THA HASHEMITE KINGDOM OF JORDAN

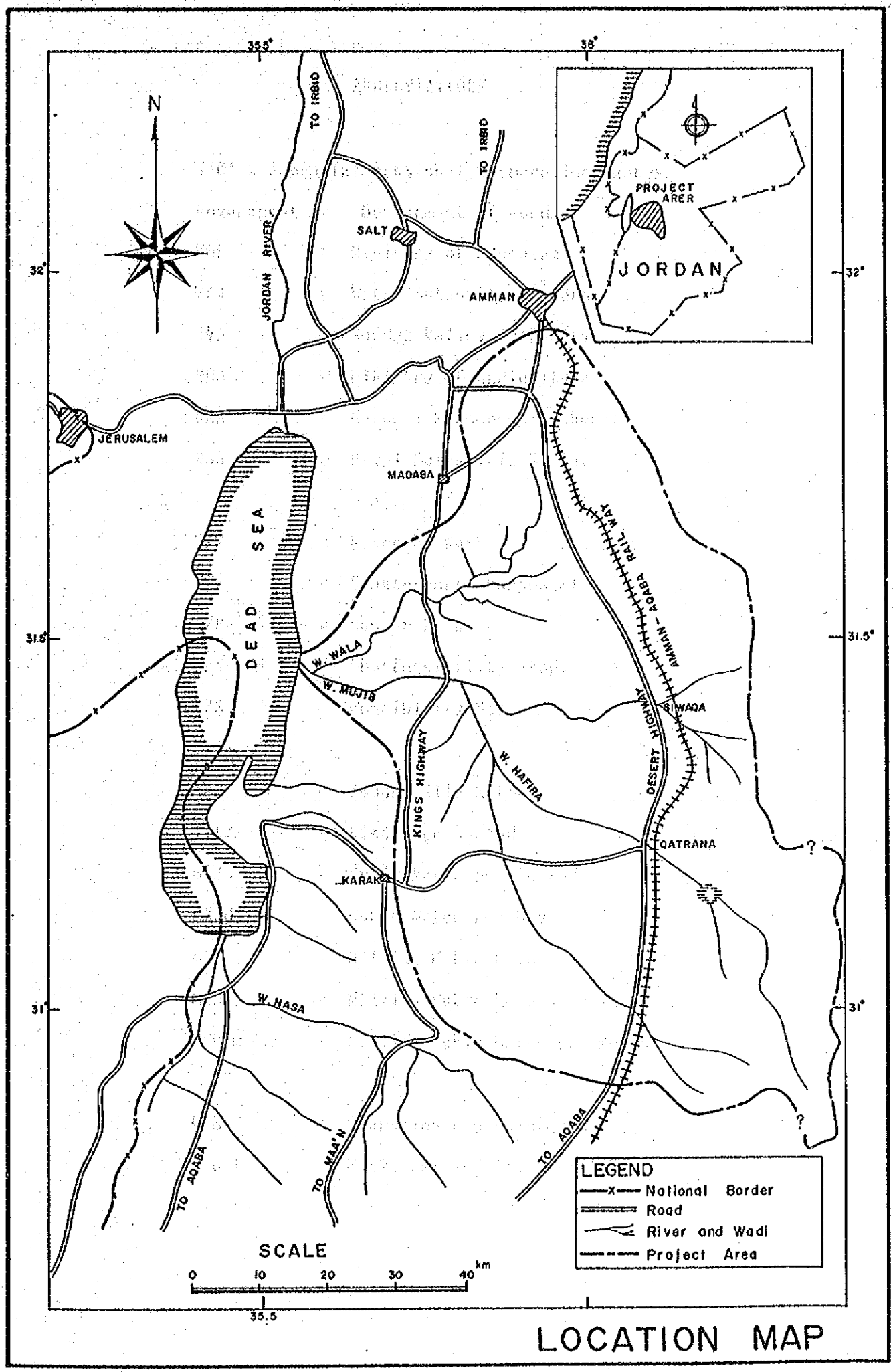
MINISTRY OF PLANNING

HYDROGEOLOGICAL AND WATER USE STUDY OF THE MUJIB WATERSHED

INCEPTION REPORT

NOVEMBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY


35.5°
36°
N
TO IRBID
TO IRBID
JORDAN RIVER
SALT
AMMAN
PROJECT AREA
JORDAN
32°
32°
JERUSALEM
MADABA
DEAD SEA
AMMAN - AQABA RAILWAY
31.5°
31.5°
W. WALA
W. MUJIB
KINGS HIGHWAY
W. HAFIRA
DESERT HIGHWAY
SIWAQA
QATRANA
KARAK
31°
31°
W. HASA
TO AQABA
TO MA'AN
TO AQABA
LEGEND
National Border
Road
River and Wadi
Project Area
SCALE
0 10 20 30 40 km
35.5
LOCATION MAP

ABBREVIATIONS

JICA	=	Japan International Cooperation Agency
Government	=	Government of Jordan
MOP	=	Ministry of Planning
WAJ	=	Water Authority of Jordan
JVA	=	Jordan Valley Authority
MOA	=	Ministry of Agriculture
NRA	=	Natural Resources Authority
RSS	=	Royal Scientific Society
S/W	=	Scope of Work
C/P	=	Counterpart Personnel
M/P	=	Master Plan
Pre-F/S	=	Pre-feasibility Study
F/S	=	Feasibility Study
km2	=	Square Kilo Meter
lit/s	=	Liter per Second
m3/s	=	Cubic Meter per Second
m3/d	=	Cubic Meter per Day
MCM	=	Million Cubic Meter
MCM/y	=	Million Cubic Meter per Year
MCM/m	=	Million Cubic Meter per Month
O & M	=	Operation and Maintenance
M & I	=	Municipal and Industrial

CONTENTS

ANNEXES

I. SCOPE OF WORK AND MINUTES FOR HYDROGEOLOGICAL AND WATER USE STUDY OF THE MUJIB WATERSHED IN THE HASHEMITE KINGDOM OF JORDAN

II. STAY OF EACH EXPERT IN JORDAN

FIGURES

Fig.1 Map of Study Area

Fig.2 Location Map of Hydrologic, Geologic and Hydrogeologic Study

TABLES

Tab.1 Proposed Dam Site

1. INTRODUCTION

1001 The Hashemite Kingdom of Jordan is making steady progress in the economic development of the country. However, limited availability of water which is one of rare resources in the country has at all times been the obstacles. Great efforts have been made for the sector of water resources development making investments of about one sixth of the national budget. The efforts will be continued in the years to come.

1002 Among several measures taken by the Government for this sector, the Water Authority of Jordan (WAJ) was established in 1983 mainly for the purpose to cope with the rationalization of water allocation in entire Jordan.

1003 The largest water consuming area of municipal and industrial (M & I) water in the country is the Greater Amman area in which more than one half of the nation's population is concentrated. This area showed an explosive increase in population in the recent years, and the water supply has constantly been deficient. Increasing trend of demand for water is foreseen to continue also in the future. Some projects have been and will be implemented to augment the water supply to this area. Nevertheless, it is anticipated that the water supply to the area will come to a limit if water sources which has not been clarified are not put into consideration.

1004 The Wadi Mujib basin is located adjacent to the water consuming area. Outflow from the basin consists of the base flow, which is small in comparison with the size of the basin,

and the flood flow which is only observed in the six rainy months. The base flow is dependent on shallow aquifers in the basin. Both base flow and flood flow are discharged to the Dead Sea without being used. On the other hand, the basin has a considerable amount of groundwater resources especially in the upper basin situated on the highland. Part of the groundwater resources in the upper basin have in fact been developed and used for the water supply to Amman and for the private sectors for agriculture.

1005 However, the water resources in the Mujib basin has not been investigated and studied in detail as yet. Despite the proximity to the water consuming center, the Mujib groundwater resources has not been incorporated in the water master plans of nation-wide scale.

1006 Thus the Government of Jordan decided to implement the hydrogeological and water use study of the Wadi Mujib Watershed (the Study), and requested the Government of Japan to provide the required technical assistance. In response to this request, the Government of Japan through the Japan International Cooperation Agency (JICA), the official agency for the implementation of the technical cooperation programs of the Government of Japan, commenced to undertake the study with emphasis on the hydrogeological study in close cooperation with the Government of Jordan through WAJ as an executive authority of the Study.

1007 JICA organized a Preliminary Study Team and dispatched the team to Jordan in June 1985. The Scope of the Work for the Study (the S/W) was agreed upon in July 1985. Entire text of the S/W

is attached hereto. JICA further organized the Study Team (the Team) and dispatched it to Jordan in late October 1985. The Team commenced the works immediately after the arrival.

1003 This is an Inception Report dealing with the plan of operation of the study based on the agreed S/W as well as on the initial findings obtained through the site visits.

2. THE STUDY

A. Present Status and Needs

2101 The Mujib Basin : The basin of Wadi Mujib is located to the south of the capital city Amman. Wadi Mujib river system consists of Wadi Wala and Wadi Mujib which join at a point approximately 2.5 km from the Dead Sea. Wadi Mujib finally debouches to the Dead Sea. Catchment area is 6,750 km2 consisting of 2,050 km2 of Wadi Wala and 4,700 km2 of Wadi Mujib. The basin is approximately 120 km long and 60 km wide (Ref. Fig.1 Map of Study Area).

2102 All the tributaries of Wadi Mujib originate on highland, ranging from 700 m to 800 m in elevation. These tributaries flow down, joining one after another with comparatively gentle slopes on the highland, and with steep slopes in the middle and lower reaches through canyons and gorges. Elevation of the estuary is 399 m below sea level as of 1985.

2103 The basin belongs to the semi-arid area. Yearly precipitation varies from 350 mm in the north western corner to 50 mm or less in the south-eastern corner, and about one half of the basin receives only less than 150 mm. Upper reaches of most of the tributaries are dry in the dry season, but carry flood discharge in the rainy season from November through April. Perennial base flow is seen on the only lower most reaches, but the discharge, approximately 1.2 m3/s, is extremely small as compared with the size of the basin. Majority of both of the

base and surface flows are discharged to the Dead Sea without being used.

2104 Geography : The Desert Highway which ties the capital to the sole sea port Aqaba runs through the basin on the highland desert. The Kings Highway runs between the Desert Highway and the Dead Sea linking the local towns and the villages. Being semi-arid, the lands in the basin are not used for agriculture except for limited number of farms on the northern part of highland and on the riparian strips along the river courses on the lower reaches.

2105 Population is scarce. Notable towns are Karak located on the south-western watershed, Jiza and Dhiban. The Queen Alia International Airport is situated in the northern part of the basin. Madaba city is located outside but close to the northwestern watershed. Existing fertile farmlands near Madaba and Karak are located outside but adjacent to the north-western and south-western parts of the watershed respectively.

2106 Amman, the capital as well as the largest city of the nation having a population of 0.78 million as of 1984, is located adjacent to the northern edge of the watershed. The Greater Amman area, defined as an area within 30 km radius centering about Amman, encompasses such big cities and towns as Zarqa, Madaba, and Salt. This area has an overlapping portion with the Mujib basin. More than one half of the nation's population is concentrated in the Greater Amman Area.

2107 Hydrogeology : Mujib groundwater basin is composed of

Cretaceous limestone and sandstone with total thickness of more than 1,000 m. The aquifer unit is composed of (1) limestone aquifer unit in B2/A7 formation which is recharged by rain, (2) limestone aquifer unit in A6/A1 formation and (3) deep sandstone aquifer unit in Kurnub and Disi formations which store huge amount of fossile groundwater. Productive aquifers are preliminary recognized in limestone formations of B2/A7. Perennial base flow which appears on the lower reaches of Wadi Wala and Wadi Mujib is mainly dependent on the aquifers in limestone (A-7 to A1) unit and sandstone (K2 and K1 to D) unit.

2108 Groundwater basin in the Mujib watershed is preliminary divided into three sub-basins : 1) "northwest Mujib basin" which covers the most area in the Wala watershed and (2) "South-east Mujib basin" which covers the most part in the Mujib basin and (3) "east Desert basin" which is located along and to the east of Desert Highway. Groundwater in the west Mujib basin flows from the east to the west and discharged to the Dead Sea. On the other hand groundwater flow in the east Desert basin flows out to north east discharged to the Azurak area with minor recharge.

2109 Groundwater resources : Groundwater is a major water source of drinking water in Jordan and conceived to be a best future water source in view of quality. Part of the groundwater resources located close to the Greater Amman area and northern Jordan have already been exploited for the municipal, industrial and irrigation purposes. It indicates that even allowing to transmit groundwater for long distance, these source are economical to be developed.

2110 Water supply in the Greater Amman area, consisting mostly of municipal water supply and partly of industrial water supply, largely depends upon local wells. Water consumption per capita is low in general. However, because of a rapid increase in population, the water supply has always been deficient. A large portion of the national budget had been spent to cope with the enlarging demands for water. Nevertheless it is forecast that the area will suffer from a water deficit before the turn of the century if new water sources which have not been incorporated in the existing plans, like that of the Mujib basin, are not taken into account.

2111 Present water use in the Mujib basin: Water supply to Amman from the Mujib basin is made from the Jiza, Siwaqa and Qatrana well fields. Water from the Sultana well field is supplied to Karak. In the northern part of the basin, irrigation farming by groundwater is widely made by the private sectors. Small irrigation farming in the middle and lower reaches of Wadi Wala depends on the groundwater and base flow respectively. Water for the Abyod Phosphate Project located in the south of the basin is supplied from the Wadi Abyod well field.

2112 Need: Therefore, the water resources in the Mujib basin, which has not yet been studied in detail and the water resources are still not fully used, is thought to be a possible relief to the water supply to Amman. Also the water of the Mujib basin has such advantages as a proximity to the water consuming areas as well as an availability of water resource entirely within the territory of the Kingdom. On the other hand, use of the Mujib

basin's water within the basin will contribute to the regional development of the locality.

B. Initial Findings

2201 General: Series of fact-finding tours were made covering majority of the Mujib basin down to the estuary, the Jordan valley and the water consuming areas during the period of November 1 to 21, 1985 accompanied by the counterparts senior officials of WAJ. Through these fact-findings tours as well as through the information given by the officials concerned, the Team obtained many initial findings based on which the Study will be directed.

2202 Hydrogeology: Base flow measurement at the confluence of Wadi Mujib and Wadi Wala is being carried out by Water Resources Department of WAJ including the items of flow discharge, electric conductivity (E.C.) and total dissolved solid (T.D.S). Followings are the results of recent base flow measurement which was carried out at the end of dry season on 16 October 1985;

Wadi	Flow Discharge (lit/s)	E.C. (micromho/cm)	T.D.S (ppm)
Wala	767	1,500	960
Mujib	335	2,070	1,325
Confluence	1,100	1,674	1,061

The base flow in the Wadi Wala is supplied from aquifers of limestone unit in B2 through A1 formations. The base flow in the Wadi Mujib is supplied from the aquifers of limestone units in A3 through A1 formations and sandstone units in K2 through K1

formations.

2203 Groundwater resources : Partial development of the groundwater in the basin is already under way. Extracted groundwater is used for the water supply to Amman, local irrigation and domestic uses. Existing well fields of Qastal and Siwaqa supplied 7 MCM in 1983, or 22 % of the total water use of the city of Amman. Siwaqa well field was further developed, and 12 productive wells were drilled. The pumping capacity as of 1985 is 10.5 MCM. Groundwater wells in the basin amount to 300 in total consisting of about 250 private wells and about 50 Governmental wells which are being used for domestic water supply. These wells were drilled mostly in B2/A7 limestone formation with varying depths from 200 to 400 m.

2204 Groundwater exploration : Intensive exploratory drilling program is being carried out by WAJ including ; (1) 16 boreholes with varying depths from 200 to 250 m located in the middle reaches of Wadi Wala around the Kings Highway bridge to sound the productive aquifer in Ajlun (A7 through A2) formation and (2) 3 boreholes with depths from 500 to 750 m which are sunk in the middle reaches of Wadi Mujib around the Kings Highway bridge to sound the deep sandstone aquifers of Kurnub and Disi formation. In addition to WAJ's program, NRA performed exploratory well drilling program in the oil shale field which is located in the southern part of the Mujib basin. Altogether 16 production wells and 12 observation boreholes have been drilled in B2/A7 formation. Data from these wells will be fully used for groundwater model of the Study.

2205 Surface water development : The damsites proposed before such as the Rumeil and Nukhella sites with a few supplemental sites would not be favorable for high dams from technical view point as well as means of water use. They are located so low in elevation that water from these reservoirs needs to be pumped up by 300 m to 600 m except for area located below. If they are used for highland irrigation, costs of water would become very high.

2206 These sites have favorable topographies both for dams and reservoirs. On each site, however, B2/A7 limestone unit which is pervious and rich in cavities are existing, and thereby there are great possibilities of heavy leakage of water. In other words, these sites are not favorable for the year-round storage of flood outflows. Likelihood is seen along the whole stretches of lower reaches of Wadi Wala and Wadi Mujib.

2207 The flood outflow use will be conceived as follows: namely,

- Series of dams are to be planned on the middle and upper reaches including those proposed previously,
- Dams will have function to store flood water considering the recharging of groundwater and sediment trapping,
- As the groundwater flow to the west of the groundwater divide is finally concentrated to the estuary, such recharging will reinforce not only the yield of groundwater on the highland but also the base flow on the lower reaches.
- Such damsites are mainly to be selected relatively at high elevations for minimizing the required pump heads as well as

for effectuating the recharge.

- Dams are to be low in consideration of leakage.

Also the river training is to be considered on the upper reaches of the southern tributaries. At present, stagnant water on such reaches is only effective to recharge groundwater outside the groundwater divide and to increase evaporation. Hence, it is desirable to switch such recharging to the areas inside the divide. River training works by which stagnant water could flow out swiftly to the inside area of the divide is thought effective.

2208 Agriculture and Irrigation: Both of rainfed and irrigated farms are made. The rainfed area is located around Madaba, Jiza, Zabib, Dhiban and Karak. Main crops are wheat, barley and some kinds of fruits. The ground water irrigation schemes have been exploited by private sector on the highland especially in Madaba and Jiza areas. Main crops are vegetables such as tomato, cucumber, eggplant, water melon and cauliflower. Some of the surface water resources in the Mujib basin is also used for small-scale farms on the narrow strips along the rivers. Main crops are almost same as in the groundwater irrigation schemes.

2209 Soils: Soil type in the Mujib basin is generally classified into two soil groups, namely Yermosol and Xerosol which terminology is defined by FAO standard. The Yermosol is expanded in dry areas where rainfall is less than 150 mm a year. Majority of the area where the rainfall is more than 200 mm is covered by the Xerosol.

2210 Irrigation area: As for the irrigable area, three blocks

are tentatively identified; they are (1) existing farm lands near Madaba, (2) existing farm lands near Karak and (3) a belt on the highland centering about the Desert Highway. Of these blocks (1) and (2) are cultivated receiving precipitation of more than 300 mm a year, whereas most of block (3) is uncultivated receiving precipitations of 150 mm or less a year. Hence, the irrigation areas under the present study will be selected mainly from this block.

2211 There are several junctions of the Desert Highway with the tributaries of Wadi Wala and Wadi Mujib. Areas centering about these junctions seem most favorable to study on irrigation development for such reasons that the soils (probably Yermosol) are comparatively more favorable, that the topographies are suited and that water is available nearby. Irrigation water supply will depend on the conjunctive use of groundwater and surface water.

2212 As for the base flow on the lower most reaches, the planning of the groundwater resources development on the upper basin will be made keeping in mind to minimize the effect of the upstream obstruction of groundwater on the base flow.

2213 Demands for water: As to the demands for water, the highest priority is given to the water supply to the Greater Amman area for which the most favorable water source is groundwater. Amount of the irrigation water demands are to be elaborated during the Study in combination with the irrigation potentials for which water source will be surface water, groundwater or more probably conjunctive use of these two. In

addition, an oil shale area, located in the southern Mujib basin to the east of Karak, will be developed in the near future as the result of exploration by NRA is promising. Also, a phosphate ore mining is existing in the southern edge of the basin, and this mining depends on the well but might require more water. Water source for these purposes will have to be considered duly.

2214 Strategy: Taking into account all of the above mentioned factors, it is first necessary to elaborate the master plan on the water resources development synthesizing all of the available water resources, which will consist mainly of groundwater including recharging and the surface water, and the demands thereof with the priority of development. For this aim, it is required to prepare form up an inventory study on all of the conceivable elementary plans without exception . Some of them are to be selected by comparison and formulated to projects each of which form an integral part of the master plan. Hence, for the comparison purpose, each of the elementary plan will have to be studied on the Pre-F/S precision.

2215 In any case, it is evident that the highest priority of the elemental project in the Master Plan will be given to the project to supply water to the Greater Amman area. Hence, the feasibility study (the F/S) need to be commenced prior to the final completion of the Master Plan. It will be possible to commence the F/S after the availability of water becomes clarified and the water allocation plan is made approximately.

2216 Impacts of the water resources development in the Mujib basin to the nation wide water use will become evident with the

progress of the Master Plan study. One example of impacts concelvable even at the present stage is as follows: namely,

- Used water in Amman flows finally into Wadi Zarqa. Water supplied from the Mujib basin will add the discharge of Wadi Zarqa and will result in benefitting the other irrigation project areas.

C. Plan of Operation

2301 Basic concept of the present Study is defined as follows: namely,

- To clarify the potential water resources in the Mujib basin, to assess the demands for water, and to plan optimum use of available water taking into consideration of the total national benefit.

2302 Objectives : Towards the basic concept, the objectives of the Study are as follows: namely,

1) To conduct a hydrogeological study for the groundwater development within the Wadi Mujib Basin,
2) To conduct a potential study for the surface water (flood flow storage and recharging effects in the Wadi Mujib Basin), and,
3) To formulate a Master Plan for the water resources development.

2303 Approach : To achieve the objectives, the approach is as follows: namely,

(1) Potential of the groundwater in the Mujib basin will be clarified,

(2) Potential of the surface water in the basin will be clarified by means of identifying potential damsites and evaluating the potential storage effects by dams considering recharging effects,

(3) Future demands for water supply in the Greater Amman Area will be elaborated,

(4) Agricultural potential in the basin will be studied,

(5) All conceivable development plans will be formulated and inventoried,

(6) Comparison will be made between each of the inventoried plan both from technical and economic view points. Assessment of benefits and estimation of costs will be made on the Pre-F/S precision.

(7) Priorities will be given to each of the selected plans, and thus the Master Plan will be elaborated.

(8) Feasibility study will be made on the project to supply water to the Greater Amman area which is most important and urgent, and therefore will be given the highest priority.

2304 Plan of Operation : In line with the approach, the actual study works by the Team is, by the period-wise classification, divided into four parts, namely Parts A, B, C and D. Outline of the study in each part are:

Part A : Data collection, analysis and review,

Part B : Field Survey,

Part C : Analysis and alternative study

Part D : Project and Master Plan formulation.

Detailed description of the plan of operation of each parts is

given in the chapters to follow.

3. PLAN OF OPERATION FOR PART A (Inception)

A. Objective

3101 In part A of the study, preliminary field investigations which include preparatory work, inception work, data collection and preliminary analysis, preparation of tender documents for groundwater investigations and installation of hydro-stations for monitoring will be carried out. The data collection will be completed by the middle of December 1985. The tendering and installation of the hydro-stations will be finished by the end of December 1985.

B. Plan of Operations

3201 The data collection will be made for the major investigation items of i) socio-economy and institution, ii) natural environment, iii) M & I water supply plan and water demand and iv) irrigation.

3202 Investigation for socio-economy and institution will include general socio-economy, land use, institution and law and related development plan.

3203 Investigation for natural environment will include geomorphology, soils, meteology, hydrology, geology and hydrogeology.

3204 Investigation for M & I water supply and water demand will include water supply system and well inventory for domestic and M

& 1, water use and mid to long term water supply plan.

3205 Investigations for irrigation will include present land use and irrigation system, inventory of well for irrigation purpose, irrigation plan and agronomy.

3206 Hydrologic and meteorologic equipment which covers both surface hydrology and groundwater hydrology will be installed in the selected stations as shown in Fig.2. The equipment which will be donated by JICA includes ; 1) four units of automatic water level recorders for surface gauging stations, 2) two units of rainfall gauges, 3) two units of evaporation pans, 4) two units of current meters, 5) four units of water content meters (tensiometers), 6) four units of automatic water level recorders, 7) one unit of borehole electrical conductivity meter and 8) one unit of borehole current meter. Items 1) through 6) will be arrived at Amman airport by the middle of December 1985. WAJ is kindly requested to construct the gauging stations in order to install the JICA's donating equipment.

3207 For assessment of the land resources in the whole Mujib basin from the view points of agricultural and irrigation development, preliminary data collection will carried out. Main items to be investigated includes the present conditions of topography, land use, soils, agriculture, agro-economy as well as the existing surface irrigation schemes and groundwater irrigation schemes in the Mujib basin.

3208 Based on the collected data, information and results of fact finding field trips, the land resources for highland

irrigation development in the Mujib basin will be primarily assessed without considering the development of water sources. Moreover, appreciable and profitable crops for agriculture development in highland irrigation area will be studied.

3208 Preliminary analysis : After data collection, preliminary analysis will be carried out by each sectors, including computer programming for both hydrologic model and groundwater model, which will be performed in Japan after middle of December 1985.

4. PLAN OF OPERATION FOR PART B (Field Survey)

A. Objectives

4101 In part B of the Study which is field investigation in Jordan, a feasibility level of field investigation for groundwater development and M & I water supply and a master plan level of field investigation for the potential dam schemes will be carried out after examining existing data in part A study. Part B is composed of sub-parts; (1) the first sub-part B-1 is investigations for groundwater and dam scheme including items of hydrology and its monitoring, hydrogeology (well drilling) topography, geology (test boring for dams and reservoirs and construction material), (2) the second sub-part B-2 is investigations for M & I water supply and highland irrigation scheme including items of topography, foundation, water source facility, electricity, pipeline, construction cost, irrigation and agronomy. The sub-part B-1 will be completed by the end of June 1986 at the time submitting progress report. The sub-part B-2 will start after completing part C-1 and will be finished by the middle of November 1986 at the time submitting interim report.

B. Plan of Operations

a. Part B-1 (Groundwater and Dam)

4201 Hydrology and hydrogeology : The hydrologic survey after installing both meteo-hydro station and groundwater (observation well) station will be carried out as a part of WAJ's monitoring

net work with fully association of WAJ. The survey covers rainfall, evaporation, flood discharge, sediment load, soil moisture (pf), base flow, groundwater level and water quality. (ref.Fig.2 Location Map of Hydrologic, Geologic, and Hydrogeologic Study)

4202 Base flow : The base flow measurement will be carried out in both rain and dry season (February and June, 1986) with assistances of topographic survey crew. During flow discharge measurement typical water samples will be taken and then send to RSS for the chemical analysis. At the same time, groundwater sample from representative tubewells are also taken to compare the chemical composition.

4203 Groundwater investigation : Geological mapping will be carried out using topographic map with scale 1/50,000, area photographs and land sat photos. Exploratory well drilling will be carried out to examine the productivity of aquifers in B2-A7 limestone formation, the drilling work is scheduled to be completed within 5 months after commencement of the work of which date will be beginning of February 1986.

4204 Test well drilling : Four (4) boreholes will be drilled in the area of middle to upper Mujib basin, in order to cooperate with drilling campaign program by WAJ. Total drilling depth will be 1,300 m with a maximum depth of 400 m. After drilling, electric logging will be carried out to distinguish the apparent resistivity of aquifers and aquitards. After screening and developing the test hole, pumping test which consists of preliminary pumping, step drawdown test and continuous pumping

test. During continuous pumping test, flow velocity logging will be performed to examine productivity of each aquifer unit in B2/A7 formation. At the end of pumping test water sampling will be made and then the water samples will be sent to RSS for the chemical analysis. This test well drilling will be carried out by JICA study team.

4205 Potential dam site : Sixteen (16) potential damsites including Rumeil and Nukheila damsites are selected in view of the topographic conditions on the map of 1/50,000 in scale. Locations are shown in Fig.1. The catchment area, estimated flood runoff, elevation and main purposes of each dam are shown in Table-1.

4206 Topographic survey : By this survey following maps and data necessary for this study will be prepared.

(1) Map in 1/7,500 scale with two (2) meter contour intervals, for all the conceivable damsites including and these reservoir areas which mapped from air photo of 25,000 scale provided by WAJ
(2) Map of 1/10,000 scale with 10 meter contour intervals for the Wadi channels of lower Wadi Mujib and lower Wadi Wala from air photo of 1/25,000 scale provided by WAJ
(3) Profile and cross sections along lower Wadi Mujib and lower Wadi Wala which will be carried out keeping pace with base flow measurement made by the Team
(4) Profile along Wadi Hatira, i.e, upper area of the existing Qatrana dam for the river training study provided by WAJ

Check levelling from national bench marks or triangulation points to each damsite and channel will be carried out by the Team.

4207 Engineering Geology : Geological mapping in 1/7,500 scale for all damsites will be carried out for flood storage dam scheme considering groundwater recharge dams with emphasis to pervious limestone on the river bed, abutments and reservoir areas. Exploratory drilling with pressure permeability test will be carried out to sound the representative geological condition which will covers the all potential dam axes and reservoirs. This work will be carried out by WAJ with assistance of the expert of the Team. Nine (9) boreholes are scheduled to be drilled along the dam axes at right abutment, river bed and left abutment or reservoir areas of Rumeil ,Mujib and Sueida No.1 dam sites as shown in Fig.2. Total depth of drilling will be 360 m (= 3 sites x 3 holes x 40 m). Results of past studies, such as geological investigations of Tannour dam will be fully refereed.

4208 Construction material survey : Pitting with 5 m depth will be carried out at the representative borrow areas in the Study area such as Rumeil , Mujib and Sueida No.1 damsite to examine the available impervious materials. Physical soil tests i.e, natural moisture content, specific gravity, particle size distribution, consistency test on about 50 samples from the test pits will be carried out at laboratory in Amman. The reconnaissance for dam construction materials, i.e, impervious material, filter and rock materials, and concrete aggregates will be carried out at all the potential sites to supplement the above survey.

4209 Survey on costs : Unit cost is an important element of this study and contract rates of recently constructed dams and those that are being constructed dams and those that are being constructed, inflation and other cost indices will be collected and review of these data will be made.

b) Part B-2 (M & I Water Supply and Highland Irrigation)

4301 M & I water supply : Upon preliminary determination of available amount of groundwater and productive well fields, investigation and planning of such facilities as, pump, electricity, treatment and transmission will be carried out.

4302 Topographic survey: For planning and preliminary design of required facilities, including the transmission main, necessary topographic surveys will be carried out at respective sites. Results of the past surveys or available data, if any, will be utilized fully.

4303 Geological survey : Necessary geological survey will be made on the sites for the main structures including the transmission main. For these geotechnical works, the results of the past studies or information, if any, will be fully used.

4304 Planning : Planning will be made on the following items;

(1) Location of the following facilities;

-Boreholes of well field

-Pumping station to intake; conveyance of water, and booster.

-Reservoirs; collecting, connecting and terminal reservoirs

(1) in Amman

-Transmission pipe line including connecting pipe line between terminal reservoir and existing water distribution system in Amman

(2) Layout of facilities of (1)

(3) Power supply facilities

(4) Control system for water supply

4305 Survey on costs : Survey will be made on the availability and costs of construction materials and labors required for the construction of the Project. The latest data and information available from the recent projects in Jordan. As for the operation and maintenance (O & M) cost, the past records of the existing system under WAJ administration will be useful.

4306 Agriculture and Irrigation : Referring to the results of the water resource development study in the Mujib basin (i.e, available dam sites, possible water amount of agriculture and irrigation development, etc.), field investigation and additional data collection of the following items will be carried out for up-dating the primary agriculture and irrigation study. Furthermore, preliminary demarcation of proposed irrigation area will be made by using topographic map with a scale of 1/50,000.

(1) Up-dated data on agronomy and agro-economy.

(2) Field soil survey and soil analysis for the cross check of available soil maps.

-Proposed test pit 5 sites (2 meters depth).

-Soil profile hole by hand auger 50 sites (1 meter depth).

(3) Water quality analysis, if necessary.

(4) Additional collection on available soil maps and land classification maps.

(5) Inventory survey on existing irrigation scheme including deep groundwater irrigation scheme.

(6) Construction cost and materials survey.

(7) Preliminary demarcation of the proposed irrigation area.

5. PLAN OF OPERATION FOR PART C (Analysis)

A. Objectives

5101 In the part C of the Study which is analytical work in Japan, a feasibility study on groundwater development and M & I water supply and master plan level study on the potential dam schemes will be carried out on the basis of the result of field investigation in Jordan. Part C is composed of two sub-parts; (1) the first sub-part (C-1) is potential analysis on groundwater development and potential dam schemes, and (2) the second sub-part (C-2) is study on the water use for Amman water supply by groundwater and the highland irrigation schemes. The sub-part C-1 will start after completing the B-1 will be completed by the middle of June 1986. The sub-part C-2 also will start after completing B-2 will be finished by the middle of January 1987 and then will be transferred to master plan study of part D.

B. Plan of Operations

a. Part C-1 (Potential Analysis for Water Source)

5201 Hydrology and Hydrogeology: The hydrologic studies including monitoring on both for surface water source and for groundwater source will be continued throughout the field work period of sub-part B-1 as that more data could be available to the sub-part C-1. All the hydrologic data in and around the Mujib basin will be compiled in micro-computer data bank system. Flood analysis will be carried out by Basin-Catchment-Method and Soil-Moisture-Index-Method both for available flood flow volume

of long-term average and peak discharge of extreme case. The former result will be utilized for the potencial storage at each proposed damsite and the latter is for the operation of water reservoir according to actual flow forcasting. Base flow will be analysed by the method of multiple tank model and statistic and probability. The multiple tank model method will couple hydrologic system and hydrogeologic system in order to estimate groundwater recharge and base flow in the Wadis. Analysis on pumping test which includes flow velocity logging will be made by estimating relative coefficient of permeability (transmissivity) of each aquifers in the multiple layered limestone unit.

5202 Groundwater Model Simulation : Taking account of the multi-layered aquifer system in the basin, quasi-three dimensional simulation model will be applied by using mathematical method of Alternative Direction Implicit (ADI) and/or Finite Element Method (FEM). The simulation model will couple the analysis on economic viability of the groundwater development by estimating water source cost of pumping wells.

5203 Geology : Stratigraphic analysis will be made to classify aquifer unit in the basin, taking account of not only groundwater simulation but also dam scheme in limestone foundation. Also study with reconnaissance on availability of groundwater recharge dam will be carried out, and the recommendations, if any, for the future investigations would be given in the final report. For these works, the results of the past studies or information, if any, will be fully used.

5204 Construction Material : Assessment of construction

materials including soil, river deposit (sand and gravel) and rock will be made to determine the type of dam and its cost.

5205 Flood Storage Dam : Taking into account the topograph, geology, hydrometeorology, economic considerations and environmental aspects, the all the potential flood storage dams will be compared and evaluated in each respective purpose such as M & I water supply, highland irrigation, recharge of groundwater, oil shale development and Southern Ghors irrigation. After the above preliminary evaluation, the several proposed dams will be selected and the optimum dam height will be determined by study of probable flood discharge at the proposed damsites respectively. The preliminary design for the above selected dams will be carried out as follows:

(1) Study of design conditions such as topography (relief of the sites, etc. from topographic maps, profiles and cross sections), geology (assumed rock lines, foundation formation lines, location of faults and weak zones, permeability in foundation and reservoir, etc.), materials (location of quarry sites and borrow areas, quantities, qualities, accessibility, etc.), hydrometeorology (spillway design flood, determining workable days, etc.), environment (restriction to construction work, etc.) as well as high water level (HWL) and low water level (LWL) of the reservoir or pumping and release discharges.
(2) Study of design criteria and standards including design concepts.
(3) Determination of design values such as strength and permeability of construction materials of rock, earth and

sand, and foundation of dams and reservoirs, etc.

(4) Determination of the dam axes and layouts, dam types, free board, etc.

(5) Stability analysis of the dams and grout study if necessary.

(6) Structual and hydraulic design of spillway, pump house, inlet/outlet canal and structure, etc. if necessary.

(7) Determination of provisional alignment of the access road.

(8) Work quantity calculation.

5206 Cost Estimate : the unit price adopted for the study will be estimated from the break down of unit prices for the principal work items and the overall unit prices for other minor work items. For both items tender rates of similar projects, prices indices, labors and material costs, facilities and equipment costs, and other data and related information will be used. The construction cost of each dam will be estimated based on the unit price estimated and the work quantity calculated from the preliminary designs. It will consist of:

(1) Direct construction cost, including land acquisition,

(2) Physical contingency and reserve,

(3) Administration and engineering expenses,

(4) Price escalation cost and

(5) Interest during construction period.

5207 Assessment of Benefit : Benefit for each flood storage dam will accrue from supplying water for mainly irrigation and M & I including water supply for oil shale development, considering groundwater recharge condition. Benefit to be allocated to each dam scheme will be assessed on the basis of irrigation and M

& I water supply studies period in part C-2.

5208 Project Evaluation : The economic evaluation of each dam scheme or dam series if necessary, will be made comparing the annual equivalent cost and benefit and calculating the economic internal rate of return (EIRR). Financial analysis of the above scheme will made in a manner acceptable to international financing agencies. The analysis will also be made from the social and environmental view points.

b) Part C-2 (Water Use Study)

5301 Water Demand : Water demand will be estimated based on the projection by category such as domestic, industrial, commercial and public uses in the Amman metropolitan area. The projection will be given as the result of review of the water demand forecasts which have been studied in the National Water Master Plan in 1977 and in other plans since 1977, taking the following items into consideration;

(1) Up-date socio economic data related to water demand, and
(2) Various development plans of the Government.

The estimation of water demand for domestic use will be the product of population, served ratio (the ratio of the population served with water to the total population) and per capita consumption. The population projection will be made every five years till the year 2005. Appropriate mathematical function or annual growth rate method will be applied for the population projection. The served ratio and per capita consumption will be

considered in a gradual increase trend. In estimating the future served ratio and per capita consumption, discussions with MOP and WAJ will be needed. The water demand for industrial and commercial uses will largely depend on he forecast of future aspects in industrial and commercial developments. Namely, the future water demand for these uses will be affected by regional development plans and consequently by estimation of gross regional product (GRP). Therefore, efforts will be made to obtain the data and information on the regional development plans and GRP. The water demand projection for the above uses will be made after establishing a correlation between future water demand for the above uses and GRP which will be estimated based on the regional development plans. But, when this GRP-based approach were found unrealistic, then some other methods would be sought and applied.

The water demand for public use will comprise those of Government buildings, schools, hospitals, transport facilities, fire-fightings and fountains. It will be projected based on a correlation between the water demand for public use and urban population. For this purpose, the data on the above will have to be collected. Total water demand will be the sum of water demands for domestic, industrial, commercial and public uses estimated through the aforementioned methods.

5302 Formulation of Water Supply Schemes : After the available amount of groundwater from the basin has been assessed, then the water supply schemes for Greater Amman area will be formulated. Provisional time schedule for development, dosign and cost estimate of each scheme will be worked out.

5303 Arrangement of Long-term Water Supply Plan : The aforementioned water supply schemes will be arranged sequentially to meet the water demand in the Study area. They will form a long-term water supply plan covering the period of 1992 to 2005, if the on-going East Ghor Pipeline Project could meet the demand until 1992. The said arrangement will be made by comparing each scheme's cost per unit amount of water to be supplied for the study area, the scheme with the lesser cost will be given the higher priority. For the above arrangement, other factors than the said cost, such as the duration of the scheme i.e. the period in which the scheme can meet the water demand, will also be taken into account.

5304 Implementation program and Cost Estimates : Implementation program and construction schedule will be worked out keeping in mind that the completion of the scheme facilities and the start of water supply thereby could be in time for the foreseeable water supply shortage which would take place presumably in 1992 under the existing plus on-going East Ghor Pipeline facilities.

5305 Institutional study will be made for both aspects of the implementation including construction, and the O & M of the completed facilities. As for the latter, WAJ will possibly take care of the new system with necessary expansion.

5306 Cost estimates will be made based on the work quantities and unit cost obtained through the above-mentioned studies. Construction cost will be estimated on the schemes. Physical contingencies and possible future price escalation will be duly considered. Estimated costs will be broken down into the foreign

and local currency portions as well as into the annual disbursement schedules.

5307 Economic evaluation: The economic viability of the Project will be assessed by calculating the Economic Internal Rate of Return (EIRR). The benefit of the Project except irrigation is taken to be the cost of the second best scheme. Namely, the cost saved by implementing the Project is considered as the benefit of the Project from the point of view of the whole economy. The sensitivity test will be made taking into consideration such factors as unforeseeable increase in costs and also unforeseeable decrease in benefits.

5308 Financial analysis will be made for the assessment of financial soundness of the Project to the executive agency of the Project. The analysis will be made with the water charge on the revenue side and the investment and O & M costs on the outgo side. The cash flow will be worked out and the repayability will be assessed. According to the results, some recommendations, if needed, will be made on some items like a necessity of subsidy or renewal of water charge tariff.

5309 Selection of crops : the selection of the most profitable crops and proposed cropping pattern for the project will be made taking account of the conditions of climate, soils,water quality, irrigation method, farm unit, availability of labor-input and market.

5310 Demarcation of the proposed irrigation area : On the basis of preliminary demarcation of the proposed area, up-dated

data and additional fact finding in the field, alternative demarcations of the proposed area will be made and technical priority of the alternatives will be studied by using topo-maps with a scale of 1/50,000.

5311 Primary Design of Irrigation Network : In accordance with alternative plan of the proposed area, typical design of irrigation and drain network will be made, taking into account the drip irrigation method.

5312 Preliminary cost estimate : Construction cost of irrigation facilities and O & M cost concerned to irrigation system will be preliminary estimated in accordance with the alternative plan.

5313 Benefit estimate : Agricultural benefit will be estimated based on the expected yield of crops and international or domestic market prices.

5314 Irrigation water requirement : The irrigation water requirement will be estimated on the basis of proposed cropping pattern and irrigation method.

6. PLAN OF OPERATION FOR PART D (Master Plan)

A. Objectives

6101 In part D of the study, a master plan study (the M/P study) on the water resources development in the Mujib basin will be made. Also a study will be made on the impacts of the M/P onto the national water master plan.

6102 On the basis of the results of the field investigations in Jordan to be completed by the middle of November 1986, the analytical works will be continued in Japan until the preparation of the Final Report in March 1987.

B. Plan of Operation

6201 The target year of the M/P Study will be the year 2005.

6202 The M/P study will made through the general work flow as shown below (ref. Para 2304),

- Assessment of the potential of water resources,
- Assessment of the future demands for water,
- Formulation of plans combining the above two, resulting in making an inventory of development plans,
- Comparison of the inventoried plans,
- Determination of priorities of the plans.

6203 Assessment of the potential of water resources will be made based on the results of such studies as:

(1) analysis of groundwater potential,

(2) availability of flood outflow by dams, if any,

(3) Recharging effects by dams, if any,

(4) Analysis of groundwater potential when recharging effects, if any, is taken into account.

Finally, locations and available amounts of water will be clarified.

6204 Assessment of future demands for water will be made. Such demands will consist of,

(1) Demands for M & I water supply to the Greater Amman area,

(2) Demands for irrigation water resulting from the potential study on irrigation farming,

(3) Other demands: for example those for the oil shale development.

Finally, the locations and amounts of water demands will be clarified.

6205 Putting into consideration the locations and amount of the demands and available water, the formation of plans will be made, and an inventory of plans will be drawn up. Then, assessment of benefits and estimations of costs for each plan will be worked out on the Pre-F/S precision. As work is to be made for the comparison of the plans, such assessments and estimations will be made on common basis so that indication values on common level will be obtained.

6206 Next, comparison of the plans will be made in view of the importance to the nation, the socio-economic needs, the contribution to the other sectors and so forth. Through this procedure, some of the plans will be sieved out and some plans will remain. On the plans remained, priorities will be given

and such plans will turn to the projects. Thus the M/P study will be achieved.

6207 At the present inception stage, it is not foreseen how many plans will remain with priority in the M/P. Nevertheless, it is for certain clear that the project to supply M & I water to the Greater Ammnn area will have the highest priority from every view points. for this reason, F/S study for this project will be proceeded almost keeping pace with the whole M/P study.

6208 Environment assessment will be made for the items of groundwater pollution and surface storage scheme, including not only natural environment but also socio-economic impacts for instance, as trans-migration, settlement of nomads, aesthetic aspect and so on.

6209 Groundwater monitoring system will be established including organization and computer data filing system.

6210 The water resources in the Mujib basin have not been incorporated duly in the existing national water master plan though the former will play a great role to the latter. Upon completing the M/P Study, therefore, the impacts and contribution of the Mujib water resources onto the future water use in the kingdom will be studied.

7. WORK PLAN

A. Coordination with MOP and WAJ

7101 The Study will be carried out with a close coordination with MOP and WAJ. For the collection of date and information required for the Study, the cooperation of MOP is needed. For the water demand forecast, the development policies established in MOP and the concerned Ministries will be fully referred to. In the process of the Study, discussions among MOP, WAJ and the Team will be held whenever needed.

7102 Transfer of knowledge from the Team to the counterparts provided by WAJ will be considered in any aspects of the Study, with the emphasis on the use of computer and micro-computer for the hydrologic analysis and groundwater simulation.

B. Work Schedule and Experts

7201 The Study is scheduled to be performed as shown in the Table attached to the S/W. The field survey in Jordan will be completed by the middle of November 1986. The Study thereafter will be continued in Japan and completed in the middle of June 1987 by submitting the Final Report.

7202 The experts assigned to the Study are as shown below:

ASSIGNMENT	NAME
Team Leader	Takao ICHIMIYA
Hydrogeologist	Masahiro MURAKAMI

Environmental Expert	Hajime TAKAHASHI
Drilling Expert	Hiroyasu NISHINOSONO
Dam Engineer	Sadao SANEKATA
Hydrologist/Computer Expert	Mamoru KUWABARA
Engineering Geologist	Tadashi NAKAYU
Survey Engineer	Kuniaki TAKAMATSU
Economist	Dr. Kinichi OHNO
Water Supply Engineer	Akira NAGUMO
Construction Planning Expert	Hiroshi NAKASEKO
Irrigation/Drainage Engineer	Shoichiro BAN
Agronomist	Dr. Masao ISHIKAWA

The Study in Jordan of each expert for the field study is scheduled as shown in ANNEX II.

C. Counterparts

7301 Counterpart personnel to the Team were assigned by WAJ immediately after the arrival of the Team in Jordan. These assigned counterpart personnel are as shown below:

Department of Study and Water Research - WAJ

Dr. Omar M. Joudeh (Counterpart Team Leader)

Eng. Abdelrehman M. Hemud (Hydrology, Hydrogeology & Geology)

Eng. Mahir Iskandar (Dams, Construction & Planning)

Eng. Fayez Arikat (Socio-Economy, Water Supply & Surveying)

Eng. Fayyad Barakat (Drilling & Geology)

Eng. Musa Nassar (Irrigation & Agronomy)

Assisting Staff

Eng. Ibrahim Farah

Eng. Najib Ayub

Eng. Ismail Hashem

Eng. Yousef Atiyeh

Geo. Walid Hussein

Hydro. Daoud Hijazi

Department of Water Resources Development & Services - WAJ

Eng. Bader Hirzallah (Hydrology, Hydrogeology & Geology)

Dr. Jamil Rashdan (Hydrogeology)

7302 Working rooms were provided in due time in the building of the Study and Water Reserch Department of WAJ. These rooms are located close to the rooms of the counterpart personnel.

7303 As for the vehicles, WAJ provided to the Team four drivers and fuel as needed, and the Team provided vehicles by local rental. For occasional needs like field trips, necessary vehicles with drivers and fuel were provided by WAJ. This system will be continued throughout the study period.

D. Reports

7401 Reports will be prepared by the Team as indicated in the S/W attached hereto, The reports to be prepared are as follows:

(1) Progress Report (20 copies to MOP)

(2) Interim Report (20 copies to MOP)

(3) Draft Final Report (20 copies to MOP)

(4) Final Report (50 copies to MOP)

7402 The Progress Report will compile the result of field investigation for all the study items with emphasis on groundwater and dams which include the results of well inventory, geological mapping, test well drilling, base flow measurement, topographic survey, hydrological measurement, dam boring and material testing. The report will be submitted to MOP by the middle of June 1986.

7403 The Interim Report will contain ; i) the result of field survey with emphasis on M & I water supply and highland irrigation and ii) analytical results on groundwater simulation and flood water storage dam. The report will be submitted to MOP by the middle of November 1986.

7404 The contents of the Interim Report will be studied further in Japan based on more detailed analysis of data collected through field survey. Draft Final Report will present the final conclusion of the Study and be submitted in the middle of March 1987, to MOP for comments. Final Report will be prepared incorporating the comments, if any, of MOP on the Draft Final Report and submitted to MOP by the middle of June, 1987.

SCOPE OF WORK

ON

HYDROGEOLOGICAL AND WATER USE STUDY OF THE

MUJIB WATERSHED

IN

THE HASHEMITE KINGDOM OF JORDAN

AGREED UPON BETWEEN

MINISTRY OF PLANNING

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Dr. Ziad Fariz,
Secretary General,
Ministry of Planning,

Mr. Hiroyoshi Ihara,
Leader of the Preliminary
Study Team,
Japan International
Cooperation Agency

JULY 3, 1985

I) INTRODUCTION:

In response to the request of the Government of the Hashemite Kingdom of Jordan, the Government of Japan decided to implement the hydrogeological and water use study of the MUJIB WATERSHED (hereinafter referred to as "the Study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan Internation Cooperation Agency (Hereinafter referred to as "JICA"), the official agency for the implementation of the technical cooperation programmes of the Government of Japan, undertake the Study in close cooperation with the authorities of the Government of the Hashemite Kingdom of Jordan. The present document sets forth the Scope of Work for the Study.

II) OBJECTIVE OF THE STUDY:

1) To conduct a hydrogeological study for the groundwater development within the Wadi Mujib Basin.

2) To conduct a potential study for the surface water (flood flow storage in the Wadi Mujib Basin).

3) To formulate a Master Plan for the water resources development.

III) OUTLINE OF THE STUDY:

In order to achieve the objective mentioned above, the study shall cover the following items:

Part A: Data collection, analysis and review.

1) Existing reports (previous studies, national plan, sectoral reports etc.).

2) Existing wells (location, depth, pump capacity, etc.).

3) Maps on topography, geology, land use etc.

4) Data on meteorology, hydrology, geology, etc.

5) Data on economy, agriculture, sociology, environment etc.

6) Data on institution, administration, law and regulation, design criteria, etc.

7) Tendering of topographic survey, drillings, etc.

Part B: Field survey.

1) Field reconnaissance (Investigation).

2) Topographic Survey (longitudinal survey in Wadi Mujib and Wala, cross sectional survey at proposed dam site).

3) Hydrogeological Survey for groundwater potential:

a) Geological investigation.
b) Geoelectric (Seismic) detecting.
c) Monitoring of existing wells.
d) Base flow survey.
e) Test well drilling.
f) Well logging and pumping test.
g) Water quality test.

4) Hydrological survey:

a) Installation of rain gauge and water level gauge.

b) Measurement of rainfall, water levels and flood discharge.

5) Others.

Part C: Analysis and Alternative Study.

1) Groundwater.

a) Identification of productive aquifers.

b) Computer simulation analysis of groundwater model.

c) Assessment of safe yield of groundwater.

d) Assessment of influence on the base flow at the lower reach, both quantitatively and qualitatively.

2) Surface water (flood flow storage).

a) Estimation of long term flood discharge.

b) Estimation and evaluation of exploitable discharge.

3) Water allocation.

a) Demand projection.

b) Alternatives for water allocation (Municipal, Industrial and Irrigation).

Part D: Project and Master Plan Formulation.

1) Groundwater development (Feasibility Study level).

2) Flood flow storage plan.

3) Water allocation plan.

4) Observation network plan.

IV) WORK SCHEDULE:

The whole work will be carried out in accordance with the attached tentative study schedule (Annex 1).

V) REPORTS:

JICA will prepare and submit the following reports in English to the Government of the Hashemite Kingdom of Jordan:

1) Inception Report (Twenty (20) copies). At the beginning of the field survey.

2) Progress Report (Twenty (20) copies).

3) Interim Report (Twenty (20) copies).

4) Draft Final Report (Twenty (20) copies).

The Government of Jordan will provide JICA with its comments within one (1) month after the receipt of the Draft Final Report.

5) Final Report (Fifty (50) copies)
(Executive Summary Report, Hundred (100) copies)
within two (2) months after receipt of the Jordan Government's comments on the Draft Final Report.

VI) UNDERTAKINGS OF THE GOVERNMENT OF THE HASHEMITE KINGDOM OF JORDAN:

1) To facilitate the smooth conduct of the Study, the Government of the Hashemite Kingdom of Jordan shall take necessary measures;

a) To secure the safety of the Japanese Study Team.

b) To permit the members of the Japanese Study Team to enter, leave and sojourn in Jordan for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees.

c) To exempt the members of the Japanese Study Team from taxes, duties and other charges on equipement, machinery and other materials brought into Jordan for the conduct of the study.

d) To exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese study team for their services in connection with the implementation of the study.

e) To provide the necessary facilities to the Japanese study team for the remittance as well as utilization of the funds introduced into Jordan from Japan in connection with the implementation of the study.

f) To secure permission for entry into all areas as required for the proper conduct of the study.

g) To secure permission to take all data and documents (including photographs) related to the Study out of Jordan to Japan by the Japanese Study Team.

h) To provide the medical services as needed. Its expenses will be chargeable on the members of the Japanese Study Team.

2) The Government of the Hashemite Kingdom of Jordan shall bear claims, if any arises against the members of the Japanese Study Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese Study Team.

3) The Water Authority of Jordan (hereinafter referred to as "WAJ") shall act as counterpart agency to the Japanses Study Team and also coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

4) WAJ shall, at its own expenses, provide the Japanese Study Team with the following, in cooperation with other relevant organization:

a) Available data and information related to the Study.

b) Topographic survey and test boring.

c) Counterpart personnel.

d) Suitable office space with necessary equipment.

e) Credentials or identification cards.

f) Drivers and fuel and maintenance.

VII) UNDERTAKINGS OF JICA:

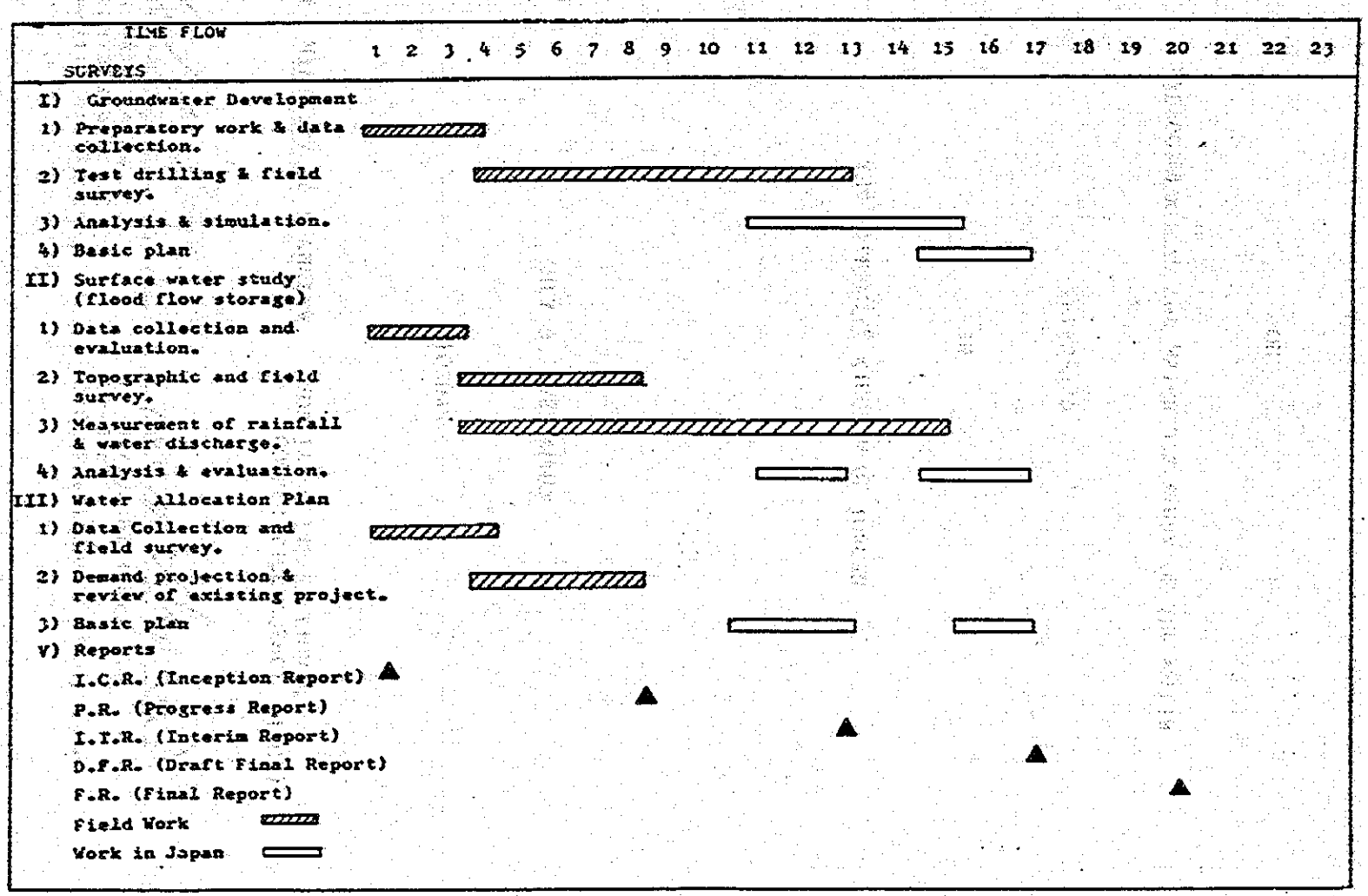
For the implementation of the Study, JICA shall take the following measures:

1) To dispatch, at its own expense, study teams to Jordan.
2) To pursue technology transfer to Jordan counterpart personnel in the course of the Study.
3) To provide appropriate number of vehicles for the Study.

VIII) JICA and WAJ shall consult with each other in respect of any matter that may arise from or in connection with the Study.

ANNEX - 1

TENTATIVE SCHEDULE



MINUTES OF DISCUSSIONS

ON

HYDROGEOLOGICAL AND WATER USE STUDY OF THE MUJIB WATERSHED

IN

THE HASHEMITE KINGDOM OF JORDAN

JULY 3, 1985 AMMAN

JORDAN

FOR MINISTRY OF PLANNING

Dr. Ziad Fariz
Secretary General
Ministry of Planning

FOR JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Mr. Hiroyoshi Ihara
Leader
JICA Preliminary Study Team

MINUTES OF DISCUSSIONS

The Government of Japan has dispatched a Preliminary Study Team headed by Hiroyoshi Ihara to the Hashemite Kingdom of Jordan in order to agree upon the scope of work on the hydrogeological and water use study of the Mujib Watershed.

The Team stayed in Jordan from 26th June to 4th July, 1985 and held a series of discussions with the Jordanian officials from Ministry of Planning and Water Authority of Jordan.

Japanese side and Jordanian side confirmed the following:

1) The target year of the Master Plan shall be the year of 2005.

2) Jordanian side will organize a joint committee with authorities concerned for the smooth conduct of the study.

3) A potential study for the surface water (Objective 2) will be carried out at a pre-feasibility level.

4) Jordanian side will bear the cost for the topographic survey, geological, foundation investigation (including test boring) for the potential dam sites which shall be carried out under the supervision of the Japanese Study Team.

5) Japanese side will carry out the test well drilling.

6) Jordanian side will provide Japanese side with its comments on draft final reports through the diplomatic channel.

7) Jordanian side will provide the Study Team with the appropriate number of drivers and fuel for the vehicles.

8) Jordanian side requested that a few counterpart should be trained in Japan for the purpose of technology transfer. And Japanese side took note of it.

9) Japanese side will provide appropriate number of vehicles for the Study.

LIST OF ATTENDANCE:

1) Jordanian side:

Mr. M. S. Kilani, President	WAJ
Mr. Mahmood Talhoni, Secretary General	WAJ
Dr. Omar Joudeh	WAJ
Mr. Bader Hirzallah	WAJ
Mr. M. Iskander	WAJ
Mr. F. Areikat	WAJ
Mr. A. M. Hemud	WAJ
Dr. Jamil Rashdan	WAJ
Mr. P. Johnson	MOP
Miss Muna Jawhari	MOP

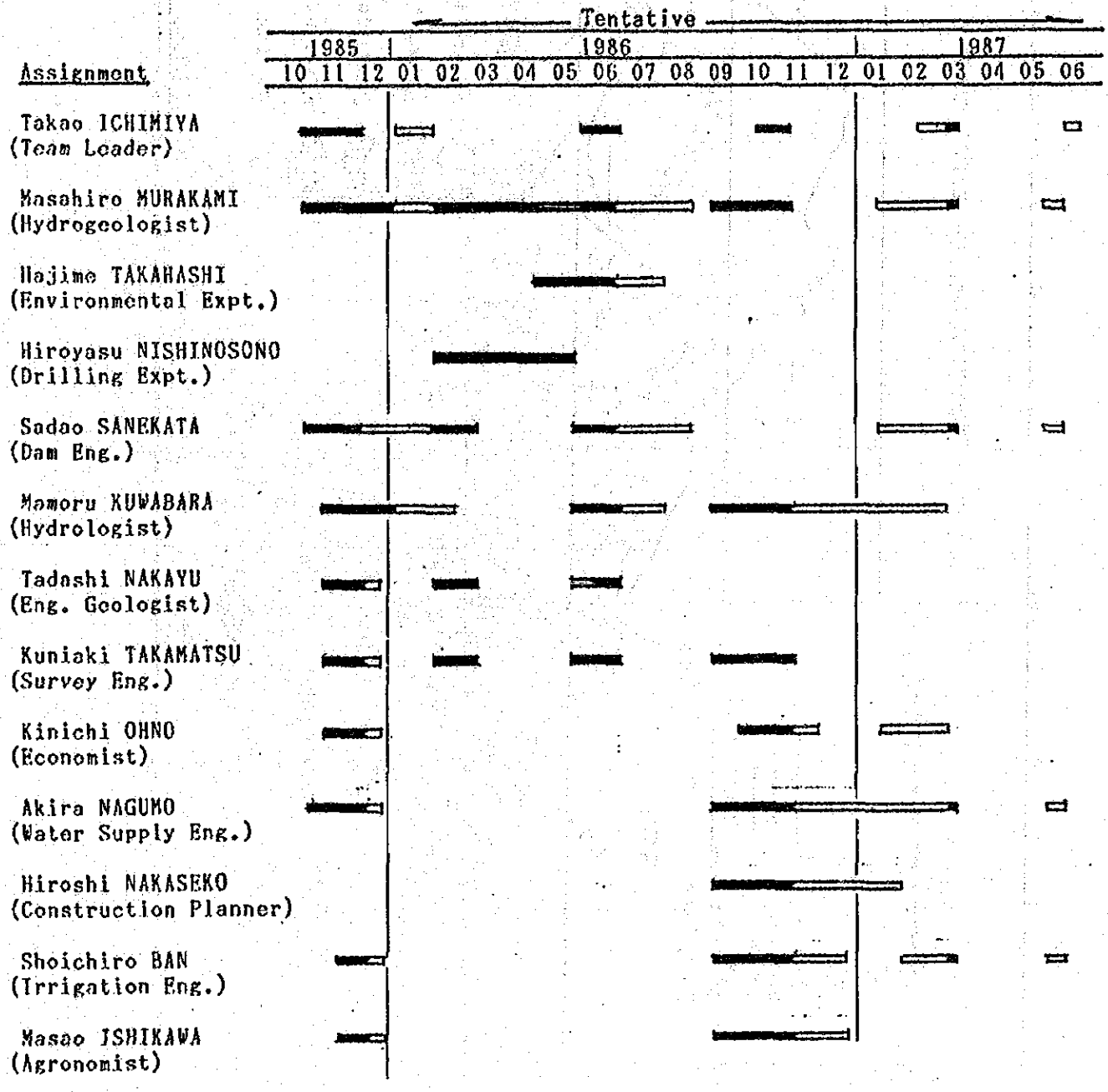
2) Japanese side:

Mr. Hiroyoshi Ihara	Team Leader
Mr. Kenji Yokokawa	Member
Mr. Fumio Kikuchi	"
Mr. Yoshio Kashiwai	"
Mr. Naofumi Kondo	"
Mr. Yushi Kitahara	Embassy of Japan

ANNEX II

ASSIGNMENT SCHEDULE FOR HYDROGEOLOICAL AND WATER USE STYDY OF THE MUJIB WATERSHED IN THE HASHEMITE KINGDOM OF JORDAN

(As of 30 Oct.1985)



Remarks; ▬ Field ▭ Home

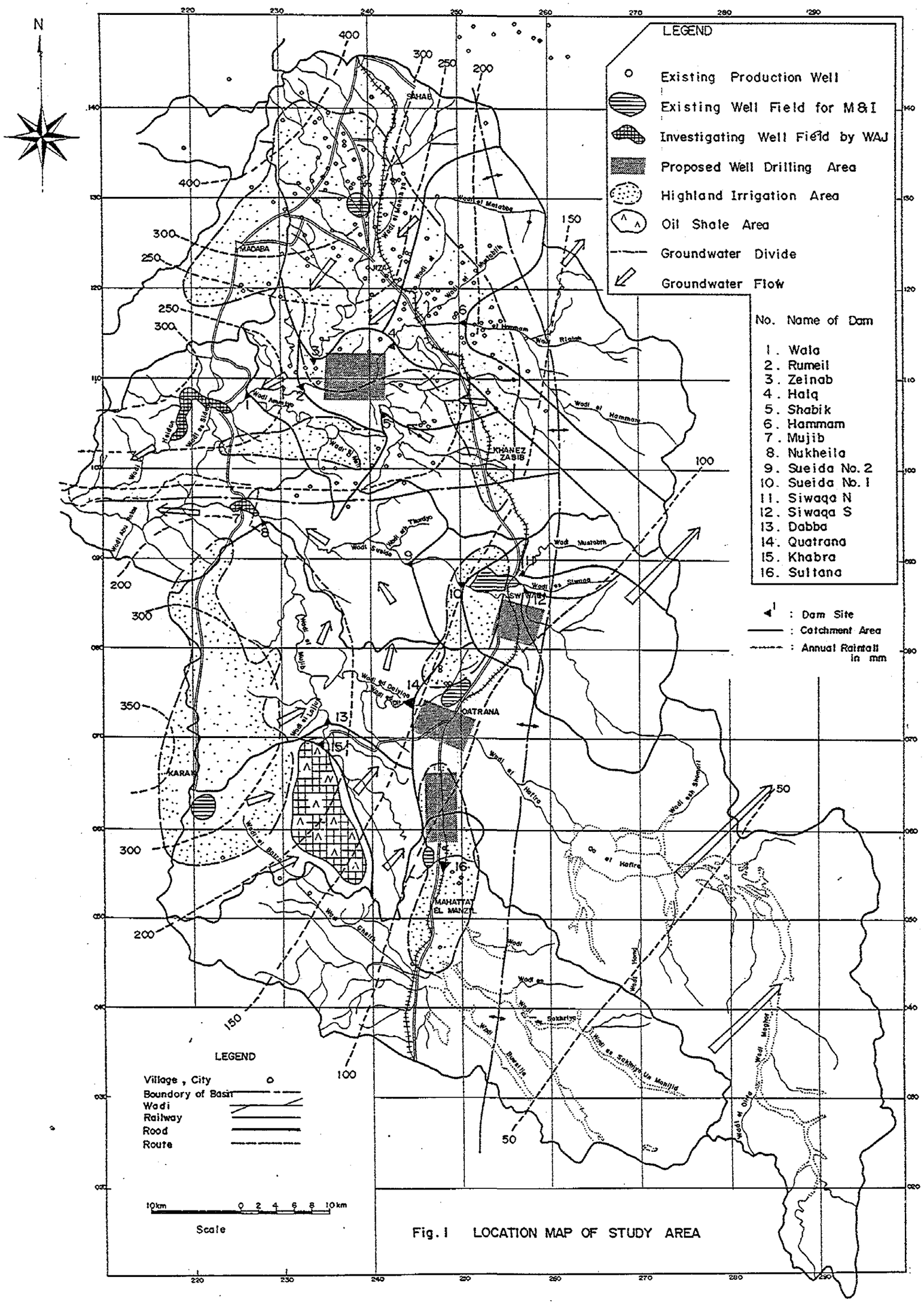


Fig. 1 LOCATION MAP OF STUDY AREA

TABLE - 1

PROPOSED DAM SITE

NO.	DAM	CATCHMENT AREA (KM^2) U*	ELEVATION EL (M)	PURPOSE (REMARKS: Alt. = Alternative)
1	Wala	1,776 (15.8)	490-560	M&I; Highland irrigation; Southern Ghor irrigation.
2	Rumeil	1,622 (14.4)	550-600	- do - (Alt. 1)
3	Zeinab	506 (4.5)	630-680	Highland irrigation; Recharge of groundwater.
4	Halq	756 (6.7)	650-680	- do -
5	Shabik	224 (2.0)	655-680	- do -
6	Hammam	346 (3.1)	696-710	Recharge of groundwater, Highland irrigation.
7	Mujib	4,526 (48.9)	120-180	Southern Ghor Irrigation.
8	Nukheila	3,740 (40.4)	170-220	- do - (Alt. 7)
9	Sueida (2)	558 (6.0)	650-680	Highland irrigation; Recharge of groundwater.
10	Sueida (1)	472 (2.8)	690-720	- do - (Alt. 9)
11	Siwaqa North	108 (0.6)	770-800	- do -
12	Siwaqa South	262 (1.6)	750-780	- do -
13	Dabba	1,554 (13.8)	630-680	Oil shale development; Highland irrigation.
14	Quatrana	1,660 (14.8)	750-770	Highland irrigation; Recharge of groundwater.
15	Khabra	228 (2.6)	690-720	Oil shale development; Highland irrigation. (Alt. 13.)
16	Sultani	1,140 (10.1)	810-820	Highland irrigation; Recharge of groundwater.

Note: U* Estimated flood runoff: MCM/Year.

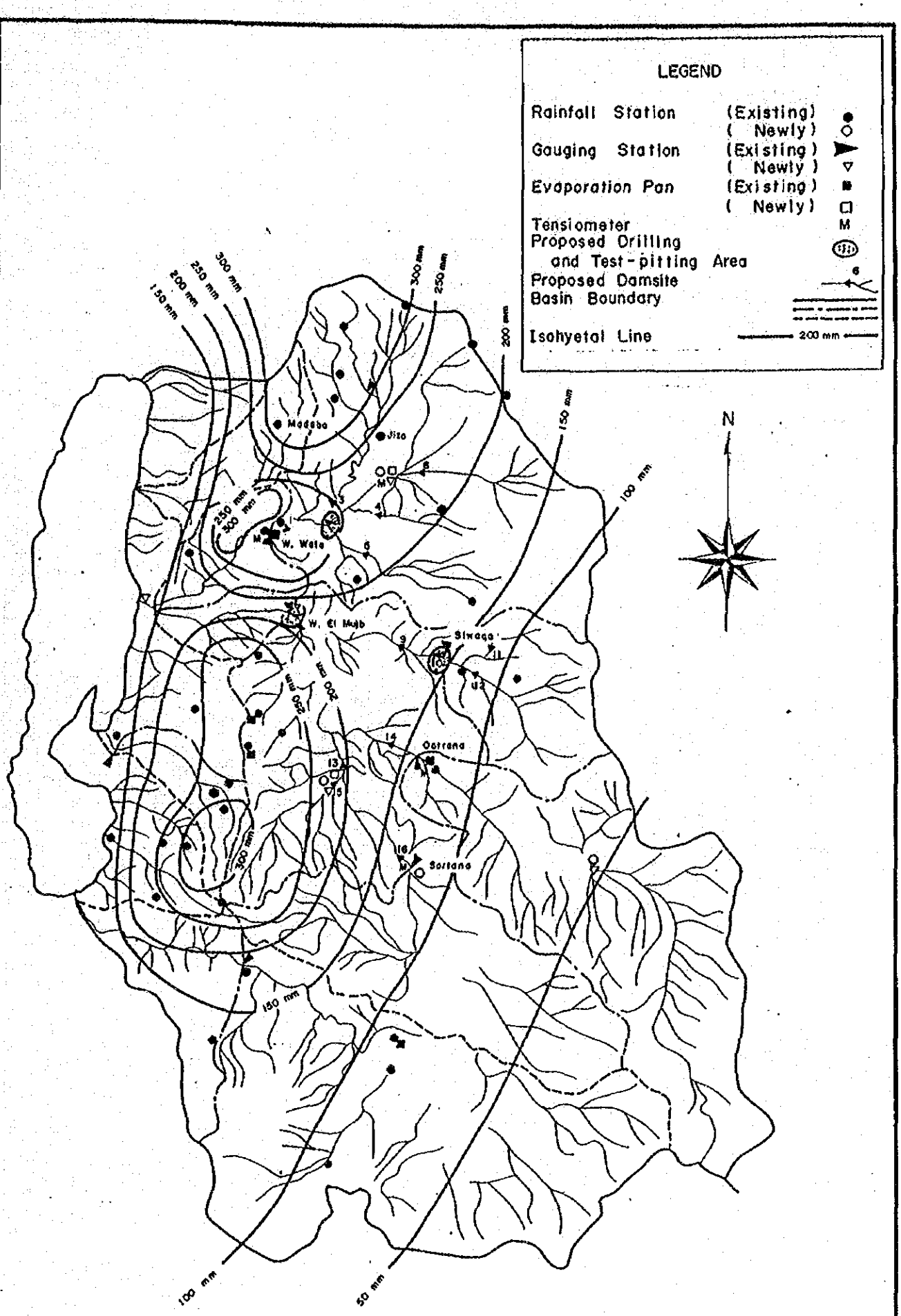


Fig.2 · Location Map of Hydrologic, Geologic and Hydrogeologic Study