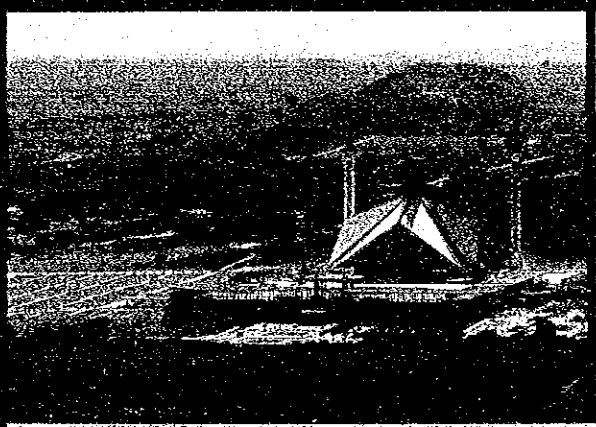
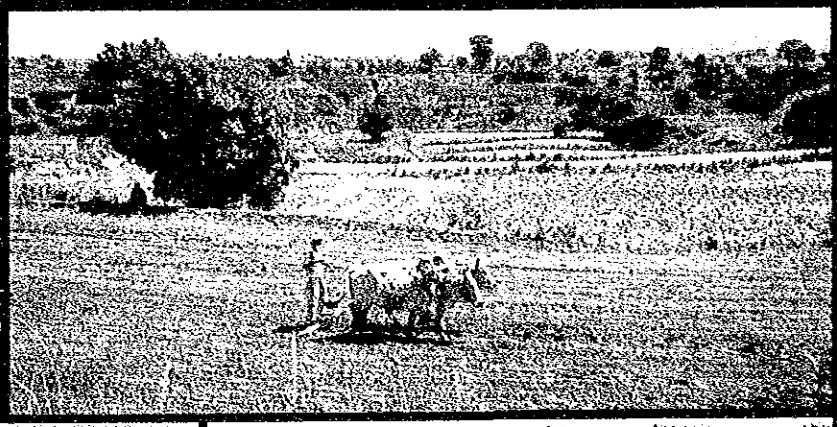
THE ISLAMIC REPUBLIC OF PAKISTAN

THE FEASIBILITY STUDY ON UPPER KURANG RIVER IRRIGATION PROJECT

EXECUTIVE SUMMARY





JUNE, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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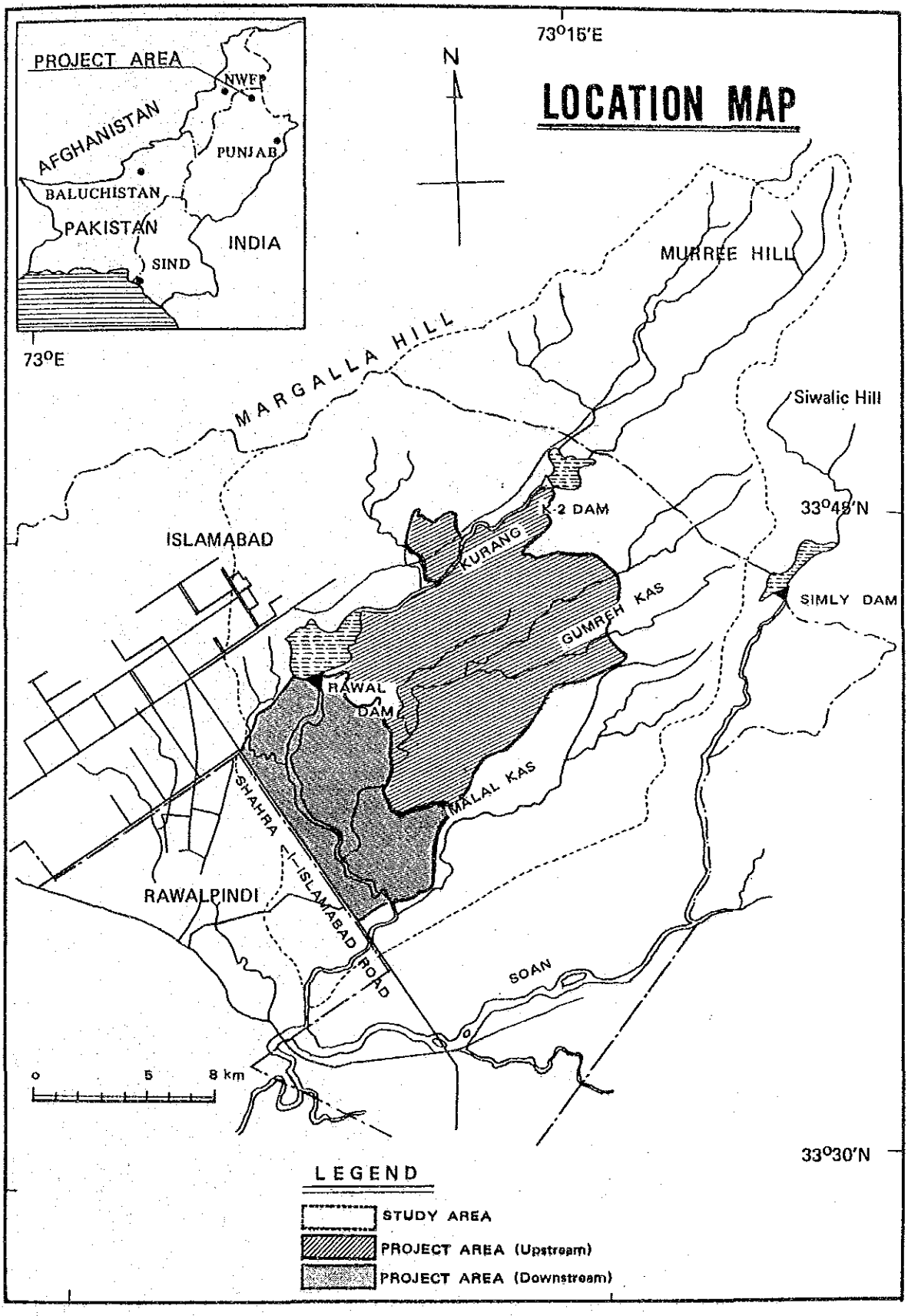
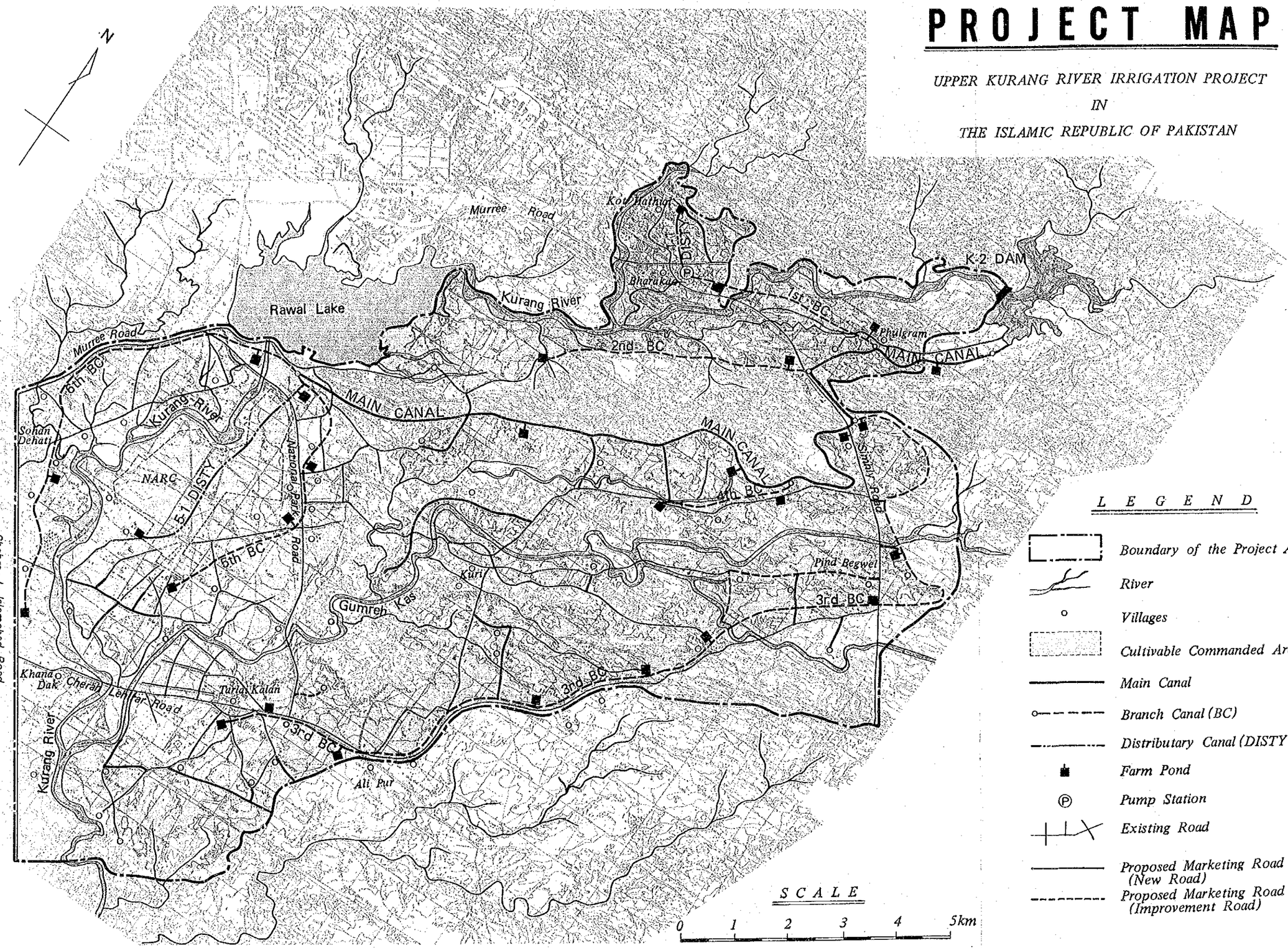

LOCATION MAP
PROJECT AREA
NWFP
AFGHANISTAN
PUNJAB
BALUCHISTAN
PAKISTAN
INDIA
SIND
73°E
73°15'E
N
MURREE HILL
MARGALLA HILL
Siwalic Hill
33°45'N
ISLAMABAD
K-2 DAM
KURANG
GUMREH KAS
SIMLY DAM
RAWAL DAM
MALAL KAS
SHAHRA
ISLAMABAD
ROAD
RAWALPINDI
SOAN
0
5
8 km
33°30'N
LEGEND
STUDY AREA
PROJECT AREA (Upstream)
PROJECT AREA (Downstream)

PROJECT MAP

UPPER KURANG RIVER IRRIGATION PROJECT

IN

THE ISLAMIC REPUBLIC OF PAKISTAN



OUTLINE OF UPPER KURANG RIVER IRRIGATION PROJECT

1. Project Area

Location	:	Islamabad Capital Territory
No. of Union Council	:	6 Union Councils (Bharakao, Phulgran, Kuri, Kirpa, Tarlai, Sohan)
Population	:	58,500 persons (1981)
Major River	:	Kurang River and Gumreh Kas

2. Cultivable Commanded : 6,600 ha

Kharif Season Cropping Area	:	6,600 ha (100%)
Rabi Season Cropping Area	:	2,772 ha (42%)
Total	:	9,372 ha (142%)

3. Water Resources

		Rawal Damsite	K-2 Damsite
Catchment Area	:	275.1 sq.km	137.0 sq.km
Annual Runoff Discharge	:	103.0 MCM	62.1 MCM
Dry Year, 1/5 Probability	:	78.7 MCM	47.4 MCM
Dry Year, 1/10 Probability	:	69.7 MCM	41.1 MCM

4. Reservoir Operation

Without Project			
Runoff Discharge	:	103.0 MCM	-
Water Demand	:	45.3 MCM	-
Spillage	:	55.9 MCM	-
With Project			
Reservoir Operation	:	Combined reservoir operation of Rawal and K-2 Dams	
Inflow/Runoff Discharge:		73.4 MCM	62.1 MCM
Water Demand	:	50.4 MCM (Domestic Supply Stage I)	25.1 MCM (Irrigation)
Spillage	:	25.4 MCM	36.5 MCM

5. Reservoir Dimension

Reservoir Area	:	300 ha (Max. EL.649.8 m)
Retention Water Level	:	647.0 m
Min. Water Level	:	643.0 m
Gross Storage Capacity	:	29.4 MCM
Live Storage Capacity	:	18.5 MCM
Dead Storage Capacity	:	10.9 MCM

6. Project Facility

K-2 Dam		Main Dam	Saddle Dam
Dam Type	:	Zoned	Modified Homogeneous
Dam Height	:	53.0 m	12.0 m
Dam Volume	:	1,870 x 10^3 cu.m	190 x 10^3 cu.m
Spillway Capacity	:	1,840 cu.m/sec	-
Diversion Flood	:	690 cu.m/sec	-
Irrigation Canal			
Max. Canal Capacity	:	4.0 cu.m/sec	
Canal Length	:	130.0 km	
Canal type	:	Concrete Flume	
On-Farm Development	:	6,600 ha	
Road	:	18.6 km	
Agricultural Supporting Facilities	:	Building, Machinery and Others	

7. Project Cost

Foreign Portion	:	Rs. 667,500 x 10^3
Local Portion	:	Rs. 662,900 x 10^3
Total	:	Rs.1,330,400 x 10^3

8. Project Evaluation

Internal Rate of Return	:	13.0%

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ABBREVIATIONS AND GLOSSARY

1) Agencies

ABAD	Agency for Barani Areas Development
ADBP	Agricultural Development Bank of Pakistan
BARD	Barani Agricultural Research and Development Project
CDA	Capital Development Authority
EAD	Economic Affairs Division
ICTA	Islamabad Capital Territory Administration
IDWP	Islamabad Development Working Party
JICA	Japan International Cooperation Agency
LGRD	Local Government and Rural Development, ICTA
MFAC	Ministry of Food, Agriculture & Cooperative
NARC	National Agricultural Research Center
NCRD	National Center for Rural Development
PADSC	Punjab Agricultural Development and Supplies Corporation
PARC	Pakistan Agricultural Research Council
PSC	Punjab Seed Corporation
PERI	Punjab Economic Research Institute
PHED	Public Health Engineering Department
RACC	Rural Area Coordinating Committee
RMC	Regional Meteorological Center
SDO	Small Dams Organization
UC	Union Council
WAPDA	Water and Power Development Authority

2) Others

ASTM	American Society for Testing and Materials
Barani	Rainfed Farming Area
CCA	Cultivable Commanded Area
ICT	Islamabad Capital Territory
IRDP	Integrated Rural Development Programme
Katcha	Unmetalled or unpaved canal
Kharif	Summer season

Markaz	Integrated rural development center
Master Plan	Master Plan for Integrated Rural Development Project
MIRAD	Model Integrated Rural Area Development
Pacca	Paved canal by stone masonry
Panchayat	Elected local body at grassroots level
Project Area	Area of 12,900 ha located on both banks of the Kurang River and Gumreh Kas River
Rabi	Winter season
RHC	Rural Health Center
Sarpanch	Head of the Panchayat
Study Area	Total catchment area of the Kurang River, 580 sq.km
Study Team	JICA Study Team assigned to the Feasibility Study

3) Units of Measurement

mm	millimeter
cm	centimeter
m	meter
km	kilometer
sq.cm	square centimeter
sq.m	square meter
sq.km	square kilometer
MSM	million square meter
l, lit.	liter
cu.m	cubic meter
MCM	million cubic meter
gal	gallon
A.F	acre feet
lit/sec	liter per second
m/sec	meter per second
cusec	cubic feet per second
MGD	million gallon per day
ppm	part per million
ms/cm	million siemens per centimeter
pH	potential of hydrogen
EC	electric conductivity
g	gram
kg	kilogram
ton, m.t.	metric ton

EL	elevation above mean sea level
MSL	mean sea level
FWL	full water level
HWL	high water level
LWL	low water level
TRAM	total readily available moisture
sec.	second
min.	minute
hr.	hour
min.	minimum
max.	maximum
%	percent
No.	number
°C	degree centigrade
°F	degree fahrenheit
Cl	chlorine
HP	horse power
ET	evapotranspiration
N	nitrogen
P	phosphate
K	potassium
O & M	operation and maintenance
KWh	Kilowatt hour
EIRR	economic internal rate of return
B/C	benefit cost ratio
FY	fiscal year
Rs	Rupees (currency of Pakistan)
US$	US Dollar

4) Conversion Factors

Unit		Comparison	English Equivalent
Unit of Length:			
Millimeter (mm)		0.001 meter	0.0394 inch
Centimeter (cm)		0.01 meter	0.3937 inch
Meter (m)			3.2800 foot
Kilometer (km)		1,000 meter	0.6213 mile
Unit of Area:			
Square centimeter	(sq.cm)	0.0001 sq.m	0.155 square inch
Square meter	(sq.m)		10.764 square feet
Hectare	(ha)	10,000 sq.m	2.471 acres
Square kilometer	(sq.km)	1,000,000 sq.m	0.386 square mile
Unit of Volume:			
Cubic centimeter	(cu.cm)		0,061 cubic inch
Liter	(lit)	0.001 cu.m	1.0567 quarts (liquid)
Cubic meter	(cu.m)	1,000 liters	35.3145 cubic feet
			0.811 x 10^{-3} acre foot

Unit of Weight:		
Gram (g)		0.0353 ounce
Kilogram (kg)	1,000 grams	2.2046 pounds
Metric Ton (mt)	1,000 kg	2,204.6 pounds
Unit of Flow:		
Liter per second (lit/sec)		0.0353 cusecs
Cubic meter per second (cu.m/sec)		35.310 cusecs

1. BACKGROUND OF THE PROJECT

1. BACKGROUND OF THE PROJECT

1.1. Agriculture in Barani Area

Outline of Punjab Barani Tract

According to the Agricultural Census of Pakistan, 1980, Barani Tract is defined as the cultivated area which is not artificially irrigated and dependent solely on rainfall. The Barani Tract in Pakistan extends in the northern and western parts of the Punjab Province, including Islamabad Capital Territory (ICT) and eight Districts in Punjab. The gross area is estimated at 86,000 sq.km (33,196 sq.mi), which is equivalent to 11 percent of the whole Pakistan and 41 percent of the Punjab Province.

In Pakistan, the Punjab Province is also a commercial and industrial center like Sind Province. However, the registered factories in the Punjab Barani Tract are more scarce in number than those in the outside areas of Barani Tract, and agriculture is the main industry in the Punjab Barani Tract.

The cultivated land ratio to the total land area in Punjab Barani Tract is 57 percent. The cropping intensity of the total cultivation area is 97 percent. All of these figures are 20 percent lower than those of the outside areas, which are attributable to the present rainfed farming in Punjab Barani Tract.

Agricultural Land Use in Barani Tract

(unit: '000 ha, %)

Items	Islamabad and Punjab Province		Whole Country
	Barani Area	Other Area	
Total Area (excluding the area unreported)	7,003	10,074	56,710
Cultivated Area (including current fallow)	3,960	7,648	20,280
Cropped Area (Kharif & Rabi)	3,843	9,733	20,130
Rate of Cultivated Area (%)	57	76	36
Cropping Intensity (%)	97	127	99

The farmers in the Barani area have practised their farming under various harsh conditions like limit in crop varieties, low level of cropping intensity and crop yield, etc. Furthermore, since the Project Area is located in the neighborhood of Rawalpindi and Islamabad Territory, the income difference between urban and rural areas and outflow of labour from rural areas are presently observed.

National Policy of Agriculture

In Pakistan, the share of agricultural sector in the gross domestic products (GDP) in 1986 was 25.5 percent which is the largest of all industries. Although GDP increased by 80 percent for those ten years from 1977 to 1986, the production of agriculture increased by 46 percent only. In considering the low growth of agricultural sector in view of unimproved figures around 55 percent of workers engaged in agriculture, there is still an income disparity between rural and urban areas.

The project will give significant impact on the area to solve the problems of low productivity of Barani agriculture and to develop the Barani area by alleviating poverty and introducing diversified agriculture, to meet varied food demand in the urban areas of Islamabad and Rawalpindi along with the national plan.

1.2. Background and Objectives of the Project

Background of the Project

The Government of the Islamic Republic of Pakistan has formulated its Five-Year National Development Plan, upon which the development policies have been positively executed in a variety of fields. The current Sixth Five-Year Plan (July 1983 - June 1988) has taken up the rural area development as cornerstones of the

national development. This comes from the thought that the rural area with 72 percent of the national population is the very base of the economic development of the nation.

The Government of Pakistan, with such background, requested the Government of Japan for technical cooperation in executing the Master Plan Study for Integrated Rural Development Project to realize the rural area development around Islamabad, the Metropolis, and the Japan International Cooperation Agency (JICA) as executing body of the Government of Japan carried out the said Master Plan study from 1985 to 1986. The current study has resulted from the aforesaid Master Plan Study with a promisingly high priority. The proposed development plan aims to effectively utilize the Kurang River water in both bank tracts of the river for irrigation of farm lands which are presently rainfed fields or the so called "Barani area" extending in the peripheral rural areas of Islamabad.

In answer to the request by the Government of Pakistan for the technical cooperation of the Feasibility Study on the Upper Kurang River Irrigation Project, which was made in May 1986, the Government of Japan dispatched a Preliminary Survey Team in February, 1987 through JICA, and decided to extend cooperation according to the results of the above survey. And the Scope of Work (S/W) for the further study of the Project was concluded between the Islamabad Capital Territory Administration (ICTA) and JICA.

The survey and study of the Project were conducted in the following two phases;

Phase I Study

Field Work	:	End of July 1987 - Beginning of Oct. 1987
Home Office Work	:	Middle of Oct. 1987 - End of Nov, 1987

Phase II Study

Field Work	:	Beginning of Dec. 1987 - Middle of Jan. 1988
Home Office Work	:	Middle of Jan. 1988 - Middle of Feb. 1988

In following elaborate discussion between Study Team and Pakistani Government Officials concerned for Draft Final Report in March 1988, the Final Report of the project was prepared in June, 1988.

The Report covers the results of studies carried out by the Study Team with the collaboration of Pakistani Government Officials concerned, and also incorporates all the provisions in respect of interim discussions held among the Pakistani Officials, the JICA Advisory Committee and the Study Team.

Objectives of the Study

The objectives of the study can be summarized as follows:

- To formulate a plan of the Kurang River water resources development and irrigated agriculture development in the currently rainfed farm fields around Islamabad by effective use of the water resources, and to carry out the Feasibility Study of the Project in terms of technology and economy as well as to make the Project evaluation;
- To formulate an agricultural development plan for raising agricultural production, increasing employment opportunities, and improving/stabilizing the living standards of local inhabitants through the introduction of irrigated agriculture, and to formulate an institutional development plan involving the establishment of farmers' organizations, which will undertake operation and maintenance of system facilities and conduct adequate water management, and provide agricultural supporting services.
- To transfer knowledge and technology to the Pakistani counterpart personnel through execution of the aforesaid survey and study.

2. PRESENT CONDITIONS IN THE PROJECT AREA

2. PRESENT CONDITIONS IN THE PROJECT AREA

2.1. Location and Geography

The Study Area on the northwestern edge of the Potwar Plateau is referred to as the rural area of Islamabad Capital Territory and lies adjacent to the urban area of Rawalpindi with population of about 800,000. The Study Area is bounded by the Murree Hills in the northeast, by the Margalla Hills in the north and northwest, by the Siwalik Hills in the east, and by the Shahra-I-Islamabad Road in the west and south.

The catchment area extends along the Kurang River, having a total area of about 580 sq.km (224 sq.mi) at the confluence with the Soan River, and involves the cultivable commanded area of about 7,300 ha (18,000 acres) under the Project.

Topographically the Study Area has a gentle slope in the direction from northwest to southeast, and covered by a vast area of reticulated gullied lands. The soil erosion is still advancing in the Area due to climatical conditions of hot and dry summer followed by heavy rains in wet season, geological conditions of deposits of wind-laid materials, and human activities in over-grazing and destruction of vegetation. Such erosion has caused serious problems with soil conservation and has also affected social affairs in the area.

In the Study Area, there are many rivers and streams running from north or northeast to south or southwest, and all of them pour themselves into the Soan River which flows through the Study Area. These tributaries of the Soan River run through the hilly areas or lower parts of mountains in the area, and their discharges fluctuate heavily by seasons (wet or dry) or by years (drought or wet). Consequently, it is quite difficult to utilize water for irrigation under such changeable conditions.

2.2. Administration and Population

Administratively the rural area of ICT is divided into 11 Union Councils (UC). They are further sub-divided into 133 villages.

The number of UCs and villages in the Project Area amounts to 6 UC and 43 villages including those in the urban area as shown below and their administrative boundaries are indicated in Figure-1.

Population and Household in the Project Area, 1987
- estimated -

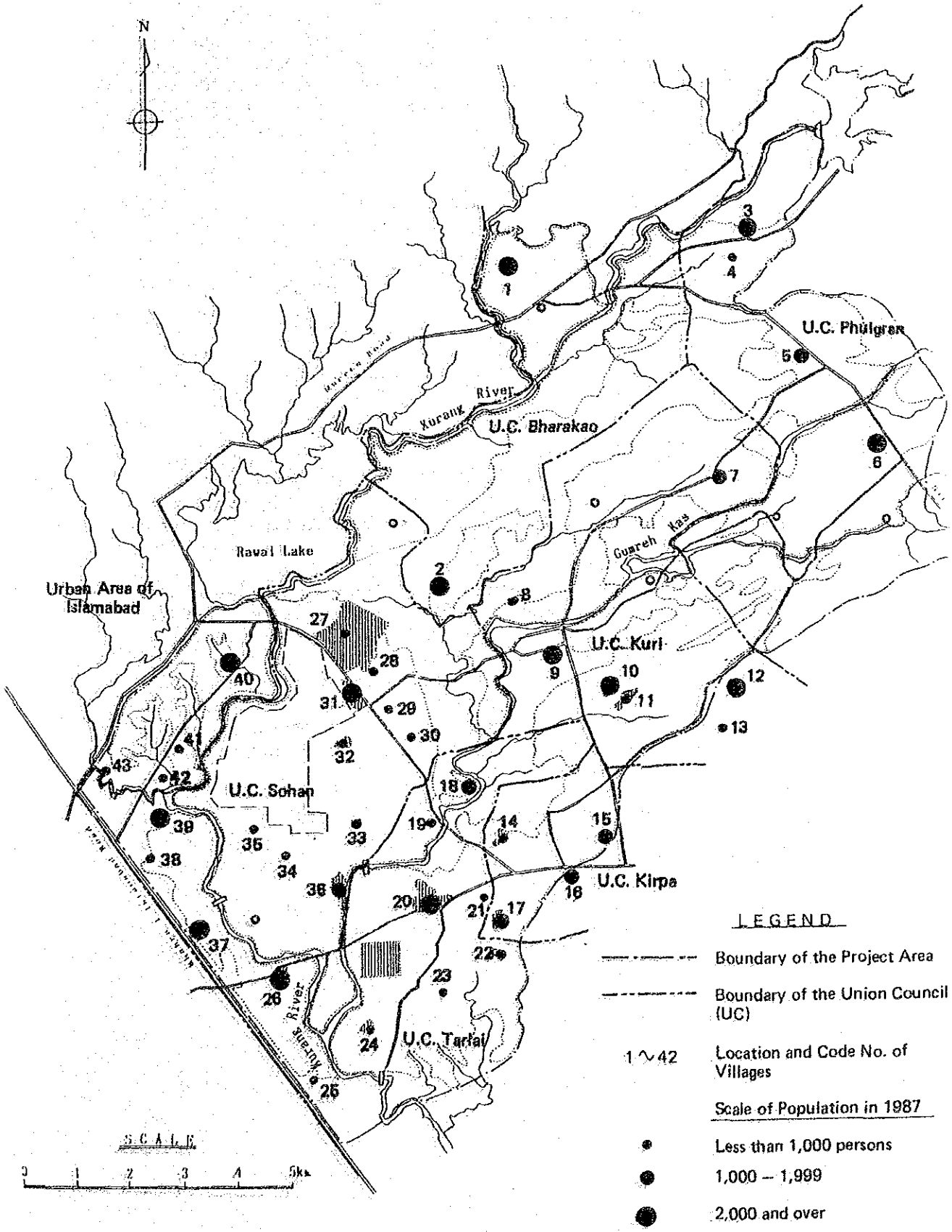
UC	Villages in Project Area	Population (persons)	Household
Rural Area			
Bharakao	2	12,300	2,000
Phulgran	4	11,500	1,900
Kuri	7	11,600	2,000
Kirpa	4	5,200	900
Tarlai	9	16,500	2,600
Sohan	13	17,700	2,800
Urban Area	4	4,200	700
Total	43	79,000	12,900

2.3. Climate and Hydrology

Climate

The Study Area for the Project extends at the elevation of about 500 to 2,500 m (1,640 to 8,200 ft) above the sea level and the cultivable commanded areas lie at the elevation of 500 to 600 m (1,640 to 1,968 ft). General climatological conditions of these areas in the Barani area are indicated in Figure-2 and their characteristics are as follows.

FIGURE-1. ADMINISTRATIVE DISTRICT AND POPULATION



- According to the rainfall record observed at Chaklala with an elevation of 510 m (317 ft) above sea level, average annual rainfall is about 1,090 mm (43 in), and this rainfall is substantially less than the rainfall observed at Murree having an average rainfall of 1,750 mm (69 in) per annum at a relative high elevation of about 2,200 m (7,216 ft) in the mountainous area. Probable rainfall at Chaklala and Murree stations is given as follows;

Probable Rainfall (1952 - 1986)

Probability	Probable Annual Rainfall (mm)	
	Chaklala	Murree
1/2	1,039	1,722
1/5	864	1,516
1/10	792	1,421

- Most of rainfall concentrates during the wet season lasting from July to September. About 60 percent of the annual rainfall is observed during the wet season at Chaklala. Rainfall is characterized by its high intensity in a short time, and usually it does not continue through a day.

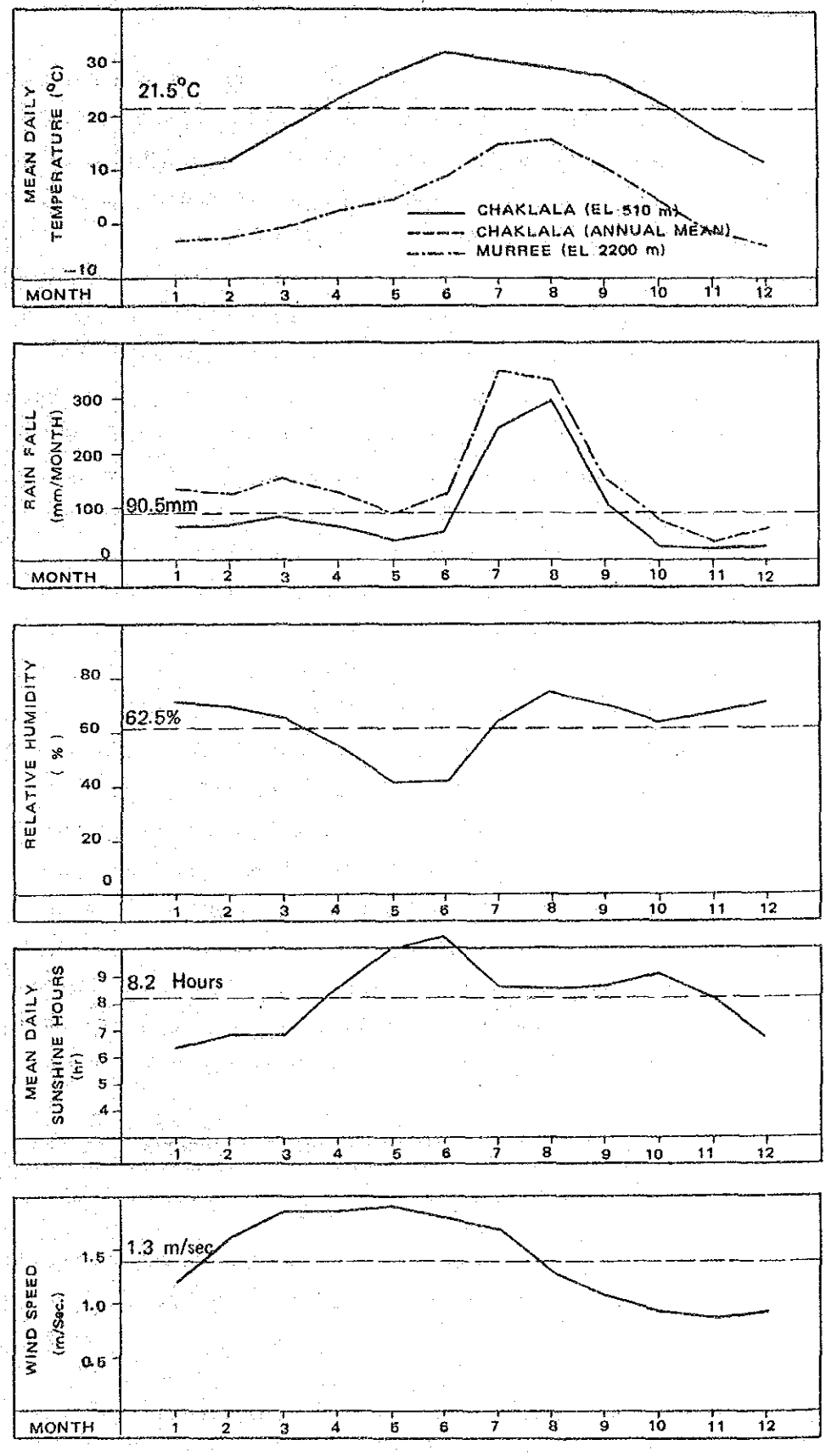
- An annual average temperature is 21.5°C in accordance with the Chaklala record, and its maximum and minimum records are 31.6°C in July and 10.0°C in January, respectively. During the period of Phase I field works in 1987, temperature of about 45°C was continuously observed from the end of July to the beginning of August in Islamabad. On the other hand, it snows sometime at Murree experiencing below zero during the winter season from December to February.

- Annual average relative humidity is recorded at 62.5 percent with the maximum of 74.7 percent in August and the minimum of about 40 percent in May and July, respectively.

- Annual average sunshine hour is recorded at 8.2 hrs and those in May and July during summer season are the longest with about 10 hrs, while those in the period from December to March are comparatively shorter with about 7 hrs.

- Annual average wind speed is observed at 1.3 m/sec with the maximum of 1.8 m/sec in May and the minimum of 0.9 m/sec in the period from October to December.

FIGURE –2. GENERAL METEOROLOGY



Hydrology

The major rivers and streams in the Study Area are the Kurang River, Gumreh Kas and Malal Kas Rivers, among which the Kurang River and Gumreh Kas River flow in the Project Area. At the middle stream of the Kurang River, Rawal Dam supplying domestic water to the Rawalpindi city is located adjacent to Islamabad.

The observation records of river runoff discharges of the Kurang River and Gumreh Kas River are not available, except the SDO's estimated inflow discharges to the Rawal Dam, which have been calculated by SDO since 1962 on the basis of daily released and spilled discharges from the Rawal Dam, and variation of storage capacity in the reservoir. According to those estimated inflow discharges, runoff discharges at the Rawal damsite with the catchment area of 275.1 sq.km are estimated at 100.9 MCM (82×10^3 acre ft).

Due to, however, the reasons that i) it is difficult to estimate the runoff discharges at the proposed K-2 damsite by applying the specific discharge to be obtained based on the SDO's inflow discharge by large difference in rainfall magnitude between the both catchment areas, and ii) since reliable runoff discharge data for the period more than 35 years will be essentially needed for the study on project formulation, those discharges at the both damsites were estimated applying theoretical method, the so-called Tank Model, which would be provided in such neighboring river basins with the Project Area, as Haro, Soan and Sil Rivers.

Following table shows the estimated runoff discharges at the Rawal and K-2 damsites;

Estimated Runoff Discharges

Item	Rawal Damsite	K-2 Damsite	Total
Catchment Area (sq.km)[1/]	138.1	137.0	275.1
Areal Rainfall (mm)	1,267.0	1,556.0	1,414.0
Average Annual Runoff Discharge (MCM) (1952 - 1986)	40.9	62.1	103.0
Average Runoff Coefficient (%)	23.4	29.1	26.5

Note: 1/ ... exclusive of K-2 Dam catchment area.

2.4. Land Use and Soil

Land Use

Present land use in the Project Area was studied on the basis of topographic map with scale of about 1:21,100 (three inches to one mile). As a result, the area of 7,300 ha (18,000 acres) was selected as a potential cultivable commanded area from the topography to enable the supply of irrigation water by gravity system from the proposed K-2 Dam.

Present Land Use in the Project Area

Land Category	Acreage (ha)	Percentage (%)
Cultivable Area	7,300	56.6
Wasted Land	3,400	26.4
Forest	1,600	12.4
Roads, Rivers and Others	600	4.6
Total	12,900	100.0

Soil

The soils in the Project Area are classified into five soil series which are given below and it is clear that the wind medium-textured soils are predominant.

Classification of Soils

Soils		Area ha	Area %
Alluvial Medium-textured Soil	①	750	10
Alluvial Fine-textured Soil	②	200	3
Wind Medium-textured Soil	④	5,800	80
Residual Soil	⑤	450	6
Gullied Medium-textured Soil	⑦	100	1
Total		7,300	100.0

The diagnostic soil profile in the Project Area is as follows;

- The surface soils consist mainly of grains by sizes ranging from fine texture to medium texture and are reddish brown or yellowish brown in color.

- Most of the subsoils consist of medium size grains and are reddish to yellowish brown in color in developing about 1.0 m deep. There are gravels found in mixture in some parts. In deeper parts of the alluvial zone, some sandy layers are found.

- The soils, although being slightly compacted and prone to form plow sole, are in weak alkali with pH value of around 7.0. The survey has revealed that the EC value is 0.3 ms at 25°C and few adverse factors for vegetable cropping can be found with sufficient chlorine but little nitrogen and sulfate as plant nutrients.

Land Classification

Land classification was made based on the criteria in consideration of the soil characteristics and climate conditions, etc. including wind, topography, extent of water management and farming practices. In the Project Area, land is classified into four classes, I, II, III and IV.

Class I : This is flat, or has a gentle slope with high suitability for vegetable production.

Class II : Suitability for fruit production is comparatively high, although this land is the sloping land with sand and gravel soils.

Class III : This land with a gentle slope has comparative high suitability for agricultural production, and is located far from water sources. Water management and farming practices would be difficult.

Class IV : This class of land corresponds to wasted land due to soil erosion, but some parts of land could be utilized for cultivation of pasture by provision of terracing works.

Present land classification in the commanded area is shown in Figure-3.

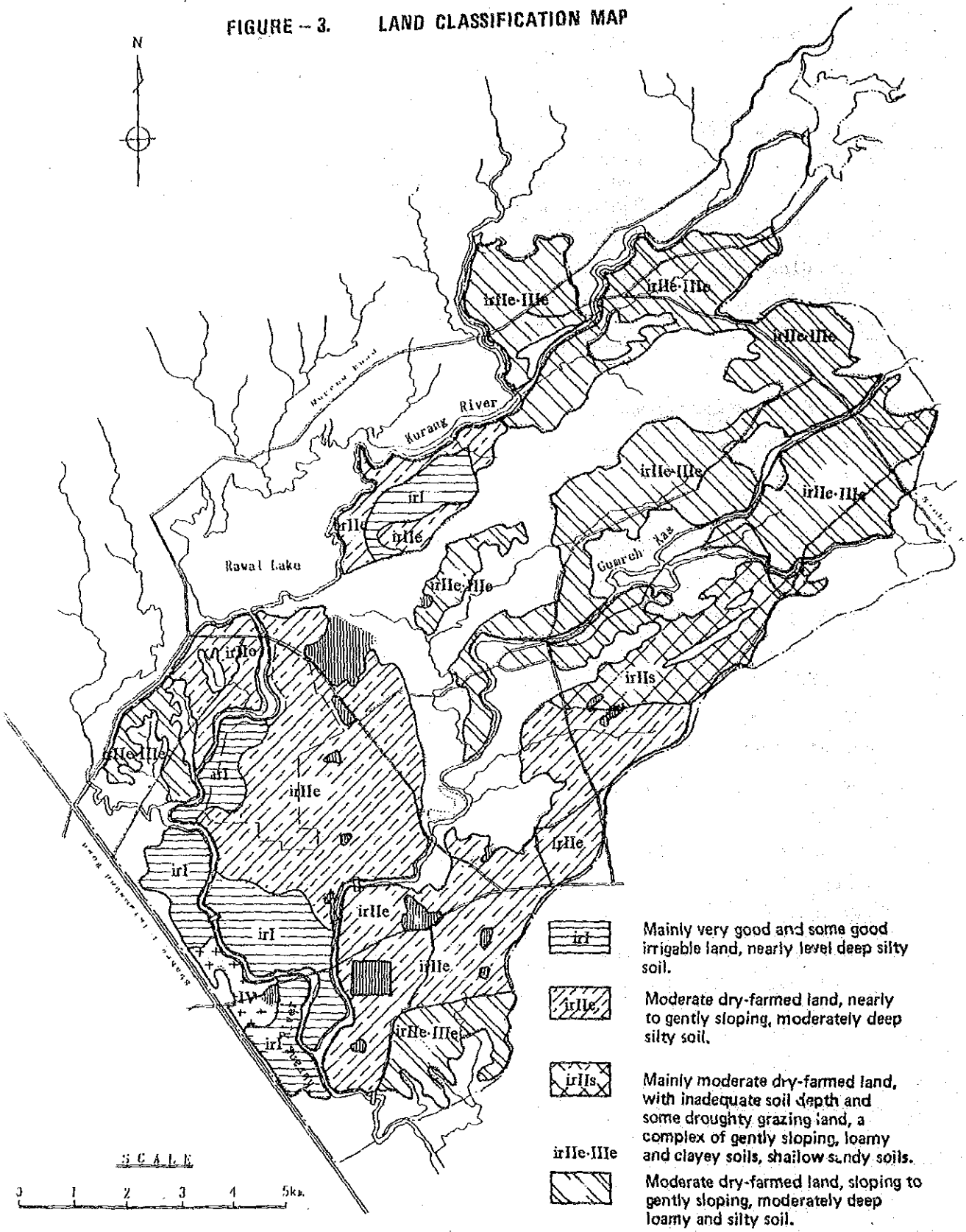
2.5. Present Agriculture

Number of Farms and Farm Size

The total number of farm households related to the Project is estimated at about 5,200 in 43 villages in 1987. The farm households in the Project Area occupy 40 percent of the total households of 12,900.

According to the Pakistan Census of Agriculture, 1980, the average farm size in three Barani Districts of Rawalpindi, Attock, and Jhelum is 2.5 ha, 4.9 ha, and 4.6 ha, respectively. In comparison with them, the average farm size per cultivator for the Project is a little smaller by 1.7 ha (4.2 acres).

FIGURE – 3. LAND CLASSIFICATION MAP



irI — Mainly very good and some good irrigable land, nearly level deep silty soil.

irIIe — Moderate dry-farmed land, nearly to gently sloping, moderately deep silty soil.

irIIs — Mainly moderate dry-farmed land, with inadequate soil depth and some droughty grazing land, a complex of gently sloping, loamy and clayey soils, shallow sandy soils.

irIIe-IIIe — Moderate dry-farmed land, sloping to gently sloping, moderately deep loamy and silty soil.

IV — Gullied land. Not applicable for cultivation.

Number of Private Landowners by Land Holding Sizes
(ICT Rural Area, 1984)

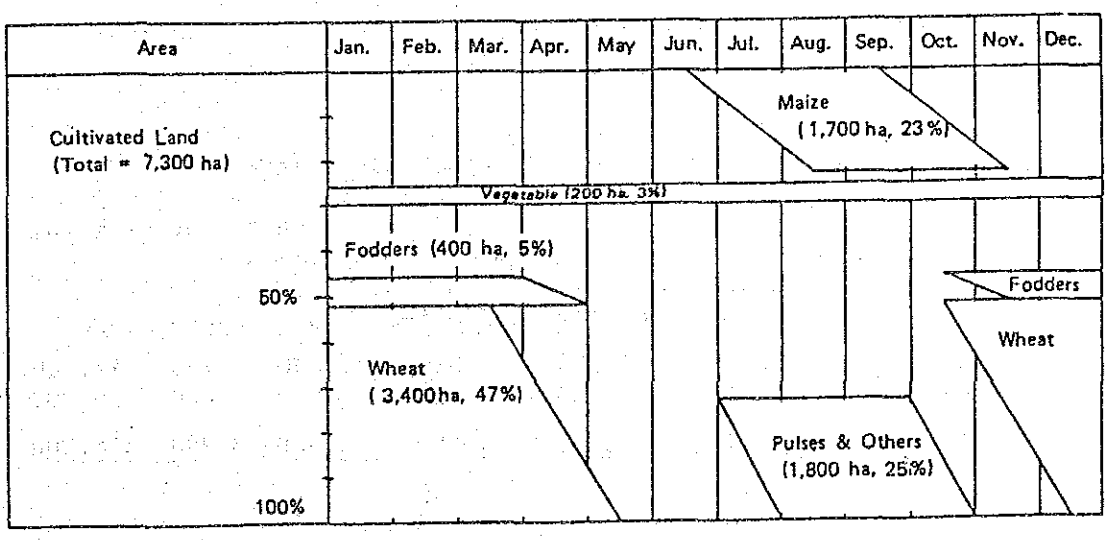
Size of Land Holding (ha)	Number of Landowners (Person)	(%)	Land Holding (ha)	(%)
Less than 0.4	37,323	(65.0)	7,780	(13.8)
0.4 - 2.0	15,674	(27.3)	20,380	(36.3)
2.0 - 4.8	2,933	(5.1)	10,100	(18.0)
4.8 - 10.0	1,053	(1.8)	7,900	(14.1)
10.0 - 20.0	344	(0.6)	4,360	(7.8)
More than 20.0	135	(0.2)	5,600	(10.0)
Total	57,462	(100.0)	56,120	(100.0)

The farmers having less than two hectares of land occupy about 92 percent of the total farm households. And the percent of the owner farms in the ICT rural area is as high as 75 percent.

Agricultural Production

The present main crops in the Project Area are wheat with the cropping ratio of 85 percent and fodder and vegetable with the remaining ratio of 15 percent in Rabi season. Annual acreage and cropping system in the Project Area seem to be rather constant although the harvesting areas of them vary depending upon rainfalls in the year.

Present Cropping Pattern



However, present crop yield remains low as shown in the following table.

Present Crop Production in Project Area

Crops	Cropped Area (ha)	Average Average Yield (ton/ha)	Production (ton)
1. Rabi Crop			
- Wheat	3,400	1.7	5,610
- Fodders	400	70.0	28,000
- Vegetable (Cabbage)	200	13.0	2,600
Sub-total	4,000		
2. Kharif Crop			
- Maize	1,700	2.0	3,400
- Pulses	1,800	0.8	1,440
- Vegetable (Cucumber)	200	15.0	3,000
Sub-total	3,700		
Total	7,700		

Animal Husbandry

The Project Area could be divided into the Upstream Area and the Downstream Area in terms of the present conditions of livestock breeding. The Upstream Area has more farm villages and households in number and larger cultivated land than the Downstream Area. The former raises more livestock per farm household than the latter, accordingly, except for poultry.

Number of Livestock in the Project Area

(unit: head, bird)

	Number of Farmer	Cattle	Buffaloes	Goats	Sheep	Poultry
Upstream Area	2,635	1,930	1,810	2,790	2,400	42,900
Downstream Area	1,960	800	750	690	600	175,300
Total	4,595	2,730	2,560	3,480	3,000	218,200

In the Project Area, milk is produced by many small farms and the total milk production is estimated at about 7,000 litres (for 30,000 to 40,000 persons).

The demand increase rate for milk in the entire Pakistan has been maintained so high by five percent in those five years, 1982 to 1987. The increase rate in the urban areas is considered to be higher than the above-mentioned. However, since the Project Area belongs to a Barani area where irrigation depends on rainfall, it is very difficult for livestock farmers to secure fodder in the Rabi season when fodder cropping area and grazing land are quite limited as compared with the Kharif season.

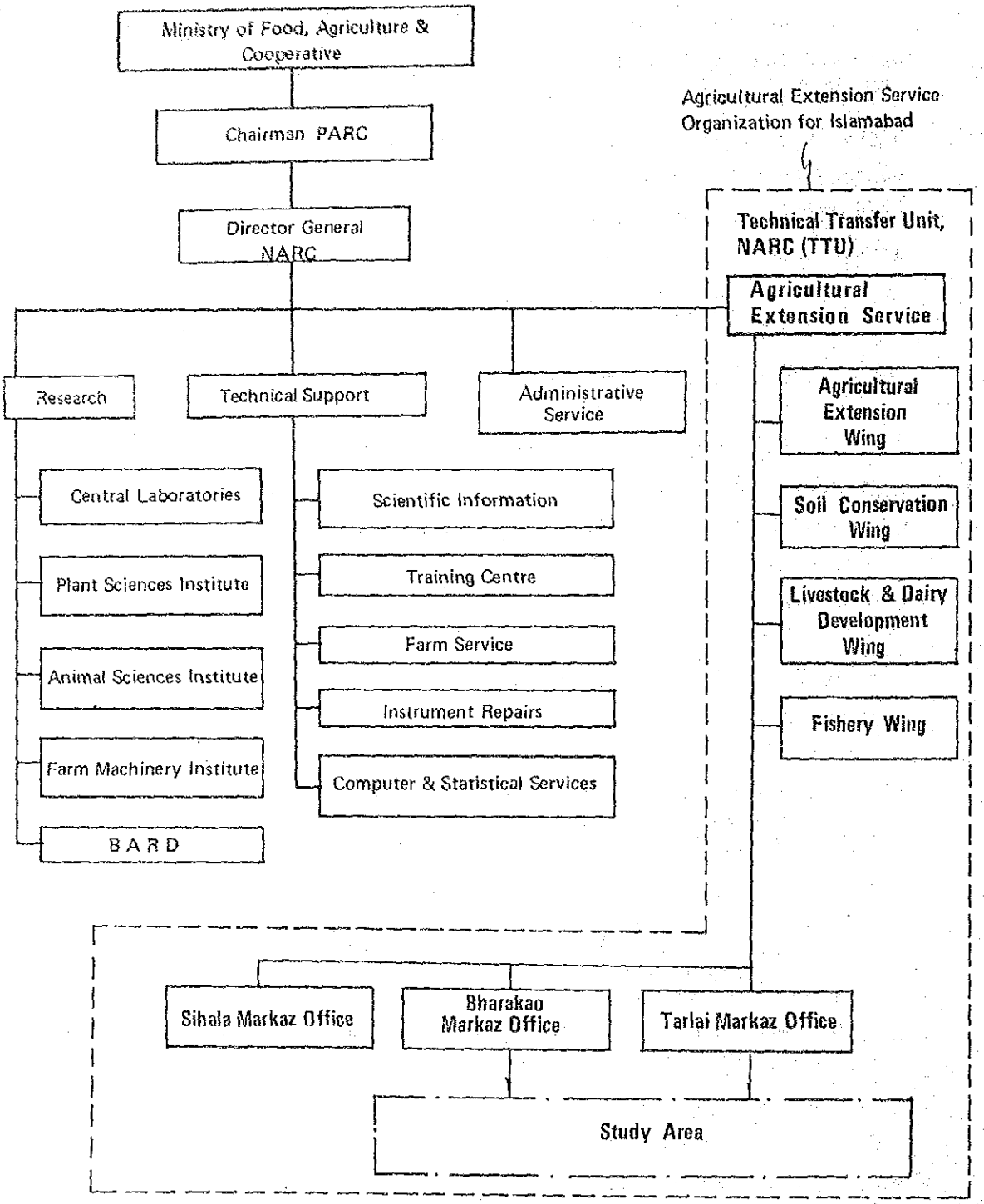
Agricultural Extension Service

The Technical Transfer Unit (TTU) of National Agricultural Research Centre (NARC) directly engaged in the agricultural extension services of ICT consists of agricultural extension, livestock & dairy development, soil conservation and fishery wings (see Figure-4).

The present problems of the extension service in ICT is mainly confronted as follows.

- Organizational linkage between research and extension is weak. The institutional arrangements for the flow of improved technology from research to extension are very poor;
- The extension workers do not have adequate in-service training facilities to refresh and update their knowledge on the latest technological development;
- The operational area and field of the on-extension workers in the forefront of services are usually too large;

FIGURE-4. NARC AND AGRICULTURAL EXTENSION SERVICE FOR ISLAMABAD AT PRESENT



Farm Economy

As a result of the farm survey and other agricultural surveys, the average cultivated area of a farm and cropping intensity at present are estimated at 1.7 ha (4.2 acres) and 106 percent, respectively.

As for the living expenses, at least Rs.6,000 to Rs.8,400 per farm are annually required on an average based on the minimum annual living expenditure per capita of Rs.1,200 to Rs.1,400. Therefore, the minimum living expenditure of the farmers in the Project Area is not covered by the income obtained from crop cultivation. It is relevant to the situation that the farmers had other income sources on the farm, such as milk sales.

Annual Income Level in the Project Area

Items	Project Area	Total of Pakistan	Rural Area of Pakistan	Rural Area of Punjab
1. Average Income of All Industries (Rs./H.H)	no data	21,300	18,500	18,300
2. Percentage of Self Cultivator (Total Farm=100)	75	81.6	82.0	81.9
3. Average Household Income of Self Cultivator (Rs./H.H)	5,440	20,900	20,700	23,600

2.6. Water Resources

The water resources for Upper Kurang River Irrigation Project are the runoff discharges of the Kurang River. As mentioned in the previous paragraph, the Rawal Dam, of which major dimensions are tabulated in Table-1, has been constructed in 1962 at the middle stream of the Kurang River and functions for domestic water supply to the Rawalpindi under the control of Small Dams Organization (SDO).

TABLE-1. SALIENT FEATURES OF EXISTING DAMS

Items	Unit	Rawal Dam	Simly Dam
River		Kurang	Soan
Catchment Area	(sq.km)	275.1	152.8
"	(sq.miles)	106	59
Reservoir			
Maximum Water Level	(ft)	1,761	2,320
Retention Water Level	(ft)	1,752	2,295
Minimum Water Level	(ft)	1,708	2,233
Gross Storage Capacity	(MCM)	58.6	35.5
"	(acre-ft)	47,500	28,750
Live Storage	(MCM)	53.0	24.7
"	(acre-ft)	43,000	20,000
Dead Storage	(MCM)	5.6	18.5
"	(Acre-ft)	4,500	15,000
Main Dam			
Type of Dam		Gravity[1/]	Rockfill
Top of Dam	(ft)	1,763.5	2,330
Dam Height	(ft)	133.5	263
Length of Dam	(ft)	700	1,010
Top Width	(ft)	14	30
U/S Slope of Dam		1:0.04	1:3.00-2.25
D/S Slope of Dam		1:0.675	1:1.75-1.5
Design Acceleration Force		0.1	0.19
Freeboad above Maximum WL	(ft)	2.5	10
Spillway[2/]			
Type		Gate-Controlled	Uncontrolled
Capacity	(m^3/s)	2,320	1,280
"	(cusec)	82,000	45,000
Crest Elevation	(ft)	1,742	2,300
Design Head	(ft)	19	20
Length of Crest	(ft)	240	110
Max. Probable Flood	(m^3/s)	3,400	2,570
"	(cusec)	120,000	90,689
Construction			
Commenced	Year	1959	1972
Completed	Year	1962	1982

Note:

1/ ... Rawal Dam has a saddle dam of rolled earth embankment.

2/ ... Simly Dam has a fuse plug spillway of 400 feet long and 12 feet high.

According to the results of water balance study of the Rawal Dam on the basis of daily runoff discharges of the Kurang River at the Rawal damsite estimated applying TanK Model method for the periods of 35 years, 1952 - 1986 and daily water demands for domestic and irrigation water supplies, about 55.9 MCM (45×10^3 acre ft) of discharges are presently spilled from the Rawal Dam without effective utilization during the wet season as shown below. These runoff discharges are considered to be the potential water resources to be developed by means of storage dam.

Available Water Resources at Rawal Dam

Item		Discharge
Catchment area	(sq.km)	275.1
Average Annual Runoff	(MCM)	103.0
Probable Annual Runoff	(MCM)	
1/5 Probability		78.7
1/10 Probability		69.7
Average Spilled Discharge	(MCM)	55.9

In addition to the above-mentioned main water resources by the K-2 Dam, supplemental water resources diverted by head works to be provided at Kc-1 and Kc-2 sites in the Kurang River and Gc-2 site in the Gumreh Kas River are expected, in order to expand the irrigation area in the drought year as large as possible by utilizing their own runoff discharges from the catchment area. Following table shows the available base flow discharges at the proposed head work sites;

Base Flow Discharge at Proposed Head Work Sites

Station	Name of River	Catchment Area (sq.km)	Base Flow Discharge (cu.m/sec)
Kc-1	Kurang River	24.9	0.62
Kc-2	Kurang River	18.0	0.22
Gc-2	Gumreh Kas	125.0	0.13
Total			0.97

2.7. Social Infrastructure

Domestic Water Supply

The source for a domestic water supply are wells and springs. The number of wells and springs in 39 villages excluding the urban area amounts to 353 and 29, respectively. The diffusion rate of wells and springs is estimated at 152 persons per one facility on an average.

Rural Electrification

The electrification in 43 villages is under well progress in the Islamabad rural area. The present electrification conditions in the Project Area are as follows:

Complete electrification	:	69%
Partial electrification	:	22%
No electrification	:	9%

Road Networks

Since the Project Area extends within the area of ICT, most of the major roads are well developed but a few. However, existing on-farm and service roads are under poor conditions, and such existing poor roads have given adverse effects to the marketing of agricultural inputs and products as well as to communication of the local people. The roads conditions prevailing in the Project Area are shown as follows:

Present Road Conditions

Road	Length	
	km	mile
- Main Road (5 lines)	12.5	(7.9)
- Other Road	30.9	(19.2)
Total	43.4	(27.1)

3. PROJECT FORMULATION

3. PROJECT FORMULATION

3.1. Objectives and Components of the Project

Objectives of the Project

The Project Area is located on the Punjab Barani Tract under subarid and subhumid climate, and the topography of the area presents heavy gully erosion from alluvial lands in extreme undulation without being cultivated. In other respect, there are many deep valleys and streams in the area. Such characteristic features of the farmland have hindered the irrigated agriculture in the Tract.

The crops grown in the Tract can be roughly specified into two, Rabi crops and Kharif crops; the former is such winter crops as wheat, barley, chick peas, lens beans, rape colza, mustard, etc., while the latter is such Rabi crops as maize, sorghum, millet, pulses, groundnuts, etc. The yield of each crop is low due to uncertainty of rainfall, particularly a little rainfall in the seeding season. Such unfavourable conditions have caused difficulty to shift to more profitable cash crops. Besides, limited green fodder crops grown between the Rabi and the Kharif croppings have been a bottleneck for encouraging animal husbandry.

In keeping pace with the magnification of the urban communities, farm management in the Project Area has been turned to subsistence farming resulting into reduction in scale and selfsufficiency. Consequently, many farmers have given up agriculture and young men have discharged to the urban areas. And, there remain only women, children and un-skillful aged farmers in the villages. Under the circumstances, the agricultural production in the Area have been decreased. The per capita agricultural income in the area is less than 1,000 Rupees per annum, which is desperately lower than the Pakistani national average by 3,600 Rupees as of 1984 - 1985.

The Government of Pakistan, therefore, has taken up the Kurang River water resources development project in possibly effective utilization of the developed water resources so as i) to raise the agricultural production, ii) to increase the employment opportunity, and iii) to level up the living standards of local people.

Components of the Project

The project components comprise the following development concept to activate the project objectives mentioned in the above.

- Water Resources Development;
  To develop water resources in the Kurang River basin by provision of K-2 Dam having an adequate storage capacity, in order to utilize effectively the present surplus water.

- Irrigation System Development;
  To provide irrigation canal system to deliver irrigation water stored in the K-2 reservoir.

- Marketing Road Development;
  To develop marketing road network to cope with transportation of agricultural production and production input materials.

- Irrigated Agricultural Development;
  To establish the irrigated agricultural plan considering i) suitable land use and cropping pattern to realize maximum utilization of water and land resources, and ii) farming cultivation practices to increase the agricultural productivity and farmer's income.

- Agriculture Institutional Development;
  To establish and promote farmer's organization and agricultural supporting services for achievement of the irrigated agricultural development in the project.

3.2. Land Use Plan

Taking into account the types of present farm management, farmers' expectation on future farm management and labour resources

available as well as high demand for vegetables, fruits and milk in ICT urban area and Rawalpindi, the following three types of farm management are proposed for the Project;

Type A : Vegetables and grains
Type B : Fruits and livestock
Type C : Grains and livestock

In consideration of the geological, topographic and meteorological conditions in the Project Area, the practicability of the types of farm management in the cultivable commanded area of 6,600 ha could be described as follows;

Type A	:	3,300 ha	(50%)
Type B	:	700 ha	(10%)
Type C	:	2,600 ha	(40%)
Total		6,600 ha	(100%)

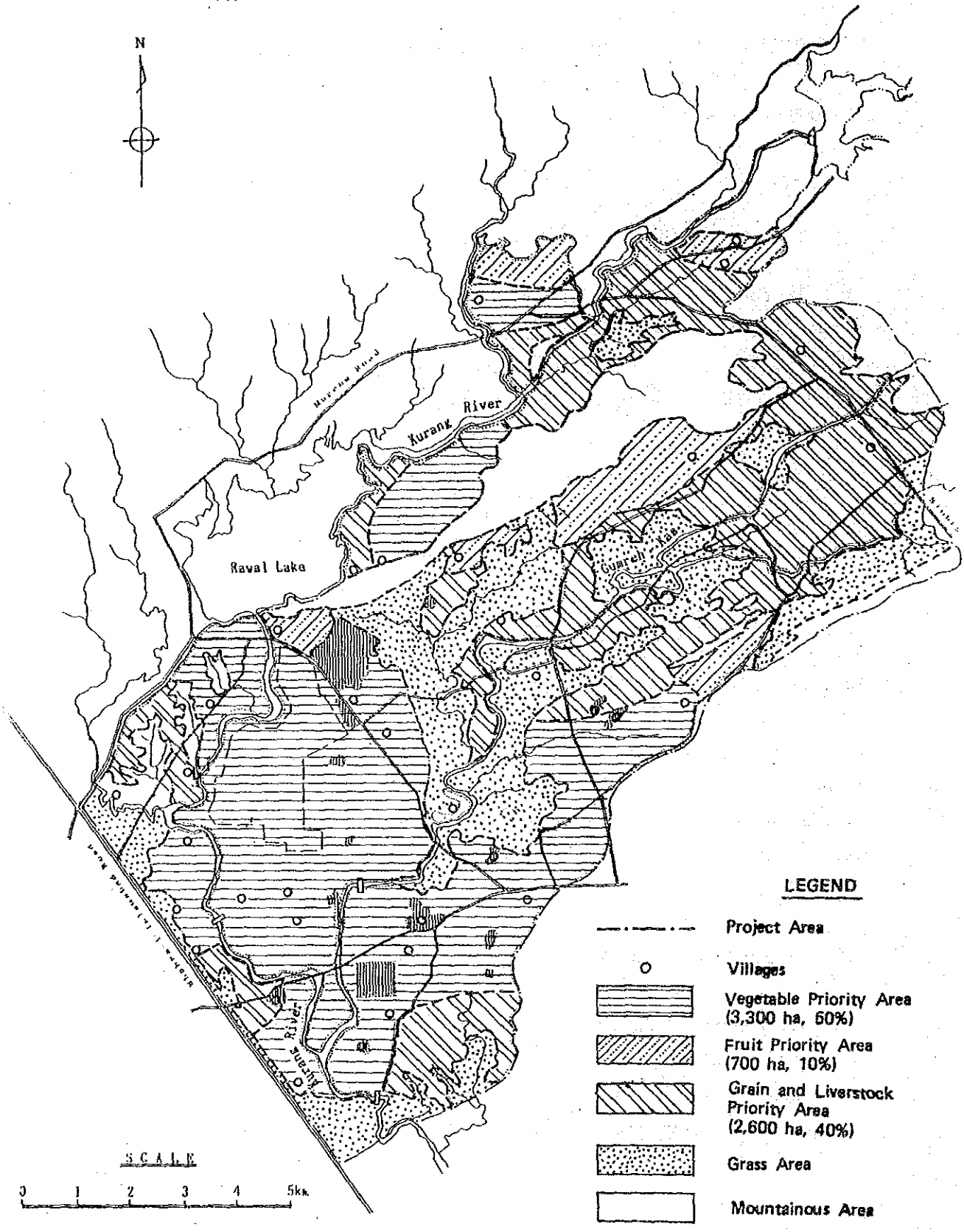
Although it is difficult to fix the areas to one of the three types of the farm management, the Project Area was divided into some areas with priority by farm management types (see Figure-5).

However, it is recommended to promote Type A which is expected to earn higher income than Type C in the vicinity of every beneficial villages, in order to avoid the unequal income distribution among the villages and among farmers.

3.3. Water Resources Plan

The runoff discharges at the proposed K-2 damsite with the catchment area of 137.0 sq.km (53 sq.mi) are estimated at 62.1 MCM/annum (50 x 10^3 ft/annum) as shown below, and the value is equivalent to about 60 percent of those at the Rawal damsite.

FIGURE-5. PRIORITY AREA FOR AGRICULTURAL PRODUCTION



Runoff Discharges at K-2 Damsite

Item	Discharge
Catchment area (sq.km)	137.0
Average Annual Discharge (MCM)	62.1
Probable Annual Discharge (MCM)	
1/5 Probability	47.4
1/10 Probability	41.1

The studies on the water resources plan for the irrigation of cultivable commanded area of 6,600 ha (16,300 acres), which has been determined to be the most optimum size for the project through alternative analyses, were made considering the following various elements;

Dam Operation Method

- Plan I : The runoff discharge of the Kurang River at the proposed K-2 damsite will be stored in the reservoir for irrigation purposes, when the spilled discharges at the Rawal Dam are observed.

- Plan II : Combined reservoir operation of the Rawal Dam and the proposed K-2 Dam will be made in taking into account the most effective utilization of the runoff discharges of the Kurang River.

Cropping Pattern and Intensity

- Cropping Pattern : Type A ... Vegetables and grains (50%)
  : Type B ... Orchard and livestock (10%)
  : Type C ... Grains and livestock (40%)

- Cropping Intensity: Case 1 ... 166% (Rabi 100%, Kharif 66%)
  Case 2 ... 154% (Rabi 100%, Kharif 54%)
  Case 3 ... 142% (Rabi 100%, Kharif 42%)

Water Demand

		Domestic Water (MCM)	Irrigation Water (MCM)
- Without Project			
° Rawal Dam	: Present Conditions	36.8	5.2
	: Stage I Conditions	51.0	5.2
	: Stage II Conditions	61.3	5.2

		Domestic Water (MCM)	Irrigation Water (MCM)
- With Project			
° Rawal Dam	: Present Conditions	36.8	-
	: Stage I Conditions	51.0	-
	: Stage II Conditions	61.3	-
° K-2 Dam		-	25.4

K-2 Dam Size : Case A ... Total storage capacity 29.4 MCM
Case B ... -do- 24.7 MCM
Case C ... -do- 20.5 MCM

Based on the above-mentioned elements, the comparative studies were made to find out the most optimum scale of the project plan, and the results are shown as follows;

Domestic Water Supply Component;

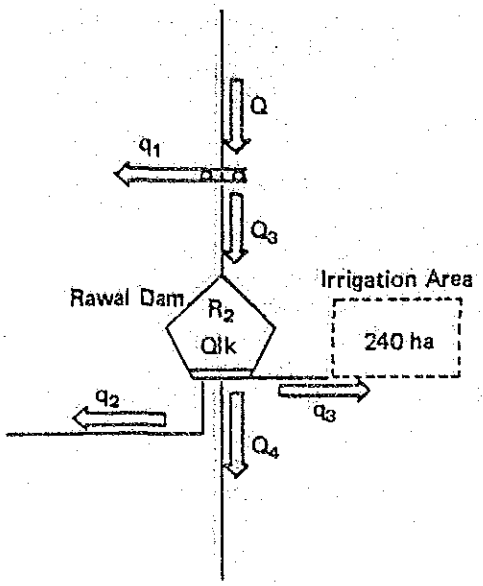
- Future Demand Expansion Plan: Stage I with annual water demand of 51.0 MCM
- Dam Operation Method : Combined reservoir operation with K-2 Dam (Plan II)

Irrigation Water Supply Component;

- K-2 Dam Size : Total storage capacity 29.4 MCM (Case A)
- Target Commanded Area : 6,600 ha
- Cropping Intensity : 142% (Case 3)
- Irrigation Networks : Gravity irrigation system connected with K-2 Dam

Figure-6 and Figure-7 show the diagrams of water resources distribution plan by the Rawal Dam and K-2 Dam in the project, which has been obtained through the careful study on water balance study involving the both dams.

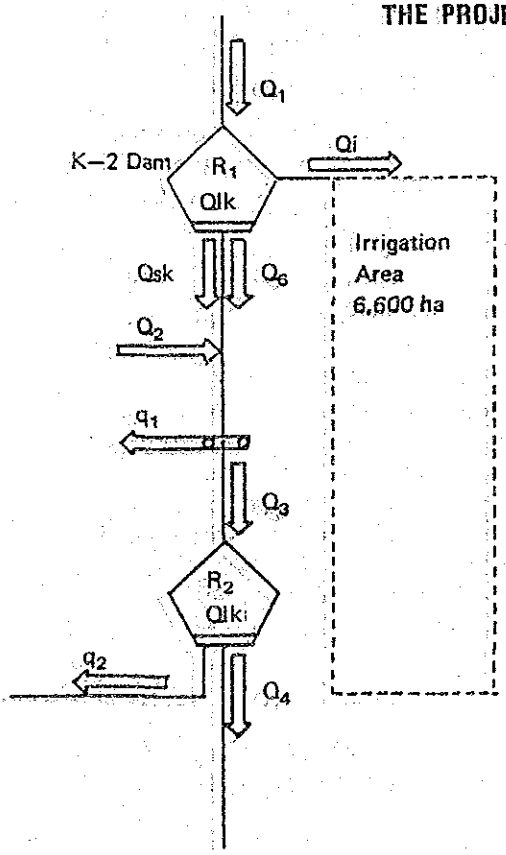
FIGURE–6. RESULT OF WATER BALANCE STUDY UNDER PRESENT CONDITIONS (WITHOUT K–2 DAM)



(unit: MCM)

			Rawal Dam Water Demand	
			Present	Stage I
Q	:	Runoff (275.1 sq.km)	103.0	103.0
q_1	:	H.W Release (Domestic)	7.5	8.4
Q_3	:	Inflow	95.5	94.6
Qlk	:	Reservoir Loss	9.2	9.1
R_2	:	Rainfall in Reservoir	7.3	7.3
q_3	:	Left Canal (Irrigation)	5.2	5.2
q_2	:	Right Canal (Domestic)	32.6	42.5
Q_4	:	Spillage	55.9	45.1

FIGURE–7. RESULT OF WATER BALANCE STUDY UNDER THE PROJECT (WITH K–2 DAM)



			Rawal Dam Water Demand	
			Present	Stage I
K–2 Dam Operation				
Q_1	:	Inflow (137.0 sq.km)	62.1 1/	62.1
Qlk	:	Reservoir Loss	3.0	2.9
R_1	:	Rainfall in Reservoir	2.4	2.4
Qi	:	Irrigation Demand	25.1	25.1
Q_6	:	Release for Rawal Dam	0.0	0.3
Qsk	:	Spillage	36.4	36.2
Rawal Dam Operation				
Q_6 + Qsk	:	Total Release	36.4	36.5
Q_2	:	Runoff (138.1 sq.km)	40.9 1/	40.9
q_1	:	H. W Release (Domestic)	4.1	7.9
Q_3	:	Inflow	73.4	69.5
Qlk	:	Reservoir Loss	9.1	8.9
R_2	:	Rainfall in Reservoir	7.3	7.3
q_2	:	Right Canal	32.6	42.5
Q_4	:	Spillage	38.8	25.4

1/ : Total runoff at Rawal Dam is estimated at 103.0 MCM

3.4. Reservoir Plan

The major dimensions of the dam and reservoir, which were obtained through the study on "Water Resources Plan" in the previous paragraph 3.3 are summarized as follows;

- Maximum Water Level : EL.649.8 m
- Retention Water Level : EL.647.0 m
- Minimum Water Level : EL.637.0 m

Reservoir operation rule of the Rawal Dam and K-2 Dam in case of Plan II is proposed as shown below;

Rawal Dam

- Inflow discharge to the Rawal Dam is runoff discharge of the Kurang River having the catchment area of 138.1 sq.km (53 sq.mi) in the downstream of the proposed K-2 Dam. Required municipal water diverted by head works such as Kurang head works, Shahdara head work and Nurpur head work at the upstream of the Rawal Dam will be subtracted from the inflow discharge.

- Outflow discharge of the Rawal Dam is municipal water of 42.5 MCM (34×10^3 acre ft) per annum corresponding to the future expansion plan of Stage I for Rawalpindi, which is presently supplied by the Rawal Dam Right Canal. Irrigation water of 5.2 MCM (4×10^3 acre ft) per annum for NARC farm, CDA nursery and private farm will be supplied by the proposed irrigation networks connected with K-2 Dam.

- Rawal Dam will be utilized in a range from retention water level of EL.534.4 m (1,753 ft) to low water level of EL.520.9 m (1,709 ft). However, when the outflow discharge from the Rawal Dam is bigger than the inflow discharge and water level of the Rawal Dam is forecasted to be lowered than the low water level of EL.520.9 m, Rawal Dam Operation Office will request to release supplemental water from the K-2 Dam.

K-2 Dam

- Inflow discharge to the K-2 Dam is runoff discharge from its own catchment area of 137.0 sq.km (53 sq.mi).

- The outflow discharge from the K-2 Dam principally is used for irrigation water for the area of 6,600 ha (16,300 acres) under the project. But as mentioned previously, necessary water of the Rawal Dam requested by the Rawal Dam Operation Office will be released through river outlet works of the K-2 Dam. The released discharge to the Rawal Dam has the higher priority than that for irrigation use.

- Reservoir operation of the K-2 Dam will be made in the range from retention water level of EL.647.0 m (2,122 ft) to low water level of EL.637.0 m (2,089 ft). According to the long-term reservoir operation study for 35 years, the followings are revealed.

- K-2 reservoir water level at the end of September, in which Rabi season cropping will be started in the proposed cropping pattern, is observed to be full water level in the rainy season, and accordingly, target cultivable commanded area of 6,600 ha (16,300 acres) could be irrigated by the stored water in the K-2 Dam.

- On the other hand, regarding the Kharif season cropping, of which cultivation will be started in coincidece with relative low reservoir water level of K-2 Dam in March, irrigation area of the Kharif season crop will be decided based on the reservoir water level at the end of January, about one month in advance.

- Namely, when K-2 reservoir water level is higher than EL.645.0 m (2,116 ft), target commanded area of 2,772 ha (42 percent of 6,600 ha) during the Kharif season could be irrigated. But when such water level is lower than EL.645.0 m, cropping area during Kharif season will be controlled by the following criteria;

Water Level of K-2 Reservoir	Kharif Season Cropping Area
more than EL.645.0 m	2,772 ha (42%)
EL.645.0 m - EL.644.0	1,000 ha (15%)
less than 644.0 m	0

3.5. Irrigation and Drainage Plan

Selection of Cultivable Commanded Area

The cultivable commanded areas of 6,600 ha (16,300 acres) are selected from the total project area of 12,900 ha (31,870 acres) in considering such land conditions to meet the project requirements as adequate elevation for gravity irrigation from the proposed K-2 Dam, topography, soil features, progress of soil conservation works, etc. and the selection has been made through the detailed field survey with the topographic map at the scale of about 1/21,100 (three inches to one mi).

The following table indicates the present land categories in the Project Area.

Cultivable Commanded Area in the Project

(unit: ha)

Items	Upstream Area	Downstream Area	Total
Cultivable Commanded Area	3,790	2,810	6,600
Wasted Land	2,440	940	3,380
Mountain/Hill Area	1,340	210	1,550
River, Road, Villages	730	640	1,370
Total	8,300	4,600	12,900

Irrigation Water Requirement

The irrigation water requirements for the areas of 6,600 ha (16,300 acres) on the basis of proposed land use and cropping pattern are estimated in considering the following criteria;

- Potential Evapotranspiration (ETo)
  Potential evapotranspiration was estimated by applying the Penman method using climatological data observed at Chaklala station.

- Crop Water Requirement (ET)
  Crop water requirement was calculated by multiplying the ETo value by the crop coefficient (Kc) corresponding to growth stages of crops.

- Effective Rainfall
  Effective rainfall for individual crops was estimated on the basis of daily water balance analysis between rainfall and crop water requirement. In the calculation, Total Readily Available Moisture (TRAM) value is decided at 35 mm.

- Irrigation Efficiency
  Irrigation efficiency for the project was decided at 60% as a whole.

Monthly diversion water requirement for the area of 6,600 ha (16,300 acre) in the project plan (cropping intensity of 142%) for the both cases of return periods of 2 and 10-years are presented in Figure-8.

Irrigation Water Distribution Plan

Distribution of irrigation water for the whole areas Upstream and Downstream Areas will be made through the proposed irrigation systems as shown in Figure-9. The maximum designed discharges of the irrigation canal are 3.96 cu.m/sec (233 cusec) with the unit water requirement of 0.6 lit/sec/ha.

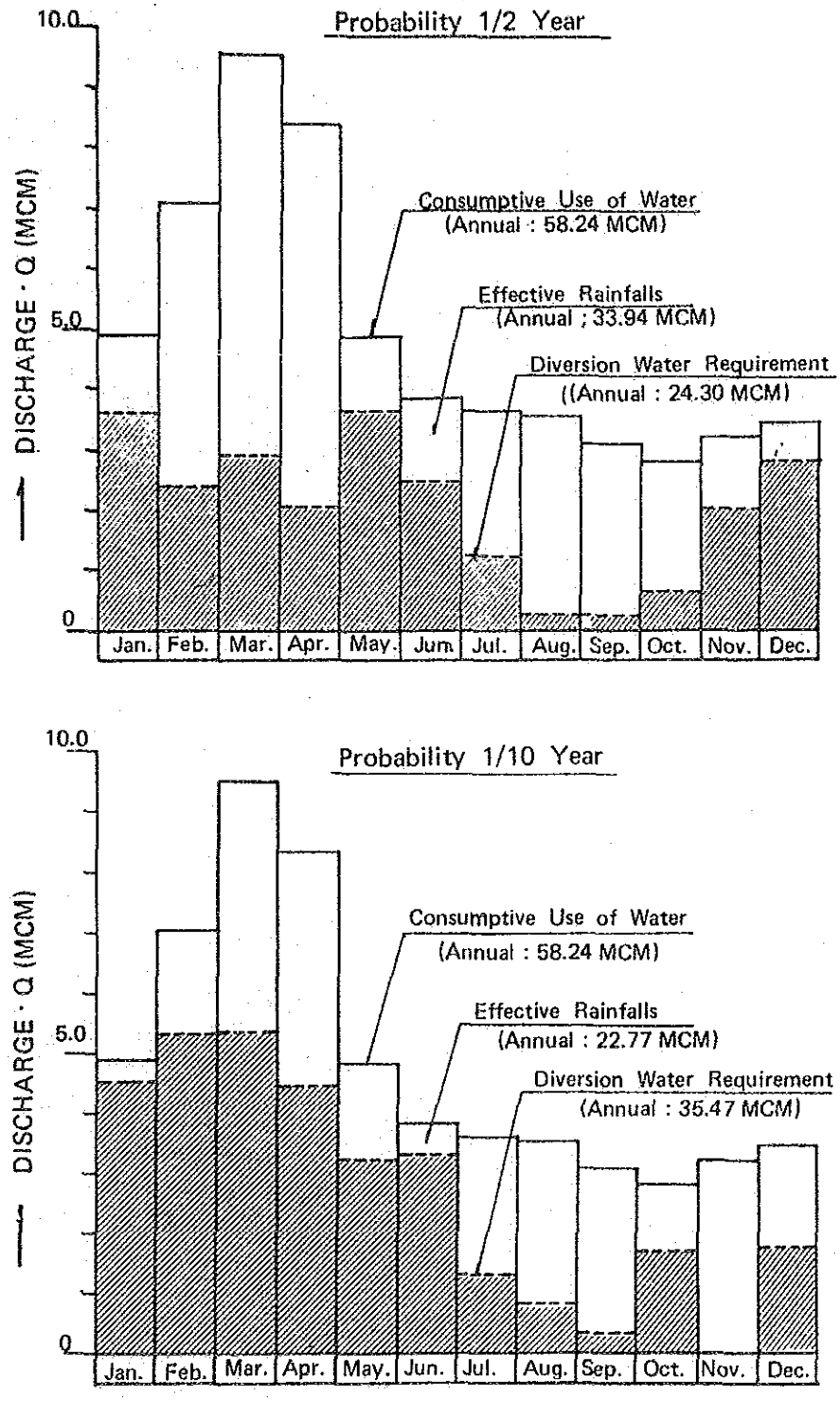
Proposed Irrigation Method for Upland Crops

In order to make studies for upland crop irrigation methods involving the adequate amount of water and irrigation interval for crops, intake rate measurements and soil water storage were observed at the field, and as a result, followings are decided that Total Readily Available Moisture (TRAM) is 35 mm (1.4 in) and irrigation interval is seven days on an average.

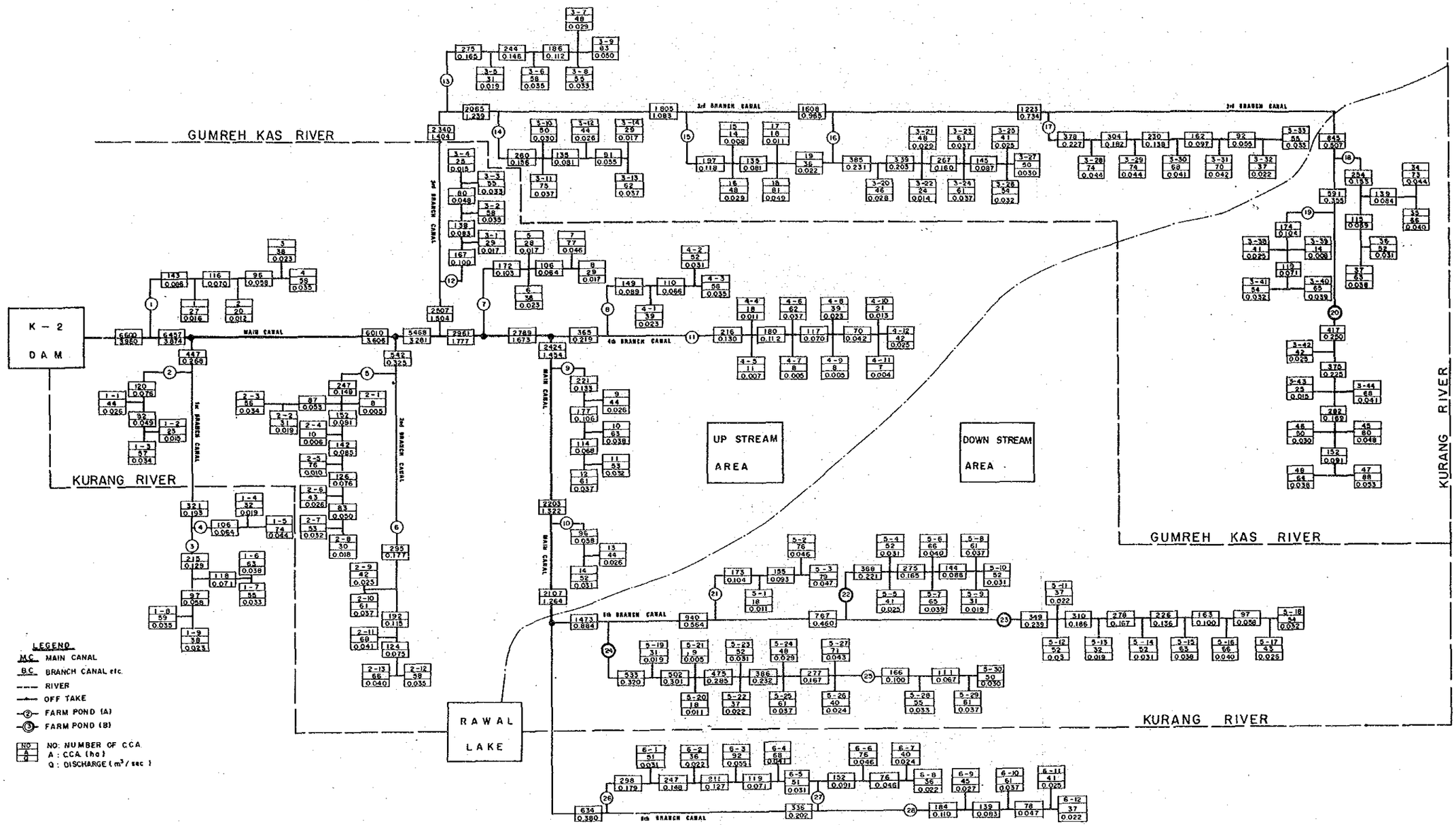
Drainage Plan

Since there are no drainage facilities in the Project Area, surface soil wash is observed in the farm land during heavy rain, and these conditions have caused a social problem to take countermeasures of soil conservation view. Accordingly, the primary objective of the drainage plan in the area is to control soil erosion. In the plan, the on-farm drainage canals are to be provided at the lowlying portion of the farm land covering 40 to 50 ha (99 - 124 acres) on an average. The design drainage modulus was decided by 14.8 lit/sec/ha (0.211 cusec/acre) in corresponding to 5-years probable rainfall.

FIGURE -8. RELATION OF CONSUMPTIVE USE OF WATER AND DIVERSION WATER REQUIREMENT



FIGURE–9. DIAGRAM OF PROPOSED IRRIGATION SYSTEM



3.6. Agricultural Production Plan

Proposed Crops for Cultivation

The proposed crops have been selected in taking the following factors into consideration;

i) Crops better suited to irrigated agriculture together with large demand and high profitability,

ii) Vegetables easily cultivable in farming techniques for the early development stage and crops to be changed into those requiring higher techniques with development advancing,

iii) Fruits for consumers close to the farms with thin and soft pericarp not to stand for long-distance transportation and grown easily in farming techniques, and

iv) Fodders not only for feeding milk cow but for retaining soil fertility,

In view of the above factors, the following crops will be introduced into the Project Area.

Cereals and Fodders;

- Rabi Season : wheat, italian rye-grass, oats, weeping lovegrass, persian clover, egyptian clover, rape and mustard and turnip
- Kharif Season: maize, sorghum, soybean, mungbeans, groundnut, alfalfa, cow-pea, sun-flower

Garden Crops - Vegetable;

- Rabi Season :
  - ° Root Vegetable: japanese radish, turnip, radish, carrot, garden beet
  - ° Leaf Vegetable: cabbage, chinese cabbage, spinach, parsley, lettuce, celery
  - ° Flower Vegetable: cauliflower, broccoly
  - ° Pulse Crops: peas

- Kharif Season:	°	Root Vegetable	carrot, horse radish, turnip, radish
	°	Leaf Vegetable	cabbage, spinach, parsley
	°	Flower Vegetable	cauliflower
	°	Fruit Vegetable	tomato, egg-plant, sweet pepper, cucumber, bottle gourd, pumpkin, quinine melon, sponge gourd, water melon, melon, okra, strawberry
	°	Pulse Crop	kidney beans, snap beans, common gram

Garden Crop - Fruit Trees -;

Peach, Loquat, Plum, Apricot, Nectarine, Pessimmon, Cherry, Lemon

Water Management for Crop Husbandry

Fundamentally, irrigation can be practised with only information available for the number of days for irrigation interval and an adequate amount of water to be replaced. For upland irrigation of crops such as vegetables, however, irrigation shall be carried under well water management.

Therefore, the water management for successful vegetable growing requires highly flexible and delicate control of irrigation water amount, intervals, etc. so as to meet requirements of crops by their kinds and types and growing stages. And farm ponds should be provided in the related fields to be successful in such sophisticated water management. In future, when nursery pots, green-houses and other farming facilities will be introduced for raising the irrigation efficiency with sprinklers, drippers, etc., the sufficient water sources should be provided as closely as possible to the fields.

Agricultural Production

The production increase by irrigation only is assumed to be in a range from 120 percent to 130 percent and the other favorable factors like introduction of new varieties, fertilization, deep plowing, uplevelling of farming techniques, etc. shall be taken into consideration in the staging manner to estimate the agricultural production expected at 10-15 years after project completion.

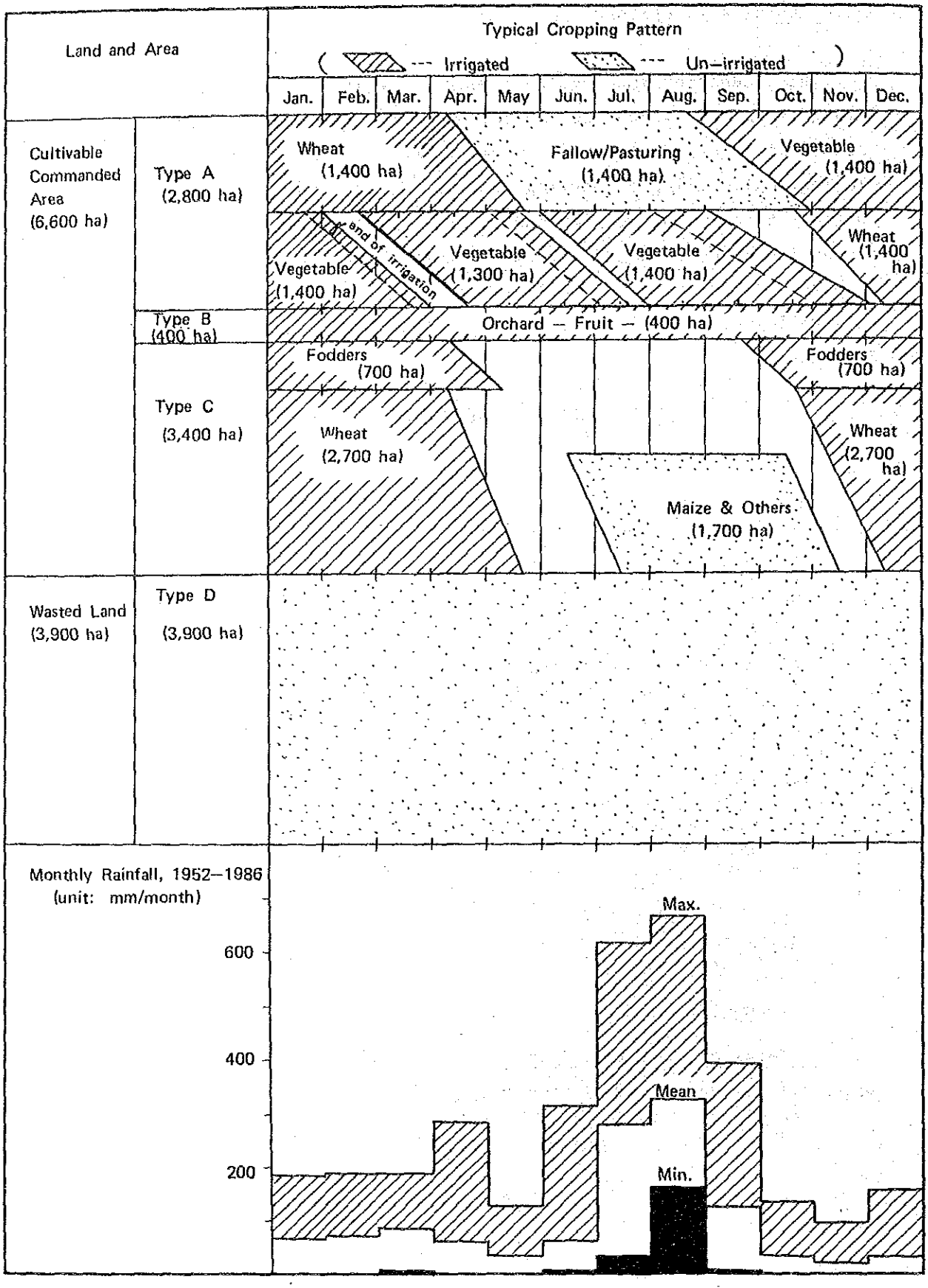
Following table indicates the proposed crop production by the Project.

TABLE-2. CROP PRODUCTION WITH PROJECT

Crops	Cropped Area (ha)	Average Yield (ton/ha)	Crop Production (ton)
1. Rabi Crops			
- Wheat	4,100	5.0	20,500
- Fodder	700	85.0	59,500
- Vegetable			
° Leaf Vegetable (Cabbage)	500	25.0	12,500
° Root Vegetable (H. Radish)	500	20.0	10,000
° Pulse Crop (Peas)	400	12.0	4,800
2. Kharif Crops			
- Vegetable			
° Fruit Vegetable (Tomato)	1,300	20.0	26,000
° Fruit Vegetable (Cucumber) (Cucumber)	1,000	15.0	15,000
° Flower vegetable (Cauliflower)	400	20.0	8,000
- Fruit (Peach)	400	20.0	8,000
- Maize1/	850	2.5	2,130
- Fodders1/	850	60.0	51,000
Total	11,000	(Cropping intensity = 167%)	
Total of Irrigated Crops	9,300	(Cropping intensity = 141%)2/	

Note: 1/ ... Un-irrigated crops
2/ ... Average cropping intensity for 35 years, 1952 - 1986.

FIGURE –10. PROPOSED CROPPING PATTERN



Animal Husbandry Program

Realization of the Project will enable to produce silage fodder crops of 60,000 tons by Rabi crop and 51,000 tons by Kharif crop, and furthermore, straw of 15,000 tons and vegetable remainders of 20,000 tons will be utilized as feeds. Such better use of these materials is expected to produce about 23,000 tons of Total Digestive Nutrients (TDN) and about 3,000 tons of Digestive Crude Protein (DCP). And on the basis of the TDN value converted, the number of head of milk cow to be bred can be estimated at 13,700 head, which are 1.8 times as many as the adult cattle bred at present in number.

Farm Management

After completion of the Project, following subjects of the farm management by development step should be taken up for the agricultural production with emphasis placed on vegetable cultivation.

Subject of Farm Management by Development Step

1st Step	-	to introduce technology of irrigation
(1st- 5th year)	-	to diversify open field vegetable varieties
	-	to raise land productivity
2nd Step	-	to improve cropping techniques
(6th - 10th year)	-	to lessen open field vegetable varieties
	-	to raise labor productivity
3rd Step	-	to firmly establish farming techniques
(11th - 15th year)	-	to grow less crops in number in rotation
	-	to raise capital productivity

3.7. Agricultural Supporting Service Plan

Agricultural Extension Services

In the Islamabad Capital Territory, rainfed farming has been practised in most of the farm land, and accomplishment of the proposed target in the agricultural production depends only upon a successful establishment of the extension service organization for irrigated agriculture.

Furthermore, the study of application of irrigation farming technology to the agriculture in the Project Area and the extension of the aforesaid study result to the local farmers will have influence on success in reaching the targeted agricultural production.

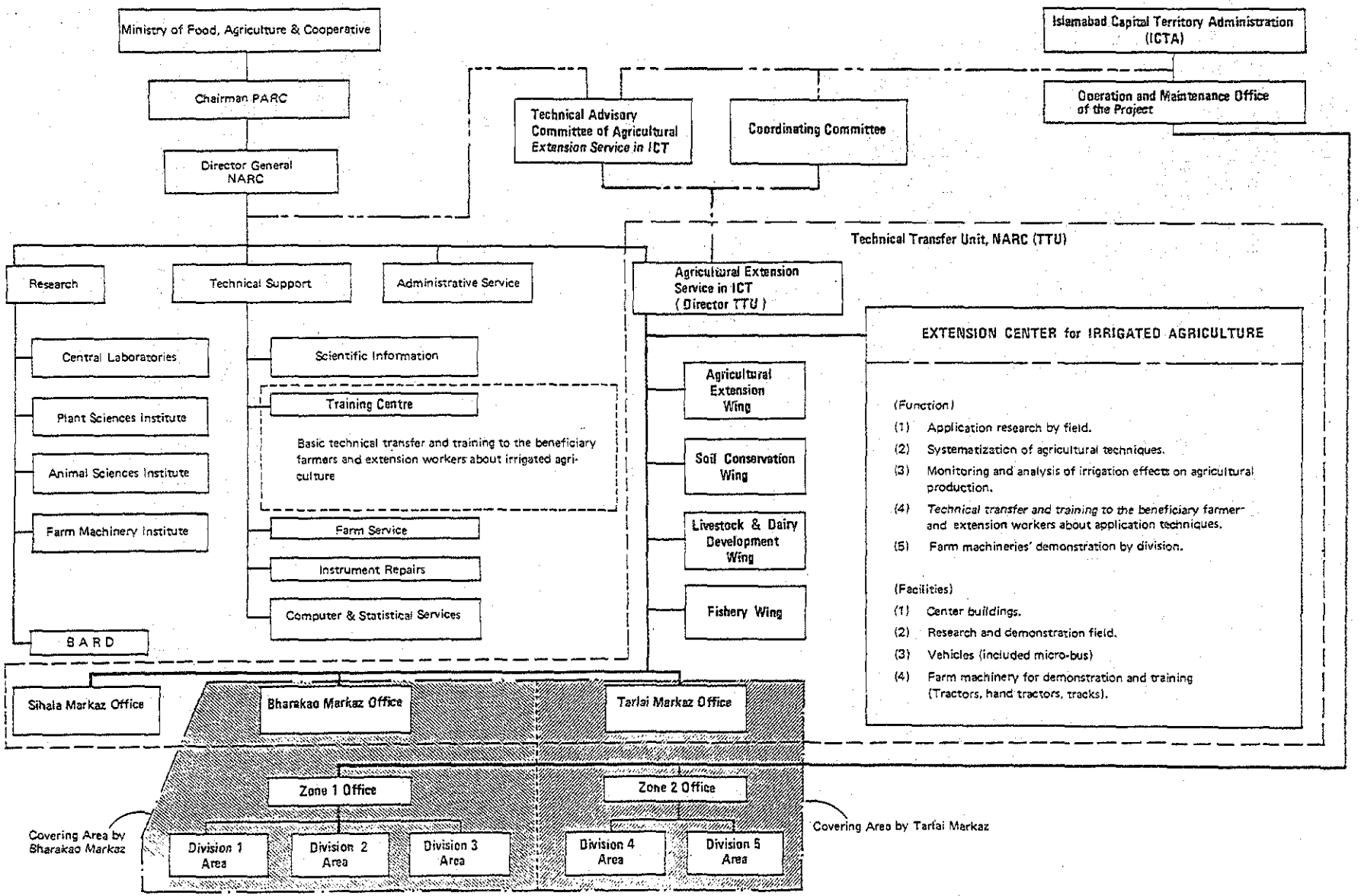
i) Study on Application of Irrigation Farming Technologies and Training on Farmers

The Extension Center for Irrigated Agriculture should be firmly established in TTU for successful extension of the irrigation farming technology in the Project Area and uplevelling of the extension service program is quite essential for the purpose.

The study, application, and training of the irrigation farming technology shall be carried out in the system with a core of the Extension Center as shown below (see Figure-11).

- Training of agricultural technology from the fundamental matters
- Application study of irrigation farming technology
- Systematization of application studies by Extension Center
- Training of applicable technology to farmers' fields
- Demonstration of the results of application studies

FIGURE–11. PROPOSED ORGANIZATION CHART OF AGRICULTURAL EXTENSION SERVICES IN THE PROJECT AREA



ii) Extension Activities

For raising agricultural productivity and realizing the proposed target yields of crops through supplying irrigation water, various applied techniques to be firmly established by the Extension Center for Irrigated Agriculture shall be diffused to the local farmers.

Such being the case, the extension services should be rendered by TTU through its department and Markaz Office.

Establishment of Water Users' Association

Successful execution of irrigation projects essentially requires to establish a Water Users' Association with beneficiary farmers for securing fair distribution of irrigation water to their fields.

ICTA, with LGRD as core, shall prepare the following matter prior to implementation of the Project so as to encourage the associations to be activated in their works.

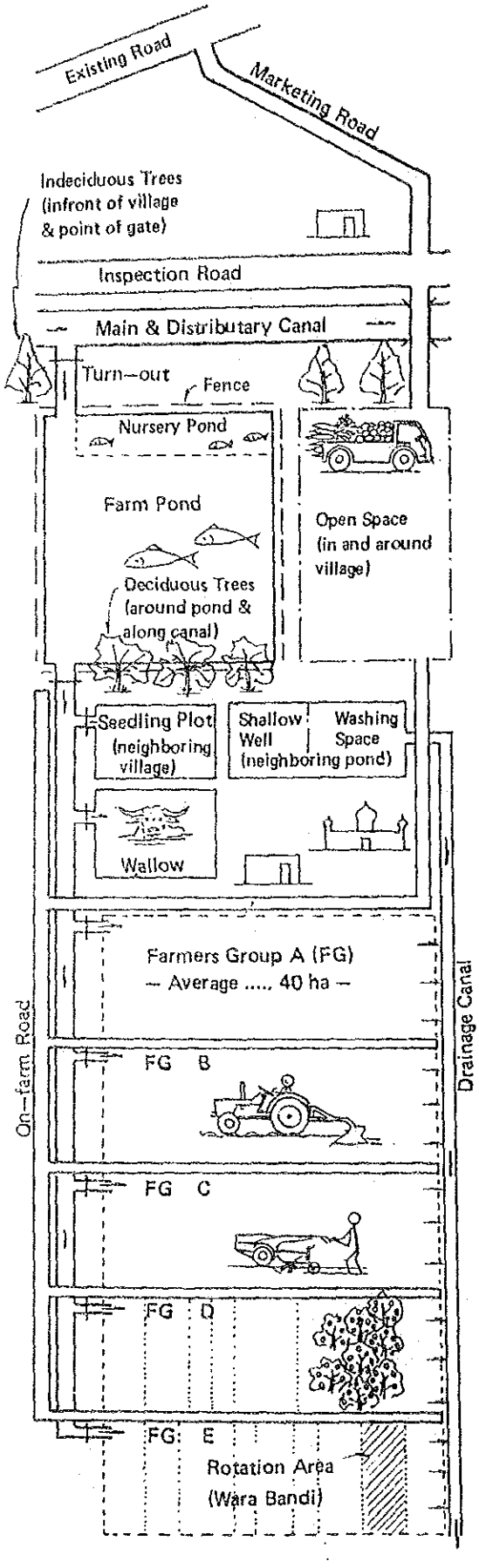
- to confirm the numbers of beneficial villages, total households and farmers,
- to study and prepare the program for organizing the Associations,
- to prepare the acts, regulations and rules for the Association activities under the administration of ICTA,
- to study the extent of O & M charges to be borne by beneficiary farmers,
- to have thorough public relations with beneficiary farmers on the works realized by Project, impacts and necessity of the Project,
- to bring up the educational staff of ICTA for giving training and guidance in organizing the Associations, and
- to study possibility to organize the Associations with function of agricultural cooperatives.

3.8. Village Development Plan

In the Study Area the disparity in income and of life environment level has become one of serious social problems between urban and rural areas. This is caused from the difference in geographical conditions between urban and rural areas, among villages and even among people in a village. For the well balanced development of the area, it is necessary to improve the base of agricultural production and villagers' life environment.

Figure-12 shows a model of the water-based village development plan. Within the scope of this project, and it is intended that as many farmers as possible can have an opportunity for leading more pleasant life through irrigated agriculture by implementing or improving the related facilities and marketing roads which are the most fundamental agricultural production bases.

FIGURE–12. MODEL OF THE WATER–BASED VILLAGE DEVELOPMENT PLAN



FARM POND

- Keeping water with night storage for timely irrigation to crops especially vegetables.
- Growing and harvesting fish.

SHALLOW WELLS & WASHING SPACE

- Supplying drinking and domestic water for all villagers.
- Supplying washing water for vegetable.

SEEDLING PLOT

- Supplying vegetable seedlings for on time transplanting

ANIMAL WALLO

- Bathing space for buffalos and other large animals.

MULTIPURPOSE OPEN SPACE

- Collection and shipment farm products in cooperation.
- Assembly and communication space.
- Sport and game space.

TRUCKS (Owned by WMG)

- Transportation of farm inputs and products and construction materials for improvement of on-farm works, and communication between town and village.

TRACTORS OR POWER TILLERS (Owned by WMG)

- Cultivation of farm land in keeping proposed cropping pattern on time and effective water use.

OFFICE OF WATER MANAGEMENT GROUP

- Operation and maintenance of the irrigation and drainage canals covering by the territory of water management group.
- Requesting the fund for procurement and operation of agricultural service equipment to banks through the Federation of Water Users' Association.
- Negotiation with dealers to lower the price of farming equipment and input materials as well as to keep the reasonable price of products.

4. PROJECT FACILITIES

4. PROJECT FACILITIES

The main facilities of the project are as follows;

- K-2 Dam
- Irrigation Canal
- On-Farm Facilities
- Marketing Road

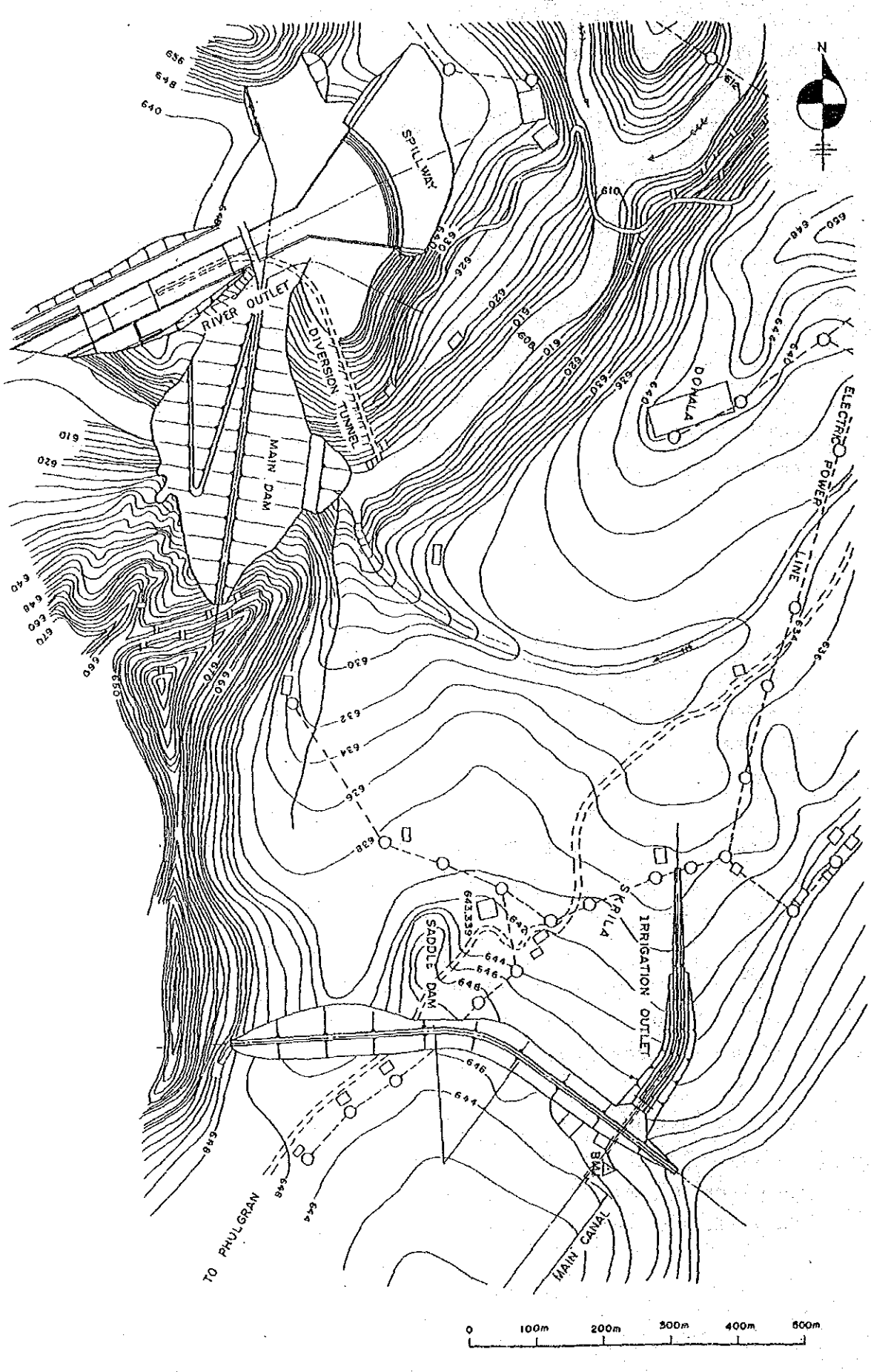
In the detailed design stage, additional topographic survey, investigation of the foundations and of the various types of the construction materials, etc. are necessary to design the safe and economical structures.

4.1. K-2 Dam

The proposed K-2 damsite is located at the northeast corner of Islamabad Capital Territory and about 15 km (9 mi) upstream of the existing Rawal Dam along the Kurang River. The village nearest to the damsite is Dohala. As shown in Figure-13, the K-2 reservoir is formed by a main dam to be constructed across the Kurang River and a saddle dam on a saddle of the left bank. K-2 Dam with a live storage of 18.5 MCM (15,000 acre ft), will be classified into a storage dam, and the stored water is used to irrigate the cultivable commanded area of 6,600 ha (13,600 acres). When water shortage occurs in the Rawal Dam in drought years and K-2 reservoir has enough storage, water stored in the K-2 reservoir will be released into the Kurang River at such rates as dictated by downstream needs for domestic water supply.

The left and right abutments of the main damsite present very different topography. The left abutment is composed of alternated sandstone and mudstone, and shows the ridge and trough topography by the differentiated erosion and the high angle inclination of strata.

FIGURE -13. K-2 DAM GENERAL PLAN



The right abutment shows table-shaped hill having one or two terrace halfway up the hill. The width of the river bed is 40 to 50 m (131 to 164 ft).

The base rocks of the damsite and the reservoir area are hard sandstone and relatively soft mudstone of Murree formations with minor part of intercalated pseudo-conglomerate and laminated sandstone. As the results of unconfined compression tests of rock cores, the compression strength for sandstone and mudstone is as follows;

Sandstone: 50 - 1,100 kgf/cm^2
Mudstone : 20 - 80 kgf/cm^2

Lugeon values of the mudstone zone except the portion near the ground surface are generally less than three, and indicate that those zones have a relatively high watertightness, but the sandstone zone, especially the boundary with the mudstone, has a relatively high permeability. The overburden is composed of terrace deposits, residuals and river deposits.

As the result of comparative study, the concrete gravity dam has no economical advantage over the embankment dam and the foundation is assumed not to be suitable for the construction of concrete gravity dam of 50 - 60 m high, so that embankment dam was adopted as the dam type for the K-2 Dam.

The main dam of 53 m high was planned as a zone type earth dam taking into consideration properties of available materials from borrow areas around the damsite and spillway excavation. On the other hand, the saddle dam of 12 m high was planned as a modified homogeneous type earth dam. The embankment volume will be about 2.1 million cubic meter in total.

There are no materials suitable for the filter zone and bedding for ripraps around the damsite, and those materials are planned to be provided by the Contractors. Other embankment materials will be obtained from borrow area for impervious materials and excavation sites for spillway and dam.

In the dam plan, such two outlet works as irrigation outlet works and river outlet works, are necessary as mentioned below.

- Irrigation Outlet Works

  The irrigation outlet works will be provided under the saddle dam and stored water will be released to the irrigation main canal by gravity flow. The maximum irrigation outlet capacity is 3.96 cu.m/sec (140 cusec).

- River Outlet Works

  When shortage of water is occurred in the Rawal Dam in a drought year, water stored in the K-2 reservoir will be released at such rates as dictated by downstream needs. The maximum river outlet capacity is 2.04 cu.m/sec (72 cusec).

In addition, the spillway with a design capacity of 1,840 cu.m/sec (66,100 cusec) and the diversion tunnel with a design capacity of 690 cu.m/sec (24,800 cusec) for diverting floods during the construction period are necessary.

The salient features of K-2 Dam are shown in Table-3.

TABLE-3. SALIENT FEATURES OF K-2 DAM

Location		North-East Corner of ICT	
River		Kurang River	
Catchment Area		137.0 sq.km :	52.9 sq.mi
Reservoir			
Maximum Water Level		649.8 m :	2,131.9 ft
Retention Water Level		647.0 m :	2,122.7 ft
Minimum Water Level		637.0 m :	2,089.9 ft
Gross Storage Capacity		29.4 MCM :	23,830 acre-ft
Live Storage Capacity		18.5 MCM :	15,000 acre-ft
Dead Storage Capacity		10.9 MCM :	8,840 acre-ft
Dam		Main Dam	Saddle Dam
Type of Earth Dam		Zoned	Modified Homogeneous
Top of Dam	(m)	652.8	652.8
Dam Height	(m)	53.0	12.0
Length of Dam	(m)	490.0	750.0
Top Width	(m)	9.0	9.0
U/S Slope of Dam		1:3.0	1:3.0
D/S Slope of Dam		1:2.5	1:2.5
Volume of Dam (m^3)		1,870,000	190,000
Spillway			
Type		Uncontrolled (Ungated)	
Capacity		1,840 m^3/s :	66,100 cusec
Crest Elevation		647.0 m :	2,122.7 ft
Design Head		2.8 m :	9.2 ft
Length of Crest		189.4 m :	621.4 ft
Diversion Tunnel			
Diversion Flood		690 m^3/s :	24,800 cusec
Diameter		9.0 m :	29.5 ft
Length		435.0 m :	1,430.0 ft
Outlet Works		Irrigation Outlet	River Outlet
Functional Purpose		Irrigation	Supplemental water supply to Rawal Lake
Design Capacity (m^3/s)		3.96	2.04
Type of Structure		Concrete Encased Pressure Pipe Conduit	Tunnel with Steel Liner Pipe
Diameter (m)		1.50 - 1.20	1.00 - 0.80