.07
1974	OCT	9.6	7.81	0.23	0.25	0.0	7.32	5.0	2.33	0.0	0.17	0.0	0.0	-0.61	0.08	0.93	0.02	2.08	0.94
1974	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.83	0.08	0.73	0.02	0.0	0.75
1974	DEC	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.72	0.0	0.05	0.0	0.0	-0.69	0.09	0.64	0.02	0.65	0.66
*T		68.6	55.73	1.65	1.78	1.92	50.37	77.2	36.34	1.77	2.61	1.74	1.95	-6.35	1.49	11.00	0.20	30.58	11.20
1975	JAN	7.2	5.84	0.17	0.19	0.0	5.48	4.2	1.98	0.0	0.14	0.0	0.0	-0.40	0.09	0.62	0.02	1.77	0.64
1975	FEB	63.0	51.12	1.51	1.64	4.45	43.52	52.1	24.53	2.14	1.76	2.06	4.53	7.37	0.14	0.40	0.02	19.65	0.41
1975	MAR	0.7	0.57	0.02	0.02	0.0	0.54	0.0	0.0	0.0	0.0	0.0	0.0	-0.95	0.15	0.80	0.02	0.0	0.82
1975	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.10	0.13	0.95	0.02	0.0	0.97
1975	MAY	2.0	1.59	0.05	0.05	0.0	1.50	0.7	0.33	0.0	0.02	0.0	0.0	-1.39	0.12	1.33	0.02	0.31	1.34
1975	JUN	1.9	1.51	0.04	0.05	0.0	1.41	0.0	0.0	0.0	0.0	0.0	0.0	-1.30	0.09	1.24	0.02	0.0	1.26
1975	JUL	1.5	1.19	0.04	0.04	0.0	1.11	0.0	0.0	0.0	0.0	0.0	0.0	-1.25	0.08	1.19	0.02	0.0	1.20
1975	AUG	15.3	12.45	0.37	0.40	0.19	11.50	10.4	4.90	0.07	0.35	0.0	0.26	-0.20	0.08	1.12	0.02	4.24	1.14
1975	SEP	3.0	2.46	0.07	0.08	0.0	2.31	0.0	0.0	0.0	0.0	0.0	0.0	-1.05	0.06	1.05	0.02	0.0	1.07
1975	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.01	0.06	0.93	0.02	0.0	0.94
1975	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.81	0.06	0.73	0.02	0.0	0.75
1975	DEC	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	0.07	0.64	0.02	0.0	0.66
*T		94.5	76.72	2.27	2.46	4.64	67.36	67.4	31.74	2.21	2.28	2.06	4.79	-2.84	1.16	11.00	0.20	25.96	11.20
1976	JAN	26.8	21.79	0.64	0.70	1.06	19.38	9.5	4.47	0.22	0.32	0.48	0.80	1.09	0.09	0.62	0.02	3.75	0.64
1976	FEB	138.4	112.35	3.32	3.60	11.75	93.68	123.4	58.12	6.08	4.17	5.99	11.84	18.97	0.23	0.40	0.02	45.75	0.41
1976	MAR	142.5	115.70	3.42	3.71	17.42	91.15	77.9	36.69	5.53	2.64	4.50	18.44	23.52	0.45	0.80	0.02	27.10	0.82
1976	APR	53.6	43.52	1.29	1.39	3.40	37.44	58.6	27.60	2.16	1.98	1.87	3.68	5.62	0.47	0.95	0.02	22.30	0.97
1976	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.79	0.44	1.33	0.02	0.0	1.34
1976	JUN	1.7	1.41	0.04	0.05	0.0	1.32	0.0	0.0	0.0	0.0	0.0	0.0	-1.60	0.39	1.24	0.02	0.0	1.26
1976	JUL	4.4	3.58	0.11	0.11	0.0	3.36	0.5	0.25	0.0	0.02	0.0	0.0	-1.44	0.37	1.19	0.02	0.23	1.20
1976	AUG	29.5	23.94	0.71	0.77	0.45	22.02	12.1	5.71	0.11	0.41	0.0	0.55	0.24	0.36	1.12	0.02	4.92	1.14
1976	SEP	4.1	3.33	0.10	0.11	0.0	3.12	1.4	0.65	0.0	0.05	0.0	0.0	-1.24	0.32	1.05	0.02	0.57	1.07
1976	OCT	0.0	0.0	0.0	0.0	0.0	0.0	5.7	2.68	0.0	0.19	0.0	0.0	-1.07	0.32	0.93	0.02	2.38	0.94
1976	NOV	13.5	10.96	0.32	0.35	0.28	10.01	6.1	2.89	0.07	0.21	0.0	0.35	-0.15	0.31	0.73	0.02	2.49	0.75
1976	DEC	6.3	5.14	0.15	0.16	0.0	4.82	12.2	5.74	0.0	0.41	0.0	0.0	-0.40	0.32	0.64	0.02	5.09	0.66
*T		420.8	341.71	10.10	10.94	34.36	286.31	307.4	144.81	14.16	10.40	12.84	35.67	41.73	4.08	11.00	0.20	114.59	11.20
1977	JAN	25.5	20.73	0.61	0.66	0.56	18.89	56.1	26.44	0.72	1.90	0.92	0.36	1.94	0.34	0.62	0.02	22.79	0.64
1977	FEB	25.9	21.03	0.62	0.67	0.88	18.85	26.2	12.35	0.52	0.89	0.39	1.02	1.83	0.33	0.40	0.02	10.42	0.41
1977	MAR	0.8	0.64	0.02	0.02	0.0	0.60	1.8	0.85	0.0	0.06	0.0	0.0	-1.09	0.36	0.80	0.02	0.77	0.82
1977	APR	39.0	31.64	0.94	1.01	2.64	27.05	41.9	19.73	1.65	1.42	1.69	2.60	3.69	0.37	0.95	0.02	15.77	0.97
1977	MAY	33.8	27.43	0.81	0.88	2.06	23.68	22.0	10.36	0.78	0.74	1.07	1.77	1.67	0.38	1.33	0.02	8.32	1.34
1977	JUN	22.9	18.60	0.55	0.60	0.26	17.20	10.1	4.74	0.07	0.34	0.0	0.32	-0.35	0.35	1.24	0.02	4.11	1.26
1977	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.55	0.35	1.19	0.02	0.0	1.20
1977	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.47	0.33	1.12	0.02	0.0	1.14
1977	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.31	1.05	0.02	0.0	1.07
1977	OCT	3.9	3.19	0.09	0.10	0.0	2.99	1.9	0.91	0.0	0.07	0.0	0.0	-1.10	0.32	0.93	0.02	0.82	0.94
1977	NOV	8.9	7.25	0.21	0.23	0.05	6.75	16.9	7.97	0.05	0.57	0.0	0.10	-0.16	0.32	0.73	0.02	7.00	0.75
1977	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.07	0.0	0.00	0.0	0.0	-0.98	0.33	0.64	0.02	0.06	0.66
*T		160.7	130.51	3.86	4.18	6.46	116.01	177.1	83.43	3.78	5.99	4.07	6.17	1.04	4.10	11.00	0.20	70.06	11.20
1978	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.98	0.34	0.62	0.02	0.0	0.64
1978	FEB	39.9	32.42	0.96	1.04	2.35	28.07	37.4	17.60	1.28	1.26	1.44	2.18	3.73	0.34	0.40	0.02	14.31	0.41
1978	MAR	4.6	3.72	0.11	0.12	0.0	3.49	5.3	2.51	0.0	0.18	0.0	0.0	-0.90	0.38	0.80	0.02	2.24	0.82
1978	APR	3.0	2.41	0.07	0.08	0.0	2.26	3.0	1.40	0.0	0.10	0.0	0.0	-1.15	0.36	0.95	0.02	1.24	0.97
1978	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.70	0.35	1.33	0.02	0.0	1.34
1978	JUN	1.9	1.51	0.04	0.05	0.0	1.42	0.9	0.41	0.0	0.03	0.0	0.0	-1.50	0.32	1.24	0.02	0.38	1.26
1978	JUL	16.4	13.32	0.39	0.43	0.0	12.50	4.6	2.17	0.0	0.16	0.0	0.0	-0.95	0.32	1.19	0.02	1.92	1.20
1978	AUG	30.0	24.37	0.72	0.78	0.27	22.60	13.8	6.48	0.07	0.47	0.0	0.34	0.12	0.32	1.12	0.02	5.63	1.14
1978	SEP	2.1	1.70	0.05	0.05	0.0	1.59	0.0	0.0	0.0	0.0	0.0	0.0	-1.32	0.31	1.05	0.02	0.0	1.07
1978	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.26	0.31	0.93	0.02	0.0	0.94
1978	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.06	0.31	0.73	0.02	0.0	0.75
1978	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.10	0.0	0.01	0.0	0.0	-0.98	0.33	0.64	0.02	0.09	0.66
*T		97.8	79.44	2.35	2.54	2.62	71.93	65.1	30.67	1.35	2.20	1.44	2.52	-7.93	4.00	11.00	0.20	25.81	11.20
1979	JAN	21.6	17.52	0.52	0.56	0.24	16.20	20.3	9.56	0.13	0.69	0.17	0.20	0.46	0.34	0.62	0.02	8.35	0.64
1979	FEB	1.2	0.96	0.03	0.03	0.0	0.90	0.0	0.0	0.0	0.0	0.0	0.0	-0.70	0.32	0.40	0.02	0.0	0.41
1979	MAR	1.3	1.03	0.03	0.03	0.0	0.97	1.6	0.74	0.0	0.05	0.0	0.0	-1.09	0.35	0.80	0.02	0.68	0.82
1979	APR	4.3	3.50	0.10	0.11	0.0	3.28	3.8	1.80	0.0	0.13	0.0	0.0	-1.07	0.34	0.95	0.02	1.60	0.97
1979	MAY	0.5	0.40	0.01	0.01	0.0	0.38	0.0	0.0	0.0	0.0	0.0	0.0	-1.66	0.33	1.33	0.02	0.0	1.34
1979	JUN	4.6	3.70	0.11	0.12	0.0	3.47	0.0	0.0	0.0	0.0	0.0	0.0	-1.44	0.30	1.24	0.02	0.0	1.26
1979	JUL	6.0	4.84	0.14	0.16	0.0	4.54	0.0	0.0	0.0	0.0	0.0	0.0	-1.35	0.30	1.19	0.02	0.0	1.20
1979	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.44	0.30	1.12	0.02	0.0	1.14
1979	SEP	3.7	3.01	0.09	0.10	0.0	2.82	0.0	0.0	0.0	0.0	0.0	0.0	-1.25	0.28	1.05	0.02	0.0	1.07
1979	OCT	5.6	4.52	0.13	0.14	0.0	4.24	28.3	13.32	0.0	0.96	0.0	0.0	-0.14	0.30	0.93	0.02	11.75	0.94
1979	NOV	1.7	1.42	0.04	0.05	0.0	1.33	1.5	0.73	0.0	0.05	0.0	0.0	-0.94	0.29	0.73	0.02	0.65	0.75
1979	DEC	19.5	15.84	0.47	0.51	0.04	14.83	44.2	20.83	0.05	1.50	0.46	-0.38	0.65	0.32	0.64	0.02	18.44	0.66
*T		69.9	56.74	1.68	1.82	0.27	52.97	99.8	46.99	0.18	3.37	0.64	-0.18	-9.98	3.78	11.00	0.20	41.46	11.20
1980	JAN	6.1	4.94	0.15	0.16	0.16	4.47	2.4	1.13	0.04	0.08	0.0	0.20	-0.53	0.33	0.62	0.02	0.98	0.64
1980	FEB	20.5	16.67	0.49	0.53	0.18	15.46	6.5	3.07	0.03	0.22	0.0	0.21	0.23	0.32	0.40	0.02	2.69	0.41
1980	MAR	21.8	17.71	0.52	0.57	0.70	15.91	8.7	4.09	0.16	0.29	0.30	0.57	0.26	0.35	0.80	0.02	3.47	0.82
1980	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.39	0.0	0.03	0.0	0.0	-1.27	0.33	0.95	0.02	0.36	0.97
1980	MAY	1.5	1.18	0.03	0.04	0.0	1.11	0.9	0.41	0.0	0.03	0.0	0.0	-1.60	0.32	1.33	0.02	0.38	1.34
1980	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.56	0.30	1.24	0.02	0.0	1.26
1980	JUL	10.7	8.67	0.26	0.28	0.0	8.13	3.0	1.41	0.0	0.10	0.0	0.0	-1.12	0.30	1.19	0.02	1.25	1.20
1980	AUG	0.1	0.11	0.00	0.00	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	-1.42	0.29	1.12	0.02	0.0	1.14
1980	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.34	0.27	1.05	0.02	0.0	1.07
1980	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.22	0.28	0.93	0.02	0.0	0.94
1980	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.26	0.0	0.02	0.0	0.0	-1.00	0.27	0.73	0.02	0.23	0.75
1980	DEC	9.9	8.01	0.24	0.26	0.0	7.51	4.9	2.32	0.0	0.17	0.0	0.0	-0.52	0.29	0.64	0.02	2.06	0.66
*T		70.5	57.27	1.69	1.83	1.04	52.70	27.8	13.09	0.23	0.94	0.30	0.98	-11.10	3.65	11.00	0.20	11.43	11.20
1981	JAN	3.5	2.84	0.08	0.09	0.0	2.66	4.3	2.01	0.0	0.14	0.0	0.0	-0.70	0.30	0.62	0.02	1.79	0.64
1981	FEB	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	0.28	0.40	0.02	0.0	0.41
1981	MAR	1.1	0.91	0.03	0.03	0.0	0.86	1.0	0.49	0.0	0.04	0.0	0.0	-1.06	0.30	0.80	0.02	0.46	0.82
1981	APR	10.1	8.16	0.24	0.26	0.0	7.66	16.5	7.77	0.0	0.56	0.0	0.0	-0.44	0.29	0.95	0.02	6.85	0.97
1981	MAY	17.6	14.28	0.42	0.46	0.47	12.94	14.0	6.61	0.22	0.47	0.31	0.38	-0.32	0.29	1.33	0.02	5.59	1.34
1981	JUN	2.4	1.95	0.06	0.06	0.0	1.83	0.0	0.0	0.0	0.0	0.0	0.0	-1.46	0.26	1.24	0.02	0.0	1.26
1981	JUL	12.5	10.16	0.30	0.33	0.10	9.43	7.6	3.56	0.04	0.26	0.0	0.14	-0.75	0.26	1.19	0.02	3.11	1.20
1981	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.39	0.25	1.12	0.02	0.0	1.14
1981	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.30	0.23	1.05	0.02	0.0	1.07
1981	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.18	0.24	0.93	0.02	0.0	0.94
1981	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.98	0.23	0.73	0.02	0.0	0.75
1981	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.90	0.25	0.64	0.02	0.0	0.66
*T		47.2	38.31	1.13	1.23	0.57	35.38	43.4	20.44	0.25	1.47	0.31	0.51	-11.18	3.19	11.00	0.20	17.79	11.20
1982	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.89	0.25	0.62	0.02	0.0	0.64
1982	FEB	150.9	122.56	3.62	3.93	13.82	101.19	140.4	66.11	7.45	4.75	6.18	15.09	22.94	0.41	0.40	0.02	51.52	0.41
1982	MAR	41.2	33.43	0.99	1.07	0.85	30.53	52.3	24.61	0.62	1.77	0.85	0.62	2.17	0.47	0.80	0.02	21.19	0.82
1982	APR	0.1	0.09	0.00	0.00	0.0	0.08	1.4	0.65	0.0	0.05	0.0	0.0	-1.35	0.43	0.95	0.02	0.59	0.97
1982	MAY	5.4	4.35	0.13	0.14	0.0	4.08	0.9	0.43	0.0	0.03	0.0	0.0	-1.59	0.41	1.33	0.02	0.40	1.34
1982	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.63	0.37	1.24	0.02	0.0	1.26
1982	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.57	0.36	1.19	0.02	0.0	1.20
1982	AUG	1.4	1.13	0.03	0.04	0.0	1.06	0.0	0.0	0.0	0.0	0.0	0.0	-1.45	0.34	1.12	0.02	0.0	1.14
1982	SEP	0.8	0.66	0.02	0.02	0.0	0.62	0.0	0.0	0.0	0.0	0.0	0.0	-1.37	0.32	1.05	0.02	0.0	1.07
1982	OCT	0.8	0.68	0.02	0.02	0.0	0.64	0.4	0.18	0.0	0.01	0.0	0.0	-1.23	0.32	0.93	0.02	0.17	0.94
1982	NOV	7.9	6.43	0.19	0.21	0.0	6.03	14.4	6.80	0.0	0.49	0.0	0.0	-0.37	0.31	0.73	0.02	6.02	0.75
1982	DEC	0.8	0.67	0.02	0.02	0.0	0.63	7.2	3.40	0.0	0.24	0.0	0.0	-0.72	0.32	0.64	0.02	3.02	0.66
*T		209.3	169.99	5.03	5.44	14.67	144.85	217.0	102.19	8.08	7.34	7.04	15.71	12.95	4.33	11.00	0.20	82.91	11.20
1983	JAN	3.6	2.93	0.09	0.09	0.0	2.75	0.8	0.40	0.0	0.03	0.0	0.0	-0.84	0.33	0.62	0.02	0.36	0.64
1983	FEB	42.5	34.54	1.02	1.11	3.16	29.26	53.6	25.24	2.31	1.81	2.01	3.46	5.62	0.35	0.40	0.02	20.11	0.41
1983	MAR	29.8	24.19	0.72	0.77	0.30	22.40	34.4	16.22	0.20	1.16	0.43	0.08	0.81	0.39	0.80	0.02	14.12	0.82
1983	APR	32.3	26.21	0.77	0.64	0.90	23.69	26.1	12.29	0.42	0.88	0.48	0.84	1.22	0.38	0.95	0.02	10.41	0.97
1983	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.70	0.36	1.33	0.02	0.0	1.34
1983	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.32	1.24	0.02	0.0	1.26
1983	JUL	0.4	0.35	0.01	0.01	0.0	0.33	0.0	0.0	0.0	0.0	0.0	0.0	-1.51	0.32	1.19	0.02	0.0	1.20
1983	AUG	38.3	31.09	0.92	1.00	1.42	27.75	13.3	6.25	0.29	0.45	0.66	1.05	1.04	0.32	1.12	0.02	5.21	1.14
1983	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.36	0.29	1.05	0.02	0.0	1.07
1983	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.24	0.30	0.93	0.02	0.0	0.94
1983	NOV	1.7	1.36	0.04	0.04	0.0	1.28	0.8	0.37	0.0	0.03	0.0	0.0	-0.96	0.29	0.73	0.02	0.33	0.75
1983	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.95	0.30	0.64	0.02	0.0	0.66
*T		148.6	120.68	3.57	3.87	5.79	107.46	129.0	60.76	3.22	4.36	3.58	5.43	-1.47	3.92	11.00	0.20	50.54	11.20
1984	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.13	0.0	0.01	0.0	0.0	-0.93	0.30	0.62	0.02	0.12	0.64
1984	FEB	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	0.29	0.40	0.02	0.0	0.41
1984	MAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.12	0.30	0.80	0.02	0.0	0.82
1984	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.25	0.28	0.95	0.02	0.0	0.97
1984	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.61	0.27	1.33	0.02	0.0	1.34
1984	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.50	0.24	1.24	0.02	0.0	1.26
1984	JUL	6.0	4.83	0.14	0.15	0.0	4.54	0.3	0.12	0.0	0.01	0.0	0.0	-1.28	0.24	1.19	0.02	0.11	1.20
1984	AUG	0.1	0.05	0.00	0.00	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	-1.36	0.22	1.12	0.02	0.0	1.14
1984	SEP	3.3	2.68	0.08	0.09	0.0	2.52	4.7	2.20	0.0	0.16	0.0	0.0	-1.03	0.21	1.05	0.02	1.94	1.07
1984	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.16	0.21	0.93	0.02	0.0	0.94
1984	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.95	0.21	0.73	0.02	0.0	0.75
1984	DEC	2.5	2.03	0.06	0.07	0.0	1.91	7.7	3.63	0.0	0.26	0.0	0.0	-0.55	0.22	0.64	0.02	3.22	0.66
*T		11.8	9.59	0.28	0.31	0.0	9.00	12.9	6.08	0.0	0.44	0.0	0.0	-13.46	2.99	11.00	0.20	5.40	11.20
*M		127.3	103.34	3.06	3.31	6.58	90.39	111.3	52.41	3.20	3.76	3.09	6.69	-0.78	3.34	11.00	0.20	43.32	11.20

TABLE 3-2 SUMMARY OF GROUNDWATER SIMULATION (CASE 1)

*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY *** WADI JIZZI BASIN *** PROPOSED CONDITION = AFTER PROJECT *** (UNIT = MCM/MONTH)

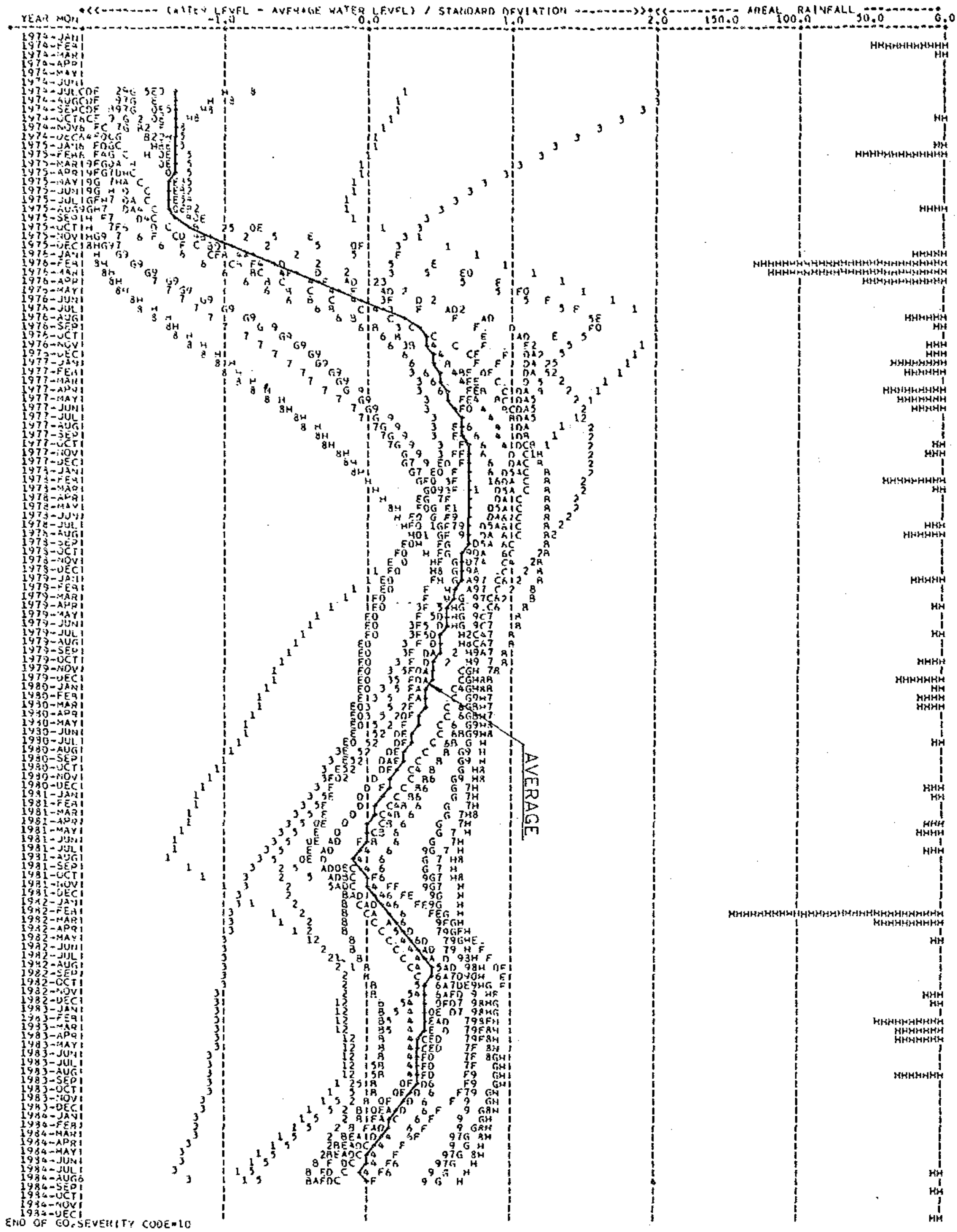
		A B O V E D A M							B E L O W D A M												
YEAR	MON	AREAL RAIN (1)	FALAJ USE (2)	BASE FLOW (3)	RUN -OFF (4)	EVAPO -TRANS (5)	DRCT RECHR (6)	SPILL -AGE (7)	AREAL RAIN (8)	RUN -OFF (9)	DRCT RECHR (10)	RUN -SEA (11)	RECHA -RGE (12)	STORA -GE (13)	G.W -SEA (14)	IRRIGA -TION (15)	OTHER USES (16)	ADD-L USES (17)	EXTRAC -TION (18)	EVAPO -TRANS (19)
1974	JAN	2.35	0.07	0.08	0.0	2.20	0.0	0.0	0.64	0.0	0.05	0.0	0.0	-0.59	0.07	0.62	0.02	0.0	0.64	0.58
1974	FEB	32.25	0.95	1.03	1.92	28.34	1.92	0.0	29.63	1.77	2.13	0.0	1.77	6.35	0.10	0.40	0.02	0.0	0.41	24.58
1974	MAR	4.71	0.14	0.15	0.0	4.42	0.0	0.0	1.66	0.0	0.12	0.0	0.0	-0.66	0.11	0.80	0.02	0.0	0.82	1.49
1974	APR	1.85	0.05	0.06	0.0	1.74	0.0	0.0	0.36	0.0	0.03	0.0	0.0	-0.99	0.11	0.95	0.02	0.0	0.97	0.33
1974	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.45	0.11	1.33	0.02	0.0	1.34	0.0
1974	JUN	0.25	0.01	0.01	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.35	0.10	1.24	0.02	0.0	1.26	0.0
1974	JUL	1.61	0.05	0.05	0.0	1.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.25	0.09	1.19	0.02	0.0	1.20	0.0
1974	AUG	3.21	0.09	0.10	0.0	3.01	0.0	0.0	0.53	0.0	0.04	0.0	0.0	-1.09	0.09	1.12	0.02	0.0	1.14	0.47
1974	SEP	1.68	0.05	0.05	0.0	1.57	0.0	0.0	0.45	0.0	0.03	0.0	0.0	-1.07	0.08	1.05	0.02	0.0	1.07	0.40
1974	OCT	7.81	0.23	0.25	0.0	7.32	0.0	0.0	2.33	0.0	0.17	0.0	0.0	-0.61	0.09	0.93	0.02	0.0	0.94	2.08
1974	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.83	0.09	0.73	0.02	0.0	0.75	0.0
1974	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.72	0.0	0.05	0.0	0.0	-0.70	0.09	0.64	0.02	0.0	0.66	0.65
*T		55.73	1.65	1.78	1.92	50.37	1.92	0.0	36.34	1.77	2.61	0.0	1.77	-4.24	1.12	11.00	0.20	0.0	11.20	30.58
1975	JAN	5.84	0.17	0.19	0.0	5.48	0.0	0.0	1.98	0.0	0.14	0.0	0.0	-0.41	0.10	0.62	0.02	0.0	0.64	1.77
1975	FEB	51.12	1.51	1.64	4.45	43.52	4.45	0.0	24.53	2.14	1.76	0.0	2.14	9.44	0.13	0.40	0.02	0.0	0.41	19.65
1975	MAR	0.57	0.02	0.02	0.0	0.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.94	0.14	0.80	0.02	0.0	0.82	0.0
1975	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.10	0.13	0.95	0.02	0.0	0.97	0.0
1975	MAY	1.59	0.05	0.05	0.0	1.50	0.0	0.0	0.33	0.0	0.02	0.0	0.0	-1.40	0.13	1.33	0.02	0.0	1.34	0.31
1975	JUN	1.51	0.04	0.05	0.0	1.41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.33	0.12	1.24	0.02	0.0	1.26	0.0
1975	JUL	1.19	0.04	0.04	0.0	1.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.28	0.11	1.19	0.02	0.0	1.20	0.0
1975	AUG	12.45	0.37	0.40	0.19	11.50	0.19	0.0	4.90	0.07	0.35	0.0	0.07	-0.24	0.11	1.12	0.02	0.0	1.14	4.24
1975	SEP	2.46	0.07	0.08	0.0	2.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.09	0.10	1.05	0.02	0.0	1.07	0.0
1975	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.05	0.11	0.93	0.02	0.0	0.94	0.0
1975	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.85	0.10	0.73	0.02	0.0	0.75	0.0
1975	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.77	0.11	0.64	0.02	0.0	0.66	0.0
*T		76.72	2.27	2.46	4.64	67.36	4.64	0.0	31.74	2.21	2.28	0.0	2.21	-1.01	1.39	11.00	0.20	0.0	11.20	25.96
1976	JAN	21.79	0.64	0.70	1.06	19.38	1.06	0.0	4.47	0.22	0.32	0.0	0.22	1.54	0.12	0.62	0.02	0.0	0.64	3.75
1976	FEB	112.35	3.32	3.60	11.75	93.68	10.17	1.59	58.12	6.08	4.17	0.0	7.66	24.98	0.21	0.40	0.02	0.0	0.41	45.75
1976	MAR	115.70	3.42	3.71	17.42	91.15	6.45	10.97	36.69	5.53	2.64	0.0	16.50	28.12	0.35	0.80	0.02	0.0	0.82	27.10
1976	APR	43.52	1.29	1.39	3.40	37.44	3.40	0.0	27.60	2.16	1.98	0.0	2.16	7.56	0.38	0.95	0.02	0.0	0.97	22.30
1976	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.72	0.38	1.33	0.02	0.0	1.34	0.0
1976	JUN	1.41	0.04	0.05	0.0	1.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.57	0.35	1.24	0.02	0.0	1.26	0.0
1976	JUL	3.58	0.11	0.11	0.0	3.36	0.0	0.0	0.25	0.0	0.02	0.0	0.0	-1.42	0.35	1.19	0.02	0.0	1.20	0.23
1976	AUG	23.94	0.71	0.77	0.45	22.02	0.45	0.0	5.71	0.11	0.41	0.0	0.11	0.24	0.35	1.12	0.02	0.0	1.14	4.92
1976	SEP	3.33	0.10	0.11	0.0	3.12	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.25	0.33	1.05	0.02	0.0	1.07	0.57
1976	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.68	0.0	0.19	0.0	0.0	-1.09	0.34	0.93	0.02	0.0	0.94	2.38
1976	NOV	10.96	0.32	0.35	0.28	10.01	0.28	0.0	2.89	0.07	0.21	0.0	0.07	-0.17	0.33	0.73	0.02	0.0	0.75	2.49
1976	DEC	5.14	0.15	0.16	0.0	4.82	0.0	0.0	5.74	0.0	0.41	0.0	0.0	-0.42	0.34	0.64	0.02	0.0	0.66	5.09
*T		341.71	10.10	10.94	34.36	286.31	21.80	12.56	144.81	14.16	10.40	0.0	26.71	54.82	3.84	11.00	0.20	0.0	11.20	114.59
1977	JAN	20.73	0.61	0.66	0.56	18.89	0.56	0.0	26.44	0.72	1.90	0.0	0.72	2.84	0.36	0.62	0.02	0.0	0.64	22.79
1977	FEB	21.03	0.62	0.67	0.88	18.85	0.88	0.0	12.35	0.52	0.89	0.0	0.52	2.21	0.34	0.40	0.02	0.0	0.41	10.42
1977	MAR	0.64	0.02	0.02	0.0	0.60	0.0	0.0	0.85	0.0	0.06	0.0	0.0	-1.11	0.38	0.80	0.02	0.0	0.82	0.77
1977	APR	31.64	0.94	1.01	2.64	27.05	2.64	0.0	19.73	1.65	1.42	0.0	1.65	5.37	0.39	0.95	0.02	0.0	0.97	15.77
1977	MAY	27.43	0.81	0.88	2.06	23.68	2.06	0.0	10.36	0.78	0.74	0.0	0.78	2.71	0.41	1.33	0.02	0.0	1.34	8.32
1977	JUN	18.60	0.55	0.60	0.26	17.20	0.26	0.0	4.74	0.07	0.34	0.0	0.07	-0.38	0.39	1.24	0.02	0.0	1.26	4.11
1977	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.59	0.39	1.19	0.02	0.0	1.20	0.0
1977	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.52	0.38	1.12	0.02	0.0	1.14	0.0
1977	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.43	0.37	1.05	0.02	0.0	1.07	0.0
1977	OCT	3.19	0.09	0.10	0.0	2.99	0.0	0.0	0.91	0.0	0.07	0.0	0.0	-1.15	0.38	0.93	0.02	0.0	0.94	0.82
1977	NOV	7.25	0.21	0.23	0.05	6.75	0.05	0.0	7.97	0.05	0.57	0.0	0.05	-0.21	0.37	0.73	0.02	0.0	0.75	7.00
1977	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.0	0.00	0.0	0.0	-1.04	0.39	0.64	0.02	0.0	0.66	0.06
*T		130.51	3.86	4.18	6.46	116.01	6.46	0.0	83.43	3.78	5.99	0.0	3.78	4.68	4.53	11.00	0.20	0.0	11.20	70.06
1978	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.03	0.39	0.62	0.02	0.0	0.64	0.0
1978	FEB	32.42	0.96	1.04	2.35	28.07	2.35	0.0	17.60	1.28	1.26	0.0	1.28	5.14	0.36	0.40	0.02	0.0	0.41	14.31
1978	MAR	3.72	0.11	0.12	0.0	3.49	0.0	0.0	2.51	0.0	0.18	0.0	0.0	-0.94	0.42	0.80	0.02	0.0	0.82	2.24
1978	APR	2.41	0.07	0.08	0.0	2.26	0.0	0.0	1.40	0.0	0.10	0.0	0.0	-1.20	0.41	0.95	0.02	0.0	0.97	1.24
1978	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.76	0.41	1.33	0.02	0.0	1.34	0.0
1978	JUN	1.51	0.04	0.05	0.0	1.42	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.57	0.39	1.24	0.02	0.0	1.26	0.38
1978	JUL	13.32	0.39	0.43	0.0	12.50	0.0	0.0	2.17	0.0	0.16	0.0	0.0	-1.02	0.40	1.19	0.02	0.0	1.20	1.92
1978	AUG	24.37	0.72	0.78	0.27	22.60	0.27	0.0	6.48	0.07	0.47	0.0	0.07	0.05	0.40	1.12	0.02	0.0	1.14	5.63
1978	SEP	1.70	0.05	0.05	0.0	1.59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.39	0.38	1.05	0.02	0.0	1.07	0.0
1978	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.34	0.39	0.93	0.02	0.0	0.94	0.0
1978	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.13	0.38	0.73	0.02	0.0	0.75	0.0
1978	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.01	0.0	0.0	-1.05	0.40	0.64	0.02	0.0	0.66	0.09
*T		79.44	2.35	2.54	2.62	71.93	2.62	0.0	30.67	1.35	2.20	0.0	1.35	-7.24	4.75	11.00	0.20	0.0	11.20	25.81
1979	JAN	17.52	0.52	0.56	0.24	16.20	0.24	0.0	9.56	0.13	0.69	0.0	0.13	0.56	0.41	0.62	0.02	0.0	0.64	8.35
1979	FEB	0.96	0.03	0.03	0.0	0.90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.76	0.38	0.40	0.02	0.0	0.41	0.0
1979	MAR	1.03	0.03	0.03	0.0	0.97	0.0	0.0	0.74	0.0	0.05	0.0	0.0	-1.15	0.42	0.80	0.02	0.0	0.82	0.68
1979	APR	3.50	0.10	0.11	0.0	3.28	0.0	0.0	1.60	0.0	0.13	0.0	0.0	-1.13	0.41	0.95	0.02	0.0	0.97	1.60
1979	MAY	0.40	0.01	0.01	0.0	0.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.74	0.41	1.33	0.02	0.0	1.34	0.0
1979	JUN	3.70	0.11	0.12	0.0	3.47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.39	1.24	0.02	0.0	1.26	0.0
1979	JUL	4.84	0.14	0.16	0.0	4.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.44	0.39	1.19	0.02	0.0	1.20	0.0
1979	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.39	1.12	0.02	0.0	1.14	0.0
1979	SEP	3.01	0.09	0.10	0.0	2.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.35	0.37	1.05	0.02	0.0	1.07	0.0
1979	OCT	4.52	0.13	0.14	0.0	4.24	0.0	0.0	13.32	0.0	0.96	0.0	0.0	-0.23	0.39	0.93	0.02	0.0	0.94	11.75
1979	NOV	1.42	0.04	0.05	0.0	1.33	0.0	0.0	0.73	0.0	0.05	0.0	0.0	-1.03	0.38	0.73	0.02	0.0	0.75	0.65
1979	DEC	15.84	0.47	0.51	0.04	14.83	0.04	0.0	20.83	0.05	1.50	0.0	0.05	1.03	0.41	0.64	0.02	0.0	0.66	18.44
*T		56.74	1.68	1.82	0.27	52.97	0.27	0.0	46.99	0.18	3.37	0.0	0.18	-10.31	4.75	11.00	0.20	0.0	11.20	41.46
1980	JAN	4.94	0.15	0.16	0.16	4.47	0.16	0.0	1.13	0.04	0.08	0.0	0.04	-0.61	0.41	0.62	0.02	0.0	0.64	0.98
1980	FEB	16.67	0.49	0.53	0.18	15.46	0.18	0.0	3.07	0.03	0.22	0.0	0.03	0.16	0.39	0.40	0.02	0.0	0.41	2.69
1980	MAR	17.71	0.52	0.57	0.70	15.91	0.70	0.0	4.09	0.16	0.29	0.0	0.16	0.48	0.43	0.80	0.02	0.0	0.82	3.47
1980	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.39	0.0	0.03	0.0	0.0	-1.35	0.41	0.95	0.02	0.0	0.97	0.36
1980	MAY	1.18	0.03	0.04	0.0	1.11	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.69	0.41	1.33	0.02	0.0	1.34	0.38
1980	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.65	0.39	1.24	0.02	0.0	1.26	0.0
1980	JUL	8.67	0.26	0.28	0.0	8.13	0.0	0.0	1.41	0.0	0.10	0.0	0.0	-1.22	0.40	1.19	0.02	0.0	1.20	1.25
1980	AUG	0.11	0.00	0.00	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.39	1.12	0.02	0.0	1.14	0.0
1980	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.44	0.37	1.05	0.02	0.0	1.07	0.0
1980	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.33	0.38	0.93	0.02	0.0	0.94	0.0
1980	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.26	0.0	0.02	0.0	0.0	-1.10	0.37	0.73	0.02	0.0	0.75	0.23
1980	DEC	8.01	0.24	0.26	0.0	7.51	0.0	0.0	2.32	0.0	0.17	0.0	0.0	-0.62	0.39	0.64	0.02	0.0	0.66	2.06
*T		57.27	1.69	1.83	1.04	52.70	1.04	0.0	13.09	0.23	0.94	0.0	0.23	-11.92	4.76	11.00	0.20	0.0	11.20	11.43
1981	JAN	2.84	0.08	0.09	0.0	2.66	0.0	0.0	2.01	0.0	0.14	0.0	0.0	-0.80	0.39	0.62	0.02	0.0	0.64	1.79
1981	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.78	0.36	0.40	0.02	0.0	0.41	0.0
1981	MAR	0.91	0.03	0.03	0.0	0.86	0.0	0.0	0.49	0.0	0.04	0.0	0.0	-1.15	0.40	0.80	0.02	0.0	0.82	0.46
1981	APR	8.16	0.24	0.26	0.0	7.66	0.0	0.0	7.77	0.0	0.56	0.0	0.0	-0.53	0.38	0.95	0.02	0.0	0.97	6.85
1981	MAY	14.28	0.42	0.46	0.47	12.94	0.47	0.0	6.61	0.22	0.47	0.0	0.22	-0.12	0.39	1.33	0.02	0.0	1.34	5.59
1981	JUN	1.95	0.06	0.06	0.0	1.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.57	0.37	1.24	0.02	0.0	1.26	0.0
1981	JUL	10.16	0.30	0.33	0.10	9.43	0.10	0.0	3.56	0.04	0.26	0.0	0.04	-0.86	0.37	1.19	0.02	0.0	1.20	3.11
1981	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.51	0.37	1.12	0.02	0.0	1.14	0.0
1981	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.42	0.35	1.05	0.02	0.0	1.07	0.0
1981	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.30	0.36	0.93	0.02	0.0	0.94	0.0
1981	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.10	0.35	0.73	0.02	0.0	0.75	0.0
1981	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.02	0.36	0.64	0.02	0.0	0.66	0.0
*T		38.31	1.13	1.23	0.57	35.38	0.57	0.0	20.44	0.25	1.47	0.0	0.25	-12.15	4.46	11.00	0.20	0.0	11.20	17.79
1982	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.00	0.36	0.62	0.02	0.0	0.64	0.0
1982	FEB	122.56	3.62	3.93	13.82	101.19	10.71	3.11	66.11	7.45	4.75	0.0	10.56	29.09	0.44	0.40	0.02	0.0	0.41	51.52
1982	MAR	33.43	0.99	1.07	0.85	30.53	0.85	0.0	24.61	0.62	1.77	0.0	0.62	2.98	0.52	0.80	0.02	0.0	0.82	21.19
1982	APR	0.09	0.00	0.00	0.0	0.08	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.41	0.49	0.95	0.02	0.0	0.97	0.59
1982	MAY	4.35	0.13	0.14	0.0	4.08	0.0	0.0	0.43	0.0	0.03	0.0	0.0	-1.67	0.49	1.33	0.02	0.0	1.34	0.40
1982	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.72	0.46	1.24	0.02	0.0	1.26	0.0
1982	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.67	0.47	1.19	0.02	0.0	1.20	0.0
1982	AUG	1.13	0.03	0.04	0.0	1.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.56	0.46	1.12	0.02	0.0	1.14	0.0
1982	SEP	0.66	0.02	0.02	0.0	0.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.48	0.43	1.05	0.02	0.0	1.07	0.0
1982	OCT	0.68	0.02	0.02	0.0	0.64	0.0	0.0	0.18	0.0	0.01	0.0	0.0	-1.35	0.44	0.93	0.02	0.0	0.94	0.17
1982	NOV	6.43	0.19	0.21	0.0	6.03	0.0	0.0	6.80	0.0	0.49	0.0	0.0	-0.48	0.43	0.73	0.02	0.0	0.75	6.02
1982	DEC	0.67	0.02	0.02	0.0	0.63	0.0	0.0	3.40	0.0	0.24	0.0	0.0	-0.84	0.45	0.64	0.02	0.0	0.66	3.02
*T		169.99	5.03	5.44	14.67	144.85	11.56	3.11	102.19	8.08	7.34	0.0	11.19	18.88	5.44	11.00	0.20	0.0	11.20	82.91
1983	JAN	2.93	0.09	0.09	0.0	2.75	0.0	0.0	0.40	0.0	0.03	0.0	0.0	-0.96	0.45	0.62	0.02	0.0	0.64	0.36
1983	FEB	34.54	1.02	1.11	3.16	29.26	3.16	0.0	25.24	2.31	1.81	0.0	2.31	7.54	0.44	0.40	0.02	0.0	0.41	20.11
1983	MAR	24.19	0.72	0.77	0.30	22.40	0.30	0.0	16.22	0.20	1.16	0.0	0.20	1.14	0.49	0.80	0.02	0.0	0.82	14.12
1983	APR	26.21	0.77	0.84	0.90	23.69	0.90	0.0	12.29	0.42	0.88	0.0	0.42	1.60	0.48	0.95	0.02	0.0	0.97	10.41
1983	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.82	0.48	1.33	0.02	0.0	1.34	0.0
1983	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.71	0.45	1.24	0.02	0.0	1.26	0.0
1983	JUL	0.35	0.01	0.01	0.0	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.65	0.45	1.19	0.02	0.0	1.20	0.0
1983	AUG	31.09	0.92	1.00	1.42	27.75	1.42	0.0	6.25	0.29	0.45	0.0	0.29	1.56	0.46	1.12	0.02	0.0	1.14	5.21
1983	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.50	0.43	1.05	0.02	0.0	1.07	0.0
1983	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.39	0.44	0.93	0.02	0.0	0.94	0.0
1983	NOV	1.36	0.04	0.04	0.0	1.28	0.0	0.0	0.37	0.0	0.03	0.0	0.0	-1.10	0.43	0.73	0.02	0.0	0.75	0.33
1983	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.10	0.44	0.64	0.02	0.0	0.66	0.0
*T		120.68	3.57	3.87	5.79	107.46	5.79	0.0	60.76	3.22	4.36	0.0	3.22	0.59	5.44	11.00	0.20	0.0	11.20	50.54
1984	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13	0.0	0.01	0.0	0.0	-1.07	0.44	0.62	0.02	0.0	0.64	0.12
1984	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.83	0.42	0.40	0.02	0.0	0.41	0.0
1984	MAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.26	0.44	0.80	0.02	0.0	0.82	0.0
1984	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.39	0.42	0.95	0.02	0.0	0.97	0.0
1984	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.77	0.42	1.33	0.02	0.0	1.34	0.0
1984	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.65	0.40	1.24	0.02	0.0	1.26	0.0
1984	JUL	4.83	0.14	0.15	0.0	4.54	0.0	0.0	0.12	0.0	0.01	0.0	0.0	-1.44	0.40	1.19	0.02	0.0	1.20	0.11
1984	AUG	0.05	0.00	0.00	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.39	1.12	0.02	0.0	1.14	0.0
1984	SEP	2.68	0.08	0.09	0.0	2.52	0.0	0.0	2.20	0.0	0.16	0.0	0.0	-1.20	0.37	1.05	0.02	0.0	1.07	1.94
1984	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.32	0.38	0.93	0.02	0.0	0.94	0.0
1984	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.11	0.36	0.73	0.02	0.0	0.75	0.0
1984	DEC	2.03	0.06	0.07	0.0	1.91	0.0	0.0	3.63	0.0	0.26	0.0	0.0	-0.71	0.38	0.64	0.02	0.0	0.66	3.22
*T		9.59	0.28	0.31	0.0	9.00	0.0	0.0	6.08	0.0	0.44	0.0	0.0	-15.29	4.83	11.00	0.20	0.0	11.20	5.40
*M		103.34	3.06	3.31	6.58	90.39	5.15	1.42	52.41	3.20	3.76	0.0	4.63	1.53	4.12	11.00	0.20	0.0	11.20	42.03

FIGURE 3-11 DEVIATION OF GROUNDWATER LEVEL (CASE 2)
(12-MONTHS MOVING AVERAGE)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	DA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	BOS-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	OA-2	I	SEA		

FIGURE 3-12 DEVIATION OF GROUNDWATER LEVEL (CASE 3)
(12-MONTHS MOVING AVERAGE)



SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL	SYMBOL	WELL
1	OA-1	2	JA-6	3	JA-4	4	JA-5
5	JA-3	6	EA-1	7	JA-1	8	BOS-2
9	WSI-26	0	JA-2	A	NJ-1	B	AE-61
C	NJ-4	D	AE-91	E	NJ-3	F	AE-99
G	14-M	H	OA-2	I	SEA		

TABLE 3-3 SUMMARY OF GROUNDWATER SIMULATION (CASE 2)

*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY *** WADI JIZZI BASIN *** PROPOSED CONDITION * AFTER PROJECT ***

(UNIT = MCM/MONTH)

		<<-- A B O V E	D A M					-->>	<<-- B E L O W	D A M											-->>
YEAR	MON	AREAL RAIN (1)	FALAJ USE (2)	BASE FLOW (3)	RUN -OFF (4)	EVAPO -TRANS (5)	DRCT RECHR (6)	SPILL -AGE (7)	AREAL RAIN (8)	RUN -OFF (9)	DRCT RECHR (10)	RUN -SEA (11)	RECHA -RGE (12)	STORA -GE (13)	G.W -SEA (14)	IRRIGA -TION (15)	OTHER USES (16)	ADD-L USES (17)	EXTRAC -TION (18)	EVAPO -TRANS (19)
1974	JAN	2.35	0.07	0.08	0.0	2.20	0.0	0.0	0.64	0.0	0.05	0.0	0.0	-0.67	0.07	0.62	0.10	0.0	0.73	0.58
1974	FEB	32.25	0.95	1.03	1.92	28.34	1.92	0.0	29.63	1.77	2.13	0.0	1.77	6.26	0.10	0.40	0.10	0.0	0.50	24.58
1974	MAR	4.71	0.14	0.15	0.0	4.42	0.0	0.0	1.66	0.0	0.12	0.0	0.0	-0.75	0.11	0.80	0.10	0.0	0.91	1.49
1974	APR	1.85	0.05	0.06	0.0	1.74	0.0	0.0	0.36	0.0	0.03	0.0	0.0	-1.08	0.11	0.95	0.10	0.0	1.06	0.33
1974	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.54	0.11	1.33	0.10	0.0	1.43	0.0
1974	JUN	0.25	0.01	0.01	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.43	0.10	1.24	0.10	0.0	1.35	0.0
1974	JUL	1.61	0.05	0.05	0.0	1.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.33	0.09	1.19	0.10	0.0	1.29	0.0
1974	AUG	3.21	0.09	0.10	0.0	3.01	0.0	0.0	0.53	0.0	0.04	0.0	0.0	-1.17	0.09	1.12	0.10	0.0	1.23	0.47
1974	SEP	1.68	0.05	0.05	0.0	1.57	0.0	0.0	0.45	0.0	0.03	0.0	0.0	-1.15	0.08	1.05	0.10	0.0	1.16	0.40
1974	OCT	7.81	0.23	0.25	0.0	7.32	0.0	0.0	2.33	0.0	0.17	0.0	0.0	-0.70	0.09	0.93	0.10	0.0	1.03	2.08
1974	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.92	0.08	0.73	0.10	0.0	0.84	0.0
1974	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.72	0.0	0.05	0.0	0.0	-0.78	0.09	0.64	0.10	0.0	0.74	0.65
*T		55.73	1.65	1.78	1.92	50.37	1.92	0.0	36.34	1.77	2.61	0.0	1.77	-5.29	1.11	11.00	1.26	0.0	12.26	30.58
1975	JAN	5.84	0.17	0.19	0.0	5.48	0.0	0.0	1.98	0.0	0.14	0.0	0.0	-0.49	0.10	0.62	0.10	0.0	0.73	1.77
1975	FEB	51.12	1.51	1.64	4.45	43.52	4.45	0.0	24.53	2.14	1.76	0.0	2.14	9.36	0.12	0.40	0.10	0.0	0.50	19.65
1975	MAR	0.57	0.02	0.02	0.0	0.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.03	0.14	0.80	0.10	0.0	0.91	0.0
1975	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.19	0.13	0.95	0.10	0.0	1.06	0.0
1975	MAY	1.59	0.05	0.05	0.0	1.50	0.0	0.0	0.33	0.0	0.02	0.0	0.0	-1.48	0.12	1.33	0.10	0.0	1.43	0.31
1975	JUN	1.51	0.04	0.05	0.0	1.41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.41	0.11	1.24	0.10	0.0	1.35	0.0
1975	JUL	1.19	0.04	0.04	0.0	1.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.36	0.11	1.19	0.10	0.0	1.29	0.0
1975	AUG	12.45	0.37	0.40	0.19	11.50	0.19	0.0	4.90	0.07	0.35	0.0	0.07	-0.32	0.10	1.12	0.10	0.0	1.23	4.24
1975	SEP	2.46	0.07	0.08	0.0	2.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.17	0.10	1.05	0.10	0.0	1.16	0.0
1975	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.13	0.10	0.93	0.10	0.0	1.03	0.0
1975	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.93	0.10	0.73	0.10	0.0	0.84	0.0
1975	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.85	0.10	0.64	0.10	0.0	0.74	0.0
*T		76.72	2.27	2.46	4.64	67.36	4.64	0.0	31.74	2.21	2.28	0.0	2.21	-2.01	1.33	11.00	1.26	0.0	12.26	25.96
1976	JAN	21.79	0.64	0.70	1.06	19.38	1.06	0.0	4.47	0.22	0.32	0.0	0.22	1.46	0.11	0.62	0.10	0.0	0.73	3.75
1976	FEB	112.35	3.32	3.60	11.75	93.68	10.17	1.59	58.12	6.08	4.17	0.0	7.66	24.90	0.20	0.40	0.10	0.0	0.50	45.75
1976	MAR	115.70	3.42	3.71	17.42	91.15	6.45	10.97	36.69	5.53	2.64	0.0	16.50	28.04	0.34	0.80	0.10	0.0	0.91	27.10
1976	APR	43.52	1.29	1.39	3.40	37.44	3.40	0.0	27.60	2.16	1.98	0.0	2.16	7.50	0.37	0.95	0.10	0.0	1.06	22.30
1976	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.80	0.37	1.33	0.10	0.0	1.43	0.0
1976	JUN	1.41	0.04	0.05	0.0	1.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.64	0.34	1.24	0.10	0.0	1.35	0.0
1976	JUL	3.58	0.11	0.11	0.0	3.36	0.0	0.0	0.25	0.0	0.02	0.0	0.0	-1.50	0.34	1.19	0.10	0.0	1.29	0.23
1976	AUG	23.94	0.71	0.77	0.45	22.02	0.45	0.0	5.71	0.11	0.41	0.0	0.11	0.17	0.33	1.12	0.10	0.0	1.23	4.92
1976	SEP	3.33	0.10	0.11	0.0	3.12	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.32	0.32	1.05	0.10	0.0	1.16	0.57
1976	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.68	0.0	0.19	0.0	0.0	-1.16	0.32	0.93	0.10	0.0	1.03	2.38
1976	NOV	10.96	0.32	0.35	0.28	10.01	0.28	0.0	2.89	0.07	0.21	0.0	0.07	-0.24	0.31	0.73	0.10	0.0	0.84	2.49
1976	DEC	5.14	0.15	0.16	0.0	4.82	0.0	0.0	5.74	0.0	0.41	0.0	0.0	-0.49	0.33	0.64	0.10	0.0	0.74	5.09
*T		341.71	10.10	10.94	34.36	286.31	21.80	12.56	144.81	14.16	10.40	0.0	26.71	53.92	3.68	11.00	1.26	0.0	12.26	114.59
1977	JAN	20.73	0.61	0.66	0.56	18.89	0.56	0.0	26.44	0.72	1.90	0.0	0.72	2.77	0.34	0.62	0.10	0.0	0.73	22.79
1977	FEB	21.03	0.62	0.67	0.88	18.85	0.88	0.0	12.35	0.52	0.89	0.0	0.52	2.14	0.32	0.40	0.10	0.0	0.50	10.42
1977	MAR	0.64	0.02	0.02	0.0	0.60	0.0	0.0	0.85	0.0	0.06	0.0	0.0	-1.18	0.36	0.80	0.10	0.0	0.91	0.77
1977	APR	31.64	0.94	1.01	2.64	27.05	2.64	0.0	19.73	1.65	1.42	0.0	1.65	5.30	0.37	0.95	0.10	0.0	1.06	15.77
1977	MAY	27.43	0.81	0.88	2.06	23.68	2.06	0.0	10.36	0.78	0.74	0.0	0.78	2.65	0.38	1.33	0.10	0.0	1.43	8.32
1977	JUN	18.60	0.55	0.60	0.26	17.20	0.26	0.0	4.74	0.07	0.34	0.0	0.07	-0.45	0.36	1.24	0.10	0.0	1.35	4.11
1977	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.66	0.37	1.19	0.10	0.0	1.29	0.0
1977	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.59	0.36	1.12	0.10	0.0	1.23	0.0
1977	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.50	0.34	1.05	0.10	0.0	1.16	0.0
1977	OCT	3.19	0.09	0.10	0.0	2.99	0.0	0.0	0.91	0.0	0.07	0.0	0.0	-1.22	0.35	0.93	0.10	0.0	1.03	0.82
1977	NOV	7.25	0.21	0.23	0.05	6.75	0.05	0.0	7.97	0.05	0.57	0.0	0.05	-0.27	0.34	0.73	0.10	0.0	0.84	7.00
1977	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.0	0.00	0.0	0.0	-1.10	0.36	0.64	0.10	0.0	0.74	0.06
*T		130.51	3.86	4.18	6.46	116.01	6.46	0.0	83.43	3.78	5.99	0.0	3.78	3.88	4.26	11.00	1.26	0.0	12.26	70.06
1978	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.09	0.36	0.62	0.10	0.0	0.73	0.0
1978	FEB	32.42	0.96	1.04	2.35	28.07	2.35	0.0	17.60	1.28	1.26	0.0	1.28	5.07	0.36	0.40	0.10	0.0	0.50	14.31
1978	MAR	3.72	0.11	0.12	0.0	3.49	0.0	0.0	2.51	0.0	0.18	0.0	0.0	-1.00	0.40	0.80	0.10	0.0	0.91	2.24
1978	APR	2.41	0.07	0.08	0.0	2.26	0.0	0.0	1.40	0.0	0.10	0.0	0.0	-1.26	0.38	0.95	0.10	0.0	1.06	1.24
1978	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.81	0.38	1.33	0.10	0.0	1.43	0.0
1978	JUN	1.51	0.04	0.05	0.0	1.42	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.63	0.36	1.24	0.10	0.0	1.35	0.38
1978	JUL	13.32	0.39	0.43	0.0	12.50	0.0	0.0	2.17	0.0	0.16	0.0	0.0	-1.08	0.37	1.19	0.10	0.0	1.29	1.92
1978	AUG	24.37	0.72	0.78	0.27	22.60	0.27	0.0	6.48	0.07	0.47	0.0	0.07	-0.01	0.36	1.12	0.10	0.0	1.23	5.63
1978	SEP	1.70	0.05	0.05	0.0	1.59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.45	0.35	1.05	0.10	0.0	1.16	0.0
1978	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.39	0.36	0.93	0.10	0.0	1.03	0.0
1978	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.19	0.35	0.73	0.10	0.0	0.84	0.0
1978	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.01	0.0	0.0	-1.11	0.37	0.64	0.10	0.0	0.74	0.09
*T		79.44	2.35	2.54	2.62	71.93	2.62	0.0	30.67	1.35	2.20	0.0	1.35	-7.95	4.40	11.00	1.26	0.0	12.26	25.81
1979	JAN	17.52	0.52	0.56	0.24	16.20	0.24	0.0	9.56	0.13	0.69	0.0	0.13	0.51	0.38	0.62	0.10	0.0	0.73	8.35
1979	FEB	0.96	0.03	0.03	0.0	0.90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.82	0.35	0.40	0.10	0.0	0.50	0.0
1979	MAR	1.03	0.03	0.03	0.0	0.97	0.0	0.0	0.74	0.0	0.05	0.0	0.0	-1.21	0.39	0.80	0.10	0.0	0.91	0.68
1979	APR	3.50	0.10	0.11	0.0	3.28	0.0	0.0	1.80	0.0	0.13	0.0	0.0	-1.19	0.37	0.95	0.10	0.0	1.06	1.60
1979	MAY	0.40	0.01	0.01	0.0	0.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.79	0.37	1.33	0.10	0.0	1.43	0.0
1979	JUN	3.70	0.11	0.12	0.0	3.47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.35	1.24	0.10	0.0	1.35	0.0
1979	JUL	4.84	0.14	0.16	0.0	4.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.50	0.36	1.19	0.10	0.0	1.29	0.0
1979	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.35	1.12	0.10	0.0	1.23	0.0
1979	SEP	3.01	0.09	0.10	0.0	2.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.40	0.34	1.05	0.10	0.0	1.16	0.0
1979	OCT	4.52	0.13	0.14	0.0	4.24	0.0	0.0	13.32	0.0	0.96	0.0	0.0	-0.28	0.35	0.93	0.10	0.0	1.03	11.75
1979	NOV	1.42	0.04	0.05	0.0	1.33	0.0	0.0	0.73	0.0	0.05	0.0	0.0	-1.08	0.34	0.73	0.10	0.0	0.84	0.65
1979	DEC	15.84	0.47	0.51	0.04	14.83	0.04	0.0	20.83	0.05	1.50	0.0	0.05	0.98	0.37	0.64	0.10	0.0	0.74	18.44
*T		56.74	1.68	1.82	0.27	52.97	0.27	0.0	46.99	0.18	3.37	0.0	0.18	-10.94	4.32	11.00	1.26	0.0	12.26	41.46
1980	JAN	4.94	0.15	0.16	0.16	4.47	0.16	0.0	1.13	0.04	0.08	0.0	0.04	-0.66	0.37	0.62	0.10	0.0	0.73	0.98
1980	FEB	16.67	0.49	0.53	0.18	15.46	0.18	0.0	3.07	0.03	0.22	0.0	0.03	0.10	0.36	0.40	0.10	0.0	0.50	2.69
1980	MAR	17.71	0.52	0.57	0.70	15.91	0.70	0.0	4.09	0.16	0.29	0.0	0.16	0.44	0.39	0.80	0.10	0.0	0.91	3.47
1980	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.39	0.0	0.03	0.0	0.0	-1.40	0.37	0.95	0.10	0.0	1.06	0.36
1980	MAY	1.18	0.03	0.04	0.0	1.11	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.74	0.37	1.33	0.10	0.0	1.43	0.38
1980	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.70	0.35	1.24	0.10	0.0	1.35	0.0
1980	JUL	8.67	0.26	0.28	0.0	8.13	0.0	0.0	1.41	0.0	0.10	0.0	0.0	-1.27	0.36	1.19	0.10	0.0	1.29	1.25
1980	AUG	0.11	0.00	0.00	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.57	0.35	1.12	0.10	0.0	1.23	0.0
1980	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.49	0.33	1.05	0.10	0.0	1.16	0.0
1980	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.37	0.34	0.93	0.10	0.0	1.03	0.0
1980	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.26	0.0	0.02	0.0	0.0	-1.15	0.33	0.73	0.10	0.0	0.84	0.23
1980	DEC	8.01	0.24	0.26	0.0	7.51	0.0	0.0	2.32	0.0	0.17	0.0	0.0	-0.67	0.35	0.64	0.10	0.0	0.74	2.06
*T		57.27	1.69	1.83	1.04	52.70	1.04	0.0	13.09	0.23	0.94	0.0	0.23	-12.48	4.27	11.00	1.26	0.0	12.26	11.43
1981	JAN	2.84	0.08	0.09	0.0	2.66	0.0	0.0	2.01	0.0	0.14	0.0	0.0	-0.84	0.35	0.62	0.10	0.0	0.73	1.79
1981	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.82	0.32	0.40	0.10	0.0	0.50	0.0
1981	MAR	0.91	0.03	0.03	0.0	0.86	0.0	0.0	0.49	0.0	0.04	0.0	0.0	-1.20	0.35	0.80	0.10	0.0	0.91	0.46
1981	APR	8.16	0.24	0.26	0.0	7.66	0.0	0.0	7.77	0.0	0.56	0.0	0.0	-0.58	0.34	0.95	0.10	0.0	1.06	6.85
1981	MAY	14.28	0.42	0.46	0.47	12.94	0.47	0.0	6.61	0.22	0.47	0.0	0.22	-0.16	0.35	1.33	0.10	0.0	1.43	5.59
1981	JUN	1.95	0.06	0.06	0.0	1.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.61	0.32	1.24	0.10	0.0	1.35	0.0
1981	JUL	10.16	0.30	0.33	0.10	9.43	0.10	0.0	3.56	0.04	0.26	0.0	0.04	-0.90	0.33	1.19	0.10	0.0	1.29	3.11
1981	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.55	0.32	1.12	0.10	0.0	1.23	0.0
1981	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.46	0.30	1.05	0.10	0.0	1.16	0.0
1981	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.34	0.31	0.93	0.10	0.0	1.03	0.0
1981	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.14	0.30	0.73	0.10	0.0	0.84	0.0
1981	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.06	0.31	0.64	0.10	0.0	0.74	0.0
*T		38.31	1.13	1.23	0.57	35.38	0.57	0.0	20.44	0.25	1.47	0.0	0.25	-12.66	3.91	11.00	1.26	0.0	12.26	17.79
1982	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.04	0.31	0.62	0.10	0.0	0.73	0.0
1982	FEB	122.56	3.62	3.93	13.82	101.19	10.71	3.11	66.11	7.45	4.75	0.0	10.56	29.05	0.39	0.40	0.10	0.0	0.50	51.52
1982	MAR	33.43	0.99	1.07	0.85	30.53	0.85	0.0	24.61	0.62	1.77	0.0	0.62	2.94	0.46	0.80	0.10	0.0	0.91	21.19
1982	APR	0.09	0.00	0.00	0.0	0.08	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.45	0.44	0.95	0.10	0.0	1.06	0.59
1982	MAY	4.35	0.13	0.14	0.0	4.08	0.0	0.0	0.43	0.0	0.03	0.0	0.0	-1.70	0.44	1.33	0.10	0.0	1.43	0.40
1982	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.76	0.41	1.24	0.10	0.0	1.35	0.0
1982	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.71	0.41	1.19	0.10	0.0	1.29	0.0
1982	AUG	1.13	0.03	0.04	0.0	1.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.60	0.40	1.12	0.10	0.0	1.23	0.0
1982	SEP	0.66	0.02	0.02	0.0	0.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.52	0.38	1.05	0.10	0.0	1.16	0.0
1982	OCT	0.68	0.02	0.02	0.0	0.64	0.0	0.0	0.18	0.0	0.01	0.0	0.0	-1.39	0.39	0.93	0.10	0.0	1.03	0.17
1982	NOV	6.43	0.19	0.21	0.0	6.03	0.0	0.0	6.80	0.0	0.49	0.0	0.0	-0.52	0.38	0.73	0.10	0.0	0.84	6.02
1982	DEC	0.67	0.02	0.02	0.0	0.63	0.0	0.0	3.40	0.0	0.24	0.0	0.0	-0.87	0.39	0.64	0.10	0.0	0.74	3.02
*T		169.99	5.03	5.44	14.67	144.85	11.56	3.11	102.19	8.08	7.34	0.0	11.19	18.44	4.87	11.00	1.26	0.0	12.26	82.91
1983	JAN	2.93	0.09	0.09	0.0	2.75	0.0	0.0	0.40	0.0	0.03	0.0	0.0	-1.00	0.39	0.62	0.10	0.0	0.73	0.36
1983	FEB	34.54	1.02	1.11	3.16	29.26	3.16	0.0	25.24	2.31	1.81	0.0	2.31	7.50	0.39	0.40	0.10	0.0	0.50	20.11
1983	MAR	24.19	0.72	0.77	0.30	22.40	0.30	0.0	16.22	0.20	1.16	0.0	0.20	1.11	0.44	0.80	0.10	0.0	0.91	14.12
1983	APR	26.21	0.77	0.84	0.90	23.69	0.90	0.0	12.29	0.42	0.88	0.0	0.42	1.56	0.42	0.95	0.10	0.0	1.06	10.41
1983	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.86	0.42	1.33	0.10	0.0	1.43	0.0
1983	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.74	0.40	1.24	0.10	0.0	1.35	0.0
1983	JUL	0.35	0.01	0.01	0.0	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.68	0.40	1.19	0.10	0.0	1.29	0.0
1983	AUG	31.09	0.92	1.00	1.42	27.75	1.42	0.0	6.25	0.29	0.45	0.0	0.29	1.53	0.40	1.12	0.10	0.0	1.23	5.21
1983	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.38	1.05	0.10	0.0	1.16	0.0
1983	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.42	0.38	0.93	0.10	0.0	1.03	0.0
1983	NOV	1.36	0.04	0.04	0.0	1.28	0.0	0.0	0.37	0.0	0.03	0.0	0.0	-1.14	0.37	0.73	0.10	0.0	0.84	0.33
1983	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.13	0.38	0.64	0.10	0.0	0.74	0.0
*T		120.68	3.57	3.87	5.79	107.46	5.79	0.0	60.76	3.22	4.36	0.0	3.22	0.20	4.77	11.00	1.26	0.0	12.26	50.54
1984	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13	0.0	0.01	0.0	0.0	-1.10	0.38	0.62	0.10	0.0	0.73	0.12
1984	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.86	0.36	0.40	0.10	0.0	0.50	0.0
1984	MAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.29	0.38	0.80	0.10	0.0	0.91	0.0
1984	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.42	0.36	0.95	0.10	0.0	1.06	0.0
1984	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.80	0.36	1.33	0.10	0.0	1.43	0.0
1984	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.69	0.34	1.24	0.10	0.0	1.35	0.0
1984	JUL	4.83	0.14	0.15	0.0	4.54	0.0	0.0	0.12	0.0	0.01	0.0	0.0	-1.47	0.34	1.19	0.10	0.0	1.29	0.11
1984	AUG	0.05	0.00	0.00	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.56	0.33	1.12	0.10	0.0	1.23	0.0
1984	SEP	2.68	0.08	0.09	0.0	2.52	0.0	0.0	2.20	0.0	0.16	0.0	0.0	-1.23	0.31	1.05	0.10	0.0	1.16	1.94
1984	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.35	0.32	0.93	0.10	0.0	1.03	0.0
1984	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.14	0.31	0.73	0.10	0.0	0.84	0.0
1984	DEC	2.03	0.06	0.07	0.0	1.91	0.0	0.0	3.63	0.0	0.26	0.0	0.0	-0.74	0.32	0.64	0.10	0.0	0.74	3.22
*T		9.59	0.28	0.31	0.0	9.00	0.0	0.0	6.08	0.0	0.44	0.0	0.0	-15.65	4.13	11.00	1.26	0.0	12.26	5.40
*M		103.34	3.06	3.31	6.58	90.39	5.15	1.42	52.41	3.20	3.76	0.0	4.63	0.86	3.73	11.00	1.26	0.0	12.26	43.32

TABLE 3-4 SUMMARY OF GROUNDWATER SIMULATION (CASE 3)

*** SURFACE AND SUB-SURFACE WATER BALANCE STUDY *** WADI JIZZI BASIN *** PROPOSED CONDITION = AFTER PROJECT ***

(UNIT = MCM/MONTH)

YEAR	MON	ABOVE DAM: AREAL RAIN (1)	FALAJ USE (2)	BASE FLOW (3)	RUN -OFF (4)	EVAPO -TRANS (5)	DRCT RECHR (6)	SPILL -AGE (7)	BELOW DAM: AREAL RAIN (8)	RUN -OFF (9)	DRCT RECHR (10)	RUN -SEA (11)	RECHA -RGE (12)	STORA -GE (13)	G.W -SEA (14)	IRRIGA -TION (15)	OTHER USES (16)	ADD-L USES (17)	EXTRAC -TION (18)	EVAPO -TRANS (19)
1974	JAN	2.35	0.07	0.08	0.0	2.20	0.0	0.0	0.64	0.0	0.05	0.0	0.0	-0.75	0.07	0.62	0.10	0.08	0.81	0.58
1974	FEB	32.25	0.95	1.03	1.92	26.34	1.92	0.0	29.63	1.77	2.13	0.0	1.77	6.21	0.09	0.40	0.10	0.05	0.55	24.43
1974	MAR	4.71	0.14	0.15	0.0	4.42	0.0	0.0	1.66	0.0	0.12	0.0	0.0	-0.85	0.11	0.80	0.10	0.10	1.01	1.48
1974	APR	1.85	0.05	0.06	0.0	1.74	0.0	0.0	0.36	0.0	0.03	0.0	0.0	-1.20	0.10	0.95	0.10	0.12	1.18	0.33
1974	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.70	0.10	1.33	0.10	0.17	1.60	0.0
1974	JUN	0.25	0.01	0.01	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.09	1.24	0.10	0.16	1.50	0.0
1974	JUL	1.61	0.05	0.05	0.0	1.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.47	0.08	1.19	0.10	0.15	1.44	0.0
1974	AUG	3.21	0.09	0.10	0.0	3.01	0.0	0.0	0.53	0.0	0.04	0.0	0.0	-1.30	0.07	1.12	0.10	0.14	1.37	0.47
1974	SEP	1.68	0.05	0.05	0.0	1.57	0.0	0.0	0.45	0.0	0.03	0.0	0.0	-1.27	0.06	1.05	0.10	0.13	1.29	0.40
1974	OCT	7.81	0.23	0.25	0.0	7.32	0.0	0.0	2.33	0.0	0.17	0.0	0.0	-0.80	0.07	0.93	0.10	0.12	1.15	2.06
1974	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.00	0.07	0.73	0.10	0.09	0.93	0.0
1974	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.72	0.0	0.05	0.0	0.0	-0.85	0.07	0.64	0.10	0.08	0.83	0.65
*T		55.73	1.65	1.78	1.92	50.37	1.92	0.0	36.34	1.77	2.61	0.0	1.77	-6.55	0.98	11.00	1.26	1.40	13.66	30.41
1975	JAN	5.84	0.17	0.19	0.0	5.48	0.0	0.0	1.98	0.0	0.14	0.0	0.0	-0.55	0.08	0.62	0.10	0.08	0.81	1.76
1975	FEB	51.12	1.51	1.64	4.45	43.52	4.45	0.0	24.53	2.14	1.76	0.0	2.14	9.33	0.10	0.40	0.10	0.05	0.55	19.52
1975	MAR	0.57	0.02	0.02	0.0	0.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.11	0.12	0.80	0.10	0.10	1.01	0.0
1975	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.29	0.11	0.95	0.10	0.12	1.18	0.0
1975	MAY	1.59	0.05	0.05	0.0	1.50	0.0	0.0	0.33	0.0	0.02	0.0	0.0	-1.63	0.10	1.33	0.10	0.17	1.60	0.31
1975	JUN	1.51	0.04	0.05	0.0	1.41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.54	0.08	1.24	0.10	0.16	1.50	0.0
1975	JUL	1.19	0.04	0.04	0.0	1.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.48	0.08	1.19	0.10	0.15	1.44	0.0
1975	AUG	12.45	0.37	0.40	0.19	11.50	0.19	0.0	4.90	0.07	0.35	0.0	0.07	-0.43	0.07	1.12	0.10	0.14	1.37	4.21
1975	SEP	2.46	0.07	0.08	0.0	2.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.28	0.07	1.05	0.10	0.13	1.29	0.0
1975	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.22	0.07	0.93	0.10	0.12	1.15	0.0
1975	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.99	0.06	0.73	0.10	0.09	0.93	0.0
1975	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.90	0.07	0.64	0.10	0.08	0.83	0.0
*T		76.72	2.27	2.46	4.64	67.36	4.64	0.0	31.74	2.21	2.28	0.0	2.21	-3.08	1.00	11.00	1.26	1.40	13.66	25.80
1976	JAN	21.79	0.64	0.70	1.06	19.38	1.06	0.0	4.47	0.22	0.32	0.0	0.22	1.41	0.08	0.62	0.10	0.08	0.81	3.73
1976	FEB	112.35	3.32	3.60	11.75	93.68	10.17	1.59	58.12	6.08	4.17	0.0	7.66	24.88	0.17	0.40	0.10	0.05	0.55	45.48
1976	MAR	115.70	3.42	3.71	17.42	91.15	6.45	10.97	36.69	5.53	2.64	0.0	16.50	27.98	0.30	0.80	0.10	0.10	1.01	26.92
1976	APR	43.52	1.29	1.39	3.40	37.44	3.40	0.0	27.60	2.16	1.98	0.0	2.16	7.42	0.33	0.95	0.10	0.12	1.18	22.15
1976	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.93	0.33	1.33	0.10	0.17	1.60	0.0
1976	JUN	1.41	0.04	0.05	0.0	1.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.76	0.30	1.24	0.10	0.16	1.50	0.0
1976	JUL	3.58	0.11	0.11	0.0	3.36	0.0	0.0	0.25	0.0	0.02	0.0	0.0	-1.61	0.30	1.19	0.10	0.15	1.44	0.23
1976	AUG	23.94	0.71	0.77	0.45	22.02	0.45	0.0	5.71	0.11	0.41	0.0	0.11	0.07	0.29	1.12	0.10	0.14	1.37	4.88
1976	SEP	3.33	0.10	0.11	0.0	3.12	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.41	0.27	1.05	0.10	0.13	1.29	0.57
1976	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.68	0.0	0.19	0.0	0.0	-1.23	0.28	0.93	0.10	0.12	1.15	2.37
1976	NOV	10.96	0.32	0.35	0.28	10.01	0.28	0.0	2.89	0.07	0.21	0.0	0.07	-0.29	0.27	0.73	0.10	0.09	0.93	2.47
1976	DEC	5.14	0.15	0.16	0.0	4.82	0.0	0.0	5.74	0.0	0.41	0.0	0.0	-0.53	0.28	0.64	0.10	0.08	0.83	5.06
*T		341.71	10.10	10.94	34.36	286.31	21.80	12.56	144.81	14.16	10.40	0.0	26.71	53.01	3.19	11.00	1.26	1.40	13.66	113.87
1977	JAN	20.73	0.61	0.66	0.56	18.89	0.56	0.0	26.44	0.72	1.90	0.0	0.72	2.74	0.30	0.62	0.10	0.08	0.81	22.65
1977	FEB	21.03	0.62	0.67	0.88	18.85	0.88	0.0	12.35	0.52	0.89	0.0	0.52	2.13	0.28	0.40	0.10	0.05	0.55	10.35
1977	MAR	0.64	0.02	0.02	0.0	0.60	0.0	0.0	0.85	0.0	0.06	0.0	0.0	-1.24	0.31	0.80	0.10	0.10	1.01	0.77
1977	APR	31.64	0.94	1.01	2.64	27.05	2.64	0.0	19.73	1.65	1.42	0.0	1.65	5.22	0.32	0.95	0.10	0.12	1.18	15.66
1977	MAY	27.43	0.81	0.88	2.06	23.68	2.06	0.0	10.36	0.78	0.74	0.0	0.78	2.53	0.33	1.33	0.10	0.17	1.60	8.25
1977	JUN	18.60	0.55	0.60	0.26	17.20	0.26	0.0	4.74	0.07	0.34	0.0	0.07	-0.56	0.32	1.24	0.10	0.16	1.50	4.08
1977	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.76	0.31	1.19	0.10	0.15	1.44	0.0
1977	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.68	0.31	1.12	0.10	0.14	1.37	0.0
1977	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.29	1.05	0.10	0.13	1.29	0.0
1977	OCT	3.19	0.09	0.10	0.0	2.99	0.0	0.0	0.91	0.0	0.07	0.0	0.0	-1.28	0.30	0.93	0.10	0.12	1.15	0.82
1977	NOV	7.25	0.21	0.23	0.05	6.75	0.05	0.0	7.97	0.05	0.57	0.0	0.05	-0.31	0.29	0.73	0.10	0.09	0.93	6.96
1977	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.0	0.00	0.0	0.0	-1.13	0.31	0.64	0.10	0.08	0.83	0.06
*T		130.51	3.86	4.18	6.46	116.01	6.46	0.0	83.43	3.78	5.99	0.0	3.78	3.09	3.66	11.00	1.26	1.40	13.66	69.60
1978	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.12	0.31	0.62	0.10	0.08	0.81	0.0
1978	FEB	32.42	0.96	1.04	2.35	28.07	2.35	0.0	17.60	1.28	1.26	0.0	1.28	5.07	0.30	0.40	0.10	0.05	0.55	14.21
1978	MAR	3.72	0.11	0.12	0.0	3.49	0.0	0.0	2.51	0.0	0.18	0.0	0.0	-1.05	0.34	0.80	0.10	0.10	1.01	2.23
1978	APR	2.41	0.07	0.08	0.0	2.26	0.0	0.0	1.40	0.0	0.10	0.0	0.0	-1.33	0.33	0.95	0.10	0.12	1.18	1.23
1978	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.93	0.32	1.33	0.10	0.17	1.60	0.0
1978	JUN	1.51	0.04	0.05	0.0	1.42	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.73	0.30	1.24	0.10	0.16	1.50	0.38
1978	JUL	13.32	0.39	0.43	0.0	12.50	0.0	0.0	2.17	0.0	0.16	0.0	0.0	-1.17	0.31	1.19	0.10	0.15	1.44	1.91
1978	AUG	24.37	0.72	0.78	0.27	22.60	0.27	0.0	6.48	0.07	0.47	0.0	0.07	-0.09	0.30	1.12	0.10	0.14	1.37	5.59
1978	SEP	1.70	0.05	0.05	0.0	1.59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.53	0.29	1.05	0.10	0.13	1.29	0.0
1978	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.45	0.30	0.93	0.10	0.12	1.15	0.0
1978	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.22	0.29	0.73	0.10	0.09	0.93	0.0
1978	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10	0.0	0.01	0.0	0.0	-1.12	0.31	0.64	0.10	0.08	0.83	0.09
*T		79.44	2.35	2.54	2.62	71.93	2.62	0.0	30.67	1.35	2.20	0.0	1.35	-8.65	3.71	11.00	1.26	1.40	13.66	25.65
1979	JAN	17.52	0.52	0.56	0.24	16.20	0.24	0.0	9.56	0.13	0.69	0.0	0.13	0.49	0.32	0.62	0.10	0.08	0.81	8.30
1979	FEB	0.96	0.03	0.03	0.0	0.90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.81	0.29	0.40	0.10	0.05	0.55	0.0
1979	MAR	1.03	0.03	0.03	0.0	0.97	0.0	0.0	0.74	0.0	0.05	0.0	0.0	-1.25	0.32	0.80	0.10	0.10	1.01	0.67
1979	APR	3.50	0.10	0.11	0.0	3.28	0.0	0.0	1.80	0.0	0.13	0.0	0.0	-1.25	0.31	0.95	0.10	0.12	1.18	1.59
1979	MAY	0.40	0.01	0.01	0.0	0.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.90	0.31	1.33	0.10	0.17	1.60	0.0
1979	JUN	3.70	0.11	0.12	0.0	3.47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.68	0.29	1.24	0.10	0.16	1.50	0.0
1979	JUL	4.84	0.14	0.16	0.0	4.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.29	1.19	0.10	0.15	1.44	0.0
1979	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.66	0.29	1.12	0.10	0.14	1.37	0.0
1979	SEP	3.01	0.09	0.10	0.0	2.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.47	0.27	1.05	0.10	0.13	1.29	0.0
1979	OCT	4.52	0.13	0.14	0.0	4.24	0.0	0.0	13.32	0.0	0.96	0.0	0.0	-0.33	0.28	0.93	0.10	0.12	1.15	11.67
1979	NOV	1.42	0.04	0.05	0.0	1.33	0.0	0.0	0.73	0.0	0.05	0.0	0.0	-1.11	0.28	0.73	0.10	0.09	0.93	0.64
1979	DEC	15.84	0.47	0.51	0.04	14.83	0.04	0.0	20.83	0.05	1.50	0.0	0.05	0.97	0.30	0.64	0.10	0.08	0.83	18.33
*T		56.74	1.68	1.82	0.27	52.97	0.27	0.0	46.99	0.18	3.37	0.0	0.18	-11.57	3.55	11.00	1.26	1.40	13.66	41.21
1980	JAN	4.94	0.15	0.16	0.16	4.47	0.16	0.0	1.13	0.04	0.08	0.0	0.04	-0.67	0.31	0.62	0.10	0.08	0.81	0.97
1980	FEB	16.67	0.49	0.53	0.18	15.46	0.18	0.0	3.07	0.03	0.22	0.0	0.03	0.12	0.29	0.40	0.10	0.05	0.55	2.68
1980	MAR	17.71	0.52	0.57	0.70	15.91	0.70	0.0	4.09	0.16	0.29	0.0	0.16	0.40	0.32	0.80	0.10	0.10	1.01	3.45
1980	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.39	0.0	0.03	0.0	0.0	-1.46	0.30	0.95	0.10	0.12	1.18	0.36
1980	MAY	1.18	0.03	0.04	0.0	1.11	0.0	0.0	0.41	0.0	0.03	0.0	0.0	-1.84	0.30	1.33	0.10	0.17	1.60	0.38
1980	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.79	0.28	1.24	0.10	0.16	1.50	0.0
1980	JUL	8.67	0.26	0.28	0.0	8.13	0.0	0.0	1.41	0.0	0.10	0.0	0.0	-1.35	0.28	1.19	0.10	0.15	1.44	1.24
1980	AUG	0.11	0.00	0.00	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.64	0.28	1.12	0.10	0.14	1.37	0.0
1980	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.55	0.26	1.05	0.10	0.13	1.29	0.0
1980	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.42	0.27	0.93	0.10	0.12	1.15	0.0
1980	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.26	0.0	0.02	0.0	0.0	-1.17	0.26	0.73	0.10	0.09	0.93	0.23
1980	DEC	8.01	0.24	0.26	0.0	7.51	0.0	0.0	2.32	0.0	0.17	0.0	0.0	-0.68	0.27	0.64	0.10	0.08	0.83	2.05
*T		57.27	1.69	1.83	1.04	52.70	1.04	0.0	13.09	0.23	0.94	0.0	0.23	-13.04	3.43	11.00	1.26	1.40	13.66	11.36
1981	JAN	2.84	0.08	0.09	0.0	2.66	0.0	0.0	2.01	0.0	0.14	0.0	0.0	-0.85	0.28	0.62	0.10	0.08	0.81	1.78
1981	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.81	0.26	0.40	0.10	0.05	0.55	0.0
1981	MAR	0.91	0.03	0.03	0.0	0.86	0.0	0.0	0.49	0.0	0.04	0.0	0.0	-1.23	0.28	0.80	0.10	0.10	1.01	0.46
1981	APR	8.16	0.24	0.26	0.0	7.66	0.0	0.0	7.77	0.0	0.56	0.0	0.0	-0.63	0.27	0.95	0.10	0.12	1.18	6.81
1981	MAY	14.28	0.42	0.46	0.47	12.94	0.47	0.0	6.61	0.22	0.47	0.0	0.22	-0.26	0.27	1.33	0.10	0.17	1.60	5.55
1981	JUN	1.95	0.06	0.06	0.0	1.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.69	0.25	1.24	0.10	0.16	1.50	0.0
1981	JUL	10.16	0.30	0.33	0.10	9.43	0.10	0.0	3.56	0.04	0.26	0.0	0.04	-0.98	0.25	1.19	0.10	0.15	1.44	3.09
1981	AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.61	0.24	1.12	0.10	0.14	1.37	0.0
1981	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.52	0.23	1.05	0.10	0.13	1.29	0.0
1981	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.23	0.93	0.10	0.12	1.15	0.0
1981	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.16	0.23	0.73	0.10	0.09	0.93	0.0
1981	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.06	0.23	0.64	0.10	0.08	0.83	0.0
*T		38.31	1.13	1.23	0.57	35.38	0.57	0.0	20.44	0.25	1.47	0.0	0.25	-13.17	3.02	11.00	1.26	1.40	13.66	17.68
1982	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.04	0.24	0.62	0.10	0.08	0.81	0.0
1982	FEB	122.56	3.62	3.93	13.82	101.19	10.71	3.11	66.11	7.45	4.75	0.0	10.56	29.07	0.32	0.40	0.10	0.05	0.55	51.22
1982	MAR	33.43	0.99	1.07	0.85	30.53	0.85	0.0	24.61	0.62	1.77	0.0	0.62	2.92	0.38	0.80	0.10	0.10	1.01	21.06
1982	APR	0.09	0.00	0.00	0.0	0.08	0.0	0.0	0.65	0.0	0.05	0.0	0.0	-1.49	0.36	0.95	0.10	0.12	1.18	0.58
1982	MAY	4.35	0.13	0.14	0.0	4.08	0.0	0.0	0.43	0.0	0.03	0.0	0.0	-1.79	0.36	1.33	0.10	0.17	1.60	0.40
1982	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.84	0.33	1.24	0.10	0.16	1.50	0.0
1982	JUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.77	0.33	1.19	0.10	0.15	1.44	0.0
1982	AUG	1.13	0.03	0.04	0.0	1.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.65	0.32	1.12	0.10	0.14	1.37	0.0
1982	SEP	0.66	0.02	0.02	0.0	0.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.57	0.30	1.05	0.10	0.13	1.29	0.0
1982	OCT	0.68	0.02	0.02	0.0	0.64	0.0	0.0	0.18	0.0	0.01	0.0	0.0	-1.42	0.31	0.93	0.10	0.12	1.15	0.17
1982	NOV	6.43	0.19	0.21	0.0	6.03	0.0	0.0	6.80	0.0	0.49	0.0	0.0	-0.53	0.30	0.73	0.10	0.09	0.93	5.98
1982	DEC	0.67	0.02	0.02	0.0	0.63	0.0	0.0	3.40	0.0	0.24	0.0	0.0	-0.87	0.31	0.64	0.10	0.08	0.83	3.00
*T		169.99	5.03	5.44	14.67	144.85	11.56	3.11	102.19	8.08	7.34	0.0	11.19	18.00	3.86	11.00	1.26	1.40	13.66	82.42
1983	JAN	2.93	0.09	0.09	0.0	2.75	0.0	0.0	0.40	0.0	0.03	0.0	0.0	-0.99	0.31	0.62	0.10	0.08	0.81	0.36
1983	FEB	34.54	1.02	1.11	3.16	29.26	3.16	0.0	25.24	2.31	1.81	0.0	2.31	7.52	0.31	0.40	0.10	0.05	0.55	19.98
1983	MAR	24.19	0.72	0.77	0.30	22.40	0.30	0.0	16.22	0.20	1.16	0.0	0.20	1.09	0.35	0.80	0.10	0.10	1.01	14.03
1983	APR	26.21	0.77	0.84	0.90	23.69	0.90	0.0	12.29	0.42	0.88	0.0	0.42	1.52	0.34	0.95	0.10	0.12	1.18	10.34
1983	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.94	0.34	1.33	0.10	0.17	1.60	0.0
1983	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.82	0.31	1.24	0.10	0.16	1.50	0.0
1983	JUL	0.35	0.01	0.01	0.0	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.74	0.31	1.19	0.10	0.15	1.44	0.0
1983	AUG	31.09	0.92	1.00	1.42	27.75	1.42	0.0	6.25	0.29	0.45	0.0	0.29	1.47	0.31	1.12	0.10	0.14	1.37	5.17
1983	SEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.58	0.29	1.05	0.10	0.13	1.29	0.0
1983	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.45	0.30	0.93	0.10	0.12	1.15	0.0
1983	NOV	1.36	0.04	0.04	0.0	1.28	0.0	0.0	0.37	0.0	0.03	0.0	0.0	-1.15	0.29	0.73	0.10	0.09	0.93	0.33
1983	DEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.12	0.30	0.64	0.10	0.08	0.83	0.0
*T		120.68	3.57	3.87	5.79	107.46	5.79	0.0	60.76	3.22	4.36	0.0	3.22	-0.19	3.77	11.00	1.26	1.40	13.66	50.21
1984	JAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13	0.0	0.01	0.0	0.0	-1.09	0.30	0.62	0.10	0.08	0.81	0.12
1984	FEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.83	0.28	0.40	0.10	0.05	0.55	0.0
1984	MAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.31	0.30	0.80	0.10	0.10	1.01	0.0
1984	APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.46	0.28	0.95	0.10	0.12	1.18	0.0
1984	MAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.88	0.28	1.33	0.10	0.17	1.60	0.0
1984	JUN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.76	0.25	1.24	0.10	0.16	1.50	0.0
1984	JUL	4.83	0.14	0.15	0.0	4.54	0.0	0.0	0.12	0.0	0.01	0.0	0.0	-1.53	0.25	1.19	0.10	0.15	1.44	0.11
1984	AUG	0.05	0.00	0.00	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.61	0.24	1.12	0.10	0.14	1.37	0.0
1984	SEP	2.68	0.08	0.09	0.0	2.52	0.0	0.0	2.20	0.0	0.16	0.0	0.0	-1.27	0.23	1.05	0.10	0.13	1.29	1.93
1984	OCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.38	0.23	0.93	0.10	0.12	1.15	0.0
1984	NOV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.15	0.22	0.73	0.10	0.09	0.93	0.0
1984	DEC	2.03	0.06	0.07	0.0	1.91	0.0	0.0	3.63	0.0	0.26	0.0	0.0	-0.73	0.23	0.64	0.10	0.08	0.83	3.21
*T		9.59	0.28	0.31	0.0	9.00	0.0	0.0	6.08	0.0	0.44	0.0	0.0	-16.02	3.10	11.00	1.26	1.40	13.66	5.37
*M		103.34	3.06	3.31	6.56	90.39	5.15	1.47	52.41	3.20	3.76	0.0	4.63	0.17	3.02	11.00	1.26	1.40	13.66	*******