THE ISLAMIC REPUBLIC OF PAKISTAN
CAPITAL DEVELOPMENT AUTHORITY

THE REGIONAL STUDY
FOR
WATER RESOURCES DEVELOPMENT POTENTIAL
FOR
THE METROPOLITAN AREA
OF
ISLAMABAD-RAWALPINDI

MAIN REPORT

FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Islamic Republic of Pakistan, the Japanese Government has decided to conduct a basic design study on the Water Resources Development Potential in the Metropolitan Area of Islamabad / Rawalpindi and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Pakistan a Study Team, headed by Mr. Satoshi Kadowaki of Sanyu Consultants Inc., comprising members of Sanyu Consultants Inc. and Yachiyo Engineering Co., Ltd. from December 1986 to March 1987 and from July to September 1987.

The Team exchanged views on the Project with the officials concerned of the Government of Pakistan and conducted a field survey in the said area. After the team returned to Japan, further studies were made and as a result this Report has been prepared.

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

I wish to express my deep appreciation to the officials concerned of the Government of Pakistan for their close cooperation extended to the Study Team.

February, 1988

Kensuke Yanagiya

KENSUKE YANAGIYA
President
Japan International Cooperation Agency

February, 1988

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo

Dear Sir,

LETTER OF TRANSMITTAL

It is our pleasure to submit to you the Final Report of the Regional Study for Water Resources Development Potential for Metropolitan Area of Islamabad and Rawalpindi.

The field survey and study have been conducted in two stages during the period from December, 1986 through November, 1987.

This Report consists of five separate volumes : VOLUME I - Executive Summary of the study providing the summary and recommendations; VOLUME II - Main Report of the regional study describing the results of survey and analysis ; VOLUMES III, IV and V - Appendices of the report providing the information on the technical and socio-economic aspects.

We hope that realization of the proposed schemes would greatly contribute to the water resources development in the Metropolitan area.

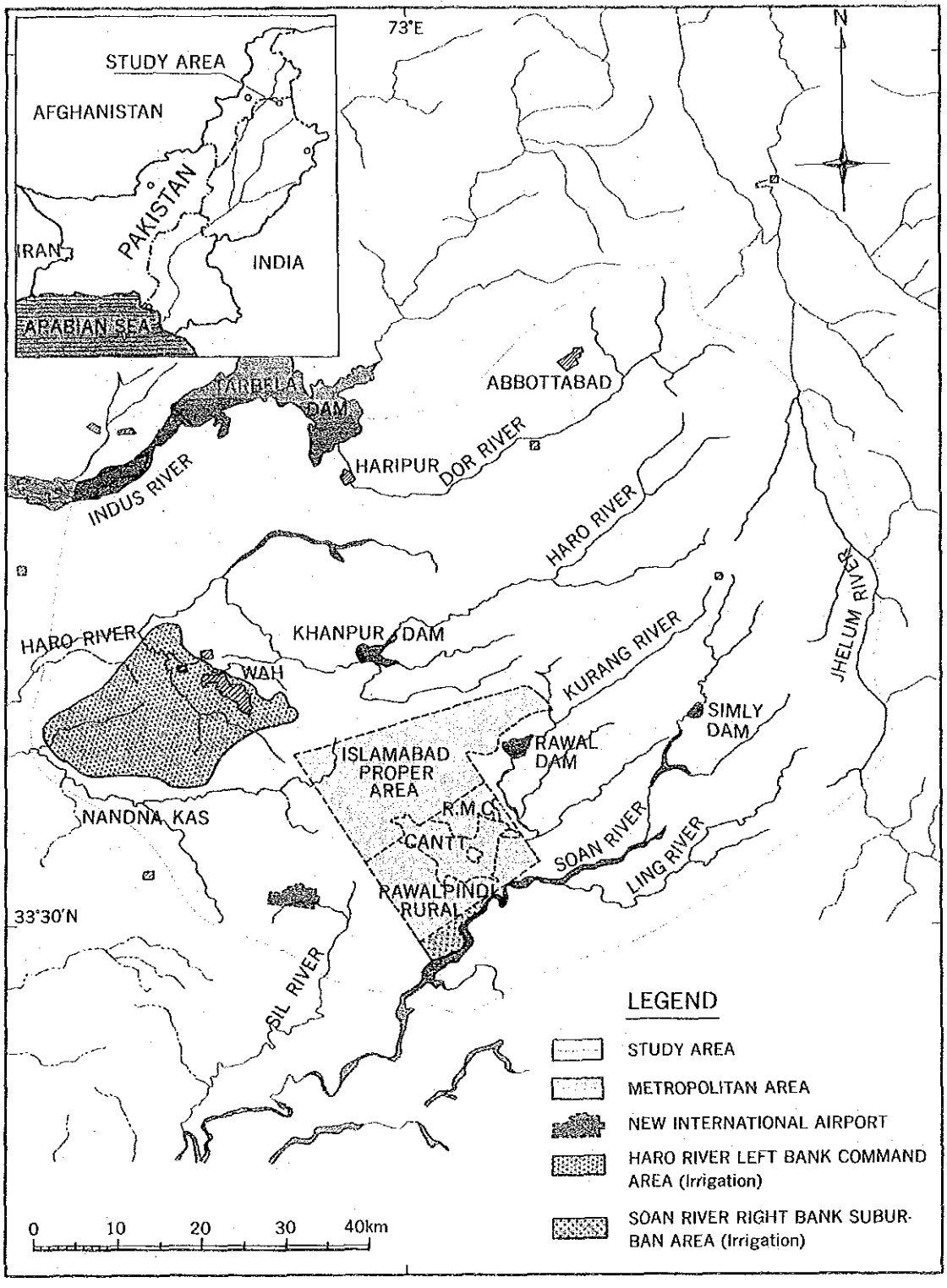
Finally, we take this opportunity to express our sincere gratitude to Japan International Cooperation Agency, Ministry of Foreign Affairs, Ministry of Construction, Ministry of Agriculture, Forestry and Fisheries of the Government of Japan, the Embassy of Japan in Pakistan, Advisory Committee and the officials concerned of the Government of Pakistan which gave useful advice to the Study Team during the field survey and study periods.

Respectfully yours,

S. Kadowaki

Satoshi Kadowaki
Team Leader
for
Regional Study

LOCATION MAP OF STUDY AREA



GENERAL MAP OF WATER RESOURCES DEVELOPMENT SCHEME

NORTH WEST FRONTIER PROVINCE

5,000m 0 5 10 15km

Miles 5 4 3 2 1 0 5 10Miles

LEGEND

- Province Boundary
- Study Area
- Catchment Area
- Existing Dam
- Main City
- Local Town
- Main Road
- Railway
- River
- Proposed Dam
- Proposed Diversion Dam
- Hightening of Existing Dam
- Pump Station
- Canal
- Pipeline
- Tunnel
- Treatment Plant
- Tubewell
- Metropolitan Area
- Proposed New International Airport
- Haro River Left Bank Command Area
- Soan River Right Bank Suburban Area
- Haro River Right Bank Command Area (Existing)

Tarbela Dam
Abbottabad
D-1
Rajoia
Havelian
Haripur
Dor River
DW-1
Dc-1
H-4
Murree
Jw-1
Jp-1
Tarbela Model
Haro R
Khanpur Dam
Jc-1
Wah
Haro River
HCP-1
(KC-2)
Attock
Nilan Kas
Islamabad
Kurang River
Rawal Dam
Simly Dam
Gumreh Kas
Kc-1
Kc-6
Kep-1
Kep-2
Bahtar
Nandna Kas
ANp-1
Shahkas Dam
Chemh
S-1
M-1
Matal Kas
Rawalpindi
Pind Dadn
Sc-1
KL-1
Soan River
Kahuta
Fatehjang
Swp-1
Lc-1
Lp-1
L-1
Sw-3
Sip-1
SL-1
SLc-1
Chahan
SLp-1
Sil River
Soan River
PUNJAB PROVINCE
Mangla Dam
Jhelum River

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CONTENTS OF APPENDIX

LIST OF REFERENCE

Code	Source
WA-1	SEDIMENT APPRAISAL OF PAKISTAN RIVERS. WAPDA
WA-2	SIRAN BASIN RECONNAISSANCE REPORT. WAPDA
WA-3	HARO BASIN RECONNAISSANCE REPORT. WAPDA
WA-4	SOAN BASIN RECONNAISSANCE REPORT. WAPDA P.C.I SCHEME OF TARBELA & MANGLA DAMS
WA-5	WATERSHED MANAGEMENT PROJECT. WAPDA
WA-6	FINAL REPORT FOR SMALL DAMS PROJECT. ADB
WA-7	FLOOD CONTROL SECTOR PROJECT. ADB
WA-8	V.T.CHOW. HANDBOOK OF APPLIED HYDROLOGY McGRAW-HILL, 1964
UR-1	POPULATION CENSUS REPORT OF ISLAMABAD IN MARCH 1981
UR-2	1981 DISTRICT CENSUS REPORT OF RAWALPINDI
GE-1	HYDROGEOLOGIC INVESTIGATION IN HARO RIVER POTWAR PLATEAU PUNJAB PROVINCE, WAPDA
GE-2	GROUNDWATER INVESTIGATION FOR WATER SUPPLY SCHEME FEDERAL CAPITAL AREA PHASE-1, WAPDA
GE-3	AVAILABILITY OF GROUNDWATER IN SELECTED SECTORS AREA OF ISLAMABAD, WAPDA
GE-4	HYDROGEOLGIC INVESTIGATION IN SOAN BASIN POTWAR PLATEAU PUNJAB PROVINCE, WAPDA
GE-5	AVAILABLITY OF GROUNDWATER FOR WATER SUPPLY SCHEMES OF PHED RAWALPINDI CIRCLE, WAPDA
GE-6	TECHNICAL REPORT ON GROUNDWATER RESOURCES IN HARIPUR AREA, WAPDA
GE-7	GEOELECTRIC STUDIES FOR GROUNDWATER INVESTIGATION IN PAKISTAN ORDNANCE FACTORIES WAH PREMISES, WAPDA
GE-8	EFFECTS OF KHANPUR DAM ON TUBEWELLS INSTALLED AT HEAVY ENGG. COMPLEX TAXILA, HFF

Code	Source
IR-1	THE SIXTH FIVE YEAR PLAN
IR-2	RECONNAISANCE SOIL SURVEY, SOIL SURVEY OF PAKISTAN RAWALPINDI (1967), ATTOCK (1970)
IR-3	PAKISTAN CENSUS OF AGRICULTURE, 1980
IR-4	FAO TECHNICAL PAPER NO.24
EC-1	JICA STUDY TEAM
EC-2	SMALL DAMS ORGANIZATION, ISLAMABAD
EC-3	AGRICULTURE DEPT., GOVT. OF THE PUNJAB
EC-4	PLANNING & DEVELOPMENT DEPT., GOVT. OF THE PUNJAB
EC-5	PAKISTAN STATISTICAL YEAR BOOK 1986
EC-6	HOUSING CENSUS 1981
EC-7	HOUSING CENSUS 1980
EC-8	PUNJAB DEVELOPMENT STATISTICS 1986
EC-9	ECONOMIC SURVEY 1985 - 86
HY-1	FAO IRRIGATION AND DRAINAGE PAPER 24 "CROP WATER REQUIREMENT", REVISED 1977

ABBREVIATIONS

1. Organizations

ABAD	:	Agency of Barani Area Development
CAA	:	Civil Aviation Authority
CANTT	:	Cantonment
CB	:	Cantonment Board
CDA	:	Capital Development Authority
FAO	:	Food and Agriculture Organization
HFF	:	Heavy Foundry and Forge
HMC	:	Heavy Mechanical Complex
HRF	:	Heavy Rebuild Facotry
ICTA	:	Islamabad Capital Terriotry Authority
JICA	:	Japan International Cooperation Agency
MES	:	Military Engineering Service
NARC	:	National Agriculture Research Center
NESPAK	:	National Engineering Service (Pakistan) Ltd.
PAF	:	Pakistan Air Force
PARC	:	Pakistan Agriculture Research Council
PHED	:	Public Health Engineering Department
PIA	:	Pakistan International Airline
PIDC	:	Pakistan Industrial Development Corporation
POF	:	Pakistan Ordnance Factories
RCB	:	Rawalpindi Cantonment Board
RMC	:	Rawalpindi Municipal Corporation
RMC	:	Regional Meteorological Centre
SDO	:	Small Dams Organization
WAPDA	:	Water and Power Development Authority
WHO	:	World Health Organization

2. Units

AF	:	acre feet
cfs	:	cubic feet per second
cm	:	centimeters
cu.m	:	cubic meters
cu.m/d	:	cubic meters per day
cm.d	:	" " " "
cmd	:	" " " "
cu.m/sec	:	cubic meters per second
cusec	:	cubic feet per second
ft	:	feet
gal (gal)	:	imperial gallons
gcd, GCD	:	imperial gallons capita per day
ha	:	hectares
hr.	:	hours
kg	:	kilogrammes
km	:	kilometers
lit.	:	liters (litres)
lcd, LCD	:	liters capita per day
m	:	meters (metres)
MCM	:	million cubic meters
mg/d	:	million gallons per day
MGD	:	million gallons per day
min	:	minutes
MLD	:	million liters per day
mm	:	milimeters
ppm	:	parts per millions
Re.	:	rupee
Rs.	:	rupees
sec.	:	seconds
sq.	:	square
sq.m	:	square meters
sq.km	:	square kilometers
yd	:	yards

3. Others

CA	:	Cultivable Area
CCA	:	Cultivable Command Area
DA	:	Drainage Area
EL	:	Elevation
EIRR	:	Economic Internal Rate of Return
FIRR	:	Financial Internal Rate of Return
GNP	:	Gross National Product
GDP	:	Gross Domestic Product
O/M	:	Operation and Maintenance
P.C.I.	:	Planning Commision I Pro Forma
ADP	:	Annual Development Programme
AMSL	:	Above Mean Sea Level
HRLBCA	:	Haro River Left Bank Command Area
SRRBSA	:	Soan River Right Bank Suburban Area

CURRENCY AND CONVERSION FACTORS

Length

1 inch	= 25.40 mm	1 mm	= 0.03937 inches
1 foot = 12 inches	= 0.3048 m	1 m	= 3.281 feet
1 yard = 3 feet	= 0.9144 m	1 m	= 1.094 yards
1 statute mile	= 1.609 km	1 km	= 0.6214 miles

Area

1 in^2	= 6.452 cm^2	1 cm^2	= 0.1550 in^2
1 ft^2	= 0.09290 m^2	1 m^2	= 10.76 ft^2
1 yd^2	= 0.8361 m^2		= 1.196 yd^2
1 acre	= 0.4047 ha	1 ha	= 2.471 acres
1 sq.stat.mile	= 2.59 km^2	1 km^2	= 0.386 sq.stat.mile

Volume

1 in^3	= 16.39 cm^3	1 cm^3	= 0.06102 in^3
1 ft^3	= 0.02832 m^3	1 m^3	= 35.32 ft^3
	= 28.32 litre	1 litre	= 0.03532 ft^3
1 gallon (imp)	= 4.546 litre		= 0.2200 gallon(imp)
1 acre-ft	= 0.12335 ha-m	1 ha-m	= 8.107 acre-ft
	= 1,233.5 m^3		
	= 0.0012335 MCM	1 MCM	= 810.7 acre-ft

Weight

1 lb = 16 oz	= 0.4536 kg	1 kg	= 2.205 lb
1 cwt = 112 lb	= 50.80 kg		= 0.01969 cwt
1 long ton (2240 lb)	= 1.016 metric ton		= 0.0009843 long ton
1 cotton bale	= 178 kg		= 0.00562 cotton bale

1 maund/acre	= 92.39 kg/ha	1 kg/ha	= 0.01082 maund/acre

Capacity and velocity

1 cusec	= 0.02832	cu.m/sec	1 cu.m/sec	= 35.31	cusec
1 MGD	= 4.546	MLD	1 MLD	= 0.220	MGD
1 Knot	= 1.85	km/hr	1 m/sec	= 3.281	ft/sec
1 foot/sec	= 0.3048	m/sec		= 196.9	ft/min
1 foot/min	= 0.508	cm/sec	1 km/hr	= 0.541	Knot
1 mile/min	= 1.609	km/min		= 0.6214	mile/hr

Temperature

°F = 1.8°C x 32 °C = (°F - 32) x 5/9

Pressure

1 atmosphers	= 76.0	cm.Hg	1 inch H20	= 2.49	mbar
1 bar	= 1.013	atm	1 mbar	= 0.750	mm Hg
1 inch Hg	= 0.0334	atm	1 lb/in^2	= 51.7	mm Hg

Exchange Rate

1.0 $US = Rs.17.0 = ¥153.0

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

1.1. Authorization and Report

This Report has been prepared in accordance with the implementing arrangement for a regional study on water resources development potential in the metropolitan area of Islamabad-Rawalpindi agreed upon between the Government of Islamic Republic of Pakistan and the Government of Japan dated August 25, 1986.

This report consists of Executive Summary, Main Report and Appendix and was compiled based on the field survey, analysis and review of collected data/informations, careful studies in Pakistan and Japan including a series of discussion meetings between governmental officials and the study team, and the interim report which was submitted to the Government of Pakistan on July 1987.

1.2. Background of Regional Study

The metropolitan area (the twin cities of Islamabad and Rawalpindi) is situated at the north-eastern corner in the north of Punjab Province. The capital of the country was transferred from Karachi to Islamabad in 1958 in accordance with the Federal Government's policy.

The present population of Islamabad and Rawalpindi is about 0.28 and 0.95 million, respectively. It is forecasted that the ultimate population of the twin cities in the year 2030 will reach 1.0 million for Islamabad and 2.35 million for Rawalpindi.

Islamabad is securing water from Simly dam, which was completed in 1982, tubewells located in the National Park area and the Sectoral area, and natural streams flowing down into the Capital

Development Authority territory area. On the other hand, Rawalpindi is obtaining water from Rawal Lake and tubewells located mainly in its service area. The Khanpur project is scheduled to complete in the late 1980's and supply water of about 100 MGD (455 MLD) on average to both cities of Islamabad and Rawalpindi. It has been forecasted that the water demand in the metropolitan urban area in the year 2000 would be satisfied with the existing water supply systems, water conduction of the Khanpur project and some new water supply facilities scheduled to be developed by the said year, while the target year of the capital development project has been set for the year 2030. At present, there is no definitive master plan for urban water supply beyond the year 2000 in the metropolitan area. Therefore, the master plan beyond year 2000, regarding effective utilization of water resources and water demand projection for the urban, industrial, irrigation and for the new international airport shall be timely prepared.

Under the circumstances, the Government of Pakistan has decided that a regional study on the water resources development potential for the metropolitan area and its vicinity irrigable area be undertaken early in order to formulate an adequate water supply schedule.

In response to the request of the Government of Pakistan, the Government of Japan dispatched a preliminary survey team headed by Mr. Shiro ICHIHARA to Pakistan from February 10th to 22nd, 1986, through the Japan International Cooperation Agency (hereinafter referred to as JICA), and carried out the preliminary survey on the project in close cooperation with the Pakistani authorities concerned.

As a result of the preliminary survey, the Government of Japan decided to undertake the Master Plan Study on the Project in accordance with the Laws and Regulations in force in Japan.

The JICA, an official agency responsible for implementation of technical cooperation programmes of the Government of Japan, will carry out the Study in close cooperation with the authorities of Pakistan. Furthermore, the JICA will conduct training and technology transfer to the counterpart personnel appointed by the Government of Pakistan in the course of the study.

1.3. Study Area and Scope of the Study

The study area of the Master Plan includes two categories: water supply beneficial area and water resources development potential area. The former covers the Islamabad and Rawalpindi urban area in the metropolitan, irrigation areas on the Left Bank of Haro river of about 16,000 ha and the close vicinity of the metropolitan area with about 1,000 ha (excluding area commanded by the Master Plan Study for the Integrated Rural Development Project) and the proposed international airport area.

The latter covers the vicinity of the metropolitan area as the area for water resources development potential evaluation including the water supply beneficial area as mentioned above.

The scope of the study is stipulated in the Scope of Work which has been agreed upon by both Governments and its summary is as follows:

1) To collect and review the relevant existing maps, data, information and reports related to the water resources development plan and water supply project of urban area and irrigation purpose.

2) To conduct a field survey in topography, foundation geology, hydrogeology, water quality, land use, soil condition and cropping pattern of the irrigable area.

3) To study the urban water demand projected by the year 2010 up to the year 2030, the water demand for the new international airport and the irrigation water requirement.

4) To evaluate water resources development potential such as surface runoff water from rivers/streams and groundwater.

5) To conduct an analysis of the water balance between water supply and demand and to recommend the optimum development scale of respective water resources.

6) To prepare a layout plan and preliminary plans for the selected water resource facilities such as storage dams, diversion dams, conduction canals, pumping stations and related structures necessary by the year 2010 and 2030.

7) To study and establish a comprehensive water resources development plan on the basis of evaluation of the water balance analysis and socio-economic conditions of the project area.

8) To recommend high priority projects and to prepare implementation programmes of the priority projects including the preliminary cost estimate required for the project implementation and financial proposal.

9) To prepare recommendation on the optimum operation and maintenance methodology of the developed water resource facilities including watershed management and installation of telemeter systems.

1.4. Establishment of the Committees

Since the study will range over a fairly large area, it will be closely related to water supply beneficiaries, its implementation agencies and the government authorities concerned with the water resources development project, such as the federal government, provincial government, governmental factories, corporation agencies and the city water supply authority.

The Coordination Committee and the Technical Working Committee, therefore, are essential for the study team to coordinate these interwoven relations and encourage to carry out the study smoothly. The member lists of the respective committees are as follows;

A. Coordination Committee

1. Chairman
   Mr. Abdul Hameed
   Additional Secretary
   Cabinet Division
   Government of Pakistan

2. Member
   Mr. A.R. Javaid
   Deputy Director General (Services)
   Capital Development Authority
   Government of Pakistan

3. Member
   Mr. Aijaz Akhtar
   Chief (PP&H)
   Planning and Development Division
   Government of Pakistan

4. Member
   Mr. S. Navid Ali Nasri
   Joint Secretary
   Ministry of Water and Power
   Government of Pakistan

5. Member
   Mr. Ataullah Khan
   Project Director
   Khanpur Dam Project
   WAPDA, Government of Pakistan

6. Member
Mr. Khawaja Zaheer Ahmad
Deputy Commissioner
Islamabad Capital Territory Administration
(ICTA)

7. Member
Mr. Mohammad Faheem
Deputy Secretary (Consortium)
Economic Affairs Division (EAD)
Government of Pakistan

8. Member,
Mr. Mohammad Akram (Brig. Rtd.)
Project Director (North)
Civil Aviation Authority (CAA)
Government of Pakistan

9. Member,
Mr. Malik Mubarak Ahmed
Superintending Engineer, PHE Circle
Government of Punjab

10. Member
Mr. Mohammad Jalil Khan
Superintending Engineer
Central Irrigation Circle
Government of North West Frontier Province (NWFP)

11. Member
Mr. Fazle Amin
Senior Engineer
Cantonment Board
Ministry of Defence
Government of Pakistan

12. Member
Mr. Mohammad Pervez Masud
Commissioner
Rawalpindi Division

B. Technical Working Committee

1. Chairman
Mr. A.R. Javaid
Deputy Director General (Services)
Capital Development Authority
Government of Pakistan

2. Mr. Mustansar Khan
Deputy Chief
Planning and Development Division
Government of Pakistan

3. Mr. Junaid
Deputy Secretary
Ministry of Water & Power
Government of Pakistan

4. Mr. Malik Mubarak Ahmed
Superintending Engineer
Public Health Engineering Department (PHED)
Government of Punjab

5. Mr. Aftab Ahmed
Deputy Chief
Cabinet Division (CDA Wing)
Government of Pakistan

6. Mr. Mohammad Aslam
Director (W & S) Development
Capital Development Authority (CDA)
Government of Pakistan

7. Mr. A.Q. Nomani
Director (Water Supply)
Capital Development Authority (CDA)
Government of Pakistan

8. Mr. Fida Hussain
Water and Power Development Authority (WAPDA)
Government of Pakistan

9. Mr. Hafiz Ullah
Project Director,
Small Dams Organization (SDO)
Irrigation Department,
Government of Punjab

1.5. Assignment of the Advisory Committee and Study Team

A. Advisory Committee

Designation	Name	Official Position
Chairman (First Phase)	ICHIHARA Shiro	Director, Sea Coast Division River Bureau, Ministry of Construction
Chairman (Second Phase)	ISHIZAKI Katsuyoshi	Director, Disaster Preparedness Division River Bureau, Ministry of Construction
Water Resources Development	TSUNEMATSU Hiroshi	Expert Officer, Water Administration Division, Hokkaido Development Agency
River & Hydrology	IKENO Hidetsugu	Deputy Director, Sea Coast Division, River Bureau, Ministry of Construction
Water Use	MIYAZAKI Takeshi	Deputy Director, Irrigation Facilities Management Office, Ministry of Agriculture, Forestry and Fisheries

B. Study Team

Team Leader	KADOWAKI Satoshi	Sanyu Consultants
River, Watershed Management Engineer	TOHYAMA Murao	Yachiyo Engineering
Water Resources Development Planner	INABA Tadao	Sanyu Consultants
Hydrologist Hydraulic Engineer	MATSUBARA Yasuo	Sanyu Consultants
Geologist Hydrogeologist	SASAKI Yoosuke	Yachiyo Engineering
Urban Water Planner	MATSUYAMA Masaru	Sanyu Consultants

Irrigation Engineer	GOTO Eiji	Sanyu Consultants
Design Engineer (Dam)	HIRATSUKA Masahide	Yachiyo Engineering
Design Engineer (Canal)	KONISHI Sumio	Sanyu Consultants
Socio-Economist	ISHIBASHI Naomichi	Sanyu Consultants
Topo-Surveyor	AOYAGI Katsuyuki	Sanyu Consultants
Hydrogeologist	YAMAZAKI Akira	Sanyu Consultants

CHAPTER II. BACKGROUND OF THE REGIONAL STUDY AREA

CHAPTER II. BACKGROUND OF THE REGIONAL STUDY AREA

2.1. Location

This study concerns with water resource development in respond to future water demand in and around the capital district. The area which was the object of the study is centered around Islamabad and Rawalpindi and extends to the main Indus river and the Jhelum river.

The principle rivers of the study area, the Dor river, the Haro river and the upper reach of the Soan river are located in the table-land area and the alluvial plateau of northern Pakistan. The area is situated from latitude 33° - 25' to 34° - 15'N and from longitude 72° - 30' to 73° - 30' E and covers approximately 6,800 km^2.

2.2. Topography and Geology

2.2.1. Topography

The study area can be divided into two geomorphological units. One is the eastern mountainous area consisting of the Margala Hills, Murree Mountains and Hazara Mountains. The other is the western plain area named "Potwar Plateau".

In the mountainous area, steep mountain ranges (highest summit approx. 9,000 ft.) run in the SW-NE direction. The river system shows a dendritic pattern elongating in the same direction.

Potwar Plateau's particular composition is of low lying hills tending to be in the WSW-ENE direction and the surrounding alluvial plain. In the western part of Potwar Plateau severe soil erosion is taking place, and highly dissected plain with deep gullies showing

the features of the so-called "bad land topography" is spreading over a wide area.

2.2.2. Geology

A. Stratigraphy and Lithology

The particular arrangement which the layers in the study area show is that they get older from South to North and can be divided into four geological units, as shown in Figure II-2-1.

a. Precambrian to Paleozoic Rocks

Precambrian to Paleozoic rocks are exposed in the northern part of the study area and consist of slate, sandstone and conglomerate with intercalations of limestone. They are relatively hard and compact. The main part of the Dor river basin is composed of these layers.

b. Mesozoic Rocks and the Eocene to Paleocene Series

Mesozoic rocks and Eocene to Paleocene series are exposed in the central part of the study area. They are mainly composed of limestone and occasionally of intercalate sandstone and shale layers.

The limestone is, in general, black, hard and compact. However, it is highly corroded along the bedding planes and cracks and many cavities have been formed. The intercalated shale is highly sheared and shows fault-like features. The main part of the Haro river basin consists of these layers.

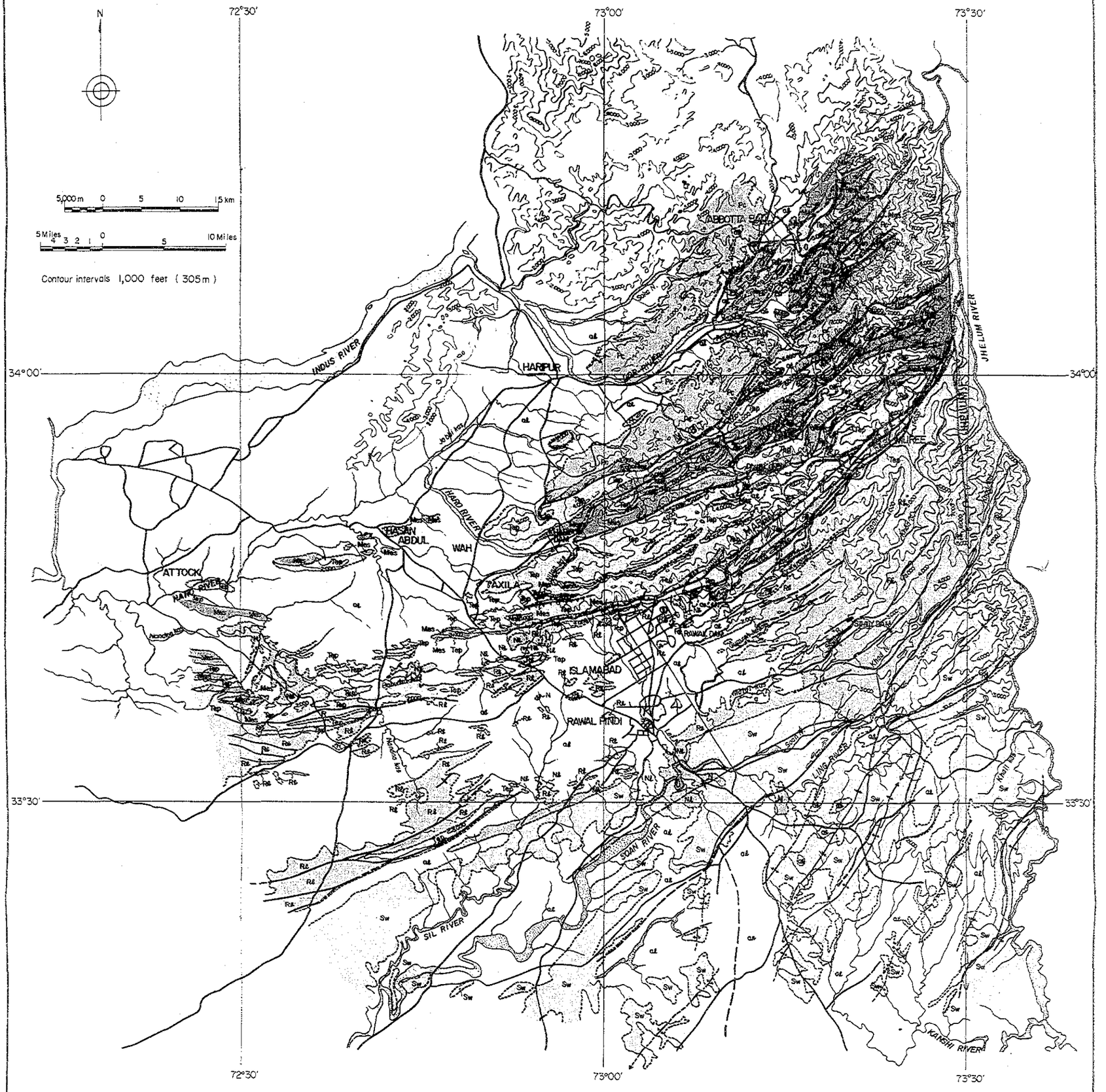


Figure II-2-1. Geological Map of the Study Area

c. Miocene to Pliocene Series

Exposures of Miocene to Pliocene series have been recognized in the southern part of the study area. The lithology of the Miocene to Pliocene series is an alternation of sandstone and shale. They are generally weak, highly weathered and not able to endure erosion well. Among them, the shale is highly sheared and has turned into very weak red clay.

The Soan river basin is composed of these layers.

d. Quaternary System

There is a Quaternary system widely distributed on the Potwar Plateau. It is composed of silt, sand, gravel and boulders. The maximum depth of the quaternary system is thought to be over 300 m. The main aquifers in the study area are interlayered in this deposit.

Because materials become coarser toward the mountains, high yield aquifers are distributed along the foot of the mountains.

B. Geological Structure

Because of the Himalayan uplift during the Pliocene epoch the bedrocks in the study area are highly folded, faulted and over-thrusted. Among the many deformational units, special attention should be paid to the three main faults which are Main Boundary Trust (MBT), Jhelum Fault, and Margala Fault when designing facilities. They have considerably wide fractured zones accompanied with many derivative faults. Moreover, some epicenters of earthquakes have concentrated along certain parts of these faults.

2.3. Climate

Winters are cold and summers are warm in the study area and it belongs to a comparatively warm, high precipitation climatic zone. However, the study area moves from the 450 m elevation alluvial plain located in the southwest to the 2,700 m elevation Murree hill area located in the northeast. There is a great difference in climatic conditions depending on the place. The capital area is located at the southern foot of the Murree and Margala hill areas. Its climatic conditions are average for the study area.

There are rainy seasons in both summer and winter. Mean annual precipitation ranges from 700 mm in the alluvial plain to 1,750 mm in the Murree hill region. However, there are great yearly fluctuations in the precipitation and it is therefore unstable. Moreover, 60 percent of the annual precipitation is concentrated in the monsoon season from July to September so there is polarization within the year itself. The yearly precipitation for the capital district is around 1,100 mm.

The annual mean temperature for the capital district is 21.5°C. It is 12.5°C for Murree in the hill region so there is a 9°C difference. The monthly mean temperature is highest in June, 31.6°C at the capital, 20.7°C at Murree, giving a difference more than 10°C. Because of this, Murree is used as a summer resort. On the other hand, the lowest mean temperature is for January, 10.0°C at the capital, 3.0°C at Murree. Coupled with snowfall, Murree's winters are fairly severe. However, no snowfall is recorded at the capital and it is mild climate in winters.

2.4. Watershed and Land Use

2.4.1. Watershed

The study area is approximately 6,800 km^2 and total catchment area of the Dor, Haro and Soan river basins occupies around 80 percent of the study area. The catchment areas of each of the three rivers in the study area are as shown below.

River Name	Catchment Area Region Studied (km^2)
Dor River	600
Haro River	2,500
Soan River	2,400
Others (Indus/Jhelum)	1,300
Total	6,800

There are steep mountains in the upper reaches of the Dor and Haro rivers and little level land. Valleys have been formed and accumulations on the riverbeds are mainly coarser materials such as pebbles and gravel. The lower reaches are made up of comparatively gentle sloping mountains and alluvial plateaus edroded by the rivers as they flowed. Riverbed accumulations are finer in comparison to the upper reaches. Sand and silt are the most prevalent. There are steep mountains in part of the upper reaches of the Soan River, but level alluvial plateaus have been formed in places. These are eroded by the river as it flows. In the lower reaches alluvial plateaus are distributed widely and the river meanders along them. Erosion has been intense on the plateaus and approximately 30 percent is waste land. This forms the source for the supply of sediment to the lower reaches.

2.4.2. Geology and Vegetation

The geology of the Dor and Haro River catchment areas is mainly composed of limestone layers. For the Soan river catchment area it is composed of alternation of Tertiary sandstone and shale. These basement layers are broadly overlain with Quaternary deposits comprising silt, clay and gravel layers to form the Potwar Plateau.

Because the upper reaches of the three rivers are mountainous or near mountainous, they are covered with very little forest or shrub areas. The plateaus in the lower reaches are extensive and comprised of a small number of cultivable areas for barani and areas rendered uncultivable by erosion.

The ratio of the Dor river catchment area to area of the mountains is approximately 50 percent. This is higher than that of the other areas. In its upper reaches there is about 34.4 km^2 of Reserved Forest. The ratio of the catchment area of the Haro river to the area of the mountains in approximately 20 percent. The surface is exposed by encroachments into the forest areas of grazing land development. Sediment is washed away by the monsoons and this results in an increase of hill torrents and eroded area. The ratio of the Soan river catchment area to the area of the mountain is approximately 15 percent. In the Simly basin there is about 41.5 km^2 of Reserved Forest. There are problems in the land use, including forest and grazing areas and land erosion is accelerating.

2.4.3. Land Use

Land is used in the three catchment areas as shown in the table below.

Classification	Dor River		Haro River		Soan River	
	M. Acres	%	M. Acres	%	M. Acres	%
Irrigated	0.005	3.6	0.027	3.5	0.025	0.9
Barani	0.007	4.5	0.111	14.5	0.122	4.4
Non Irrigable	0.041	27.4	0.206	27.0	1.281	46.2
Hills/Mountains	0.088	50.0	0.153	20.0	0.410	14.8
Waste	0.009	14.5	0.268	35.0	0.936	33.7
Total	0.150	100%	0.765	100%	2.774	100%

Each of the catchment areas may be roughly divided into the mountainous region in the northeast and a plateau spreading over the southwest. The climatic and topographical characteristics of each region effect changes in patterns of land use. The Haro catchment area has the highest proportion of agricultural area, the Soan catchment area is the lowest. The Dor catchment area has the highest proportion of mountains with mountains accounting for half of its total catchment area, the Soan catchment area has the lowest. The Haro and Soan catchment areas are highest in waste land, the Dor area is lowest. There is a close connection between the erodibility of land and land use conditions. Water and land conservation is an important task in each of the catchment areas.

2.4.4. Watershed Management

Mountainous areas account for about 20 percent of the catchment areas of the three rivers (Dor R., Haro R., Soan R.). Soil cover is exposed due to the exploitation of forests and grazing fields and is washed away during the monsoons, forming deep ravines. This has created a movement to prevent soil erosion and increase the life of the reservoirs.

There is no special program for the Dor river except for the afforestation with the management of the nurseries by chokidars. On the Siran river situated to the north of the Dor river catchment area the Soka Nalla watershed management program has been put in effect.

The Haro River watershed management project has two purposes, to reduce siltation in the Khanpur dam, and to improve the socio-economic conditions of the catchment area inhabitants.

Watershed management projects for Simly dam and Rawal dam on the Soan river were planned for the reduction of silting in the reservoir. The watershed management scheme in the Potwar Plateau is to reduce siltation in the Kalabagh dam.

Watershed management projects have been implemented for Tarbela dam on the Indus river and Mangla dam on the Jhelum river. The prime objectives of these watershed management projects are to reduce siltation in the dam reservoirs and to improve socio-economic conditions in the catchment area.

An outline of the watershed management programs is put together as follows.

Name of Project	Watershed	Authorities for Execution	Period	Area under Revised Scheme (km^2)
Khanpur Dam	Haro	NWFP, Forest Dept.	1986-1991	702
Simly Dam Phase II	Soan	Horticulture Div. CDA	1983-1988	153
Rawal Dam Phase-I	Kurang	Punjab SDO	1986-1988	275
Potwar Area	Soan	Punjab Forest Dept.	1983-1986	4,360
Mangla Dam	Jhelum	NWFP Forest Dept.	1983-1987	9,170

2.5. Rivers

As shown in Figure II-5-1, the Indus and Jhelum rivers flow in the northern and eastern sections of the study area. Within the study area, the Dor river, Haro river, and Soan river have their sources in the Murree hills. They flow from east to west and pour into the Indus river.

Water resources have been developed by storage dams on all but the Dor river. Such gigantic dams as the Tarbela dam on the Indus river and the Mangla dam on the Jhelum river have been constructed. The Khanpur dam on the Haro river, the Simly dam on the Soan river and the Rawal dam on the Kurang river (a tributary of the Soan river) have also been constructed. The capital is located on the middle reach of the Soan river. Its main water sources are Simly dam and Rawal dam. At present there are plans to bring water from Khanpur dam to the capital and its water resources have been assured up to the year 2000.

As in Figure II-5-2, the runoff of the rivers reaches its peak in the monsoon period. The runoff of large rivers such as the Indus and the Jhelum is mainly snowmelt. The runoff of the rivers in the study area is mainly rainfall. Because of this the runoff pattern of the rivers within the study area has two wet seasons, one peaking in March and one peaking in August. However, the amount of runoff in March is less than half of that in August.

The total annual runoff for surface flow over the entire 6,800 km^2 of the study area is estimated at around 2,000 MCM. This amount is only 3 percent and 8 percent of the annual runoff of the Indus and Jhelum rivers respectively.

In the wet periods the sediment concentration in the rivers is 10,000 to 60,000 ppm higher in proportion to the amount of runoff. The rivers transport a great quantity of sediment.

High floods occur in monsoon and sometimes in winter. However, flood water is confined in the river channels, because the river channels remain under natural condition and have enough capacities to pass floods. Accordingly, there is no particular flood control or protection project except for the Lei Nala which causes high flood frequently in the city area of Rawalpindi.

Although water right is not clearly established in the area, "Canal and Drainage Act" stipulates water rights of the water resources development projects implemented by the Federal and the Provincial Governments in Punjab Province. This Act was established in 1873 and has been revised from time to time. Such water rights as customary water usages are registered in the Tehsil offices. Table II-5-1 shows the summary of water rights and customary water usages in the study area.

Table II-5-1. Water Rights and Customary Water Usages

River	Facility/User	Purpose/General Descriptions	Tehsil
Dor	Farmers	Irrigation of 225 ha developed privately.	Abbottabad
	Farmers	Irrigation of 3,600 ha development some by N.W.F. Province and some privately.	Haripur
Haro	Farmers	Irrigation, however, unauthorized since the area treated by Khanpur Project.	Haripur
	Khanpur dam	Urban & Irrigation (details in Table III-2-1)	
	Sanjwal cantt.	Urban water (population 6,200 in '81)	Attock
Nandna	3 small dams	Irrigation and some village water (Sipiala, Bango, Shahpur: details in Table III-2-1)	Fatehjang
Jhablat	Many pumps	Urban, Industry and Irrigation (details in Table D-4-3 of Appendix D)	
Soan	Simly dam	Urban water (details in Table III-2-1)	Islamabad
	2 small dams	Irrigation (Misriot, Khasala: ")	Rawalpindi
Kurang	Rawal dam	Urban water and some irrigation (details in Table III-2-1)	Rawalpindi Islamabad
	7 Headworks	Urban water (details in Table III-2-2)	Islamabad

Other than above water usages, numerous persian wells are provided and worked for irrigation and drinking purposes along the river channels. However, these wells are not categorized in water right.

Figure II-5-1.

General View of River System

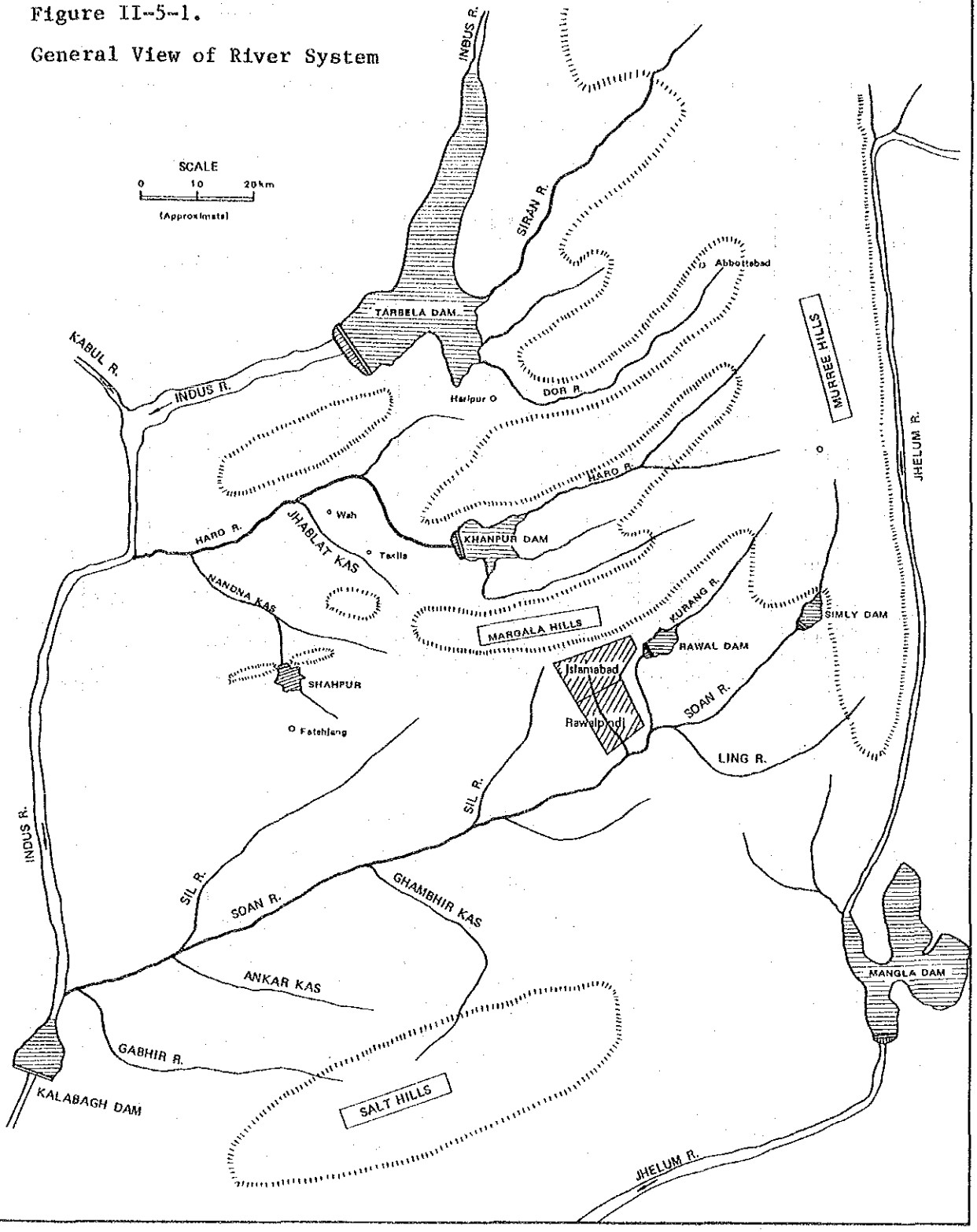
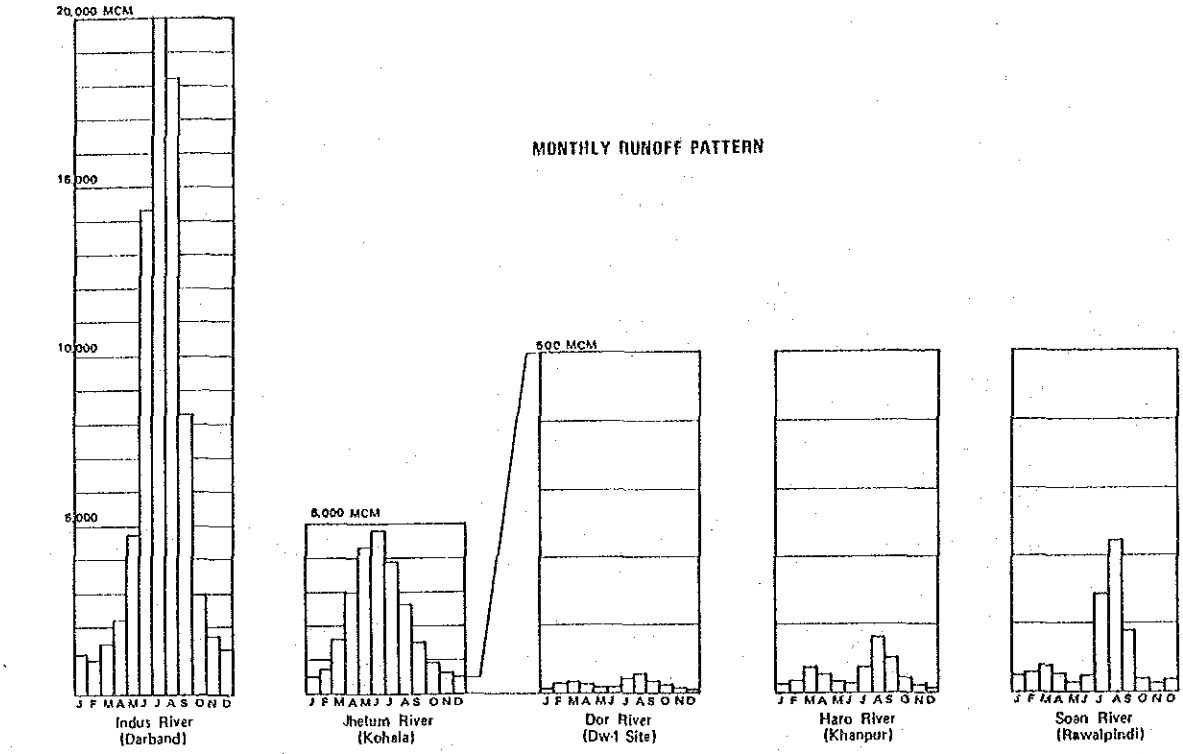
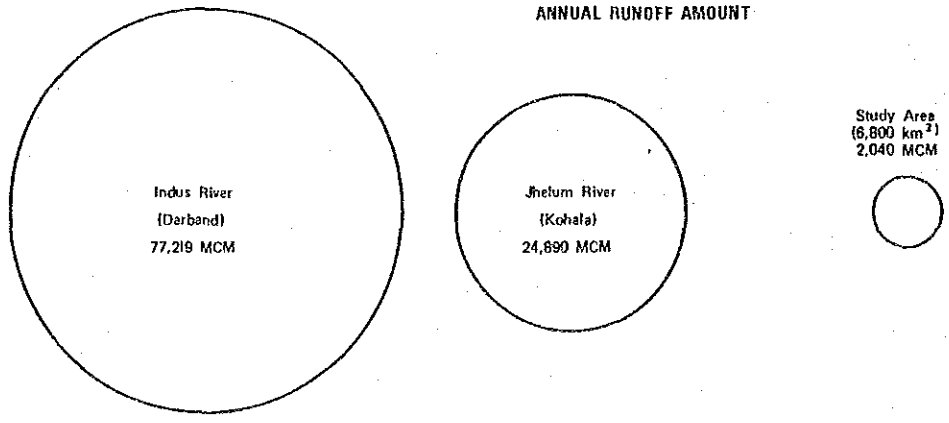


Figure II-5-2. Comparison of Runoff Pattern and Amount in Major Rivers





2.6. Water Quality

Quality of river water is greatly affected with geology of the basin. Water of rivers in the study area contains much suspended sediment in wet season, and water pollution progresses in some rivers in the alluvial plain at downstream area.

Pollution reaches very high level in the Lei Nala due to sewerage from the Metropolitan area. Pollution progresses also in the Jhablat Kas and the Sohan Nala which are tributaries of the Haro river and the Kurang river, respectively. In these rivers, therefore, it is required to provide the sewerage treatment facilities capable of reducing pollution to tolerable level in early date.

High sediment content causes not only sedimentation in the reservoir but also heavy load in operation of sedimentation tanks and filtration tanks. Therefore, for watershed management reducing the sediment production in the basin is now important subject.

Characteristics and problems of water quality are summarized as follows;

i) pH value ranges from 7.68 to 8.56, being slightly alkaline.

ii) Hardness is generally high, ranging from 122 ppm to 600 ppm (equivalent to $CaCO_3$ content) and classified into "hard" to "very hard",

iii) Sulphate ion (SO_4) content is high in the tributaries in the alluvial plain, being considered due to pollution.

iv) Cholorine (cl) content is low (12 - 42 ppm), being harmless in water use. However, cholorine content is slightly high (80 ppm) in the Lei Nala.

v) Calcium (Ca) and magnesium (Mg) contents exceed permissible level of WHO (Ca: 200 ppm, Mg: 150 ppm) in the Dor and the Haro river basins. Some chemical treatment will be necessary.

vi) Chemical oxygen demand (COD) is an expedient index to sound the pollution level of river water. Although WHO has not specified the permissible level, the value of 10 ppm is maximum permissible level in the Japanese Standard for water supply. The value of COD ranges from 1.5 ppm to 7.5 ppm within 10 ppm. However, COD reaches the high level as 7.5 ppm in the Dhamrah Kas draining the sewerage of Wah and Taxila industrial zones.

vii) Ammonia nitrogen (NH_4-N) content is remarkably high in the Lei Nala which is severely polluted. Although NH_4-N value of Dhamrah Kas was not measured in this study, the value is considered to be high due to high value of COD in this river. In the rivers other than above rivers, the content of NH_4-N is within low level.

viii) Suspended sediment concentration is 10,000 to 60,000 ppm higher in proportion to the amount of runoff in wet season.

2.7. Socio-Economic Conditions

The Project Region incorporates administratively two distinctly different units, i.e. Islamabad District which is under direct jurisdiction of the Federal Government and Rawalpindi Division which is under jurisdiction of the Provincial Government of the Punjab. The term of the Project Region used here signifies an administrative region encompassing urban water service and irrigation areas under the Project. Rawalpindi Division consists of four Districts, of which Rawalpindi District and Attock District belong to the Project Region. Seventy one percent of Islamabad urban sector and the entire urban sector along with a fraction of rural sector in Rawalpindi District fall under the urban water service area of the Project. The irrigation water service areas lie in both Attock and Rawalpindi District.

2.7.1. Population

According to Population Census 1981 population of the Region was 3,605,795 as of March 15, 1981, occupying 7.6 percent and 4.3 percent of Provincial and national population, respectively. District-wise population and urban/rural distribution are summarized in Table II-7-1.

Table II-7-1. District-Wise Population of Project Region, 1981

Item	Total	District-wise			Urban and Rural	
		Islamabad	Rawalpindi	Attock	Urban	Rural
Population	3,605,795	340,286	2,121,450	1,144,059	1,371,505	2,234,290
Share	100%	9.4%	58.9%	31.7%	38.0%	62.0%
Annual Growth Rate	2.3%	4.3%	2.3%	1.8%	4.3%	1.3%

Source: EC-6

The population in the Region grew at the average annual rate of 2.3 percent during 1972 to 1981 Census period, while Provincial and national population increased on the average at the annual rates of 2.8 percent and 3.1 percent, respectively during the same period. It is estimated based on the above growth rates that the three categories of population have now reached more than 4 million, 55 million and 100 million, respectively in the above order.

The urban population of the Region grew at the average annual rate of 4.3 percent during the inter-Census period, which contrasts with the annual growth rate of 1.3 percent recorded for the rural population of the Region. The urban population of Pakistan grew in the same period at an average annual rate of 4.4 percent, while the rural population of the country rose at the slower pace of 2.6 percent.

The population of the urban water service area under the Project was 1,010,675 at the time of 1981 population census accounting for 73.7 percent of the urban population of the Region. It grew from 1972 to 1981 at the average annual rate of 2.9 percent and is estimated to have grown from 1981 to 1987 at the annual rate of 4.5 percent to 1,320,000.

The estimated number of households in the Region in 1981 was 636,063, occupying 8.2 percent and 4.9 of Provincial and national figures, respectively.

2.7.2. Social Aspects

According to Housing Census 1980, 25.4 percent of the households in the Region were served with piped water, which is considerably higher than the Provincial and national levels of 14.0 percent and 20.3 percent. Diffusion rate of piped water in the urban sector of the Region was 62.1 percent, which sharply contrasts with 5.0 percent in the rural sector.

Forty point seven percent of the Regional households were served with electricity, which is by ten percent higher than the Provincial and national levels of 29.1 percent and 30.6 percent. Electrified urban households reached as high as 77.6 percent in the Region, while the percentage of electrification in rural households stood at 20.2 percent.

Percentage of the households using gas was 16.1 percent, whereas in the Province and Pakistan it was 4.7 and 6.5 percent, respectively. In urban sector it came to 42.8 percent, and in the rural sector it was confined to 1.2 percent.

It can be noticed from the above that fundamental amenity of home life in the Region is at a higher level than in other regions and that particularly in the urban sector it is at an advanced stage.

Table II-7-2. Diffusion of Social Infrastructure in Project Region

(unit: percent)

Item	Total	Urban	Rural	Province	Pakistan	Year
1. Diffusion Ratio of Piped Water	25.4	62.1	5.0	14.0	20.3	1980
2. Diffusion Ratio of Electricity	40.7	77.6	20.2	29.1	30.6	1980
3. Ratio of Households Using Gas	16.1	42.8	1.2	4.7	6.5	1980
4. Ratio of Enrolment at Primary Stage	67.5	-	-	47.7	40.6	1981
5. Ratio of Enrolment at Secondary Stage	66.6	-	-	20.2	17.7	1981
6. Literacy Ratio	39.6	56.0	29.4	27.4	26.2	1981
7. No. of Beds per 10,000 Persons	85	-	-	47	57	1981
8. National Road km per 10,000 Persons	61	-	-	30	50	1981
9. No. of Motor Vehicles on Road per 10,000 Persons	172	-	-	58	56	1981

Sources: EC-6, 7, 8, 9

The ratio of enrolment at the primary stage was 67.5 percent in 1981, which is by 20 percent to 30 percent ahead of the Provincial and national averages. Similarly, the ratio of enrolment at the secondary stage was 66.6 percent, by 40 percent to 50 percent ahead of the Provincial and national averages.

Again, the literacy ratio of 39.6 percent in the Region was by more than ten points higher than the Provincial and national levels. Especially in the urban sector the ratio stood at 56.0 percent, which is more than double the Provincial and national levels.

The number of beds in the medical institutions was in 1981, 85 per 100,000 people, that is 30 to 40 more than in the Province and Pakistan. Likewise, the length of roads maintained by Highway Department was 61 km per 100,000 people, which is by 10 km to 30 km greater than in the Province and Pakistan. Also, the number of motor vehicles on road was 172 per 10,000 people, which is about triple the Provincial and national averages.

These things would indicate that the Region is on average more advanced and advantaged than elsewhere in the country in educational, medical and transport infrastructure.

2.7.3. Economic Aspects

The gross domestic product (GDP) of the Region 1981 is estimated at Rs.11,241 million, which constitutes 7.2 percent of the Provincial GDP or 4.5 percent of the national GDP. Out of it, the urban sector accounted for 48.3 percent.

Structurally, the "social and personal services" and "agriculture, forestry, hunting and fishing" groups occupied the first and second places with the respective shares of 29.4 percent and 16.7 percent followed by the "wholesale and retail trade" group

(15.2%) and the "manufacturing" group (12.0%). Shares of these four groups add up to 73.3 percent. Whereas at the national level the top two groups exchange their mutual places with 29.0 percent for the "agriculture" and 16.4 percent for the "services". This situation is explained by the peculiar composition of GDP in the Regional urban sector, where the "agriculture" accounted for only 1.6 percent and the "services" occupied as much as 36.5 percent. This structural characteristic of the sector derives from the fact that it is the seat of the national government.

Per capita GDP in the Region in 1981 is estimated at Rs.3,117, which is by six percent higher than the national average of Rs.2,939. Sector wise, per capita GDP in the Regional urban sector was Rs.3,961, which exceeds the national average by more than Rs.1,000 or 35 percent. In contrast, the living standard in the rural sector was Rs.2,600, falling short of the national level by 11.5 percent.

Table II-7-3. Industrial Structure and per Capita GDP in Project Region, 1981

(unit: percent)

Item	Total	Urban	Rural	Province	Pakistan
1. Industrial Structure					
1) "Social & Personal Services" Group	29.4	36.5	22.6	10.7	16.4
2) "Agriculture, Forestry, Hunting & Fishing" Group	16.7	1.6	30.8	26.7	29.0
3) "Wholesale & Retail Trade" Group	15.2	18.4	12.2	18.5	16.4
4) "Manufacturing" Group	12.0	13.3	10.8	24.3	16.5
5) Other Groups	26.7	30.2	23.6	19.8	21.7
6) Total	100.0	100.0	100.0	100.0	100.0
2. Per Capita GDP (Rs.)	3,117	3,961	2,600	3,281	2,939

Sources: EC-6, 8, 9, 10

The industrial structure of the country in 1985-86, was 24.9 percent for the primary industry, 24.6 percent for the secondary industry and 50.5 percent for the tertiary industry. The structure has consistently changed in such a way that the secondary industry has gained ground in a parallel degree that the primary industry has lost ground.

The national economy has grown over the 10 years 1975-76 to 1985-86 at the average annual rate of 6.8 percent (GNP) or 6.5 percent (GDP). In the meantime population has increased at the annual rate of 3.1 percent. It follows from the above that the annual growth rates of per capita GNP and GDP were 3.6 percent and 3.3 percent, respectively.

Over the same period GDP deflator and consumer prices have grown at the annual rates of 8.0 percent and 8.5 percent.

As of 1985-86 GNP and GDP stand at Rs.570,719 million and Rs.527,792 million, respectively, and with the population estimated at 97.67 million per capita GNP and GDP are calculated at Rs.5,843 (= $365) and Rs.5,404 (= $338).

CHAPTER III. PRESENT CONDITIONS

CHAPTER III. PRESENT CONDITIONS

3.1. Present Water Supply

3.1.1. Urban Water Supply

A. Organizations for Urban Water Supply

In Islamabad Proper Area the CDA is responsible for both operation and maintenance of facilities for water production, distribution and supply and water resources development.

In Rawalpindi urban area the PHED is in charge of water resources development for water supply, direct water supply to the governmental research organizations such as the National Health Institute, Public Work Department and Health Colony, etc., located in the south of Rawal Lake, and water supply to the RMC and RCB.

In Rawalpindi urban area production wells are constructed by PHED, and transferred to the RMC which is responsible for operation and maintenance of water supply systems inclusive of these wells to the urban area under its jurisdiction.

On the other hand, the MES and RCB are responsible for operation and maintenance of water supply facilities to the cantonment areas under their jurisdiction. The RMC, MES and CB rarely construct their own production wells to supply water to their own service areas.

B. Water Supply

a. Islamabad

The urban water supply system of Islamabad has nine water sources at present. The CDA has been making a great effort to secure sufficient water to cope with the ever-increasing demand in Islamabad.

The average daily water supply and the rated capacity of water supply facilities in 1986 were 200,800 cu.m (44.2 million gallons) and 225,100 cu.m (49.6 million gallons), respectively, as shown in Table III-1-1. As clear in the table, all the headworks and production wells were fully operated in that year. All production facilities are plotted in Figure III-1-1.

Table III-1-1. Daily Water Production in 1986
(Islamabad Proper)

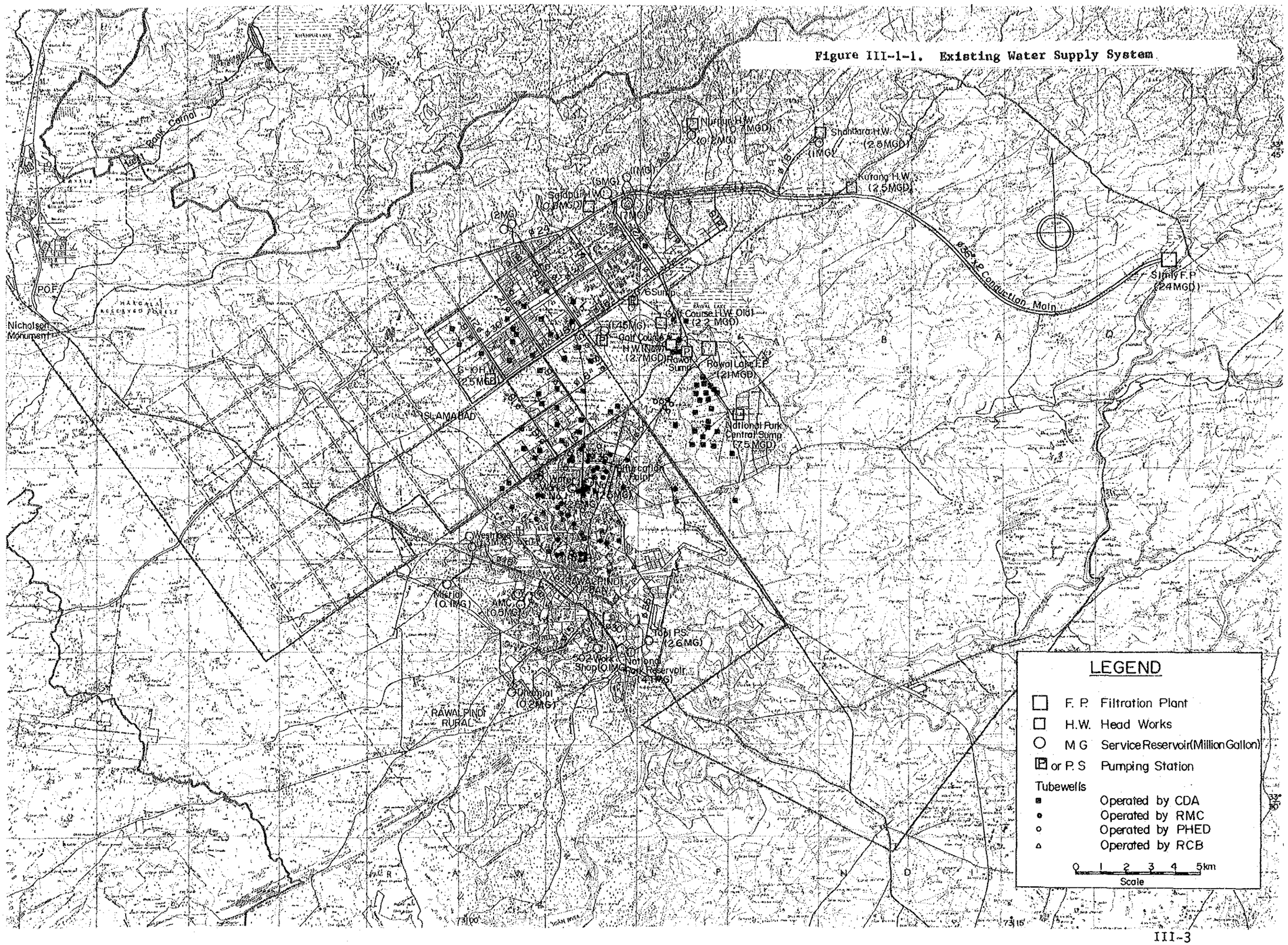
(unit: MLD (MGD))

Name of Source	Average Daily Production		Production Capacity	
Simly-Filtration Plant	95.0	(20.9)	109.1	(24.0)
Kurang H.W	-		11.3	(2.5)1/
Shahdara H.W	3.3	(0.7)	11.3	(2.5)
Nurpur H.W	3.2	(0.7)	3.2	(0.7)
Saidpur H.W	3.6	(0.8)	3.6	(0.8)
Golf Course H.W (New)	12.3	(2.7)	12.3	(2.7)
Golf Course H.W (Old)	10.0	(2.2)	10.0	(2.2)
G-10 H.W	9.1	(2.0)	11.3	(2.5)
Tube Wells in National Park Area	34.0	(7.5)	34.0	(7.5)
Tube Wells in Sectoral Area	30.3	(6.7)	30.3	(6.7)
Total	200.8	(44.2)	225.1	(49.6)

Source: CDA

Note : 1/... Not in operation since 1983 for the preparation of the future expansion.
H.W ... Head Works

Figure III-1-1. Existing Water Supply System



The average daily water consumption per capita in Islamabad is computed at 707 lit. (155 gallons) by dividing the above average daily water supply by the served population of 284,000. This high consumption is attributable to the high living standard, huge water consumption in the other categories (such as garden irrigation) than domestic use, and a great deal of leakage and wastage. Present urban water use in different categories is described in some detail in para. 4.1.3.

b. Rawalpindi Urban Area

The water supply system of Rawalpindi urban area has six major water sources at present. The average daily water supply and the rated capacity of facilities were 178,300 cu.m (39.2 million gallons) and 192,200 cu.m (45.2 million gallons), respectively, in 1986. The operation of production wells is limited to 8 to 16 hours in the summer so as to wait for the recovery of groundwater level. All production facilities are plotted in Figure III-1-1.

Table III-1-2. Daily Water Production in 1986
(Rawalpindi Urban)

(unit: MLD (MGD))

Name of Source	Average Daily Production		Production Capacity	
Rawal Lake Filtration Plant	81.7	(18.0)	95.6	(21.0)
Sohan Camp Tube Wells	11.3	(2.5)	11.3	(2.5)
PHED Tube Wells	17.8	(3.9)	17.8	(3.9)
RMC Tube Wells	47.1	(10.4)	47.1	(10.4)
CB Tube Wells	19.3	(4.2)	19.3	(4.2)
MES (Army) Tube Wells	1.1	(0.2)	1.1	(0.2)
Total	178.3	(39.2)	192.2	(42.2)

Source: PHED, RMC and MES

In Rawalpindi urban area the average daily water supply per capita in that year is computed at 263 lit (58 gallons) by dividing the above average daily water by the served population of 678,000. The present water use by categories is shown in para. 4.1.3.

3.1.2. Irrigation Water Requirement

A. General

The proposed irrigable areas are located in the Potwar plateau in the northern Punjab, which have a characteristic of Barani (rainfed) agriculture. Cropping intensity and yield in the area are fairly lower than the national averages due to the fact that farming is dependent upon physical factors of climate and soil.

Furthermore, such social infrastructure as road, electricity, communication, health and educational institutions are so poorly arranged that the living conditions of farmers are extremely backward.

At present the Agency for Barani Area Development (ABAD) set up under the Planning and Development Department of Punjab is promoting intergrated development of the area by coordinating the functions of the authorities concerned.

B. Haro River Left Bank Command Area

This area is located on the left bank of the Haro river at 10 km downstream of Khanpur dam. The area is originally a command area of the dam. As the construction of the new capital progressed, however, a rapid increase of water demand came to light in Islamabad capital area and Wah and Taxila industrial complexes. In 1973 the Government of Pakistan was obliged to revise its original plan and give high priority to urban water supply over irrigation water supply.

Consequently, a part of the irrigation area was excluded from the dam command area and remains rainfed. The area covers 16,100 ha in irrigable area and 31,500 ha in total area including Wah and Taxila cantonments, Wah industrial area and 37 villages.

The most striking feature of the area is the scouring brought about by surface erosion, which has cut pock marks of deep ravines all over the face of the area rendering about 40 percent of fertile land uncultivable. The gradient varies from place to place, but generally speaking, the area is flat and gradual from northeast to southwest.

The area comprises the north-eastern part of Attock and Fatehjang Tehsils in Attock district, and the north-western part of Rawalpindi Tehsil in Rawalpindi district. Union council including 5 to 23 villages is a basic administration unit.

In commandable area wheat and maize are major crops in winter and summer, respectively occupying about 90 percent of the total cropping, and the cropping intensity of such cash crops as vegetable and orchard is only a few percent. The area is irrigated by wells to some extent but most of it remains rainfed. Farmers in the area suffer from not only insufficiency of irrigation water but also from poor communication, inadequacy of rural health centers, shortage of educational institutions and absence of proper electrification, which retard the improvement of living conditions.

The area has a high agriculture potential due to the advantageous factors like flat topography, fertile soil and suburban area. Top priority project, therefore, is to construct irrigation facilities so as to increase agricultural productivity, then lead to higher standard of living. (Refer to Appendix F.2.2.)

C. Soan River Right Bank Suburban Area

The area is situated in the suburbs of Rawalpindi on the right bank of the Soan river covering 3,000 ha in total area and 900 ha in irrigable area.

In the northern area, hilly mountains are now under land consolidation for housing, and a fairly fertile land spreads along the right bank of the Soan river.

In spite of the fact that the area is located in the suburbs of Rawalpindi and can potentially be developed as a suburban agriculture field, this advantage has not been realized because of inadequacy of irrigation system and because of water pollution of the Soan.

Social infrastructures are well equipped in 5 villages in the area. Irrigation canal with capacity large enough to irrigate about 900 ha area exists in the center of the cultivated area, but it is not utilized because lift pumps were damaged by flood.

It is recommendable that the canal and pumps should be rehabilitated and fully utilized for irrigation. (Refer to Appendix F.2.2.)

3.2. Developed Water Resources and Existing Water Supply

3.2.1. Storage Dams

As described in Table III-2-1, there are many existing storage dams in the study area: two large dams, three medium dams and six small dams. The authorities of these dams are such as WAPDA, CDA and SDO, WAPDA being related directly or indirectly to all of these dams on the stages of investigation, design and implementation.

From the viewpoint of the project purpose, these dams could be classified into those large for hydropower and irrigation, those medium for irrigation and urban water supply, and those small for irrigation and rural water supply.

Regarding the history of dam engineering in Pakistan, the first constructed by WAPDA is the Rawal dam and the largest dam in Pakistan is the Tarbela dam.

The three dams (Rawal, Mangla and Tarbela) constructed in the 1960s and 70s were completed in rather short periods of 5 to 10 years because of force-account works of WAPDA and/or by big contractors selected in international tenders. On the contrary, the two dams in the 70's and the 80's (Simly and Khanpur) took long periods of 10 to 20 years.

It is said as reasons that during constructions, there were some revisions of project formulations due to change of water supply targets and suspensions of works by contractors because of severe price inflation.

On the other hand, for the most parts of the study area, which is called "Potwar Plateau" by geologists and at the same time, is called "Barani" (Rainfed agriculture) area which lacks steady stream flow, the Provincial Government of the Punjab has established, under

its Irrigation Department, the Small Dams Organization. It has completed 19 small dams already in the vicinity of the study area.

From the viewpoint of dam-type, zoned earth-fill dams are eminent among the large and medium dams, and concrete gravity dams are the same among the small dams. Concrete gravity dams in the area are all of masonry in cement/sand mortal.

3.2.2. Rivers and Streams

Besides the storage dams mentioned above, three main streams and their tributaries are utilized as follows.

On the Dor river, along 28 km of its downstream which ends at Tarbela lake, there are provincial and or private irrigation facilities in various sizes. Their command area is about 225 ha in Tehsil Abbottabad and about 3,600 ha in Tehsil Haripur.

At heads of these canals, there are no permanent intake facilities such as head works but only hand pitched gravel and stone embankment to introduce the stream flow into canals.

On the Haro river, along 25 km of the downstream from the Khanpur dam there were the similar local facilities as on the Dor river but they are going to be abandoned since the new irrigation system of the Khanpur dam was completed.

At farther downstream of the Haro, in Tehsil Attock, there is no intake facility except a few private lifts for irrigation and the water supply scheme for the Sanjwal Ordnance Factory in Sanjwal Cantonment. And from the Jhablat Kas, one of tributaries of the Haro, there is a Provincial Lift Irrigation Scheme which commands about 570 ha.

In the Soan river basin, the topographic conditions are not suitable for utilization of surface flow so that there are only some head works for urban water in Islamabad and few private lifts of brick factories. (Refer to Table III-2-2)

Besides, in the lower area along rivers there are, since old times, a lot of "Persian Wheels" lifting groundwater from shallow level for irrigation and rural use.

As another way of water utilization, a mill with vertical shaft is ordinary in the area especially in basins of the Dor and the Haro.

3.2.3. Groundwater

A. Islamabad and Rawalpindi Area

In Islamabad and Rawalpindi area, more than 150 tubewells have been constructed. Among them about 20 percent of total tubewells are regularly in rest for maintenance.

Annual discharge amount by the tubewells is about 59 MCM in the capital area.

The tubewells in Islamabad are totally controlled by CDA. In Rawalpindi the authorities PHED, RMC and CB control the tubewells and a few tubewells are under the control of Pakistan National Railway.

The diameter of the tubewells is 8 to 12 inches and their depth is 60 to 180 m. The working hour is 16 to 22 hours. The discharge rate of a tubewell differs from place to place. In National Park area including Golf Course area which is a well field of the highest yield, the discharge rate of a well ranges 90 to 120 m^3/hour while in the other areas it is approx. 60 m^3/h.

The well installations are concentrated in the town area of Islamabad and Rawalpindi cities and in the National Park area. Especially in the town area of Rawalpindi city, the decrease of groundwater table is prevailing on the existing tubewells as a result of the excessive discharging in summer season.

B. Wah and Taxila Area

More than 50 tubewells are working and about 21 MCM/year has been exploited by the tubewells. The tubewells in this area are operated by many authorities (HMC, HFF, HRF, PHED etc.).

The diameter of the existing tubewells is 8 to 12 inches and the depth is 60 to 100 m. The working time is around 16 hours in general. The discharge rate of wells is the highest in the Usman Khattar well field showing over 100 m^3/hour. In other areas it is 20 to 50 m^3/hour.

Groundwater exploitation is not highly proceeded in this area compared with the capital area and the problems caused by excessive discharge have not arisen.

Table III-2-1. Existing Storage Dams in the Study Area

Name	Type (Height) m	Authority	Location (River)	Catchment A. (A.A.Inflow) sq.km. (MCM/y)	Live Storage MCM	Full W.L. (Low W.L.) m M.S.L.	Purpose	Yield (CCA)	Const. Year
Mangla	Zoned Earth-fill 138	WAPDA	Mirpur (J&K) (Jhelum)	33,300 (28,400)	6,586	366.4 → 378.6 (317.0)	Irrigation Hydro-power	5,550 MCM/year 3,300 MKWH/year	1952 - 67
Tarbela	Zoned Earth-fill 143	WAPDA	Haripur(NWFP) (Indus)	168,400 (75,200)	11,600	472.4 (396.2)	Irrigation Hydro-power	11,200 MCM/year 4,400 MKWH/year	1968 - 75
Rawal	Masonry Gravity 40.7	Irrig.Dpt. (SDG)	Islamabad (Kurang)	275.1 (103.6)	53.0	534.0 (520.6)	Urban Water Irrigation	95,500 cu.m/day to Rawalpindi. 9,100 Islamabad 24,500 Left Bank	1959 - 62
Simly	Zoned Earth-fill 80.2	CDA	Islamabad (Soan)	152.8 (140.6)	24.7	699.5 → 705.6 (580.6 → 688.2)	Urban Water	109,100 Islamabad	1972 - 82
Khanpur	Zoned Earth-fill 50.9	WAPDA	Haripur (Haro)	778.0 (327.0)	112.9	604.1 (579.7)	Urban Water Irrigation	515,400 Rawalpindi 150,000 Islamabad 101,800 Taxila 115,200 Wah 157,800 Right Bank 92,900 Left Bank	1967 - 83
Misriot	Conc. Gravity	SDO	Rawalpindi	8.1	0.30	496.9(494.8)	Irrigation	(41) ha	- 1963
Sipiala	do	SDO	Fatehjang	10.4	0.33	501.1(499.3)		(57)	- 1964
Bango	do	SDO	Fatehjang	3.1	0.09	479.5(478.2)		(30)	- 1965
Qibla Bandi	do	SDO	Attock	23.6	1.39	376.4(372.8)		(344)	- 1971
Khasala	do	SDO	Rawalpindi	25.4	1.85	406.0(401.3)		(506)	- 1985
Shahpur	do	SDO	Fatehjang	203.9	5.03	444.5(442.7)		(1,743)	- 1987

Other existing Small Dams are Tanaza, Gurabh, Rati Kassi, Narali, Dungi, Dhurnal, Dhok Tahlian, Kanjoor, Channi Bor, Khokhar Zer, Garat, Walana, Surlah

Table III-2-2. Existing Head Works in the Capital Area
(CDA)

Name	Type	Location (River)	Catchment A. (sq.km)	Water Level (EL.m)	Const. Year	Facility Size Current (MGD)	Facility Size Future (MGD)	Annual Production Current (MCM/yr.)	Annual Production Future (MCM/yr.)
Saidpur	Spring	Saidpur	aprx.-	aprx.640	1962-63	0.8	0.8	1.2	1.1
Noorpur	Masonry Weir	Shahan Kala	5	600	1962-63	0.7	1.0	1.0	1.3
Kurang	Causeway & Sump	Up. Kurang R.	156	570	66	2.5	4.0	0.0[2)]	5.3
Golf Course Old	M. Weir & Sump	N. Park Ojhr H.	-	530	66	2.2	2.2	3.2	2.9
Shahdara	Gabion Weir	Shahdara R.	24	600	67	2.5	3.0	2.9	4.0
G-10	Concrete Weir	Bedarawali Kas	70	540	70	2.5	2.5	2.9	3.3
Golf Course New	Canal & Conduit	Rawal Lake[1)]	-	525	71	2.7	2.7	3.9	3.6
Total						13.9	16.2	15.1	21.5

Note: 1) Includes three Tube Wells connected to New Golf Course Water Works.

2) Supended since 1983 because of full occupation of the Conduction by the water from Simly Dam.

3.3. Implementation and Operation/Maintenance Agency

3.3.1. Implementation and Operation/Maintenance Agency of Urban Water

The entire urban water supply facilities in Islamabad such as treatment plant, conduction main, service reservoirs and distribution pipe networks are constructed, operated and maintained by CDA. Such high-level engineering as dam design and construction is committed to WAPDA.

CDA consists of chairman, members in charge of administration, finance, planning and engineering, director generals, deputy director generals and design, construction and maintenance divisions, executes their tasks smoothly.

The daily production of Islamabad urban water as of January 1987 is approximately 73.3 MCM, shared by the Simly dam by 34.7 MCM, surface water intakes (7 points) by 15.1 MCM and tube wells by 23.50 MCM.

Urban water supply to Rawalpindi is maintained by PHED. In Rawalpindi RMC, MES and CB receive benefit from water supply. Ground water development is being done by PHED or other beneficiaries and tube wells constructed by the provincial government are maintenance by RMC. The Rawal dam, the major water resource in the area, is maintained by SDO under the Irrigation and Power Department due to the fact that the original purpose of the Rawal dam was irrigation.

Maintenance of the facilities in the RMC area and cantonment area is done by urban water operation engineers under the Mayor and by Cantonment Board under the Ministry of Defence, respectively.

The daily production is approximately 65.4 MCM, shared by the Rawal dam treatment plant by 29.8 MCM and tube wells by 35.6 MCM.

3.3.2. Provisional Maintenance of Khanpur Dam

The construction of the Khanpur dam completed in 1984 for the purpose of irrigation, urban water and industrial water supply. Since the dam command area spreads over two provinces, the Punjab and NWFP, the WAPDA was in charge of planning and construction in accordance with the regulations and laws of Pakistan.

Although the dambody and the main canal to the command area have already constructed, they are utilized only for irrigation purpose, but not for other purposes. Urban water supply plan to Islamabad and Rawalpindi is still under consideration and industrial water supply is charged by groundwater. Accordingly, the maintenance of irrigation facilities were handed over to SDO, but the others were still provisionally maintenanced by WAPDA.

3.3.3. Organization for Multi-Purpose Water Resources Development

Water use in the metropolitan area has substantially intricate features. As various organizations are involved in the water resources development, they have their own development plans in their service area.

Integrated development plan is needed for effective use of water resources. As the new capital construction progresses, Islamabad and Rawalpindi will be united into one administration in future. An organization which is in charge of metropolitan water supply should be set up as early as possible.

3.4. Finance and Water Tariff Systems

3.4.1. Finance

CDA spent Rs.84.10 million as the annual cost in 1985-86 on water supply. Out of it, payment for electricity charges reached 40.8 percent, followed by depreciation accounting for 25.5 percent. Then came pay and allowance for regular establishment with 16.5 percent and store/materials with 13.1 percent. On the other hand, it collected Rs.11.62 million as water charges receipt. Consequently, if water supply department is financially to be treated independently, cost recovery ratio (ratio of receipt to cost) will be 13.8 percent with the loss amounting to Rs.72.48 million. However, the actual situation is that water supply department in CDA is not supposed to be a self-financing unit and the loss is automatically met by the subsidy of the Federal Government. In terms of the unit production cost of water, the authority spent Rs.1.64 per 1,000 lit. (Rs.7.45 per 1,000 gal) and recovered Rs.0.23 per 1,000 lit. (Rs.1.03 per 1,000 gal) in the above year.

RMC spent Rs.13.14 million as the annual cost in 1985-86 on water supply. Out of it, 57.5 percent was expended to pay for electricity charges and other contingencies. 12.5 percent and 9.9 percent were allotted for depreciation and pay and allowance of regular establishment, respectively. On the other hand, it collected Rs.4.85 million as water charges receipt in the same year. Consequently, the cost recovery ratio was 36.9 percent with Rs.8.29 million going into the red. The loss was offset by revenue in other departments. In terms of the unit production cost of water, the corporation spent Rs.0.50 per 1,000 lit. (Rs.2.29 per 1,000 gal) and recovered Rs.0.19 per 1,000 lit. (Rs.0.85 per 1,000 gal) in the above year.

Administrative organs in Rawalpindi Cantonment area spent Rs.20.45 million as the annual cost in 1985-86 on water supply. Out of it, 35.9 percent was used for the payment for electricity charges and 26.8 percent for store/materials. 14.5 percent and 10.3 percent went for pay and allowance of regular establishment and depreciation, respectively. On the other hand, they collected Rs.3.28 million as water charges receipt in the same year. Consequently, cost recovery ratio was 16.0 percent with the loss of Rs.17.17 million.

However, actually the loss is mostly met by the subsidy of the Federal Government via Defense Ministry. In terms of the unit production cost of water, the organs spent Rs.1.05 per 1,000 lit. (Rs.3.33 per 1,000 gal) and recovered Rs.0.17 per 1,000 lit. (Rs.0.76 per 1,000 gal) in the above year.

Table III-4-1. Financial Situation of Metropolitan Water Supply Organizations, 1985-86

Item	CDA	RMC	MES & CB
1. Profit & Loss (Rs. Million)			
1) O/M cost			
a. Pay & Allowance of Establishment	13.86 (16.5%)	1.30 (9.9%)	2.96 (14.5%)
b. Electricity Charges	34.29 (40.8%)	7.55 (57.5%)	7.35 (35.9%)
c. Store/Materials	11.03 (13.1%)	0.65 (4.9%)	5.48 (26.8%)
d. Depreciation	21.48 (25.5%)	1.64 (12.5%)	2.11 (10.3%)
e. Others	3.44 (4.1%)	2.00 (15.2%)	2.55 (12.5%)
f. Total	84.10(100.0%)	13.14(100.0%)	20.45(100.0%)
2) Water Charges Receipt	11.62	4.85	3.28
2. Unit Cost of Water, Rs./1,000 lit. (Rs./1,000 gal.)			
1) Production Cost	1.64 (7.45)	0.50 (2.29)	1.05 (3.33)
2) Recovery of Production Cost	0.23 (1.03)	0.19 (0.85)	0.17 (0.76)

Source: CDA, RMC, MES, CB

The average production cost of urban water covering the entire Metropolitan areas is calculated at Rs.1.22 per 1,000 lit. (Rs.5.54 per 1,000 gal). Whereas, only Rs.0.21 per 1,000 lit. (Rs.0.93 per 1,000 gal) is recovered as water charges receipt. That is to say, the overall recovery ratio is confined to 16.8 percent.

If water supply authorities are to financially stand on their own feet, household should pay Rs.1.01 per 1,000 lit. (Rs.4.58 per 1,000 gal) on the assumptions that water rate for commercial/industrial users is twice as high as that for domestic users. At present, the average income and water demand per month of a Metropolitan household is estimated at Rs.2,713 and 32.54 m^3, respectively. Consequently, the average water payment per month of a household works out at Rs.33 under the above water rate, corresponding to 1.2 percent of its income.

World Bank considers it all right when water payment is kept within 5 percent of household income. It would be preferable if it could be contained within 3 percent.

It is clear from the above that domestic (and, therefore, all) users have enough means to get water supply authorities financially stand on their own feet. The existing situation where the authorities are subsidized extensively is given rise to by the interactions of various factors centering on the existing water tariff systems.

3.4.2. Water Tariff Systems

Water tariff systems of CDA include the quantity rate system and the flat rate system. Coexistence of two mutually different systems is witnessed also in water tariff systems of any other administrative organ in the Metropolitan areas. Under the quantity rate system CDA charges Rs.0.79 per 1,000 lit. (Rs. 3.60 per 1,000

gal.) for domestic and public users and Rs.1.32 per 1,000 lit. (Rs.6.00 per 1,000 gal) for commercial and industrial users. Under the flat rate system it imposes fixed monthly charges on individual users on the basis of plot size, dimensions of dwellings/buildings, diameters of pipelines, etc. At present the quantity rate system is applied to 18 percent of the users in Islamabad, and the remaining 82 percent fall under the flat rate system.

As already mentioned, CDA now spends Rs.1.64 (Rs.7.45) to produce 1,000 lit. (1,000 gal) of urban water, and financial loss is obviously inevitable under the existing the quantity rates. However, if present water tariff systems were unified into the quantity rate system, CDA would recover more than 50 percent of cost on the assumptions that billing and collection are perfect. But the reality is that the recovery ratio is only 13.8 percent as already mentioned. The reason is the flat rate system and its over whelming prevalence. Therefore, the fundamental measure the authorities must take in order to attain financial independence of water supply is to completely abolish the flat rate systems and establish the quantity rate systems that will make them solvent. It is impossible, however, to realize it overnight and it is essential to drastically change both hardware and software aspects of water supply service. That is to say, all the related aspects of technology, products, institution, personnel, psychology and organization must be changed/elevated in a coordinated, parallel manner. Specifically, it is necessary that the circumstances should mature to such a level where all day service, perfect metering and quantity rate systems can be realized completely and simultaneously.

Table III-4-2. Quantity Rate Systems in Metropolitan Areas, 1987

(unit: Rs./1,000 lit.(Rs./1,000 gal.))

Administrative Organ	Domestic/Public Users	Commercial/Industrial Users
CDA	0.79 (3.60)	1.32 (6.00)
RMC	Discontinued	1.10 (5.00)
MES	0.88 (4.00)	1.32 (6.00)
CB	Discontinued	Discontinued

Sources: CDA, RMC, MES, CB

In RMC area commercial and industrial users pay Rs.1.10 per 1,000 lit. (Rs.5.00 per 1,000 gal) under the quantity rate system. The quantity rate for domestic and public users has been discontinued. Under the flat rate system RMC imposes fixed yearly charges on individual users on the basis of diameters of pipelines, plot size, etc.

The users to whom the quantity rate system is applied account for only 2 percent.

CB in Rawalpindi Cantonment area has recently discontinued the quantity rate system and now applies the flat rate system only. Under the flat rate system it imposes fixed monthly charges on individual users on the basis of diameters of pipelines, plot size, etc. MES in the same area enforces both quantity and flat rate systems. Under the quantity rate system it charges Rs.0.85 per 1,000 lit. (Rs.4.00 per 1,000 gal) for domestic and military users and Rs.1.32 per 1,000 lit. (Rs. 6.00 per 1,000 gal) for commercial and industrial users. Under the flat rate system it imposes fixed monthly charges on individual users on the basis of diameters of pipelines, plot size, etc. It is said that the quantity rate system is applied to 40 percent of the users.

Financial problems of the water supply authorities in Rawalpindi are the same as those of CDA. Therefore, the solutions are identical, too. This is the reason why progressive, systematic and planned improvements under a single organizational set-up unifying the entire Metropolitan areas are called for.