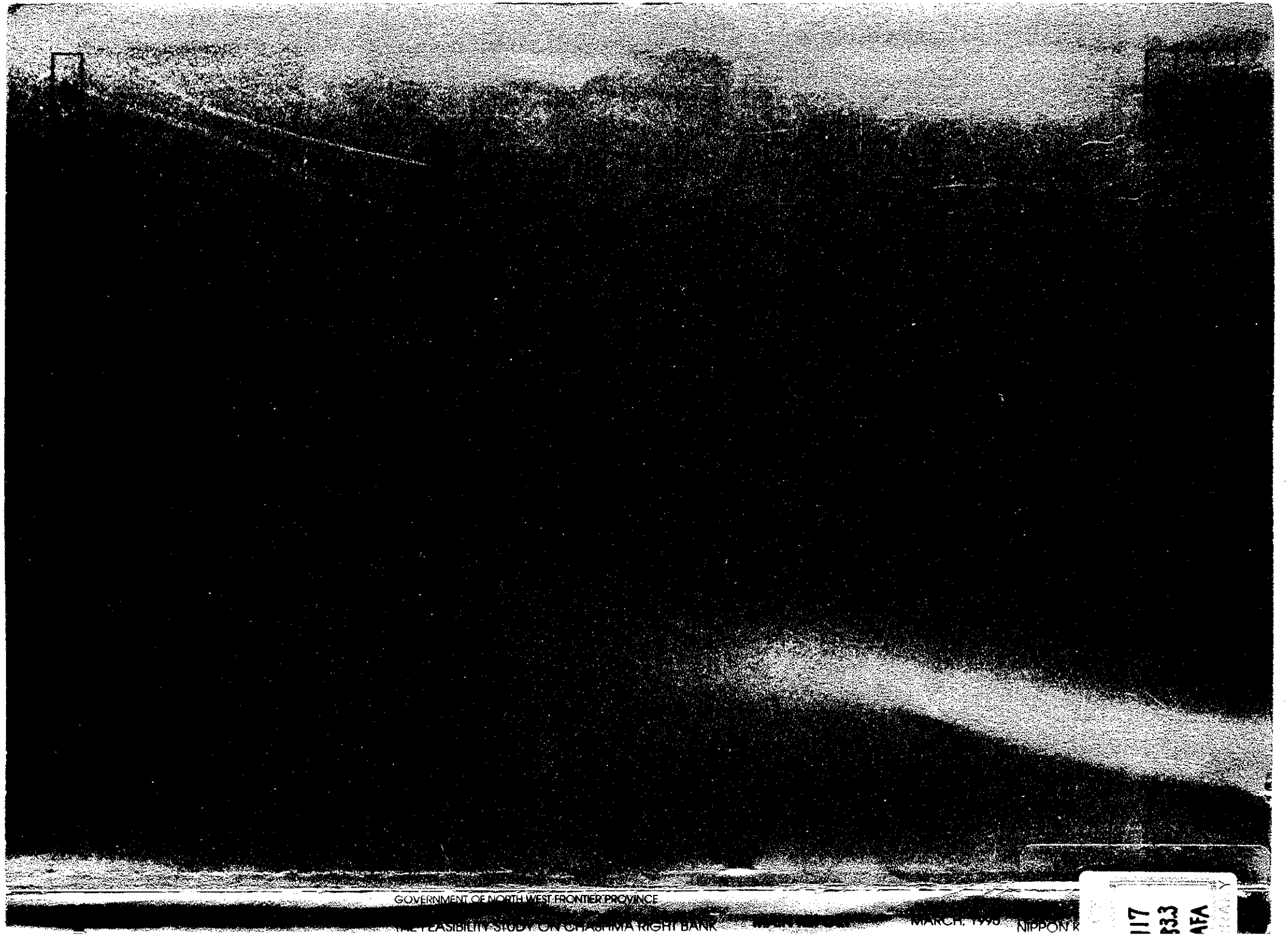

GOVERNMENT OF NORTH WEST FRONTIER PROVINCE

THE FEASIBILITY STUDY ON CHASHMA RIGHT BANK

MARCH, 1998 NIPPON K

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GOVERNMENT OF NORTH WEST FRONTIER PROVINCE
ISLAMIC REPUBLIC OF PAKISTAN

THE FEASIBILITY STUDY
ON
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT

MAIN REPORT

MARCH, 1995

NIPPON GIKEN INC.

NIPPON KOEI CO., LTD.

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Preface

In response to a request from the Government of Islamic Republic of Pakistan, the Government of Japan decided to conduct a Feasibility Study on Chashma Right Bank 1st Lift Irrigation Project and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Islamic Republic of Pakistan a study team headed by Mr.Tadashi Ohori, Nippon Giken Inc., four times between July 1993 and January 1995.

The team held discussions with the officials concerned of the Government of Islamic Republic of Pakistan, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

March 1995

Kimio Fujita
President
Japan International Cooperation Agency

March 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the Feasibility Study Report on Chashma Right Bank 1st Lift Irrigation Project in N.W.F.P. in Islamic Republic of Pakistan. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned Project. Also the report includes comments made by the agencies concerned of the Government of Islamic Republic of Pakistan during technical discussions of the draft report which were held in Islamic Republic of Pakistan.

This report presents an irrigated development plan for the area of around 110,000 ha in D. I. Khan district of the southern part of N.W.F.P. The development plan consists of 1) agricultural development, 2) irrigation and drainage, 3) farm road network, 4) institutional improvement, 5) land conservation, 6) environmental management. This project would contribute to the internal self-sufficiency in agriculture, to the betterment of health situation, to the improvement of marketing system, and to the progress of environment aspects including conservation of land resources. In the institutional improvement plan, the existing institutional constraints which have been in the way of irrigation development are reviewed. It is recommended to establish a renovated organization for consistent project implementation, operation and maintenance. This epoch-making recommendation would be expected to act toward positive impacts for other irrigation projects in Islamic Republic of Pakistan.

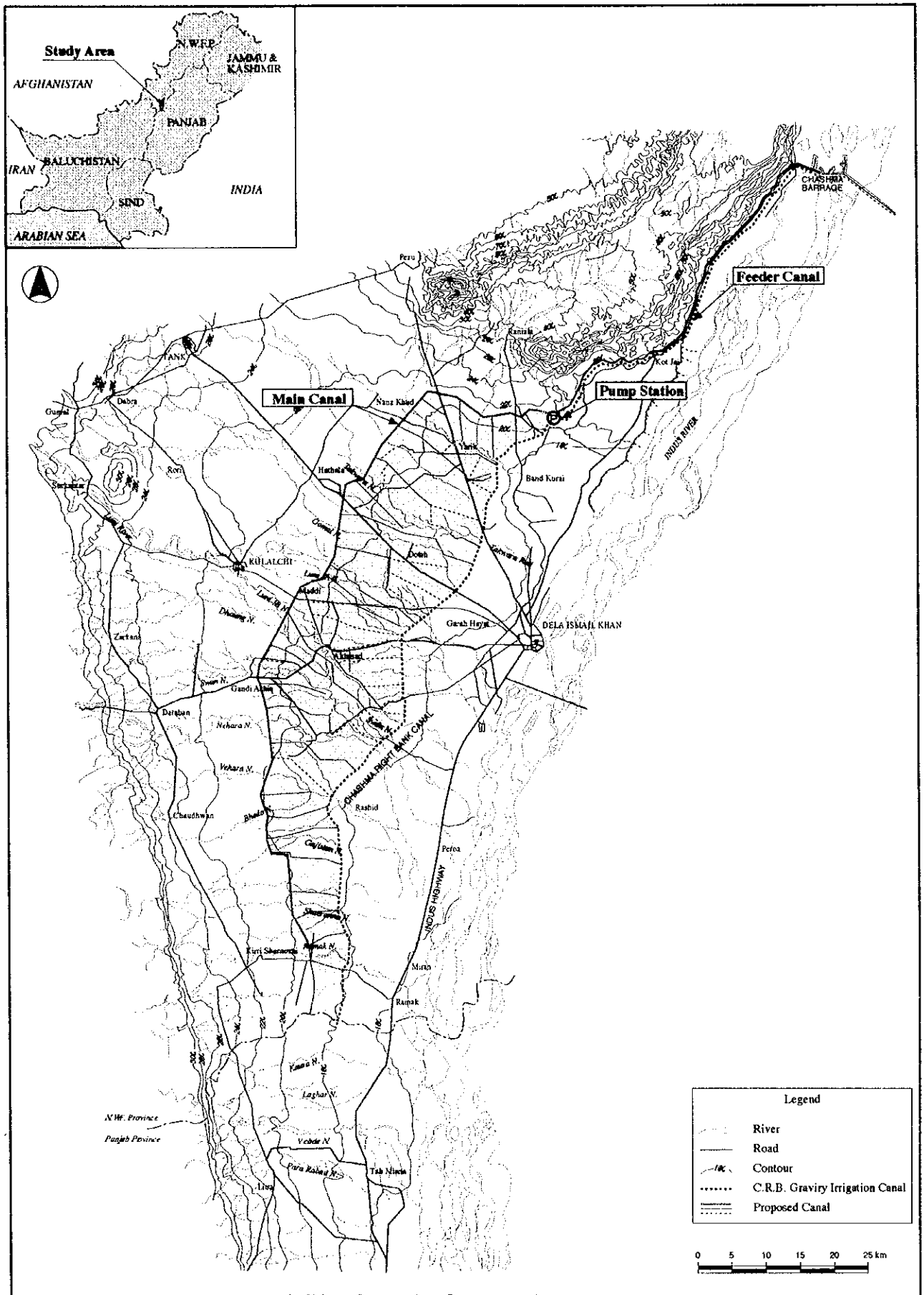
This study of the project has been carried out as a link in the chain of Chashma Right Bank Irrigation Project. Chashma Right Bank Canal Project with gravity irrigation system has already been undertaken since 1978. This lift irrigation project, therefore, should be implemented as prior as possible for the symmetrical development as the whole Chashma right bank area.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Agriculture, Forestry and Fisheries. We would also like to express our gratitude to the officials concerned of Irrigation Department of N.W.F.P. and other authorities concerned of the Government of Islamic Republic of Pakistan for the close cooperation and assistance throughout our investigation and study.

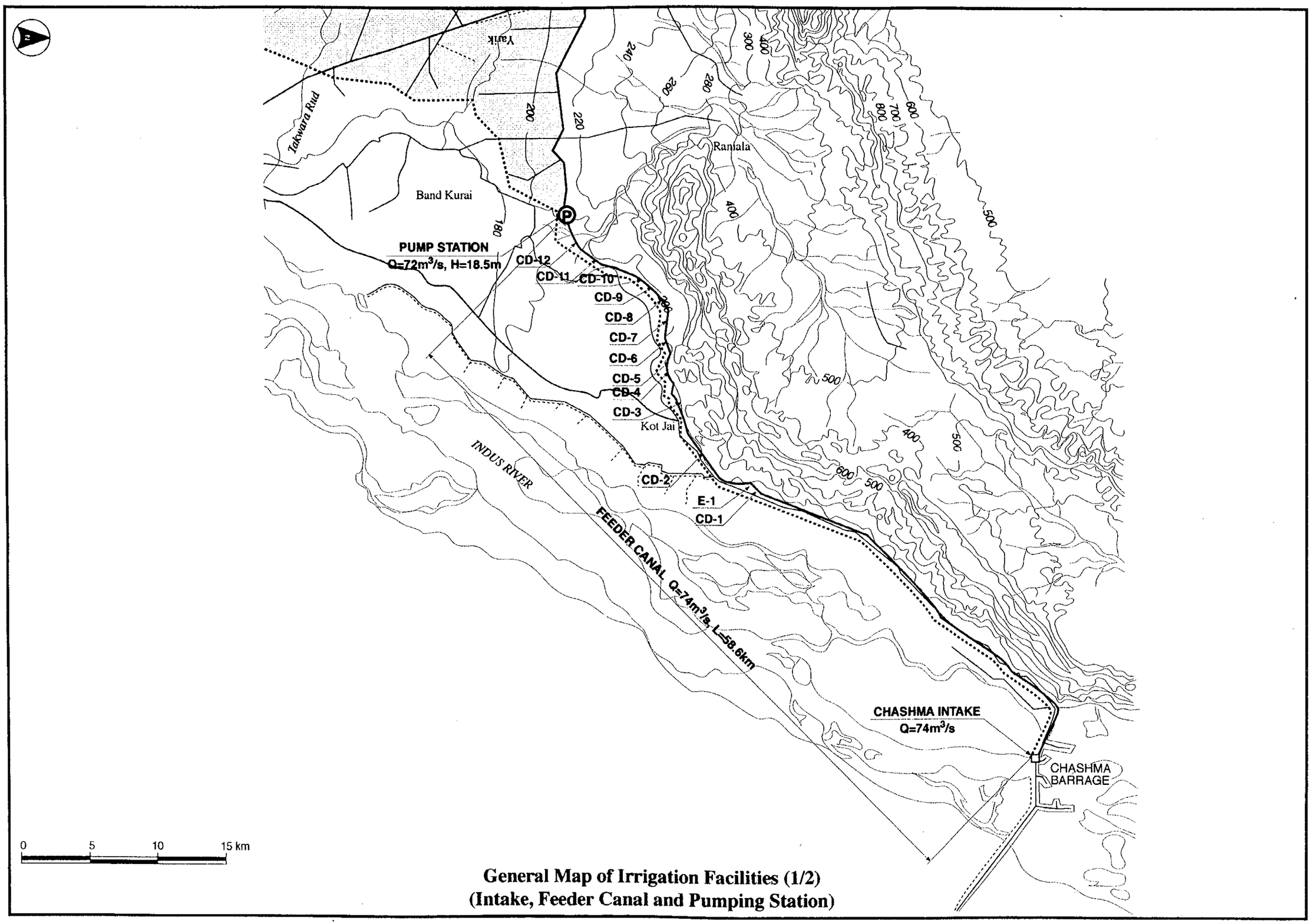
Finally, we hope that this report will contribute to further promotion of the Project.

Very truly yours,

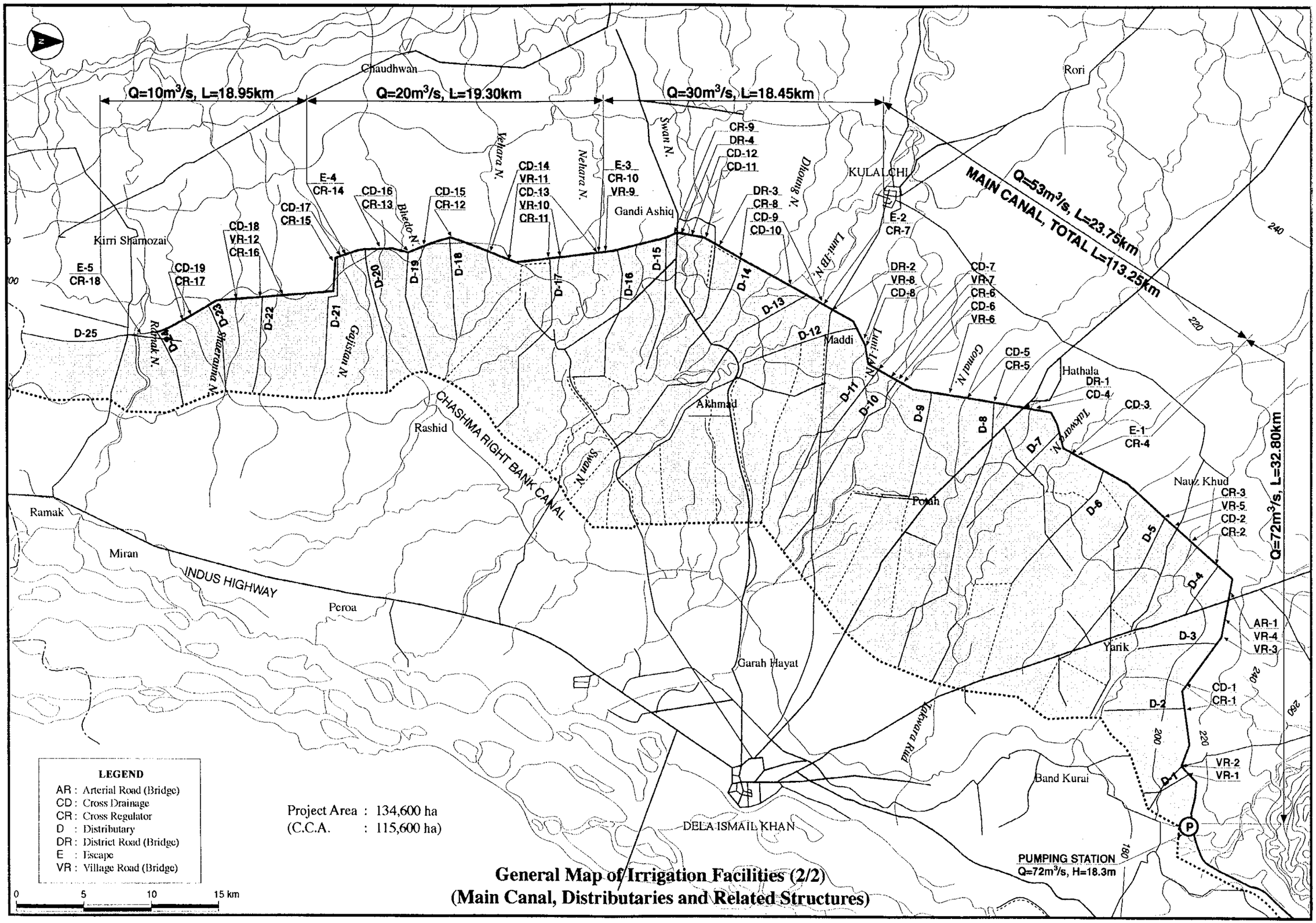
Tadashi Ohori
Team Leader,
Feasibility Study on the Chashma
Right Bank 1sr Lift Irrigation Project



LOCATION MAP OF THE STUDY AREA



General Map of Irrigation Facilities (1/2)
(Intake, Feeder Canal and Pumping Station)



General Map of Irrigation Facilities (2/2)
(Main Canal, Distributaries and Related Structures)

SUMMARY

Introduction

The irrigated land in the North West Frontier Province (NWFP) is 41% of the total cultivate area. The Government of NWFP has given the highest priority to the irrigation development in the right bank area of Indus River in D. I. Khan District. The Government of NWFP has thus been putting much stress on realization of effective use of surface water of Indus River since 1960s.

In December 1973, a PC-I Proforma to irrigate a total area of 1,360,000 acres [550,000ha] (424,900 ha in D. I. Khan District and 125,100 ha in D. G. Khan District) through pumping-cum-gravity system in Chashma Right Bank Irrigation Project was compiled in accordance with directions of the provincial Government of NWFP and submitted to the Federal Government.

Construction on the gravity system of the project started from 1978 with financial assistance by ADB and had been scheduled to complete by 1985 in three stages. Till 1992 only Stage I and Stage II of the system have been completed. The Stage III is now re-scheduled to complete in 7 years starting from fiscal year 1994/95.

As to the lift system of the Project in spite of eager request from NWFP Government, it had not been implemented for 20 years due to lack of decision on water allocation. The NWFP Government, requesting the earliest materialization of irrigated agriculture development by pumps, requested the Government of Japan to provide technical assistance for the Feasibility Study of the 1st Lift Irrigation Project (irrigating about 110,000ha in D. I. Khan District of NWFP) soon after settlement of Indus water apportionment. In reply, the Government of Japan decided to provide the Study through Japan International Cooperation Agency (JICA).

Background

The nation of Pakistan, the Islamic Republican country, is located in the Western Asia, it has the area of 796,100km^2. After accomplishment of independence from Britain together with India in 1947, it became totally an independent country.

The Per capita GDP at factor cost is US$ 383. Agricultural sector in Pakistan has the largest share around 25 % of GDP during 1987/88 to 1991/92 and holds 48 % of labor force in 1991/92. Annual growth rates of GDP during 1987/88 to 1991/92

could be estimated at 5.0 %. However GDP growth in 1992/93 was interrupted and down at 2.3 % because annual growth rate of agricultural sector was below zero due to devastating floods in 1992/93. National economy of Pakistan, therefore, is much influenced by agricultural sector.

As Pakistan is located in the arid and semi-arid zones, its agriculture is highly dependent on irrigation. Total plain area of the country is 57,800,000 ha, and 20,700,000 ha (36%) is for agriculture, and within that area 16,200,000 ha (78%) is under irrigation. But there still remains some room for expansion of the potential area, and the existing agricultural systems are not intensive so that future improvement is needed including the management of irrigation facilities.

Within 8,300,000 ha of the total potential arable area of the NWFP, 23 % (1,900,000 ha) of the potential area is under cultivation and only 41 % (789,000 ha) of cultivated area is under irrigation.

The cropping pattern of Pakistan consists of the cropping of grain such as wheat during winter (Rabi) from October to March and the cropping of rice and cotton during summer (Kharif) from April to September. Wheat is the most important crop which has the largest area, value and popularity as food. But in the non-irrigation area, as the unpredictable weather restricts stable agricultural production, NWFP suffers from insufficient food supply.

The Indus River is the most important water source for promoting the irrigation in Pakistan. Due to delayed decision on "Water Apportionment", losses in national economy and denial of employment opportunities had been emerged. A complete consensus by mutual agreement on the apportionment of the waters of the Indus River System between the Provinces was finally reached in March, 1991. The apportionment of the waters of the Indus River System to NWFP province is 14% excluding Chashma Right Bank 1st Lift Irrigation Project.

Present Condition of the Study Area

In this Feasibility Study, the Study Area of 141,700 ha in its entirety is defined as follows:

Eastern boundary:	C.R.B. Canal
Western boundary:	Proposed 1st Lift Canal, which takes off from the beginning point at around RD 185 of CRBC. at altitude 209.0m

(685.7 ft.) to the terminal point at the provincial boundary of NWFP and Punjab near Ramak.

Southern boundary: Provincial boundary with Punjab.

Northern boundary: Khaisora Range.

The main topographic features around the Study Area are composed of the Mountains of the Sulaiman, Khisor, Marwat and Bhittanni Ranges, and the Piedmont Plain composed of deposition of degraded material transported by streams of the Sulaiman Ranges forms the plain. The Study Area is a poorly vegetated plain sloping gently (1/300 to 1/1,000) down to Indus River from west toward east.

The groundwater table in the Study Area is at the depth of between 50 and 100 ft (15-30m). Recharge of groundwater is made along the western and northern mountainous boundary by the lateral sub-surface flow and by infiltration of surface water through bottom of tributaries. Total storage of extractable fresh groundwater in the alluvial fan until a depth of 200 meters, is estimated at $310,000 \times 10^6$ m^3. On the contrary, the average annual recharge of fresh groundwater fan fill roughly amounts to 100×10^6 m^3.

The climate of the Study Area is semi-arid and is characterized by large seasonal variations. Summer daily temperatures varies 18-46°C, in winter 12-34°C, and annual rainfall varies 200-400mm (annual average: 273mm). Estimated ETo by the modified Penman method is 1,590.6mm per year.

The Study Area is located in the meandering flood plain of the Indus River which extend between the Indus River and the foot hills of Suleiman Range. Floodwater on the flood plain originates from five (5) major and numerous number of small Zams (Zam is a local term for perennial Rod Kohi). Total catchment area of Zams is around 40,000 km^2. Although the annual rainfall is relatively low, highly intensive rains of short duration do occur occasionally causing floods in Zams which extend to their upper portions and run over the Study Area.

The Indus river water are classified C_1S_1 (Low sali, Low sodium) at the Chashma reservoir and in CRBC canal and seems to be quite suitable for irrigation. On the contrary, other surface water sample at each Nullah indicate C_2S_1 (Medium salinity, Low sodium) or C_3S_1 (High salinity, Low sodium). These results show that salinity issues will be emerged if improper irrigation practice is continued for a long time from Rod Kohi sources.

Quality of ground water in the Study Area is C_2S_1 (Medium salinity, Low sodium) or C_3S_1 (High salinity, Low sodium) and is not suitable for irrigation.

The soil textures in the Study Area are classified from sand to loam, mainly loam or clay loam. The soils are suitable for cropping, although most of them are slightly alkaline (the pH is about 8.0 to 8.5). Most of the soils show electric conductivity below 0.5 mS/cm and are classified into non salinity soil. Effectiveness of nitrogen fertilization is high as natural nitrogen contents are low.

Good or moderate irrigable land covers 90% of the area. Present land capability classification in the Study Area is shown in the following table.

Class	Land capability	Extent (ha)	Ratio (%)
I	Good irrigable land	60,950	43.0
II	Moderate irrigable land	66,730	47.1
III	Marginal irrigable land	9,210	6.5
IV	Unproductive land	4,810	3.4

The total acreage of the Study Area is about 141,700 ha, of which 105,700 ha (75%) is cultivable, but cropped area varies year by year depending on the amount of rainfall and flood. The present land use is shown in the following table.

Land use	Area (ha)
Cultivated area	
- Tube well irrigation area	940
- Rod Kohi / Barani cultivation area	105,700
Grazing area / Cultivable waste land	28,800
Uncultivated area	
- Residential area	1,450
- Gullies, torrent beds and others	4,810
Total Area	141,700

The Study Area located in D. I. Khan district is under two tehsils of D. I. Khan and Kulachi. The former comprises 13 union councils and 102 mouzas and the latter 1 union councils and 2 mouzas. Administrative divisions covering the Study Area are summarized As follows;

Item	No. of Union Council	No. of Mouza	Area (km^2)	
Administrative Divisions				
of Study area	14	104	2,082	(28%)
D. I. Khan Tehsil	13	102	2,034	
Kulachi Tehsil	1	2	48	
D. I. Khan District	34	359	7,325	(100%)
NWFP	697	4,733	74,521	

The population and household number in the area of 104 mouzas are estimated at around 122,700 which accounts for 17% of the district population and 19,600 respectively with an average family size of 6.3. The residential population and household number within the Study Area are estimated at 83,500 and 13,340 respectively which account for 68% of those of the 104 mouzas. The population density and the rate of population increase are estimated at 59 persons/sq.km and 3.01% respectively.

The result of the population census in D. I. Khan District regarding to the age, sex and the number of labor, and the labor population rate (31.5%) in the country indicate that the labor population will increase up to 43,500 in 2010 from 26,300 in 1993.

Literacy ratio in D. I. Khan district in 1981 was 18.4% (the national average 26.2%). In the district, the ratio in rural area remained at 13.7%. In addition, education for the female is less promoted and the literacy ratio of female was limited at 8.0%.

Out of 13,340 households in the Study Area, resident agricultural land owner households are estimated at around 10,000 (75%) and the rest 3,340 (25%) are landless households such as the government employees, merchants, landless tenants, laborers, etc. Registered agricultural land covering cultivated area and some part of fallow is estimated at around 59,900 ha which accounts for 44% of the total agricultural land of 135,400 ha. Area under resident agricultural land holdings is estimated at 49,600 ha (83%). The rest of land (10,300 ha/17%) are assumed to be absentees.

Average holding size of agricultural land is 5.0 ha in resident owner households, 3.4 ha in absentee owner households, and 4.6 ha in total owner households. Agricultural land is unevenly distributed among land owner households in the Study Area. The number of marginal and small owner households below 3 ha accounts for 74%, while their share of agricultural land area is limited at 9% of total land. On the other hand,

the number of large land owner households more than 5 ha is limited at 18%, while their share of land area accounts for 84%.

For summer (Kharif) season crops, sorghum (jowar, 47%), millet (bajra, 46%) and are the major crops while wheat (54%), gram (27%) and oil-seeds (16%) are the main crops for winter (Rabi) season. 5,370ha or 5.0% of the cultivated areas of 106,640 ha are sown in the summer season. Harvesting, however, is limited only at 30% of the total sown area and remaining area is damaged. During winter season, 16,060 ha or 15.2% of the cultivated area are sown, and 39% of the total sown area is harvested. The present cropping intensity (percentage of sown area to the cultivated area) is estimated at 20.2%. In terms of harvested area to the cultivated area, however, harvesting intensity is limited at 7.4% comprising 1.5% of Kharif and 5.9% of Rabi.

The unit yields of major crops have limited at low level such as 0.72 ton/ha of sorghum and 1.06 ton/ha of wheat due to poor soil fertility, shortage of rainfall water, low level of farm inputs and traditional farming practices.

Farmers sell 58% of harvested wheat in the Study Area, or 64% in the existent CRBC Area to the market. Most of agricultural products except for wheat are brought to the market. They sell their products to Beopari (village merchant), commission agent or village shop. Beopari is a main sale destination particularly for wheat, rice, gram and oil-seed. Most of sugarcane is sold to sugar mills directly.

Wheat is the staple food for most of Pakistanies. It is always an important social and economical issue to stably supply wheat. Although self-sustenance of wheat is one of the major objectives in the 7th five-year plan, the objective was unattainable and they import the shortage. Oil-seed is also an imported item and the supply and demand is recently imbalanced and import of oil-seed is steadily increasing.

The comparison of consumption and production of foods in D. I. Khan District indicates some surplus in wheat production but at provincial level, there are shortages.

Wheat production in the province in 1991/92 was 1,163,000 tons while consumption demand amounts to 2,000,000 tons showing the shortage of 837,000 tons. Similarly, demand for oil seeds, rice, and grain considerably exceeds the production.

Of the 7,166 cooperative societies registered in NWFP, 497 are in D. I. Khan district. In the 104 mouzas in the Study Area, there are 26 societies having 1,024 household, participation rate is only less than 5% to the total number of households of 19,600. Based on the results of farm survey, there were no cooperative members in the 210 respondents. Cooperative societies in the Study Area are inactive and dormant at present.

Based on the farm survey, 98 in number or 47% of the total respondents (210) received credits from several sources. Only 27 or 28% of borrower respondents (98) were benefited by institutional credit. Institutional agricultural credit is supplied by Agricultural Development Bank of Pakistan (ADBP), cooperative banks, and commercial banks. Major sources of rural credit even in the Study Area are from non-institutional sources such as friend and neighbors (61% of the borrowers), wholesalers and businessman (6%), and others (5%).

Farm management analysis by farm size indicates that the ratio of farm income to the total is proportional to the farm size; from 39% for small and marginal farms (0.74ha) till 63% for large farms (18.9ha). Income of small and marginal households of less than 3ha is largely development on non-farm income of occasional labor employment. Annual surplus of income saved from expense is only Rp 600 for small and marginal households.

The results of questionnaire survey indicate that all the respondents are positive to establish farmers' cooperatives (associations) for each of distributary command areas in the Project implementation. 47% of the respondents have shown their necessity for participation in the cooperative at the detailed design and construction stages.

Flood irrigation has long time been practiced in the Study Area. Method to divert flood flow in the river channel (so-called Zam) is to erect earthen and gravel embankments (so-called Gandi) at suitable intervals across the river bed to dam up flood water and lead it to distributary channels immediately upstream of embankments. Areas having water rights for flood irrigation in the Study area is 27,100 ha in total.

Tube-well irrigation is practiced in the Study area but limited in scale and area and mostly privately owned. The tube-well irrigation area is concentrated along the Bannu road and at west of Ramak. Total benefit area is 130 ha in Kharif and 940 ha in Rabi by 20 numbers of tube-wells. Beneficial farmers are facing difficulties in

paying for electricity and expecting reasonable O&M cost by implementation of a large scale pumping irrigation project.

Two major problems on drainage are pointed out in the Study area. One is violent sheet flow occurred around center of the Study area, which sometimes menaced farm land and CRBC main canal with destruction. Another is chronic inundation caused along the existing canals due to insufficient drainage capacity. Some measures should be taken against these two problems in the Project formulation.

The existing roads in the D. I. Khan division are categorized 3 classes under their jurisdictions, planned, constructed, and managed by respective organizations. The density of existing roads is at 129m/km^2 in the division and 153m/km^2 in the Study Area.

The present capacity of the nations electric power supply dose not meet the national demand, however power development programs are steadily in progress. Three projects as Chashma Hydropower (184 Mw), Gomal Zam Hydropower (150Mw), Chashma Nuclear Power (300Mw), are on-going as the power development schemes in and around the Study Area.

Domestic water is almost supplied from under ground water. Coverage rate of water supply in Tehsils of the Study Area is limited 25.7% in D. I. Khan and 54.4% in Kulachi.

Current environmental conditions of the Study Area summarized as follows. No threatened species of fauna and flora vegetation is recognized. Natural vegetation had already been lost and the land is flat and waste. There is no natural fine view point in the Area. One of the archeological sites inferred in pre-Indus Valley Civilization exists in the Area. However, it has not been preserved after excavated investigation.

Irrigated agricultural development is institutionally handled by two Ministries at the national level viz. the Ministry of Food & Agriculture and the Ministry of Water and Power. Both the Ministries are quite independent of each other and keep little coordination. At the provincial level, relation between the Department of Food & Agriculture and Development of Irrigation and Power remain the same and such relation is maintained down to the field level management.

Implementation of irrigation project under the present administration system is executed by WAPDA and the Provincial Government. Objectives of the project

implementation have been focused only on construction of irrigation systems even from the planning stage, and little attention has been paid on development of farm land, establishment of farmers associations, training of farmers for irrigated agriculture, development of infrastructures and other agriculture inputs because of the idea that these are to be carried out by each of respective departments.

Construction of the irrigation project is much delayed from the initial schedule, because of the financial problem, lack of coordination between respective organizations, institutional inefficiency, lack of interest, delays in land consolidation, etc.

Basic Concept for the Project Development

In contrast to the depressed present conditions in the area, potentialities to achieve great strides are available. The Study area has high development potential from the viewpoints of land availability, water availability from the Indus river, increasing labor force availability, high farmers' volition for agriculture, electricity availability, and so on.

On the other hand, constraints for the Project development in the area are low agricultural productivity, shortage of other stable water resources, limited crop area disorderly markets and inadequate marketing facilities, small employment opportunity, severe natural condition, low versatility of irrigation system, lack of farmer's organization activities, realization of appropriate water charges, complicated institutional issues and other socio-economical impediments.

While the enhancement of social and economic welfare of the people is still pivoted, the EFYP strengthens most notably the redefinition of the government's role in the economy, being pursued at the time of fundamental change in the domestic and global economies. From these warrants, basic policy of EFYP can be professed by four issues, (a) improve macro-economic management, (b) realize good governance, (c) progress towards competitive markets, and (d) encourage private investment.

Considering the development potential of the Study area as above-mentioned constraints shall be overcome by achieving the objectives of the Project through well formulated strategies for development. Development objectives of the Project have been defined as follows:

- to realize large-scale agricultural development

- to improve basic social infrastructures
- to conserve and ameliorate the environment
- to meet with crop-based irrigation
- to promote farmers organization
- to set up effective institutions

Irrigation is a core component of the Project. Successful irrigation will contribute to the Project targets directly and indirectly. Prior to formulating the development plan, the project area and basic scheme for irrigation have to be confirmed.

Summery of Optimizing Study for the Project

	GCA (ha)	CCA (ha)	Cost Ratio *		
			Type A	Type B	Type C
60 feet	134,600	115,600	1.00	1.29	-
45 feet	110,600	95,000	1.03	more than 1.29	-
30 feet	79,800	68,500	1.02	more than 1.29	-

*: Cost ratio is (NPV par ha of each plan)/(NPV par ha of Type A, at 60 feet).

Types A, B and C are the study cases of pumping by a single station and plural stations in the main canal and each station for every distributary, respectively. Type C is not realistic and has not been examined on the cost since it requires use of whole CRBC gravity canal and accordingly reconstruction of the canal is necessitated. Results of the case study has shown that larger scale development is more advantageous for the Study Area. The case of Type A of 60-foot lift has been found optimum and therefore selected.

The Project

(The Project area)

The Project area (gross commanded area, GCA), including the irrigable area including covered area by 2.0 meters water head gained by new construction of feeder canal, is 134,600 ha. Accordingly, cultivable command area (CCA) becomes 115,600 ha, of which 108,640 ha is ordinary suitable area for irrigation and remaining 6,960 ha marginal sandy soil area.

Project Area	134,600 ha	GCA
Unproductive land	4,500 ha	
Residential land	1,400 ha	
Future resident land*	3,000 ha	
Sub-total	125,700 ha	Gross Irrigable Area (GIA)
Right of way	10,100 ha	Applying 8% of GIA
CCA	115,600 ha	

* : This will be mostly utilized unirrigable land due to high elevation.

(Agricultural development plan)

Grains(wheat, paddy and maize), gram, cash crops (sugarcane, cotton and oil seeds), fodder, fruits and vegetables have been subject to selection for cropping by taking account of meteorology, soil textures, profitability, labor and water requirements, etc. These crops have popularly been cropped in and around the Study Area and the farmers are well experienced and have no difficulty in their cropping. New crops of fruits and vegetables are to be introduced only for the local demand in the Study Area.

Cropping areas by crops have been programmed as shown in the following table by taking account of increase of demands for grains and cash crops by increase in population and income, increase of demand for fodder by increase of cattle heads and sales income of fodder, and the present cropped area for fruits and vegetables.

Seasons/Crops	Areal percentage
Kharif Season	
Cotton	10%
Pluses	5%
Maize	20%
Fodder	10%
Sugarcane	10%
Fruit/Vegetable	5%
Sub-total	60%
Rabi Season	
Wheat	45%
Oilseed	10%
Gram	10%
Fodder	10%
Sugarcane	10%
Fruit/Vegetable	10%
Sub-total	90%
Spring Season	
Spring Maize	5%
Sunflower	5%
sub-total	10%

After Implementation of the Project, sufficient irrigation water is supplied by pumping and thus a remarkable increase in unit yield is anticipated. Target unit yields of crops after the implementation have been set at 3.50 tons/ha from the present 0.63 for maize, 4.00 tons/ha from the present 1.04 for wheat, and 70.0 tons/ha from present 35.55 for sugarcane by referring the results of experiments by Agricultural Research Institute, D. I. Khan. As soon as the Project is implemented, crop production will start to increase and is assumed to reach at the target unit yields in the 7th year after completion of the construction.

(Irrigation and drainage plan)

The most popular surface irrigation methods such as furrow irrigation or horizontal boarder irrigation are to be applied to the command areas. Furrow irrigation needs neither to change the shape of present farm plots nor precise land leveling. Application of farm machinery is also easy. However for the sandy soils in the command area, their permeability is so high at the beginning stage of irrigation that careful application of surface irrigation is required.

An irrigation efficiency of 0.58 (conveyance: 0.90 x delivery: 0.86 x application: 0.75) is proposed for the area of ordinary soils.

For the sandy land, field application efficiency is assumed at 0.40. Therefore, overall irrigation efficiency for sandy land at 0.30 (conveyance: 0.90 x delivery: 0.86 x application: 0.40) is proposed.

By applying proposed cropping pattern, efficiency is assumed at 0.40. Therefore, overall irrigation, water requirement for irrigation is calculated. The results are summarized below.

Land category	Area	Volume of water requirement		Peak discharge
	(CCA)	Kharif	Rabi	
PC-1	110,500 ha	787.9 MCM	674.5 MCM	66.17 cum.s
Ordinary land	108,640 ha	619.3 MCM	544.3 MCM	63.33 cum.s
Sandy land	6,960 ha	76.7 MCM	67.4 MCM	7.84 cum.s
Sub-total	115,600 ha	696.0 MCM	611.7 MCM	71.17 cum.s
Loss for Feeder Canal		44.8 MCM	44.5 MCM	(74 cum.s)*
Total		740.8 MCM	656.2 MCM	

*: The design discharge at Chashma Intake is estimated as 74 cum/s including water conveyance loss in the feeder canal.

In the above table, water right from the Indus for the Project is defined in accordance with the water requirement for PC-1, and the design water requirement for irrigation is within the water right.

Distribution system of the Project consists of the following components.

Components	Facilities	Functions
Intake	Intake structures	to take water effectively and correctly from the Indus river
Conveyance	Feeder canal	to convey water from the intake structures to the pumping station
Lift	Pumping station	to lift conveyed water through the feeder canal to the beginning point of main canal
Transmission	Main canal	to transmit and to divert lifted water for command area
Conveyance	Distributary	to convey water timely and correctly to each *mogha*

Each component consists of the above facilities and their related structures. Institutional set up for implementation of the Project could be conducted through the newly-established authority and farmers organization so that crop-based irrigation can be introduced. Along with the institutional preparation, irrigation system which consists of the above components shall be designed for responding to the water demands.

- Intake structure shall be independent from the existing intake gate for the C.R.B. gravity system, to avoid rivalry of both water uses.

- Combination of pump shall be decided so as that water supply can respond economically to fluctuation of water demand through operating of different numbers of pumps.

- Main lift canal shall be designed to have sufficient flow velocity for prompt response to the request from each distributary.

- Regulating pond to supply water to meet the actual water requirement shall be equipped at the head of each distributary. (The regulating pond should be multipurpose, such as water regulation, domestic water supply, environmental improvement, etc.)

During field survey on the Feasibility Study, a series of interviews with the farmers were made in order to know farmers' opinion and requests for the Project. Farmers expressed their strong desire for the Project through the interview. One hundred percent of interviewees agreed to pay costly *abiana* for lift irrigation if water is available when they needed it.

Farmers' consent for the Project and self-reliance effort on the Project is essential for the success of the Project. Furthermore, providing irrigation water as farmers need is the most important condition in order to obtain full farmers' consent to the Project. It is also necessary to supply water to meet the crop water requirements so as to realize maximum productive capacity of the Project.

It is, therefore, absolutely necessary to establish certain rules on water management that water user must be subjected to. Concept of crop based irrigation of the Project is to build irrigation system and such rules which can easily supply water to any farmers in meeting the water requirement.

Basic concept for drainage planning for the Project is to drain flood water across the proposed main canal promptly through existing CRBC cross drainage structures, and not to allow excessive floods flowing into the Project area through proposed cross drainage structures across the proposed main canal. In accordance with the basic concept, four (4) components of drainage, i.e., cross drainage structures, flood carrier channel, supplemental flood drainage channel, open collector drain, are planned.

(Supplemental domestic water supply plan)

Domestic water supply including drinking use in the Project area mostly depends upon groundwater. The groundwater has not always good features in quality although it has enough quantity to local demand.

Domestic water supply in the Project area could basically follow the existing systems and future development plan of the Public Health Engineering Department in D. I. Khan. However, irrigation water of good quality conveyed through the proposed canals will be appropriated to domestic water use to the residents who need the supply.

(Farm road network plan)

Delay of prompt construction of farm road is one of constraints to easy traffic and appropriate agricultural transportation in the Project area. As the irrigation system is constructed through the Project, farmers' activities in agriculture is activated, and proper farm road network is much required for the improvement. Present road density in the Project area is only about 150 meter/km^2 (national average: 210 meter/km^2). The Project shall aim at 500 meter/km^2 road density (a national target in the 8th 5 year plan in Pakistan) in the Project area.

(Institutional improvement plan)

Implementation of the C.R.B. lift irrigation project should be made through a different approach. The most acceptable approach is that there shall be an independent statutory authority to be newly established through an act of the provincial government to carry out the planning, development and operation of the Project through involvement of farmers associations. Name of the authority is tentatively called as "Chashma Right Bank Development Authority".

The authority, to be called Chashma Right bank Development Authority with Headquarters at D. I. Khan, shall be constituted under an act of the provincial parliament, with the composition of a chairman, three members and two advisors in the board of directors.

The authority should have the minimum key staff only. During the construction stage the tasks shall mostly be managed by consultants as much as possible so that the authority would not be over-staffed, and in the project operation stage member of staff will be decreased.

The authority should be funded by the provincial government to receive the international loan directly to the authority. The funds for the proposed implementation should be disbursed strictly in accordance with the construction schedule given in the approved project document.

The authority being autonomous in nature should make its own rules. It should be given legal powers under relevant acts for smooth achievement of their duties such as power for acquisition of land, collection of revenues, etc.

Although the authority is to be set up for the development of C.R.B. lift irrigation project, the legislation should be drafted so as that it can take over the operation and maintenance of the existing C.R.B. gravity irrigation system in a later stage.

In order to eliminate various difficulties in implementation and operation of irrigation projects by the newly established authority, farmers' associations are to be newly set up. Members of the associations are given the power to distribute the water as they wish, maintain and operate the distributary and to collect water charges in a manner to generate enough extra funds to undertake small projects as they consider necessary. However, it should be kept in mind that authority functionaries should have least interference and should only advise when such a guidance is needed.

It is proposed that Unit Farmers' Association (UFA), Distributary Water Association (DFA) and Farmers Representative on the Authority shall be established.

(Land conservation plan)

The main subjects for Land/Soil conservation in the study area are 1) erosion, sedimentation and inundation caused by flood sheet flow, 2) wind erosion in dune sand area, and 3) salinity and waterlogging in the command area.

In some sand dune portions of north and south of the Project area, yearly expansion of the sand dune is noticed. Wind erosion in such sand dune area essentially required soil conservation measures from the standpoint of farmland conservation and removal of sedimentation in the canal. With wind erosion control measures, fixation of shifting sand, the shelterbelts and wind-breaks, and improved dry-farming practices should be coped.

Main canal and distributaries are designed with lining by concrete in this project. Because of good quality water from Indus river and scarce outbreak of injury of salt, salinity will not be a significant problem after completion of the Project.

Furthermore, drainage is accelerated by newly installed open collector drain as well as flood carrier channel for flood mitigation. These measures will be much effective not only for salinity control but also for water logging.

(Environmental management plan)

The environmental monitoring and evaluation is necessary to evaluate the environmental aspects and impacts caused with the lapse of time, and to rectify the significant negative or unexpected impacts at the earliest. NWFP Environmental Protection Agency (EPA) is proposed for the environmental management. The evaluation of monitoring should be reported at least once a year.

More important components or issues are groundwater level, soil salinity and human activities. Especially on human activities, it is very difficult to evaluate the monitoring. The socio-economical data, which will be collected through monitoring and evaluation on the expected project benefit at the detail design stage, should be fully used.

The most important matter is proceedings for early warning to the environment as soon as some considerable negative impacts are noticed. Anticipation from data of periodical monitoring on incidental or rapid growing negative impacts at the earliest stage, and formulation of action plans to control their intensity and extension at the minimum level are required.

Project Component and Cost Estimate

(Project components)

Location of the intake has been decided at about 1.5 km on the right side of the barrage and about 20 m in the left side of the Right Spur Dike No. 1. Designed discharge is 74 cms and the electric driven radial gate (4.8 m x 6.0 m x 4 gates) is planed for installation. However, in case the WAPDA agrees, it may be shifted to be located in the feeder channel of Chashma Hydropower Project.

The plan of a feeder canal, aligned almost parallel to the existing CRBC and keeping distance from residential areas, connects the intake and the pumping station, has been selected after detailed examination of the engineering and economic feasibility. The feeder canal is to be lined by concrete because of the advantages of reduced hydraulic head loss and seepage, prevention of growth of weeds, economy in maintenance and structural safety, etc. Major design features are longitudinal gradient of 1/14,000, design discharge of 74 cm.s, and design velocity of 1.0 m/s. Structures appurtenant to the feeder canal are eleven numbers of super passage one cross-drain structure, one escape cum silt ejector and 29 bridges.

Location of the pumping station has been selected at sandy hill near CRBC/RD/184 for shorter length of delivery pipeline and to reserve land for settling basin and escape facilities. Design conditions for the pumping station are design capacity: max. 72 cms. min. 20 cms, and actual head: 18.3 m (suction WL 190.70, delivery WL 209.00).

The most appropriate type of pump has been studied and determined to be vertical volute type mixed flow pump with umbrella-type suction due to its advantageous pump efficiency, suction efficiency and O&M. The number of pump unit is decided to be 6 units of 10 cms pump (bore 2,000 mm, 3,000 kw) and 2 units of 6 cms pump (bore 1,650 mm, 1,800 kw), by economic alternative study on construction and equipment costs and annual operational costs.

A 700 m-long pipeline is to be constructed from pump station to the beginning point of the main canal. Judging from the project implementation schedule and construction workability, a 3-series pipeline of steel pipe ø 3,200 mm has been selected.

Cross-sections of the canal and longitudinal bed slopes have been determined by giving the velocity as 1.0 m/s or nearly but less than 1.0 m/s not to allow siltation of suspended load throughout the sections. The same type and thickness of concrete

lining has been employed as in the feeder canal. Side slopes are 1:1.5 and ratio of B to D is 2.95-3.5, as same as in CRBC. The main canal with a total length of 113.25 km, is to be equipped with various appurtenant structures in the course such as cross regulator, cross drains, escape structures, head regulators, bridges, etc. Cross regulators have been employed at 18 places in order to regulate fluctuation of water level less than 0.6 m for stable division.

Command area under the Project is divided into 25 command areas by the topographical condition. Distributaries are branches of the main canal to lead water to their command areas. The distributaries are planned to be concrete-lined, and the design velocity is also 1.0 m/s so as to prevent silting of suspended load. The side slopes are 1:1.5, and B to D ratio is 1:3 as same as in CRBC system.

Along the main canal, partially elevated land higher than FSL of distributary may not be irrigated by gravity but be irrigated by installation of sump well, use of pumps and water supply form distributary. Such area may be included into the command area as sump well area and amounts to 3,970 ha in GCA or 3,660 ha in CCA which is equivalent to about 3% of the total CCA.

In the vicinity of each head regulator to take water into distributary from main canal, a regulating pond has been planned for construction. This is because it enables prompt and precise water supply in response to the request from on-farm level, water distribution more effective and water management loss at minimum. In addition, multi-purpose utility zone can be developed beside the pond including facilities of O&M office, farmers' hall, store houses, etc. The pond may also be utilized for fish culture and as a recreation area for villagers. Effective storage capacity of a regulating pond has been determined to be one-day volume at design discharge.

Flood carrier channels requiring training of existing channels are quite important drainage facilities for the Project to minimize severe damage by floods. They are to be improved to carry once-in-40-year flood floods through whole channels by training of the watercourse and cross-sectional amendment.

In order to continuously monitor the behavior of groundwater table to be caused by continuos operation of irrigation activities in the future, observation wells are to be installed for CRBC areas. Setting the interval between wells to be 4 km, 120 wells have been planned in total.

Stable and dependable supply of domestic water is to be supplemented by installation of shallow wells for drinking water at necessary places, such as relatively high-elevated land near offtake of each distributary. Sump pits and watercourses from the distributaries or regulating pond for other domestic water uses are also planned to be installed.

In addition to the present road network and those to be constructed by the on-going Farm to-market Road Project, maintenance roads along the main canal, distributaries and minors are to be constructed and served for public traffic as well. Total length of roads to be constructed under the Project and served as maintenance cum farm roads amounts to 555.9 km. In addition, 32.5 km of farm roads are to be newly constructed under the Project and consequently road density in the Project area will reach to 702 m/km^2.

Project Cost

(Construction cost)

Construction cost is the cost for construction of project facilities and is treated to be an initial cost. The cost is composed by (1) direct construction cost, (2) indirect construction cost, (3) physical contingencies, (4) price contingencies (29% (7-year-average 4.5% per anum) for foreign portion and 37% (7-year-average 5.5% per anum) for local portion), and (5) interest and service charges. The direct construction cost amounts to 10,120 million Rupees in total. Consequently, total construction cost amounts to 17,166 million Rupees consisting of 10,377 million Rupees (60%) of foreign currency portion and 6,789 million Rupees (40%) of local currency portion.

(Replacement cost)

Facilities for replacement within the Project life are pumping machineries, gates for intake, feeder canal, main canal, distributaries and regulating ponds, and O&M equipment such as vehicles, office equipment and maintenance equipment. Replacement costs for them have been estimated at Rs. 1,290.3 million equivalent to 7.5% of the project cost or 12.8% of the construction cost.

(O&M cost)

Annual O&M cost including costs for administration of the Authority and pump operation has been estimated at Rs. 293.3 million equivalent to 1.7% of the Project cost or 2.9% of the construction cost.

Project Implementation

(Implementation schedule)

The construction period of the Project is seven (7) years in accordance with the scale of the construction works, capacity for construction, and progress of institutional arrangement. Implementation of the work will be proceeded from Intake structure, Feeder canal, Pump station, Main canal and Distributary and On-farm development.

In the Phase I stage of 4-year period, Intake structure, Feeder canal, one third part of pump work (all houses, and one third numbers of pumps), one line of Delivery pipeline among 3 lines, irrigation and other facilities until Disty No. 6 having command area of 27,210 ha, will be completed.

In the succeeding Phase II of 3-year period, remaining pump, 2 lines of Delivery pipeline, irrigation and other facilities from Disty No. 7 until No. 25 having command area of 88,390 ha, will be done.

The construction cost in Phase I and II is Rs. 8,841.9 million and Rs. 8,323.8 million respectively.

(Institutional arrangement)

Soon after the conceptual approval of the project, the act should be drafted for setting up of the Chashma Right Bank Development Authority. Soon after the legislation, the authority core body should be set up to participate in loan negotiation, appoint consultants, oversee the detailed design and estimates contract documents and selection of contractors for the project, to organize farmers' associations and to oversee the planning of the infrastructural facilities.

As the work picks up, the authority should gradually expand the body and appoint five (5) agricultural extension experts, and additional 20 experts in the later stage. After approval of the Project loan, some financial experts shall be appointed.

The functions, duties, assets and responsibilities of all the relevant departments to be replaced by the authority should be transferred to the authority immediately on setting up of the authority to have a clean break from the present system to the new system. The authority takes over all or most of the developmental functions in the district within one year from the date of setting up of the core body.

Soon after the setting up of the authority it should activate its agriculture wing to help formation of farmers' associations within the stage 1 and 2 of the C.R.B. gravity canal so that the farmers are organized to use the water according to crop water requirements on the gravity canal and help in planning and design of the main lift canal.

It is further proposed that a special project unit should be set up for the development of one of the distributaries (Disty 5) of the gravity canal in accordance with the new approach.

Operation and Maintenance

(Organization for O&M)

Operation and management of the Project are to be borned by Chashma Right Bank Development Authority (CRBDA) as an main body to control them. Head quarter of CRBDA is, after the project construction, to be reorganized for implementation of O&M proceedings. In the O&M implementation stage the head quarter has to be the center to control whole O&M activities including technical assistance to the farmers.

O&M of each distributary command area is to be controlled by the Distributary O&M Office (DOMO), which is a branch office of the head quarter and staffed with the minimum personnel. O&M activities are to be carried out by farmers through the Distributary Farmers' Association (DFA).

Under the head quarter of CRBDA, Pumping O&M Office for pump operation, Intake O&M Office for intake monitoring (operation by WAPDA), Feeder Canal O&M Office for O&M of the feeder canal and Main Canal O&M Office for O&M of the main canal, are to be established.

(O&M for irrigation)

Crop-based irrigation will function successfully under will equipped circumstances as follows:

- Establishment of a realistic cropping pattern
- Elaborate water delivery schedule
- Systematic and well-trained operation
- Close communication on operation
- Accurate and timely measurement of discharge

- Reasonable water charge system and fair collection
- Adequate and useful technical advice system

Project Evaluation

(Economic evaluation)

Project evaluation has been made base on the following conditions in accordance with PC-I Guideline of the Republic of Pakistan.

(1) Project life is 50 years.

(2) Costs for the Project components are in Pakistan Rupee (Rs.) at the price level in May, 1994.

(3) Applied exchange rate of foreign currency (US$ 1.0 = Rs. 30.0 = ¥ 107.1) is an average from July, 1993 to March 1994.

(4) Economic price of local currency costs are calibrated from the market price by multiplying the standard conversion factor (SCF = 0.9).

(5) Economic price have been appraised by excluding transfer costs such as taxes, subsidies, bank interests, etc.

(6) Economic prices of international trade goods such as fertilizers and agricultural products, have been appraised from the World Bank's project prices in 2005, while those of local trade goods from financial prices.

(7) Economic price for employment of unskilled laborer has been calibrated from the financial cost by multiplying the labor conversion factor of 0.88.

(8) Economic prices of project cost, O&M cost and replacement cost have been calibrated from their financial cost by calculating the itemized. Construction conversion factors for transfer costs in the local currency portion and unskilled labor costs.

(Economic benefit)

In addition to the benefit by crop production, following benefits have been appraised into the direct benefits.

(1) Crop production benefit

(2) Benefit from saving transportation costs.

(3) Benefit from developing the upper reaches of the present flood-irrigated areas by transfer of the water right to them.

(4) Benefit from development of water source for domestic water supply by use of irrigation water.

(5) Benefit from saving of migratory cost in the summer due to improved year-round settlement of village farmers.

(6) Benefit from improved production environment.

(Economic evaluation)

An economic evaluation of the Project has been made as presented in the following table in terms of economic internal rate of return (EIRR), net present value (NPV) by 12 % discount rate and benefit/cost ratio (B/C).

Item	Crop Production =(A)	Farm Road +(A) =(B)	Water Right +(B) =(C)	Domestic Water +(C) =(D)	Migration +(D)	Total
1. EIRR	13.6	14.7	14.8	15.0	15.1	15.3
2. NPV(Rs. Million)						
- Benefit	12,505	13,624	13,755	13,969	14,018	14,238
- Cost	9,066	9,066	9,066	9,066	9,066	9,066
3. B / C	1.38	1.50	1.52	1.54	1.55	1.57

In order to evaluate the soundness of the Project against probable changes in future economic circumstances, a sensitivity analysis has also been made and resulted as follows.

Item	Crop Production =(A)	Farm Road +(A) =(B)	Water Right +(B) =(C)	Domestic Water +(C) =(D)	Migration +(D)	Total
1. Project cost overrun by 20%	11.8	12.7	12.8	13.0	13.1	13.2
2. Benefit decrease by 20%	11.0	12.0	12.1	12.3	12.3	12.5
3. Delay in construction for 2 years	11.2	12.0	12.0	12.2	12.2	12.4
4. Case 1 and 2	9.5	10.3	10.4	10.6	10.6	10.8
5. Case 1 and 3	9.8	10.5	10.6	10.7	10.8	10.9
6. Case 2 and 3	9.2	9.9	10.0	10.1	10.2	10.3
7. Case 1, 2 and 3	7.9	8.6	8.7	8.8	8.9	9.0

(Financial evaluation)

Financial evaluation of the Project has been made, based on the farm management analysis in two cases of with and without the Project, through comparisons of surplus farm income, water charges and cost for replacement of the facilities. The Farm management analysis has been made by each of three crop rotation systems and by three sizes of small (2.3 ha), medium (4.7 ha) and large (18.9 ha) farms.

From results of the farm management analysis, followings relevant to crop rotation system by farm size, water charge and replacement cost have been found.

(1) For small-scale farms, crop rotation patterns mainly for maize, oil-seeds and wheat are most economic, and the expense for water charge and replacement amounts to 30 % of net incremental farm income.

(2) For medium-scale farms, rotation patterns excluding sugarcane is economical and the expense remains at 30 % of net incremental farm income more or less.

(3) Cropping patterns mainly for sugarcane are not economical even for large-scale farms. Cropping of sugarcane in the Project Area may be feasible only by considerable decrease in production cost through operation by some large-scale corporations.

(4) For selection of crops at farmer's level, cropping patterns have to be selected for each service area of watercourses, minors and distributaries with due consideration of the above-mentioned as well as of fair and equitable allocation of irrigation water.

(Socio-economic benefit)

By implementation of the Project, increase in employment in various social and economic sectors is expected. And by increase in cropping acreage and productivity, additional labor input of 7.37 million man-day is expected annually, Furthermore by the Project construction, employment of 8.60 million man-day will be generated during seven years of construction.

As an indirect benefit of the Project, improved accessibility to the markets in D. I. Khan city and in other districts as well as improved farm road network connected to the roads along the Project canals, may be counted into.

Farmer will have income uplift according to his scale of operation farm through his original contrivance, under well water management carried out by the Farmers Association in which farmer is not given discriminative treatment to scale of farm size. As the result of this, income differentials will be expected to alleviate.

Along with the Project implementation, rapid price hike for farm and housing lands is anticipated. For large-scale farmers, the price hike of farmland works to increase the security value and credibleness of farm credits. On the other hand, it gives a negative effect to the small-scale farmers to acquire farmland. In order to promote acquisition of farmland by the marginal and tenant farmers, some remedial measures such as agrarian reform, improvement of tenancy rules, year-round non-farm job creation program, etc. are required.

Recommendation

Implementation of the Chashma Right Bank Lift Irrigation Project has been justified since it has no engineering difficulties and can expect a high EIRR as much as 15.3% and other considerable social benefits. Accordingly, the Project is recommended for early implementation.

New establishment of Chashma Right Bank Development Authority (CRBDA) is recommended as an executing agency for implementation of the project and operation and maintenance of the project facilities. In accordance with the proposal made in this Report, the prompt commencement of preparation for establishment of CRBDA including its legislation is definitely required.

In parallel to establishment of the authority, commencement of preparatory works for establishment of water users' associations is recommended. In addition to the

orientation activities to the farmers for the establishment, promotion of organizing farmers and O&M by their own organization is recommended for their field application in one of distributary command areas in the gravity irrigation area. In the course of organizing farmers' associations, effective methods for giving guidance to the farmers would be learned and will be applied to the Project. The Study Team has proposed the DDP program as discussed in "ANNEX F, Attachment F4".

Reservation of stable power source for running pumps is recommended. Close coordination and correct procedures are required for secured power supply from power projects in and around the Project. Prior to commencement of construction, a transmission line to the planned substation for the pumping station is expected for early installation by the Government of Pakistan.

Water diversion from the Indus is subject to examination and permission by the Indus River System Authority. Earely commencement of consultation with the Authority on the diversion issue shall be started, while coordination with WAPDA, who will be in charge of the intake operation, shall also be initiated on operation and management system of the intake.

Post-project monitoring and evaluation of the Project is recommended for implementation at the time proposed in this Report. Based on the results of evaluation, establishment of a system to improved operation, maintenance and management of the Project is also important.

Network of groundwater observation wells shall be maintained and in case some abnormal rise of groundwater table is found, some organizational arrangements to take necessary measures such as implementation of urgent drainage works shall be required.

Periodical survey for evaluation of crop-based irrigation accomplishment under the Project, is recommended. Findings through the evaluation shall be examined and reflected in the irrigation activities. Achievements by the farmers are expected for dissemination to other project areas as well as for public utilization.

It is also recommended that selection of crops for each command area of distributaries has to be programmed in conformity with the crop rotation system with due consideration on farm sizes.

Charging all expenditures and replacement cost seems to be considerably high burden especially for small scale farmers. It is recommended to subsidize replacement cost, staff salary and electric expenditures by reducing electric tariff, in line with the tube well tariff rates.

THE FEASIBILITY STUDY
ON
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT

MAIN REPORT

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Abbreviations

ADA	:	Agricultural Development Authority
ADB	:	Asian Development Bank
ADBP	:	Agricaltural Development of Pakistan
ARI	:	Agricultural Research Institute
AUP	:	Agricultural University Peshawar
C&W	:	Communication and Works Department
CAD	:	Command Area Development
CCI	:	Council of Common Interests
CRBC	:	Chashma Right Bank Canal
CRBDA	:	Chashma Right Bank Development Authority
DFA	:	Distributary Farmers' Association
DOMO	:	Distributary Operation and Maintenance Office
DPCC	:	District Project Coordination Committee
EFYP	:	Eighth Five Year Plan of Pakistan
EIA	:	Environmental Impact Assessment
EPA	:	Environmental Protection Agency
FAO	:	Food and Agriculture Organization
FATA	:	Federally Administrative Tribal Area
GDP	:	Gross Domestic Product
GOJ	:	Government of Japan
GOP	:	Government of Pakistan
GVA	:	Gross Value Added
HBL	:	Habib Bank Ltd.
IBRD	:	International Bank for Reconstruction and Development
ID	:	Irrigation Department
IEE	:	Initial Environmental Examination
IIMI	:	International Irrigation Management Institute
IRSA	:	Indus River System Authority
JICA	:	Japan International Cooperation Agency
MCB	:	Muslim Commercial Bank
MCO	:	Mobile Credit Officer
NBP	:	National Bank of Pakistan
NFC	:	National Fertilizer Corporation
NGO	:	Non-Governmental Organization
NHA	:	National Highway Authority
NWFP	:	North West Frontier Province
O&M	:	Operation and Maintenance
OECF	:	Overseas Economic Cooperation Fund
OFWM	:	On-Farm Water Management
PARC	:	Pakistan Agricultural Research Council
PASSCO	:	Pakistan Agricultural Storage and Services Corporation
PCC	:	Project Coordination Committee
PE&D	:	Planning Environment and Development
PHED	:	Public Health Engineering Department
PMC	:	Project Management Committee
PSCC	:	Project Supervision and Coordination Committee

RDD	:	Rural Development Department
REP	:	Rural Electrified Project
SCARP	:	Salinity Control and Reclamation Projects
SFYP	:	Seventh Five Year Plan
SSP	:	Soil Survey of Pakistan
S/W	:	Scope of Work
UBL	:	United Bank Ltd.
UFA	:	Unit Farmers' Association
USAID	:	United States Agency for International Development
WAPDA	:	Water and Power Development Authority
WEC	:	WAPDA Environmental Cell
WSS	:	Water Supply Schemes

Conversions, others

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
ft	:	feet
sq.m (m^2)	:	square meter
sq.km (km^2)	:	square kilometer
sq.mile	:	square mile
acre	:	acre
ha	:	hectare
cum (m^3)	:	cubic meter
MCM	:	million cubic meter
MAF	:	million acre feet
kg	:	kilogram
t (ton)	:	1,000 kg
lbs/ft^3	:	pound per cubic feet (=16.0185 kg/m^3)
sec (s)	:	second
hr	:	hour
cms	:	centimeter per second
m/s	:	meter per second
cum.s (cum/s, m^3/s)	:	cubic meter per second (=35.310 cfs)
cfs	:	cubic feet per second (= 28.320 liters per second)
l/s	:	liter per second
knot/hr	:	knot per hour (=1,852 m/hr)
kv	:	kilovolt
kW	:	kilowatt
Mw	:	megawatt
MVA	:	megavolt-ampere

rdmax	:	Maximum Dry Density
OMC	:	Optimum Moisture Content
CEC	:	Cation Exchange Capacity
EC	:	Electrical Conductivity
ETo	:	Potential Evapotranspiration
ETpan	:	Pan Evapotranspiration
Kc	:	Crop Coefficient
CCA	:	Cultivable Command Area
GCA	:	Gross Command Area
GIA	:	Gross Irrigable Area
EIRR	:	Economic Internal Rate of Return
NPV	:	Net Present Value
RD	:	Reduced Distance
WL	:	Water Level

CHAPTER I INTRODUCTION

1.1 History of the Study

The irrigated land in the North West Frontier Province (NWFP) in which the Study area locates, is only 45% of the total cultivated area. The Government of NWFP has given the highest priority to the irrigation development in the area of right bank of Indus River in D. I. Khan District. The Government of NWFP has been anxious for realization of this project to utilize the surface water of Indus River effectively since 1960s.

Paharpur inundation canal was constructed in the very early part of this century to irrigate 42,090 ha [104,000 acres] on the right bank of Indus river in D. I. Khan District. As the diversion of flows was not an easy job due to meandering of Indus river, the performance of the canal very often remained un-satisfactory. I&P department of NWFP Government considered the possibility of bringing out a canal on the Right Bank of Indus from Kalabagh Headworks for the irrigation of these areas.

After Preliminary studies by I&P Department, the work of the feasibility study to irrigate these areas was entrusted to WAPDA. In November 1970, the WAPDA prepared a feasibility report on the Chashma Right Bank Irrigation Project to irrigate an area of 202,340 ha [500,000 acres] (141,640 ha [350,000 acres] in D. I. Khan District and 60,700 ha [150,000 acres] in D. G. Khan District) through gravity system. In December 1973, a PC-I Proforma to irrigate a total area of 550,000 ha [1,360,000 acres] (424,900 ha [1,050,000 acres] in D. I. Khan District and 125,100 ha [310,000 acres] in D. G. Khan District) through pumping-cum-gravity system was framed in accordance with directions of the two provincial Government of NWFP and Punjab.

The construction on the gravity system of the project was started during 1978 being financed by ADB and was targeted to complete by 1985 in three stages. Till 1992 only Stage I and Stage II of the system have been completed. The Stage III is now scheduled to be completed in 7 years starting from fiscal year 1994-95. It is likely to take at least 10 years taking the completion target to 2004-2005.

As to the lift system of the Project, it could not be implemented in absence of the water accord. The NWFP Government has been actively considering the area under the 60 ft. lift for irrigated agriculture development. I&P Department of NWFP

requested WAPDA to undertake the feasibility study of the scheme for 60 ft. lift through PC-II in February 1991. Soon after the settling of Indus water apportionment, the Government of NWFP requested the Government of Japan to provide technical assistance for the Feasibility Study of this Project.

1.2 Authority of the Study

Since the water apportionment of Indus River has been settled among 4 provinces in March 1991, the Government of Pakistan (GOP) requested to the Government of Japan (GOJ) for the assistance of the feasibility study on Chashma Right Bank 1st Lift Irrigation Project(the Study). In reply that, the GOJ dispatched through the Japan International Cooperation Agency (JICA) a preliminary mission for the Preparatory Study headed by Mr. Sumio Oishi from October 26 to November 14, 1992 and the scope of work (S/W) for the feasibility study was agreed upon between the Irrigation Department of the Government of NWFP (ID) and JICA.

The S/W defines the objectives of the Study as to conduct the feasibility study on agricultural development for the Chashma Right Bank 1st Lift Irrigation Project through pump irrigation, covering an approximate project area of 110,000 ha.

Japanese government has started the Feasibility Study since March 1993, in accordance with the S/W. The S/W of the Study and minutes of meeting of the S/W are attached at the end of this volume as ATTACHMENT I

1.3 Study Area

In this Feasibility Study, the Study Area of 141,700 ha in its entirety locates in D.I.Khan District, N.W.F.P is defined as follows:

Eastern boundary:	C.R.B. Canal
Western boundary:	Proposed 1st Lift Canal having canal bed gradient at 1: 14,000 as same as CRBC, which takes off from the beginning point at around RD 185 of CRBC. at altitude 209.0m (685.7 ft.) to the terminal point at the provincial boundary of NWFP and Punjab near Ramak.
Southern boundary:	Provincial boundary with Punjab.
Northern boundary:	Khaisora Range.

1.4 Study Progress

The Study consists of Phase I and Phase II. The basic development plan of the Project was formulated in phase I. Successively, final development plan including facility planning, cost estimating, implementation scheduling and project evaluation was completed in the phase II study.

The Inception report was prepared during the preparatory home work of the Phase I study in March 1993. In line with the Inception report, the field study was carried out from July 1993 to September 1993. The Study team compiled Progress Report (I) summarizing the findings and results of the field survey. At the interim conclusion of Phase-I study, an Interim Report was complied in November 1993.

Since January 1994, the Phase II study was commenced by the study team after including the Institutional aspect in pursuance of the request by Pakistan Government. After compiling Progress Report (II) for field study of Phase II in September 1994, the team has compiled this final report for the Chashma Right Bank 1st Lift irrigation Project.

Japanese and Pakistani Participates of the Study area listed in the Table 1.1.

CHAPTER II BACKGROUND OF THE PROJECT

2.1 National Economy

2.1.1 Economy

Gross Domestic Product (GDP) at current factor cost in 1992/93 was Rs. 1,200,455 million (US$ 46.2 billion by the rate of 25.96). Per capita GDP at factor cost was Rs. 9,935 (US$ 383). Agricultural sector in Pakistan occupied around 25 % of GDP during 1988/89 to 1992/93 and held 48 % of labor force in 1993/94. Shares of GDP in industry and services sectors were 23 % and 52 %, respectively. There was no significant change in the sectoral GDP distribution during the last 5 years. Annual growth rates of GDP and per capita GDP during 1987/88 to 1992/93 could be estimated at 5.0 % and 1.8 %, respectively.

GDP growth in 1991/92 - 1992/93 was interrupted and down at around 2.3 %. This accrued mainly from a decline of 5.3 % in agricultural output due to excessive rains and devastating floods. GDP and growth rate are summarized as follows :

Sector	GVA* in 1992/93 (Rs. Million)	Share (%)	Annual Growth Rate (1987/88 - 1992/93) (% p.a.)
Agriculture	297,816	24	3.69
Industry	264,778	23	5.61
Services	637,861	53	5.32
GDP	1,200,455	100	4.98
(Per Capita GDP)	(Rs.9,935)	-	1.84

Note : * ; Gross Value Added at current factor cost

Cotton and cotton manufactures have been the main source of exports. The share of those exports during 1989/90 to 1991/92 was around 58 % to the total merchandise export amount. Rice export accounts for 6 % of the total amount. Non-traditional exports increased rapidly with 20.8 % p.a. during 1987/88 to 1991/92. Major import foods comprise edible oil, wheat and sugar which account for 4.4 %, 3.3 % and 1.1 % of the total import amount, respectively. Quantity of wheat import varied year by year from 601 to 2,171 thousand tons and 1,560 thousand tons on average during 1987/88 to 1991/92. Machinery import occupies a biggest share with around 25 % of the total.

2.1.2 Development Plans

(1) Seventh Plan review

Seventh Five Year Plan (SFYP) has been implemented since 1988/89, and 1992/93 was a last year of the Plan. Annual growth targets for SFYP were set at 6.5% in GDP and 3.3 % in per capita GDP during the plan period. These growth target could not be achieved i.e. actual growth rates were 4.98 % in GDP and 1.84% in per capita GDP. The average annual growth rate of the agricultural sector during the Seventh Plan period is estimated at 3.7% against a target of 4.7%. The shortfall is mainly due to the heavy rains and floods in 1992.

Actual crop production was below the Seventh Plan target except tobacco, vegetables, meat and milk production. Self-sufficiency in wheat could not be attained. Self-sufficiency of sugar has been attained, however the sugarcane production was below the target mainly due to lack of improved high yielding varieties. The overall growth of livestock has been 5.7% against the target of 5.3%.

(2) Eighth Plan objectives and strategies

Eighth Five Year Plan (EFYP) will be implemented from 1993/94 to 1997/98. Annual growth targets are set at 7.0% in GDP and 4.1% in per capita GDP. The annual growth rate of agricultural sector is expected to be 4.9% during the EFYP period.

The primary objective of the Eighth Plan in agriculture sector is set at the achievement of a growth rate higher than the population growth, in order to ensure food security, self-sufficiency and exportable surpluses. Integrated development of irrigation, drainage and agriculture with greater responsibility devolving on the Provincial Governments is emphasized.

The research and development activities will be focused on productivity evolving high production technology and its quick transfer to the farmers. Closer linkages will be established between the agriculture and irrigation departments. Concerted efforts will be made to improve the operational efficiency of the irrigation infrastructure and promote conjunctive use of water along with other inputs in order to rapidly increase crop production. Major emphasis will be laid on increasing the per acre yield of crops and improving the productivity of livestock, fisheries and forestry sub-sectors. Based on the above agricultural development strategy, major crop production targets during the EFYP period are expected as follows :

(Unit : %/a.n.)

Crops	7th plan Actual	8th Plan Target
Wheat	5.0	4.0
Rice	-0.8	5.5
Maize	0.9	4.0
Cotton	1.1	5.3
Sugarcane	2.9	5.0
Pulses	-0.5	4.3
Rape and mustard	0.3	3.7
Vegetables	8.7	5.0
Fruits	2.8	5.6

2.2 Agriculture in Pakistan

Pakistan is situated in arid and semi-arid climatic zones and is heavily dependent on irrigation. Of the country's total area of 57.8 million ha, 20.7 million ha were cultivated in 1991-92. The irrigated area is about 16.2 million ha of which about 11.7 million ha is under canal irrigation, most of it in Punjab and Sind provinces. More than one-third of cultivating land expanded since 1947 accrued by the irrigation improvement. It is estimated that around 79% of cropped area depend on irrigation. However, there are still potentially irrigable areas and high requirement for improvement in O&M of irrigation facilities and irrigation farming practices against the present extensive farming. Equal importance to new irrigation works is reclaiming irrigated land that has become saline through water logging and increase of ground water, especially in Sind province. Shares of surface and ground water contribution to irrigation are approximately two-thirds and one-third, respectively. North West Frontier Province (NWFP) covers 8.3 million ha, of which 1.9 million ha or 23 % is cultivated and about 0.8 million ha or 41 % irrigated. The Province is not self-sufficient in staple foods. In terms of cropped area, wheat and maize are of major importance, most of it grown under rainfed condition. Land utilization and irrigated area of Pakistan and NWFP are given as bellows:

Description	Pakistan ('000 ha)		NWFP ('000 ha)	
Cultivated Area :	20,660	(35.7%)	1,909	(22.9%)
- Net sown area	14,720		1,554	
- Current fallow area	5,940		355	
Total Cropped Area :	19,520		2,080	
- Area more than ones	4,800		526	
Un-cultivated Area :	37,120	(64.3%)	6,436	(77.1%)
- Cultivable waste	9,260		1,032	
- Not available for cultivate	24,400		4,073	
- Forest	3,460		1,331	
Total Area Reported :	57,780	(100%)	8,345	(100%)
Total Irrigated Area :	16,220	78.5%	785	41.1%

Source : Agricultural Statistics of Pakistan, 1991-92

Climate condition define two cropping patterns in Pakistan. These are wheat in Rabi season (winter season which extends from October to March) and paddy or cotton in Kharif season (summer season which extends from April to September). The six major food grains grown in Pakistan are wheat (66 %), paddy (rice, 18 %), maize (7 %), millet (4 %), sorghum (3 %) and barley (2 %), which together are grown on 11.7 million ha in 5 years' average from 1987/88 to 1991/92. After adding 1.4 million ha of pulses, the total food crop area comes 13.1 million ha. The main cash crops in Pakistan are sugarcane, cotton, oilseeds and tobacco, which together account for 4.3 million ha. In addition, 0.8 million ha are under fruits and vegetables, and 3.1 million ha are planted to other crops. This indicates that the food crops and cash crops account for 55 % and 18 % of cropped area, respectively as below :

Crops	Cropped Area ('000 ha)	(%)
Food Grain	11,667	54.6
Cash Crops	3,794	17.7
Pulses	1,420	6.6
Oilseeds	523	2.4
Vegetables	381	1.8
Fruits	452	2.1
Others	3,113	14.8
Total	21,350	100.0

Source : Agricultural Statistics of Pakistan, 1991-92

Wheat is the most important crop in terms of cropped area, production value and its role in consumption. Between 1975/76 and 1991/92, cropped area and production

increased from 6.1 to 7.7 million ha and from around 8.7 to 14.3 million tons. The larger proportion of the increase in production accrued an increase in unit yields, which doubled over this period. These increases were achieved through intensive use of fertilizer and high-yield varieties as well as irrigation. The weather, however, continue to be a crucial factor, particularly in the rainfed area. The cropping area, crop production and yield for major crops during 1987/88 - 1990/91 are estimated as below :

Item	Pakistan			NWFP		
	Cropped Area ('000 ha)	Production (000 tons)	Yield (t/ha)	Cropped Area ('000 ha)	Production ('000 tons)	Yield (t/ha)
Wheat	7,734	14,332	1.85	817	1,064	1.30
Paddy (rice)	2,064	3,233	1.57	62	116	1.87
Cotton	2,657	1,634	0.61	1	-	0.25
Gram	965	487	0.50	104	57	0.55
Sugarcane	871	36,070	41.43	102	4,376	43.05
Maize	855	1,180	1.38	500	735	1.47
Millet	424	175	0.41	13	7	0.56
Sorghum	398	231	0.58	22	15	0.70
Oilseeds(rape/mustard)	300	227	0.76	38	17	0.45

Source : Agricultural Statistics of Pakistan, 1991-92

2.3 Chashma Right Bank Irrigation Project

In the area of Chashma Right Bank, the west side of the middle reaches of Indus River a vast alluvial Plain is extending in Dera Ismail Khan District, NWFP and Dera Ghazi Khan District, Punjab Province. Due to low precipitation (274 mm), high evaporation (2,016 mm) and no irrigation water resource in the area the agricultural productivity is at very low level in spite of the fact that land itself has fairly high potentiality for agricultural development. The flood irrigation system is applied in some parts of farm lands, and the small tubewell irrigation systems are provided in very limited areas because most parts of groundwater is not usable because of the high salinity.

The initial Chashma Right Bank Canal (CRBC) Program was formulated in 1973, for the irrigation development of culturable command area of around 550,000 ha which consists of a 230,680 ha gravity irrigation system, and lift irrigation systems of a 146,480 ha 1st lift, a 100,400 ha 2nd lift and a 72,420 ha 3rd lift. After conclusion of the Indus Water Accord the water resources for the development in the area could be

brought from Indus River within their allotments.

This is the only major irrigation project to be developed in the Province of NWFP. Completed gravity irrigation system of stage I and stage II of CRBC has commenced to function. Remaining stage-III of CRBC is under construction financed by ADB. Gravity system of the Chashma Right Bank Irrigation Project is summarized as follows:

General Feature of CRBC Gravity System

	Stage I	Stage II	Stage III	Overall
C.C.A	55,800 ha	37,200 ha	137,680 ha	230,680 ha
NWFP	55,800 ha	37,200 ha	48,650 ha	141,650 ha
Punjab	-	-	89,030 ha	89,030 ha
Major works				
Main canal	84.0 km	36.5 km	143.6 km	264.1 km
Cost (10^6Rs.)	2,774.9	3,203.7	11,639.1	17,617.7
Cons. Schdl. (Plan)	1978 ----------		---------- 1985	1978-1985
Cons. Schdl. (Actual)	1978-1986	1986-1992	1994-2004	1978-2004

Lift irrigation plan on the Chachma Right Bank Irrigation Project formulated in 1973, consists of 3 phases according to the PC-I of the project. General feature of the lift irrigation schemes is as follows:

General Feature of Proposed CRBC Lift System

	1st Phase	2nd Phase	3rd Phase	Overall
Lift head	60 feet	120 feet	170 feet	
C.C.A	146,480 ha	100,400 ha	72,420 ha	319,300 ha
NWFP	110,460 ha	100,400	72,420	283,280 ha
Punjab	36,020 ha	-	-	36,020 ha
Water requirement (MCM)				
NWFP				
Kharif	787.9	717.6	516.6	2,022.1
Rabi	674.5	612.8	442.6	1,729.9
Punjab				
Kharif	281.1	-	-	281.1
Rabi	241.7	-	-	241.7

This Feasibility Study is restricted to the first lift phase which has been provided with a share of water in the Indus water accord.

2.4 Water Accord on Indus River System

(1) Historical background

The Indus river system comprises the main River Indus and its numerous tributaries, of which the important ones are, the Kabul, the Swat and the Kurram from the west, and the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej from the east. Before the British occupied the western India the irrigation in the area was done through inundation canals. From the middle of the 19th century onwards irrigation was considerable improved through construction of diversion works across the rivers.

Though the controversy for water apportionment had been kept alive by the parties concerned in the Government of India, a lot of large irrigation projects were implemented and became functional.

By the time India and Pakistan became two independent countries, the irrigation system of the Indus Basin had already become most extensive and complex in the world. On April 1, 1948 the East Punjab Government (India) arbitrarily cut off the supplies in every canal crossing into Pakistan. A serious situation developed on the Pakistan side which led to long drawn negotiations. The issue was settled with the signing of the Indus Basin Treaty through the offices of the World Bank in 1960.

Even during this time, additional three barrages on the Indus main followed in quick succession. The Kotri, Taunsa and Gudu barrages were completed in 1955, 1958 and 1962 respectively. The water allocation of these projects was substantially based upon the "Draft Sind-Punjab Agreement" of 1945.

Since the signing of the Indus Water Treaty many committees and commissions were appointed but unfortunately no decision for distribution of waters of Indus River and its tributaries among the four Provinces of the country, could be reached.

In the absence of a final settlement and award, the Provinces received irrigation supplies through ad hoc distribution arrangements of Indus waters which were notified by the Federal Government for each period/season of the year. Ad hoe sharing of only Indus command waters is done at present as per continuing practice without prejudice to the rights and claims of the Provinces on the Indus System waters.

Due to delayed decision on "Water Apportionment", losses to national economy and denial of employment opportunities had been indicated.

The Government in 1990-91 recognized the need for an early resolution of the issue. The Prime Minister set up a Sub Committee of the Cabinet to finalize the working paper and explore different options under which the outstanding issues could be resolved on a final basis. Based on the recommendations of the Sub Committee a summary was submitted to the Council of Common Interests (CCI) on 2nd January, 1991. An "Inter-Provincial Committee on apportionment of Indus Waters" was set up to examine all the previous reports on apportionment of Indus waters amongst the four provinces and formulate recommendations for the consideration of the CCI.

The four Chief Ministers met at Lahore on 3rd March, 1991 and again at Karachi on 16th March, 1991. They finally reached at a complete consensus by mutual agreement on the apportionment of the waters of the Indus River System between the Provinces.

(2) Apportionment of waters of the Indus River System

Major points of the Agreement of Apportionment of water of the Indus River adopted by the four Chief Minister's on 16th March, 1991 is reproduced below:

- In the light of the accepted water distributional principles the following apportionment was agreed to:

(in MAF)

Province	Kharif	Rabi	Total
Punjab	37.07	18.87	55.94
Sindh*	33.94	14.82	48.76
NWFP (a) Existing Canals	3.48	2.30	5.78
(b) Civil Canals**	1.80	1.20	3.00
Balochistan	2.85	1.02	3.87
	77.34 + 1.80	37.01 + 1.20	114.35 + 3.00

* Including already sanctioned Urban and Industrial uses for Metropolitan Karachi.

** Un-gauged Civil Canals Above the rim stations.

- NWFP/Balochistan Projects which are under execution have been provided their authorized quota of water as existing uses.

- Balance river supplies (including flood supplies and future storage) shall be distributed as below:

Punjab	Sindh	Balochistan	NWFP	Total
37	37	12	14	100 %

- There would be no restrictions on the Provinces to undertake new projects within their agreed shares.

- No restrictions are placed on small schemes not exceeding 5,000 acres above elevation of 1,200 ft. SPD.

- No restrictions are placed on developing irrigation uses in the Kurram/Gomal/Kohat basins, so long as these do not adversely affect the existing uses on these rivers.

- For the implementation of this accord, the need to establish an Indus River System Authority was recognized and accepted. It would have headquarters at Lahore and would have representation from all the four provinces.

- The record of actual average system uses for the period 1977-82, would form the guide line for developing a future regulation pattern. These ten daily uses would be adjusted pro-rata to correspond to the indicated seasonal allocations of the different canal systems and would form the basis for sharing shortages and surpluses on all Pakistan basis.

- The existing reservoirs would be operated with priority for the irrigation uses of the Provinces.

- The provinces will have the freedom within their allocations to modify system-wise and period-wise uses.

CHAPTER III PRESENT CONDITION OF THE STUDY AREA

3.1 Natural and Physical Condition

3.1.1 Topography, Geology and Soil Mechanics

(1) Topography and Geology

The main topographic features around D. I. Khan District are composed of three major structures below.

- The Mountains of the Sulaiman, Khisor, Marwat and Bhittanni Ranges.
- Piedmont Plain composed of deposition of the degraded material transported by the streams of the Sulaiman Ranges forms the plain.
- The Meandering Flood Plain of the Indus River composed of deposition of fine silt, mud and sand from the sediment laden flood waters of the Indus River

The Study area is located at just north western corner of INDUS PLAIN. In the northern part and west of the D. I. Khan, rock units of sedimentary origin ranging mainly from late paleozoic to early or middle pleistocene age crop out.

Within the main part of the District, deposits can be divided into two broad types. One is derived entirely from the mountains to the west and the other was laid down by the large rivers that placed the alluvium of the Indus Plain. These two type's interfinger in a transitional zone that parallels the Indus River 8 to 14 miles west of the river. East of the zone, sand deposits are extent. West of the transitional zone, the fill is mainly silty clay that contains beds of fine to medium sand and, near the mountains, gravel that is derived from the consolidated rocks. The groundwater in the study area, whose depth is among 50 and 100 ft, is flowing from north-west to south-east, namely from Sulaiman, Bhittani range to Indus river.

Permeable beds and extensive aquifer consist mainly of deposits ranging in grain size from silt to medium sand that underlies the Indus River lowland and immediately adjacent areas. This sand contains relatively little clay and constitutes a single aquifer. Within the area of the piedmont plain, the largest part of the fill consists mainly of silty clay with relatively thin beds of fine to medium sand. The fill has a low bulk permeability, but owing to grain size, saturated sand of individual beds or groups of beds should be capable of yielding.

In the upland areas of piedmont plain in the D. I. District, groundwater in the fill generally occurs under phreatic conditions. At greater depths, however, water is

under confined conditions. Recharge of groundwater occurs along the western and northern mountainous boundary by the lateral sub-surface inflow or by infiltration of water from the perennial streams and run-off through the bottom of tributaries and gullies. Total storage of extractable fresh groundwater in the alluvial fill upto a depth of 200 meters, is estimated at 310,000 x 10^6 m^3. On the contrary, the average annual recharge of fresh groundwater in the alluvial fill both from the mountainous boundary and from the Indus river roughly amount to 100 x 10^6 m^3.

The groundwater is saline except for a fresh water belt of about 10 km width along the boundaries of the alluvial plain. In most parts of the fresh water areas, the groundwater in shallower aquifers is generally saline beneath fresh water occurs.

(2) Geotechnical Properties

The geologic profile along CRBC is composed of loose recent deposits or relatively dense subrecent deposits along Rod Kohi, silt to clay layers up to the depth 50 ft, and sandy layers deeper. The main geotechnical distribution along the section is;

	Classified group	N-value	Main composition & distribution
1	Recent Rod Kohi deposits	less than 20	sand, silt & clay; along recent drainage way
2	Sub-recent Rod Kohi deposits	from 30 to 40	sand, silt & clay; along sub-recent drainage way
3	Sub-recent Piedmont Plain dep.	from 30 to 70	silt & clay; up to about 50 ft depth
4	Sub-recent Indus River dep.	more than 50	mainly sand; more than 50 ft up to at least logged depth

The soil around the area is generally, non-organic, loess-like clay (soil type classification CL) with low to medium plasticity.

Main physical properties are as follows.

- Moisture content in situ ..... 5 ~ 10 %
- Unit weight in situ (wet) ..... 100 ~ 120 lbs/ft^3
- Unit weight in situ (dry) ..... 95 ~ 105 lbs/ft^3

While main mechanical properties are as follows.

- OMC (Optimum Moisture Content) ..... 12 ~ 20 %
- ρ_{dmax} (maximum dry density) ..... 105 ~ 120 lbs/ft^3

Geotechnical properties was investigated during field survey. The results in planning sites for substantial structures are as follows:

1) Proposed Intake Site

It is of identical nature, grayish in color and generally comprise of fine to medium graded sands and trace to little silt and little or no mica at places. The soil strata are generally medium dense to dense. The following table is showing the main strata and their strength.

Stratigraphy	Thickness	Name of strata	Composition	N-value	Relative density
Layer 1	3~7m	Closure bund embankment	Fine to medium sand	30 to over than 50	Very dense
Layer 2	approx. 18m	Recent river deposit	Fine to medium sand	Matrix 10~20	Medium to a little loose
Upper part of Layer 3	4~4.5m	Recent to subrecent river deposit	Fine to med. sand partly gravel	Matrix 20~30	Medium
Layer 3	more than 8m	= do =	= do =	slightly over than 30	A little dense

2) Proposed Pumping Station Site

The ground is usually composed of fine sand or fine to medium sand, and partly intercalated with clayey or sandy silt layer of thickness from few centimeters to maximum two meters. The thin layers of fine grains are inferred that is derived from sheet flow from mountain side. The stratum of this area is largely divided into four as follows:

Stratigraphy	Thickness	Name of strata	Composition	N-value	Relative density
Layer 1	4~5m	Mainly eolian sand deposits	Sorted fine sand	5~15	Loose to medium
Layer 2	4~17m	Mainly eolian deposits	Clayey to sandy silt	10~30	Med. to relat. hard
Layer 3	11~28m	Flood deposit	Clay to fine sand	more than 40	Dense to very dense
Layer 4	more than 4m	Subrecent Indus river deposit	Mainly sorted fine sand	over than 60	Very dense

3) Typical Cross Drainage Site (Nose Nullah)

The site is mainly composed of silt, clay and partly fine sand of thickness about 1~2 m. The stratum of the site is as follows:

Depth	Name of strata	Composition	N-value	Density, or consistency
0~6.2m	Recent river deposit	Clayey to sandy soil	less than 10	Soft or loose
~10.5m	Subrecent rod kohi to piedmont plain deposit	Silt to clay	20~30	Medium to a little dense
~17.0m	= do =	Clayey silt	15~25	Hard
17.0m~	= do =	Clayey to sandy layer	30~50	Hard or dense

The groundwater level is approximately 15m.

3.1.2 Meteorology and Hydrology

(1) Meteorology

The climate of the Study Area is semi-arid and is characterized by large seasonal variations.

Characteristics of climate of the Study Area are summarized, summer daily temperatures range from 18 - 46 °C, in winter 12 - 34 °C, rainfall ranges from 200 - 400 mm, mean annual evaporation is around 2,550 mm, and relative humidity vary significantly from 38 to 65 percent during March to December, respectively. Wind direction and speed of the Study Area vary seasonally. In summer, east/northeast wind is distinguished having average wind velocity of 1.40m/s (2.7 knots/hr). In winter, west/northwest wind blowing from mountainous area occur frequently having average wind veracity of 0.99m/s (1.9 knots/hr).

Although the annual rainfall is relatively low, high intensity rains of short duration do occur occasionally causing floods in Rod Kohis which extend to upper portion and cross over the Study Area.

Rainfall around the Study Area occurs areal. According to the correlation analysis of rainfall data among several stations, rainfall zone could be limited within the circle area having radius of less than around 17 km.

Estimated ETo by the modified Penman method is 1,590.6 mm par year, having good relation with observed ETpan in around the Study area.

(2) Hydrology

The Study Area is located in the meandering flood plain of the Indus River which extend between the Indus River and the foot hills of Suleiman Range. Floodwater on the flood plain originates from five (5) major and numerous number of small Zams (Zam is a local term for perennial Rod Kohi). Total catchment area of Zams is around 40,000 km^2.

In low flows, the flood water of the Rod Kohi is utilized for crop production effectively. However during severe flood, due to lack of proper distribution and cross-drainage facilities of flood flows, the CRBC embankment is often breached and inundation of flood water is also caused in the low lying areas resulting in losses to property, communication system, canals, crops and human lives. The average annual flood damage is estimated by Pakistan side at Rs. 3.28 million , in which agricultural damage through standing water share approximately 40 percent of the total value.

In the flood irrigation aspect, farmers seem to be rather fond of flooding in their farm. In comparison with expected amount of agricultural benefit, flood damage in public and private sector are negligibly small due to lower population density and shifting to higher & safer grounds.

According to the results of frequency analysis for peak discharge, specific discharge based on 100 years return period has been calculated as 17.6$m^3/s/km^2$ at Tank Zam (2,310 km^2), and 3.6$m^3/s/km^2$ at Gomal Zam (35,580 km^2). The reason of this difference is due to non-uniform areal rainfall distribution on the catchment.

(3) Water Quality

Referring results of testing for surface water at the Chashma reservoir and CRBC canal are classified C_1S_1 (Low salinity, Low sodium), Indus river water seems to be quite suitable for irrigation. On the contrary, other surface water sample at each Nullah indicate C_2S_1 (Medium salinity, Low sodium) or C_3S_1 (High salinity, Low sodium). These results show that salinity issues will be occurred when the water is used for irrigation from Rod Kohi System.

All samples of groundwater are recognized high salinity hazard. Water quality of ground water in the Study Area mostly indicates C2S1 (Medium Salinity, Low Sodium) or C3S1 (High Salinity, Low Sodium) in consideration with results of both

tests.

3.1.3 Soil and Land Use

(1) The Soils

The soils in the Study Area were studied through existing reports and an additional reconnaissance soil survey by the Study team. The soils in the area is mainly local piedmont alluvium of the Marwat, Khisor and Suleiman Ranges derived from sedimentary rocks. Seven major soil associations and one miscellaneous land type were found in the area.

The texture of the soils varies from sand to clay, but silty clay loam is the dominant texture of the area. In general, pH of the soils varies from 8.0 to 8.6 while some soils have been above 8.6, which indicates that most of the soils of the Study Area are calcareous and moderately alkaline in nature. The soils are generally non saline, and EC (electrical conductivity) of most of the soils is less than 0.5 mS/cm. The results of total nitrogen show that the soils are generally poor in plant available nitrogen and the soils will benefit from any nitrogen fertilizer's application. Soils in the area are generally low in organic matter content which is less than 0.15%. The available phosphorous of surface horizon is 3 to 12 ppm and that of subsurface horizon is moderate to low which indicates that these soils will show a good response to phosphoric fertilizers. The soil map of the area is shown in Fig. 3.1.1, and principal properties of the soils are as follows;

	Soil series	Texture	pH	ECe (mS/cm)	Area (ha)
1.	Recent piedmont plains				
	Tikken	silty loam	8.6	0.2	36,800
	Wajan	loamy sand	8.6	0.1	7,800
2.	Sub-recent piedmont plains				
	Zindani	silty clay loam	8.6	0.4	34,900
	Gishkori	silty clay loam	8.4	0.5	20,800
	Saggu	silty clay	8.3	0.7	26,800
	Ramak	silty clay	7.9	1.6	7,300
	Banda	sandy loam	8.5	0.1	2,500
3.	Miscellaneous land type				
	Bad lands /Gullies or torrent beds				4,800

(2) Crop Suitability

Crop suitability classification is a method of rating soils with their relative suitability for the sustained production of specified crops. The four classes are defined as follows;

- Class 1 (S1) : well suited
- Class 2 (S2) : moderately suited
- Class 3 (S3) : poorly suited
- Class 4 (NS) : not suited

Crop suitability rating of the soils in the Study Area is summarized crop-wisely as follows;

Crop	Extent (ha)				Suitability Rating
	S1	S2	S3	NS	
Wheat	120,700	2,400	7,000	-	A
Cotton	54,700	34,000	32,000	9,400	C
Maize	88,700	25,400	9,000	7,000	B
Oilseed	88,700	9,400	32,000	-	B
Gram	91,100	7,000	32,000	-	B
Millet	88,700	7,000	32,000	-	B
Sorghum	88,700	34,400	7,000	-	B
Paddy	20,200	100,500	-	9,400	C
Sugarcane	54,200	32,000	34,500	9,400	C
Berseem	88,700	32,000	-	9,400	B

(3) Land Capability Classification

The land capability assessment was carried out with taking consideration the introduction of canal irrigation. Some 90% of the Study Area is classified as either good or moderate irrigable land. Consequently, most of the CCA (Cultivable Command Area) of the Project Area is covered by classes I & II soils which is suitable for irrigated cultivation. The land capability map of the area is shown in Fig. 3.1.3.2. The extent of each classification is shown as below.

Class	Land capability	Extent (ha)	Ratio (%)
I	Good irrigable land	60,950	43.0
II	Moderate irrigable land	66,730	47.1
III	Marginal irrigable land	9,210	6.5
IV	Unproductive land	4,810	3.4

(4) Present Land Use

The total acreage of the Study Area is about 141,700 ha, of which 106,640 ha (75.3%) is cultivable, but cropped area varies from year to year according to water availability. Torrent-watered cultivation (Rod Kohi) is the dominant land use in the area, which is practiced near the mountain and along large nullahs (seasonal rivers). A part of the cultivated area is irrigated by tube wells, which covers only 940 ha (0.7%). Some land is unused or rarely used for cultivation, because the land is either too high or too distant to be irrigated by the torrents. Such land is covered with sparse natural vegetation, and the major land use of this area is livestock grazing and/or cultivable waste, which covers approximately 28,800 ha (20.3%). The remaining 6,260 ha (4.4%) is not used for agriculture due to irregular relief or higher elevation, which includes gullies, torrent beds, residential area, roads and others. The land use in the Study Area is shown in Fig. 3.1.3.3, and summarized in the following table.

Land use	Area (ha)
Cultivated area	
- Tube well irrigation area	940
- Rod Kohi / Barani cultivation area	105,700
Grazing area / Cultivable waste land	28,800
Uncultivated area	
- Residential area	1,450
- Gullies, torrent beds and others	4,810
Total Area	141,700

3.2 Social and Economic Situation

3.2.1 Administrative Divisions

Local government bodies in North West Frontier Province comprise 19 districts and one municipal corporation in Peshawar, 17 municipal committees, 24 town committees and 697 union councils in 1991 which are classified as follows :

(1) District Council	Area of revenue district excluding city and populated urban areas
(2) Municipal Corporation	City having population of more than 500,000
(3) Municipal Committee	Urban area having population of 20,000 or more
(4) Town Committee	An urban area having population of more than 5,000 but less than 20,000
(5) Union Council	Rural area consisting mouzas which are sub-divided into villages

For local administration, provincial government has line department offices by a level of district and division. One divisional office covers two to five district offices. Commissioner is appointed by a level of division for coordinating local administration among provincial line departments. Deputy commissioner and assistant commissioner are also appointed by a level of district and tehsil (sub-division of district), respectively.

D. I. Khan district comprises one municipal committee in D. I. Khan, two town committees in Paharpur and Kulachi, 34 union councils, and 359 mouzas which are sub-divided by two tehsils of D. I. Khan and Kulachi. The Study area is located in D. I. Khan district and extends over two tehsils. Administrative Study area comprises 13 union councils covering 102 mouzas in D. I. Khan tehsil and one union council covering 2 mouzas in Kulachi tehsil as of March 1994. Administrative divisions of the Study area are summarized as follows :

Item	No. of Union Council	No. of Mouza	Area (km^2)	
Administrative Divisions of Study area	14	104	2,082	(28%)
D. I. Khan Tehsil	13	102	2,034	
Kulachi Tehsil	1	2	48	
D. I. Khan District	34	359	7,325	(100%)
NWFP	697	4,733	74,521	

3.2.2 Population

(1) Present demography

The Study area (141,700 ha) locates within the 104 related mouzas having 208,200 ha. The population and household number in the area of 104 mouzas are estimated at around 122,700 (which accounts for 17% of the district population) and 19,600, respectively with an average family size of 6.3. Population of the 104 mouzas is classified as rural population due to no town committees and will be directly and indirectly benefited by the 1st lift irrigation project. The residential population and household within the Study area are estimated at 83,500 and 13,340, respectively which account for 68% of those of the 104 mouzas. Demographic features of the 104 mouzas covering the Study area in 1993 are summarized as follows :

Item		Study Area	104 Mouzas	D. I. Khan	NWFP
Area	(km^2)	1,417	2,082	7,325	74,521
Population	(Person)	83,500	122,700	725,000	16,555,000
Household No.	(No.)	13,340	19,600	119,000	2,435,000
Family Size	(/H.H)	6.3	6.3	6.1	6.8
Population Density	(/km^2)	59	59	99	222
Population Growth	(%/a.n.) (1981 - 1993)	3.01	3.01	3.25	3.42

Literacy ratio of D. I. Khan district in 1981 was 18.4% which was lower than the national average of 26.2%, while comparatively higher than the provincial average of 16.7%. The ratios of rural area are commonly lower than those of urban area. In the district, the ratio in rural area remained at 13.7%. In addition, education for the female is less promoted and the ratio of female was limited at 8.0%.

(2) Future demographic status

The annual population growth in the Study area during 1981 to 1993 is estimated at a little lower growth trend of 3.01% because there are insufficient infrastructure and limited industries, and the area could not sustain livelihood of the people. Through the 1st lift irrigation and other socio-economic infrastructure development, population increase of the area will be accelerated by the in-migration from backward rainfed area. The CRBC gravity irrigation development at stage I and II has promoted in-migration from the Study area, while the population growth in the period still has a significant rate of 3.01%. It is assumed that the future population growth of 3.01%

per year will be maintained at least in the Study area. Labor force population is estimated by applying the crude active rate (the percentage of persons in labor force to total population) of 31.5 which is based on the population by age and sex in D. I. Khan district and the result of Labor Force Survey 1990-91. The demographic forecast is summarized as follows :

Year	Population	Household Number	Labor Force	Labor Force per ha of CCA
1993	83,500	13,340	26,300	0.23
2000	102,800	16,320	32,400	0.28
2005	119,200	18,920	37,500	0.32
2010	138,200	21,940	43,500	0.38

3.2.3 Land Holding and Tenure

Out of 13,340 households in the Study area, resident agricultural land owner households are estimated at around 10,000 (75%) and the rest of 3,340 (25%) are landless households such as the government officers, merchants , landless tenants, laborers, etc.

Based on the sampling data in the selected 10 mouzas (average size of agricultural land holding and their household distribution), registered agricultural land covering cultivated area and some part of fallow is estimated at around 59,900 ha which accounts for 44% of the total agricultural land of 135,400 ha. Area under resident agricultural land holdings is estimated at 49,600 ha (83%). The rest of the land (10,300 ha / 17%) is assumed to be absentees'. It is obvious that the absentee land holding is prevailing in the Study area.

Average holding size of agricultural land is 5.0 ha in resident owner households, 3.4 ha in absentee owner households, and 4.6 ha in total owner households. Agricultural land is unevenly distributed among land owner households in the Study area. The number of marginal and small owner households below 3 ha account for 74%, while their share of agricultural land area is limited at 9% of the total land. On the other hand, the number of large land owner households more than 5 ha is limited at 18%, while their share of land area accounts for 84%.

Size of Agricultural Land (ha)		Number of Household		Agricultural Land		Average Size of Agri. Land (ha/H.H)
		No.	%	ha	%	
Less than 1	(Marginal)	7,253	56	1,368	2	0.2
1 - 3	(Small)	2,291	18	4,206	7	1.8
3 - 5	(Medium)	1,097	8	4,267	7	3.9
5 and above	(Large)	2,359	18	50,056	84	21.2
Total/Average		13,000	100	59,897	100	4.6
R.H.H		10,000	77	49,620	83	5.0
A.H.H		3,000	23	10,277	17	3.4

Note : R.H.H ; Resident household, A.H.H ; Absentee household

Overall land holding status in the Study area of 141,700 ha covering the registered agricultural land of 59,900 ha, fallow, cultivable waste, and non-agricultural area was assessed. The holding balance between all land and registered agricultural land concentrates on the large owner households more than 5 ha. The holding balance in the large owner households is estimated at around 78,500 ha which accounts for 96% of the total balanced area of 81,800 ha.

According to the data collected from the selected 10 mouzas, around 33% of the registered agricultural land is tenanted. Share cropping is predominant in the Study area. Input cost and product are usually equally divided by the owners and lessee. Social status of lessees is low and bound to owners because of debts and local convention.

3.2.4 Development Plan

In NWFP, around 1,300 provincial and district projects have been implemented since 1990-91. Provincial development budget accounts for Rs. 2,745 million on average during 1990-91 to 1991-92, of which around 63 % or 1,735 million is allocated to the respective district development budget. D. I. Khan district was allocated Rs. 127.9 million which accounts for 7.4 % of the total district budget. Regarding sectoral allocation, the education budget occupies biggest share of 23 % in the province and 35 % in D. I. Khan district. The second and third shares are spent for water supply and sanitation categorized as physical planning and housing (19% in both) and road development (13 % in the province and 16 % in D. I. Khan). Agriculture budget, and water and power budget including irrigation occupy less than 10 % of the total budget, respectively as follows :

Sector	Province *1 (NWFP)	D. I. Khan *2 District
I. Share (%)		
Agriculture	5.4	6.2
Water and power	7.3	3.4
Transport & communication	12.5	16.4
Water supply and sanitation	18.7	18.9
Education	22.9	35.1
Health	15.0	11.7
Others	18.2	8.3
Total	100.0	100.0
II. Budget (Rs. Million)		
Total	2,774.7	127.9
(Provincial ; 1,009.8 District ; 1,734.9)		

Note: *1; Average of 1990/91 and 1991/92. *2; Average of 1990/91 to 1992/93

The number of on-going development plans and projects in D. I. Khan is 42 schemes comprising the following sectoral distribution :

Sector	Number of Scheme	Project Cost (Rs. Million)
Agriculture	3	115.5
Forestry & fishery	3	31.7
Transport & communication	5	242.2
Water supply and sanitation	16	70.0
Education	10	41.2
Health	4	211.8
Social welfare	1	2.8
Total	42	715.2

3.3 Agriculture

3.3.1 Present Agriculture in the Study Area

(1) General Condition

D. I. Khan district has a total area of 732,500 ha of which only about 288,000 ha (39 %) is cultivated and about 418,900 ha (57 %) is non-cultivated area as cultivable waste. About 42 % of the total cultivated area is irrigated by gravity canal

and tube well irrigation, whereas the remaining 58 % is rainfed land. The Study area is estimated at 141,700 ha by the land use survey using the topography map (1/50,000). Present cultivated land area is estimated about 106,640 ha or 75 % of the Study area. Only 940 ha (1 %) is irrigated by the tube well irrigation water, and remaining 99 % is rainfed land. The present cultivated lands are closely related to topographic and soil conditions and availability of irrigation water.

The climate in the Study Area is characterized by the distinct summer (Kharif) and winter (Rabi) seasons. The summer season extends from April to September and the winter season during the remaining months. The average annual rainfall in the Study area is about 270 mm of which some 46 % occurs in the summer months of July and August. Fluctuation of annual rainfall is big at the range from 140 mm to 425 mm on the basis of last 10 years' records. The annual mean temperature is 24.5 °C, ranging from the maximum monthly mean of 34.2 °C in June to the minimum of 12.2 °C in January. Mean sunshine hour is as short as 6.6 hours/day in November, while the other months are long ranging from 7.0 to 9.7 hours/day (Ref. Fig. 3.3.1).

There are two types of farming in the rainfed land, namely, Barani and Rod Kohi. Rod Kohi is torrent watered cultivation which is practiced by diverting and spreading the intermittent flow of the torrents in the piedmont plains. In relation to the climate conditions, inadequate and erratic rainfall under irregular distribution throughout the year arises low productivity in rainfed area. The shortage of irrigation water not only restricts increase in cropping intensity but also hampers crop productivity. The present marginal crop production keeps farmers' livelihood at subsistence level.

(2) Present Cropping Pattern and Cropping Intensity

The cropping calendar in the Study area is characterized by three distinct crop seasons, Kharif (summer), Rabi (winter) and spring. About 46 % of the annual rainfall occurs in the summer season from July to August. In the winter season, about 27 % of rainfall occurs from December to March. Under irregular rainfall pattern in the Study area, frequent crop failures occur in rainfed lands of Barani and Rod Kohi area because of inadequacy of soil moisture supplies. The present cropping calendar in the Study area is presented as below :

Crop Season	Sown	Harvested
Kharif Season Crops:	July-August	Oct.-Nov.
Rabi Season Crops:	Oct.-Nov.	March-April
Spring Season Crops :	Feb.-March	June-July

For Kharif season crops, sorghum (jowar, 47 %), millet (bajra, 46 %) and guara (4 %) are the major crops while wheat (53 %), gram (28 %) and oilseeds (16 %) are the main crops for Rabi season crops.

On the basis of 5 years' average, 5,370 ha or 5.0 % of the cultivated areas of 106,640 ha are sown in the summer season. Harvesting, however, is limited only at around 30 % of the total sown area and remaining area is damaged. During winter season, 16,060 ha or 15.2 % of the cultivated area are sown, and 39 % of the total sown area was harvested. The present cropping intensity (percentage of sown area to the cultivated area) is estimated at 20.1 %. In terms of harvested area to the cultivated area, harvesting intensity is limited at 7.4 % comprising 1.5 % of Kharif and 5.9 % of Rabi. The difference between the cropping intensity and harvesting intensity is caused by uncertain and uncontrolled water in the summer season, and acute shortage and untimely availability of water in the remaining months of the year.

The typical cropping pattern and cropping intensity in irrigated, Rod Kohi and Barani cultivated area are shown in Fig. 3.3.2. The annual cropping area and overall cropping intensity in the Study area are estimated in Table 3.3.1, and summarized as below :

Crops	Cropping Area		Cropping Intensity	
	Sown (ha)	Harvested (ha)	Sown (%)	Harvested (%)
Kharif Season Crops :				
Sorghum	2,530	775	2.4	0.7
Millet	2,470	640	2.3	0.6
Maize	10	5	-	-
Sugarcane	30	20	-	-
Cotton	60	25	-	-
Guara	230	105	0.2	0.1
Vegetables, fruits, pulses, fodders others	40	25	0.1	0.1
Sub-total	5,370	1,595	5.0	1.5
Rabi Season Crops :				
Wheat	8,540	3,590	8.0	3.3
Barley	400	145	0.4	0.1
Pulses (gram)	4,420	1,690	4.2	1.6
Oilseeds/lentil	2,580	765	2.4	0.7
Sugarcane	30	20	0.1	0.1
Vegetables, fruits, fodders, others	60	40	0.1	0.1
Sub-total	16,030	6,250	15.2	5.9
Total	21,400	7,845	20.2	7.4
Total Cultivated Area : 106,640 ha				

Note : (-) These figures are under 0.1 %.

(3) Present Crop Yields and Production

The unit yields of major crops have not reached sufficient high levels due to poor soil fertility, shortage of rainfall water, low level of farm inputs and traditional farming practices. Annual crop productions of major crops are estimated on the basis of 5 years' average data from 1987/88 to 1992/93, and summarized as follows :

Crops	Cropping Area (ha)	Unit Yield (t/ha)	Production (tons)
Kharif Season Crops :			
Sorghum	2,530	0.72	1,820
Millet	2,470	0.76	1,870
Maize	10	0.63	6
Pulses (Mung Beans)	5	0.52	3
Sugarcane	30	35.55	1,070
Cotton	60	1.41	85
Guara	230	1.56	360
Fodders	10	11.86	120
Vegetables, others	25	2.88	70
Sub-total	5,370		
Rabi Season Crops :			
Wheat	8,540	1.04	8,850
Barley	400	0.76	300
Pulses (Gram)	4,420	0.60	2,660
Oilseed (Rape/ Mustard)	2,580	0.52	1,330
Fodders	60	13.30	800
Vegetables, others	30	4.20	130
Sub-total	16,030		
Annual Cropping Area	21,400		

Ref. : Table 3.3.1

(4) Present Farming Practices and Farm Inputs

The tractor is now the dominant source of farming power for land preparation work and transportation of agricultural products. In the Rod Kohi land, the tractor mounted blade or bulldozer is used for field bund maintenance and repair of breached bunds. The traditional bullock drawn scraper board is still used. The seed-bed is not prepared properly. The field, when comes in workable condition, is stirred with local plough and planking is done with local implement called Sohaga (clod breaker and leveler). The soil is not pulverized, therefore, fine tilth is not obtained.

Improved seed is not extended in the Study area. The seed purchased from local market is of poor quality with low germinability and low yielding. The seed does not germinate well on unleveled seed-bed with clods. The shallow ploughing has a depressing effect on root development and growth. The stand of crop in such field remains poor and growth does not occur properly.

Fertilizers application is not prevailing due to the risk of crop harvest and farmers' financial constraints. Fertilizers are not used for soils with low fertility where exhaustive crops like sorghum, millet, wheat, etc. are grown. The low fertility and exhaustive cropping systems reduce crop yields. Weeding is not done at proper time. Weeds are allowed to grow and are harvested as fodder. Weeds compete with crops for moisture, light, nutrients, etc. and reduce crop yields.

Locally produced seed is not treated with fungicide, hence seed and soil borne diseases affect crops adversely. Beside farmers' financial constraints and cropping risk, spraying to protect insect and pest damages is hampered by uneasy procurement of water in the Study area.

Harvesting is usually done by hand sickle throughout the day. Harvested crop is tied into the bundles and the bundles are left in the field. Transportation from fields to threshing floors at village is done by bullock cart, donkeys or heads. Threshing is done with stick or with bullocks. Use of threshers is still limited. Timely threshing and winnowing can reduce losses. Seed for the next cropping is randomly taken from the harvest.

(5) Livestock

D. I. Khan district is not self-sufficient in beef meat, and cattle and buffalo are imported from Punjab province. On the other hand, D. I. Khan is self-sufficient in mutton meat, and some sheep and goats are exported to Punjab province. Majority of the farmers in the rural area is still suffering from malnutrition and is living under the poverty line.

Most of the farmers in the Study area always rely on livestock for their income and family consumption, but own small livestock under subsistence level. Cow (cattle) are kept for draft power, milk production and social status, which can easily be turned into cash. Buffalo milk is locally preferred and the demand in the district is increased by population growth. Goats are rapidly increasing than cattle because of the popularity of meat, lower price of breeding stock and wider range of herbage.

According to the farm survey of 210 households in the 11 mouzas, average number of livestock holding and population in the Study area are estimated as follows :

(Unit : heads)

Livestock	No. of Holding per Household	Population (1993)
Cow	5.61	62,000
Bulls/ Steer	2.14	23,700
Buffaloes	1.29	14,250
Sheep	7.10	78,600
Goats	12.08	133,600
Camels	0.36	4,000
Horses	0.07	750
Donkey (Asses)	0.17	1,900
Poultry (Chicken)	10.20	112,800

In the rainfed area, crop residue and fodder crops are insufficient. Main feed resource for livestock is free grazing in cultivable waste land under thorny bushes, plants and roughages which are consumed readily by livestock. In the irrigated land, livestock is fed by fodder crops and crop residues as well as casual free grazing.

3.3.2 Marketing System

(1) Present Marketing Flows and Marketing Channels

Farm output

Farm survey indicates that marketed ratios of wheat in the Study area and C.R.B. gravity irrigation area are 58% and 64%, respectively. As for other products, these marketed ratios are much higher. Crops are marketed through Beopari (village merchant), commission agent or village shop. Beopari is a main sale destination for wheat, rice, gram and oil seed in particular. Most of sugarcane is sold to sugar mills directly.

Wheat procured by the Food Department and PASSCO or in open market is stored once, and sold to flour millers in D. I. Khan district and then marketed through dealers and wholesalers to Kohat, Bannu, Swat and Federally Administrative Tribal Area (FATA) as well as D. I. Khan district. Most of paddy sold at the village is taken to rice mills through village merchants and marketed in D. I. Khan district, Bannu, Swat, Peshawar, Miram Shah, Rawalpindi and so on. Pulses and gram are marketed in D. I. Khan district and neighboring districts. This marketing flow is shown Fig. 3.3.3.

Oil seeds (rape and mustard seeds) are sold to dealers and marketed in D. I. Khan. Sunflower, which is one of the non-traditional oilseeds and strongly recommended by the National Oil seeds Development Project, is procured by PASSCO although production is very small in D. I. Khan district. The marketing flow is shown in Fig. 3.3.4.

Most of sugarcane is transported to sugar mills or their purchasing centers directly by farmers. There are 3 large mills, namely Chashma, Fecto and Bannu sugar mills, within and adjacent to the district of D. I. Khan. Refined sugar is marketed in D. I. Khan district, Tank, Bannu, Mingora, Mianwali and Rawalpindi through sales agents. Seed cotton is procured by dealers and conveyed to ginning factories in Bhakkar district in Punjab although its production is very small at present in the district.

Some of the fruits such as dates, mango and melon are marketed in Peshawar and Bannu in NWFP and Mianwali, Faisalabad, and Lahore in Punjab through commission agents/wholesalers. Tomato and onion are also delivered to Peshawar, Bannu and Kohat in NWFP and to Multan, Bhakkar and Sargodha in Punjab. The market flow paths in and out of the various markets are shown in Fig. 3.3.4.

Farm inputs

Both provincial government and the private sector are engaged in marketing of fertilizer. There are four major dealers in D. I. Khan district. All of imported fertilizer come from Karachi. Some of indigenous fertilizer such as Urea is delivered from the factory at Multan or other cities in Punjab. As for pesticide, there are about 10 dealers in D. I. Khan.

(2) Hierarchy of Local Markets

There are three types of markets in the D. I. Khan district. They are village markets, inter-union markets and the district markets, respectively. Main role of village market is to supply food grains, fresh fruits and vegetables to adjacent village markets, the inter-union markets and the district market in case when there are surplus to their requirements. Inter-union markets provide some market facilities in order to transact grains, vegetables, fruits and consumer goods for farmers. This market can link the village markets and the district market. Also, in some cases, this market has direct links with the markets located outside the district. The role of district market, which is situated at three locations in D. I. Khan city, remain almost the same as those of

village and inter-union markets, but the volume of transaction is much larger and the linkage to the outside from the district is stronger compared to the preceding two types of markets. Since market regulation under Agricultural Produce Market Act 1939 has not been notified by the provincial government, those are not yet regulated markets.

(3) Agricultural Processing and Storage Conditions

Wheat (flour mill)

The production of wheat in D. I. Khan district was 115,264 tons in 1991/92 though its processing capacity is 372,000 tons. Processing costs in large mills are Rs. 400 per ton in harvest season and Rs. 200 per ton in other seasons. There are 35 small flour mills with single units (mainly for home consumption) and 5 large mills in D. I. Khan city with an average milling capacity of 36 and 120 tons per day, respectively.

Oil Seeds (oil mill and extraction plant)

There are 15 single oil mills (less than 0.02 tons/unit/day) , four (4) large oil mills (12.4 tons/unit/day) and one (1) oil extraction plan in D. I. Khan district. Their annual processing capacity is estimated at 24 thousand tons by 200 days' operation. Oil from rape and mustard seeds is extracted in small oil mills with single unit of crusher. Small mills produce 23% of oil and 71 % of cake from seeds. At present, large scale oil mills (including ghee mill) and a solvent oil extraction plant (Agro Oil Extraction Industries) in D. I. Khan district are closed.

Agro Oil mill, however, has a plan to operate in the 1994/95 season by procuring sunflower. This mill can yield 12% of refined oil, 42% of meals for poultry, 6% of lint, and 28% of hull from cotton seeds. The installed processing capacity is 70 tons per day. The estimated processing costs by the firm are Rs. 1,230 per ton.

Sugarcane (sugar mill)

In D. I. Khan district and adjacent districts, three large sugar mills, namely, Chashma (D. I. Khan), Bannu (Serai Naurang), and Fecto (Bhakkar district), are operating. The calculated production cost of sugar in Chashma sugar mill amounted to Rs. 4,127 per ton. Installed capacity, cane crushed, crushing season, and recovery rates of these mills are shown below.

Mills	Installed Capacity (tons cane per day)	Crushing season (days)	Cane crushed (tons)	Recovery (%)
Chashma				
1991/92 *1	3,000	113	174,454	8.65
1992/93	3,000	131	328,422	8.43
1993/94 *2	3,000	-	400,413	8.35
Fecto				
1991/92	3,000	136	378,674	8.50
1992/93	3,000	138	403,842	8.25
1993/94 *2	3,000	-	371,986	8.11
Bannu				
1991/92	2,400	127	240,390	8.69
1992/93	2,400	119	219,262	8.45
1993/94 *2	2,400	-	220,172	8.37

Source: Each sugar mill and Pakistan Sugar Mills Association

*1 The first year of operation

*2 For the season 1993/94 up to March 15, 1994

Cotton (ginning factory)

There is no cotton ginning factory in D. I. Khan. Seed cotton in D. I. Khan, even though very little in quantity, is sold to ginners in Bhakkar or other districts in Punjab through dealers. Based on the interviews to ginners in Bhakkar, average yields of lint and cotton seed are 34% and 62%, respectively. Processing costs are Rs. 1,250 per ton of seed cotton.

Storage Facilities

Public storage facilities for agricultural inputs and output in the D. I. Khan district are operated by the Food Department, the Agricultural Department and ADA. Food Department can store wheat up to 60,000 tons in 7 godowns and up to 18,000 tons in open silo. The Agriculture Department and ADA can store food grain and fertilizer up to 27,000 m^3, and seed and fertilizer up to 9,600 m^3, respectively.

(4) Marketing Prices

Wholesale Prices and Marketing Margins

Average wholesale market prices of major crops from April in 1993 through March in 1994 at D. I. Khan market are summarized below. The price fluctuations for wheat,

wheat flour, and rice are relatively small throughout the period.

Crop	Rs. /40 kg
Wheat, Desi	150 - 173
Wheat Atta (Flour)	170 - 192
Rice, Basmati	535 - 560
Rice, Irri-6	220 - 230
Maize	160 - 240
Millet (Bajra)	175 - 240
Sorghum (Jowar)	120 - 220
Gram Black	300 - 445
Rape and Mustard Seeds	290 - 380
Onions	145 - 320
Mangoes	410 - 600

Commission agents (who sometimes double as wholesalers) charge a fee which is generally 2% of the wholesale prices from farmers and 1% from retailers for cereals, 6% from farmers and 6% from retailers for vegetables, and 3% from farmers and 6% from retailers for fruits.

Farmgate Prices

Farmgate prices have been calculated for crops on the basis of posted wholesale prices, less reductions to meet posted commission agent margins, and farmers' marketing costs (farmgate to market). Marketing costs are set at Rs. 0.1 per kg for cereals, pulses and oil seeds, Rs. 0.13 per kg for vegetables, and Rs. 0.29 per kg for fruits based on the market survey. As a result, farmgate prices of cereals, pulses and oil seeds are in a range between 74% and 93% of the average retail prices, and farmgate prices for vegetables and fruits are in a range between 54% and 82%.

(5) Food Balance

Food balance in the national level

Since wheat is the staple food of the majority of population, its availability at reasonable rates is an important socio-economic objective. Although the self-sufficiency of it was the major target in the Seventh Five Year Plan, it was not accomplished. Imported wheat amounted to 2,357 thousand tons in 1992/93. Edible oil is also imported in Pakistan. In recent years the imported quantity of edible oil is

increasing because of imbalance of demand and supply. The government emphasizes production increase of non traditional oil seeds such as sunflower, safflower, and soyabean. Although refined sugar has been one of major imported commodities in Pakistan, the imported quantity has been decreased because the indigenous production of sugar has been increased constantly. According to the Pakistan Sugar Mills Association, refined sugar will be exported to the middle east and other countries since sugar have a surplus of 0.4 million tons approximately in 1993/94.

Food balance in NWFP

Wheat is insufficient in NWFP as a whole although the production of wheat in the district of D. I. Khan is surplus compared to its population. In 1991/92, the total production amounted to 1,163 thousand tons in NWFP, while the demand is estimated at around 2,066 thousand tons. Thus, the deficit comes to 900 thousand tons, approximately. As to edible oil, demand is much larger than supply. Rice and pulses also show a deficit in NWFP. Maize itself has a surplus if simply comparing requirement and production, but a large amount of it is utilized as a substitute of wheat and raw materials for concentrated feed at present. Coarse grains have a surplus. Sugar has a deficit when it is assumed that 72% of sugarcane production is utilized for refined sugar by sugar mills.

3.3.3 Agricultural Support Services

(1) Agricultural Research

Agricultural Research Division has been created in the Ministry of Food, Agriculture and Cooperatives to supervise and coordinate the research activities of various agricultural institutes in the country both at the federal and provincial levels. Pakistan Agricultural Research Council (PARC) is the principal organization at national level for promotion and coordination of agricultural research in different fields.

Provincial Agricultural Research System and NWFP Agricultural University Peshawar (AUP) were merged under the Act of 1986. This re-organization was made by the project "Transformation and Integration of Provincial Agriculture Network (TIPAN)". The research and education are under the umbrella of NWFP/AUP. TIPAN aims at farm-oriented research and education and provides degree and non-degree training. Agricultural Research Institute (ARI), D. I. Khan located near D. I. Khan city has offices and experimental fields.

(2) Agricultural Extension

Director General Agricultural Extension based at Peshawar is responsible for extension services in NWFP. He is supported by officers from the fields of agronomy, economics, marketing, statistics and plant protection. Two ways of extension services comprising traditional services and training and visiting (T&V) system operate in D. I. Khan district. Traditional services prevails outside the CRBC Project area. Extension in the CRBC Project area is based on T&V system. The contact by the field officers under T&V is more than 5 times that of traditional service area. One T&V field assistant (FA) serves 400-500 farmers compared to 1,000 farmers under traditional services.

(3) Government Seed Farm

The Agriculture Extension operates 4 seed farms in D. I. Khan district to multiply approved varieties of wheat, paddy, maize and gram seeds. Each farm is controlled and managed by Agricultural Officer assisted by 3 Field Assistants. The day-to-day operations are carried by the share cropping tenants under their supervision. Agricultural Research Institute, D. I. Khan produces breeders nucleus seed, pre-basic seed and basic seed. The above government seed farms produce basic seed from pre-basic seed and certified seed from basic seed. Registered growers also produce basic seed and certified seed. Certified seeds are procured by Agricultural Development Authority (ADA) and sold to farmers. Seed certification is done by the national seed certification agency.

(4) Livestock Extension

District Animal Husbandry is headed by Assistant Director Livestock and Dairy Development. He is assisted by sixteen veterinary officers and 75 stock assistants and compounders. There is also one Assistant Director Artificial Insemination for D. I. Khan, Bannu, Lakki Marwat and Tank districts. He is assisted by 3 veterinary officers and 12 inseminators. One Project Director under CRBC stage-II is responsible for the area. He is assisted by two veterinary officers, 4 stock assistants and 12 supporting personnel.

(5) Farmer Organizations

The primary cooperative societies composed of individual members are federated at the secondary level usually covering a district or a division. The secondary cooperative societies are organized at the tertiary level as the apex body covering a

provincial or a nation.

The primary credit societies have the provincial cooperative banks in all the four provinces as their provincial federations. In NWFP, a provincial cooperative union is organized to promote farm input supply and marketing of products by the primary agricultural societies.

There are 7,166 registered cooperative societies in NWFP and 497 in D. I. Khan district. In 104 related mouzas covering Study area, there are 26 societies having 1,024 households of which participation rate is low less than 5% to the total number of households of 19,600. Based on the results of farm survey, there were no cooperative members in the 210 respondents. Cooperative societies in the Study area are inactive and dormant. Most of cooperative societies organized in the Study area were family member groups. To organize horizontally different families at the village level as a cooperative society, strong education and extension activities as well as financial and technical support services will be indispensable. Out of 210 samples, only two were members of "Society of Rod Kohi Cultivators" to solve the problems in Rod Khohi among villagers. This organization have a meeting once a month and more frequently during irrigation season.

(6) Marketing Support

Several marketing and price support agencies are located in the D. I. Khan district. Major agencies are the Food Department (District Food Controller), Pakistan Agricultural Storage and Service Corporation (PASSCO), and Agricultural Development Authority (ADA).

The Food Department has functions (i) to procure and store wheat, (ii) to sell the procured wheat to flour millers, (iii) to issue the license to food grain dealers and millers and (iv) to check the retail prices of essential commodities. The Food Department is a member of the price review committee headed by assistant commissioner.

The role of PASSCO of D. I. Khan district, which was established in May 1993 as a seasonal office, is to procure wheat from farmers and to stabilize the market. It also procures other agricultural products such as sunflower. The office may shift to permanent one. At present, PASSCO of D. I. Khan district has 14 office workers and 20 field officers.

ADA has responsibility on marketing of farm input. It procures quality seeds and sells to farmers. ADA also sells fertilizers to farmers though the share of the handled volume is relatively small in the total circulation of the district. The sales points are located in D. I. Khan city, Paharpur and other places in the district.

(7) Rural Credit

Based on the farm survey, 98 in number or 47% of the total respondents (210) received credits from several sources. Only 27 or 28% of borrower respondents (98) were benefited by institutional credit. Institutional agricultural credit is supplied by Agricultural Development Bank of Pakistan (ADBP), cooperative banks, and commercial banks. Main source of rural credit even in the Study area is from non-institutional sources such as friends and neighbors (61% of the borrowers), wholesalers and businessman (6%), and others (5%). Majority of borrowers (93 in number and 95% of borrowers) spent their credit for farm inputs. Annual interest rates from banks were 17 to 18%. However 60% of the total respondents have belief in interest being against religion.

Agricultural Development Bank of Pakistan (ADBP) has three branches in D. I. Khan city, Kulachi and Paharpur towns. There are no ADBP offices in the Study area. 12 mobile credit officers (MCO) in total are assigned for implementation of supervised agricultural credit and one MCO covers around 30 mouzas on average in D. I. Khan. Credit disbursement concentrates at the CRBC gravity irrigation area and the Kulachi branch has only two MCO covering around 60 mouzas per MCO.

ADBP in D. I. Khan district disbursed 879 loan cases with Rs. 33.2 million on average from 1989-90 to 1992-93. Disbursement was concentrated on development credit under medium term (above 18 months and below 5 years) and long term (more than 5 years) repayment periods which accounts for 91 % of the total amount disbursed for the same period. Medium term loans are utilized mainly for tractors and tube-wells. Long term loans are applied mainly to agro-processing facilities.

There are five commercial banks in D. I. Khan District, i.e. Allied Bank of Pakistan (ABL), Habib Bank Ltd., (HBL), National Bank of Pakistan (NBP), United Bank Ltd., (UBL), and Muslim Commercial Bank (MCB). There are no agricultural loan disbursement from MCB during 1989-90 to 1992-93. Other four commercial banks are handling agricultural loans.

3.3.4 Farm Economy

Agricultural labor force is predominant in the Study area. In D. I. Khan district, agricultural labor force accounts for 56% of the total labor force in 1989/90 which is a little lower than the provincial average of 62% and higher than the national average of 45%.

Family income and expenditure by household group are analyzed on the basis of result of farm survey. The share of farm income to the total income is increased with the scale of operating size from 39% in marginal owners (0.74 ha) to 63% in large owners (18.9 ha). Livelihood of marginal and small owners below 3 ha depends on non-farm income accrued mainly from casual labor employment. Contribution of farm income to the expenditure is also increased with the scale of operating size from 40% in marginal to 69% in large. The balance between income and expenditure, especially for marginal and small owners, is negligibly small less than Rs. 500. In order to introduce irrigation farming system which requires high agricultural costs, financial assistance will be essential in the Study area :

(Unit : Rs.'000)

Operating Size of Farm (ha)		Marginal (0.7)	Small (2.3)	Medium (4.7)	Large (18.9)	Total (12.9)
1. Income		17.6	22.1	29.4	38.1	33.1
Farm Income	(%)	(39)	(49)	(59)	(63)	(61)
Non-Farm Income	(%)	(61)	(51)	(41)	(37)	(39)
Share of Farm Income to(2)	(%)	(40)	(51)	(61)	(69)	(65)
2. Expenditure		17.4	21.6	28.2	35.3	31.1
3. Balance		0.2	0.5	1.2	2.8	2.0

3.3.5 Farmers' Concerns

The farmers' organization set-up is the most crucial issue for the effective utilization of demand based irrigation water as well as practical O&M of irrigation facilities. Union councilors elected by the villagers are supposed to serve as a link between the people and the provincial government. The existing local councils might be utilized to formulate farmers' organization for the Project Implementation. On the other hand, there are several village organizations such as society of rod kohi cultivators and cooperative societies as production based organization, and Islahi Committee (village welfare committee) and Zakat and Ushr Committee (religious tax committee), Jirga (consulting elder members for solution of village dispute), Vingar (free supply of labor and animal power to improve village infrastructure) as village community based

organization. Cooperative societies in the Study area are inactive and dormant in general. While the other community based and non-political village organizations are well established and active.

In order to formulate an appropriate farmers' organization plan, clarification of the present status of union councils, and the villagers' needs and suggestions to the Project would be indispensable. The Study team carried out the village surveys both to nine (9) union councilors and 326 villagers selected randomly in March 1994 and July 1994 covering 10 mouzas in the eight (8) unions. The followings are assessment results on the interview survey to union councilors and villagers :

(1) Socio-economic status of the respondents

A large number of councilors (8 persons) falls in the age range of 36 to 55 years old. Age of villager respondents shows a general population distribution by age and about half of the villagers (171 persons) are 18 to 35 years old. Four (4) councilors and 202 villagers (62% of the villagers) are illiterate. Two hundred and twenty two (223) villagers (68% of the villagers) and all councilors are engaged only in agriculture. The villager respondents include agriculture cum other jobs (22%) and non-agriculture (8%). Around 91% of the total respondents are agricultural households.

One hundred and thirty nine (139) villagers (43% of the villagers) are owner-cultivators. Owner cum tenants are one (1) councilor and 94 villagers (28% of the total). There are 55 villager and 8 councilor landlords (19% of the total), and eight (8) full tenants in the villagers. As regards the size of agricultural land holdings, eight (8) councilors and 102 villagers (33% of the total) hold more than 22 ha, while the majority of land is not cultivated due to shortage of rainfall and no irrigation water. Sixty eight (68) villagers (21% of the villagers) hold less than 6 ha.

(2) Activities of union councilors and villagers

Out of 9 councilors, family members of 8 councilors were members of the union councils. Six councilors have previous experience as councilor. Union councilors were asked a question on factors for contesting the union councils elections. Seven councilors wished to serve the people, one to do social work, and one did not respond. Regarding the procedure in decision-making in the union council, all councilors state that decisions are made by the chairman in consultation with other members. Six councilors receive cooperation from family group members in the implementation of development projects. The rests are from common villagers,

members of party, and local government officials, respectively.

The respondents were asked to state major problems of the villages. Majority of the respondents complain of no irrigation water supply which include 4 councilors and 258 villagers (78% to the total). The next problems in priority are no dispensary (48%), no drinking water supply (28%), bad road condition (26%), and shortage of educational facilities (16%). The villagers were asked the nature and way of participation in development projects. One hundred and nineteen (119) villagers (39% of the villagers) provided free labor, while 74 villagers (23%) limited to cooperation, and 97 villagers (37%) answer was no participation.

(3) Changes in the villages and community organization

Regarding socio-cultural changes in the villages, the respondents feel that village people have become aware of their responsibilities (76% of the total), and they develop a sense of collective working (71%) and participate in the decisions of development projects (54%). Necessity of female education is expressed by 87% of the respondents.

As far as economic changes are concerned, only 41% of the respondents feel increase in income during the last 5 years. Nutritional improvement is expressed by 53% only. Seventy four (74%) of the respondents mention that people start giving education to their children. Decrease in domination of landlord and rich families over the people is expressed by 78% of the respondents. Answers to self-transport of products to market and purchasing property are limited at 46% and 49% of the respondents, respectively.

(4) Concerns on farmers association and activities for CRBC lift irrigation project

All respondents know the Chashma 1st lift irrigation project and express positive answers on the establishment of farmers association (FA) by a unit of distributary. Participation of farmers association in design and construction stages is considered necessary only by 47% of the respondents. Regarding FA's activities, the respondents answer that O&M under distributary (69%), collection of water rate (71%), and financial management (91%) could be done by FA.

3.4 Irrigation and Drainage

3.4.1 Irrigation

(1) Flood irrigation

Flood irrigation has for long been practiced in the Study Area utilizing flood flows which occur in short period but with high peak during summer and with relatively moderate flood in winter. Method to divert flood flow in the river channel (so-called Zam) is to erect at suitable intervals earthen and gravel embankments (so-called Ganji) extending about half to full way, depending on the scale of zam, across a river bed to head up flood water and lead it to distributary channels which open immediately above the embankments. There are approximately 40 number of such embankments within the Study area.

Flood water in the distributary channel is head up by earthen bund and guided into the farm field surrounded by embankments (also called Bund), often at a height of less than 1m but sometimes as high as 2m. The site of each embankments across the river and distributary channels, the order and sometimes the proportional rate of water intake are registered in the water rights. The area having water rights for flood irrigation in the Study area is 27,100 ha in total.

The size of field plot irrigated by flood water can be measured on aerial photographs. The Study area is roundly divided into 12 sub-areas in accordance with river course of major zams. Taking one to two sample area of about 1,000 ha in these sub-areas, field plot size was measured at each sample area. Average size of farming field was estimated at about 2.6 ha, in the distribution of area from 0.3 ha to 12.0 ha.

(2) Tube-well irrigation

Tube-well irrigation is practiced in the Study area but limited in scale and area , and mostly privately owned. The tube-well irrigation area is located along the Bannu road and at west of Ramak. Total benefit area is 130 ha in Kharif and 940 ha in Rabi at 20 numbers of tube-wells.

Tube-well irrigation area is well facilitated by concrete lined watercourses which were constructed under the Program of "On Farm Water Management on Special Watercourse in NWFP". Intensive and elaborate farming are practiced in the tube-well benefit area. Irrigation methods such as furrow, basin and border irrigation are selected to meet with the cultivated crops.

(3) Land availability for irrigation

According to the soil investigation in D. I. Khan District, intake family which is significant water infiltrating rate at centimeters per hour, is 3.75 for Sandy Loam, 2.5 for Loam, 1.25 for Silt Loam, and 0.25 for Silty Clay Loam, respectively.

In the Study area, Loam and Silt Loam of soils are dominant. In view point of irrigation practice, every kind of surface irrigation methods may be applicable. Sand dune area is found in northern and southern portions of the Study area. According to the irrigation experience on the sand dune in CRBC, it has been observed that such land have become productive because of mixing of fine sediments brought by canal water with sand soil. A soil survey of sandy area under CRBC indicate that a layer deeper than 6 ~ 20 cm is with low percolation rate due to this phenomena. During winter season, wheat has been planted at the sand dune in the Study area, taking rain water only.

(4) Notable knowledge on CRBC Project

After completion of the implementation of CRBC Stage I and Stage II, notable and useful information was obtained through the post project evaluation and investigations especially on operation and maintenance aspects.

1) Water losses from irrigation canal

IIMI has made field investigations on water losses from distributaries of CRBC. The result of the study indicates that an average seepage loss rate at 1.5 l/s per 1,000m2 of wet area of canal, which is lower than the design value at 2.4 l/s as unlined canal. Considering the soil classification in the Study Area dose not differ greatly from that of CRBC command area, design value of irrigation efficiency derived from smaller conveyance losses may be taken greater than the CRBC design value of 0.53.

2) Water shortage

According to the special study for post evaluation on CRBC Project by ADB, it was concluded that actual discharge of canal in wet season was increased up to 50 % of design value while the discharge in dry season was decreased by 20 ~ 50 % of design value. Reasons to describe the difference of discharge between actual operation and the design were estimated as follows:

- Inaccurate estimation of water requirement
- Mis-estimation of effective rainfall in wet season
- Inadequate water management
- Difference between designed cropping plan and actual cropping pattern

3) Keen desires for crop based irrigation

Farmers used to select their cultivating crops in consideration with momentary conditions even though those are not recommended in the proposed clopping pattern. Water shortage mentioned above has been caused by this difference between designed cropping pattern and farmers' intention at the moment. Forcing farmers to cultivate in line with fixed cropping pattern sometimes hinders liberal agricultural activities of farmers.

In addition to the above, it should be noted that the *Warabandi* system is practiced in the CRBC command area. It is the rotation system of canal water with fixed turn and time intervals. Farmers are willing to hold certain applicability in selecting their crops, having sense of saving water as applying *warabandi.*

3.4.2 Drainage

(1) Present drainage system

The rivers in the Study area have some peculiar characteristics as given below.

- The courses of rivers are neither distinct nor permanent. These change and silt up due to heavy sediment during flood flows.

- The uncontrolled and random diversions for the propose of flood irrigation by the people known as Rod Kohi result into a phenomena of no fixed stream courses and unnatural run-off characteristic.

- There are 48 cross drainage structures across the C.R.B. gravity canal. No well defined flood channels exist flowing into these outlets from the Study area. The flood capacity flowing away from the Study area is thus limited to the designed capacities of these outlets to avoid inundation in the Study area.

Two major problems on drainage are pointed out regarding the Study area. One is violent sheet flow occurred around center of the Study area, which sometimes menaced farm land and CRBC main canal with destruction. Another is permanent

inundation caused along existing canal due to insufficient drainage.

Location and design capacity of each existing cross drainage structure in the C.R.B. gravity canal has been given as per actual flooding situation. If there were mismatches between present stream courses and location of existing cross drainage structures, the river system might be modified so as to match with condition of such existing structures. Accordingly, the present river system must be considered with its implication on the these existing cross drainage structures. The present river system is shown in Fig. 3.4.1.

(2) Flowing capacity for drainage

1) Design discharge of nullahs

In C.R.B. gravity canal project, design peak flood was analyzed at $0.23m^3/s/km^2$ of specific peak discharge with 40 years return period. The design flood discharge in each nullah (river) could be referred in the Fig. 3.4.2. These design discharges have been estimated through statistical analysis for major nullahs, synthetic unit hydrograph for catchment area greater than 10 sq.miles, rational method for catchment area smaller than 10 sq.miles, respectively.

2) Hydrological analysis for plain area

As long as each field has water storage function by peripheral bund as it is, run-off component from plain area may be neglected. However in case of any change in the farm management in the plain area, run-off condition from the plain area such as shortening of time of peak, and increasing of peak discharge is likely to be experienced.

Assuming that uniform sheet flow occurs in the plain area, run-off discharge from the plain has been estimated with Kinematic Wave Method during the field survey. The result is summarized in the following table.

	Length of plain (km)	Slope of plain	Time of peak discharge (hr)	Specific peak (cms/sq.km)
Case 1	8.0	1/400	6.6	1.86
Case 2	17.5	1/850	21.1	0.74

(3) Routine study at proposed outlet of lift irrigation canal

In order to know the flooding situation around proposed cross drainage structure when flood come, flood routine study is carried out. Crossing point with Budh nullah is selected as a typical site in consideration with magnitude of discharge, topographical condition, type of cross drainage structure.

For the routing study, information in items below are used:

- Relation between water stage and water volume (H-V relation) in and around upstream of the site
- Run-off hydrograph of the Nullah in each return period
- Flowing capacity of proposed cross drainage structure flowing flood down below main canal

Utilizing above condition, routine study is conducted. According to the result, maximum water stage of inundation on upper potion of the proposed cross drainage structure at Budh Nullah is assumed at 204.32 m even in the case of 100 year return period flood. That cause 2.65 meter water stage up at the nullah, estimating 358 ha of inundation .

3.5 Infrastructure

3.5.1 Road

The existing road which run in the D. I. Khan division are grouped into 3 classes under their jurisdiction, and planned, constructed and managed by such organizations as shown below.

- Arterial Road : NHA (National Highway Authority)
- District Road : C&W (Communications & Works Department)
- Village Road : RDD (Rural Development Department)

Major road network on the D. I. Khan District is as illustrated in Fig. 3.5.1.

These roads are structurally classified into 3 grades, and the length of each grade of roads is as listed below.

Total Length of Road in D. I. Khan Division

(Unit: km)

Classification in grade	C&W		RDD		Total	
	existing	planning	existing	planning	existing	planning
Highway and Black topped road	683	78	68	40	751	118
Shingle road	272	-	75		347	-
Katcha road	-	-	60	-	60	-
Total	955	78	203	40	1,158	118

Note: Black topped road .....metalled with more than 4 m width
Shingle road.....less than 4 m width
Katcha road .....less than 3 m width

The density of existing road is calculated at 129 m/km^2 (106 m/km^2 under C&W and 22 m/km^2 under RDD).

Within the above, the existing road in the Project Area (Gross Command Area) is as listed below and the density is about 153 m/km^2.

Length of Existing Road in the Project Area

Class	Length (km)	Jurisdiction
Black topped road	141.0	NHA/C&W
Shingle road	41.0	C&W/RDD
Katcha road	23.5	C&W/RDD
Total	205.5	

3.5.2 Electricity

The present capacity of the nation's electric power supply dose not meet the national demand. The power development program however, is steadily in progress. The generating capacity is expected to increase to 3,691 Mw during the period from July 1992 to March 1995, and further strengthening program is scheduled to increase to 7,991 Mw till April 2000.

About 45 % of all village in D. I. Khan Tehsil, and 16 % in Kulachi Tehsil have been electrified When the additional village electrification to be assisted by OECF and IBRD as Rural Electrification Project (REP) will be completed, the percentage of electrification can be expected to become 86 %.

The national grid of power transmission line is as shown in Fig. 3.5.2.

The power development schemes in and around the Study Area are scheduled as follows:

(1) Chashma Hydropower, 184 Mw	The construction work may be started within 1993, and it is expected to complete in 1997.
(2) Gomal Zam Hydropower, 150 Mw	Dam construction project is under preparation and the power plant may be commissioned early next century.
(3) Chashma Nuclear Power, 300 Mw	It is under construction and is scheduled to be completed by 1999.

The power transmission lines of 132 kvA have been already installed on site as shown in Fig. 3.5.3 and the electric power has been transmitted to the existing sub-stations in Pezu and D. I. Khan which are located about 30 km far from the proposed pump house site in this Project. They are not sufficient in capacity to supply the power to the proposed pumps at present.

The power supply to this Project however rely upon the Chashma Hydropower Project by extending new transmission line about 60 km long.

Therefore the power source for the pumping station of this Project is ensured by completion of the Chashma Hydropower Project.

3.5.3 Domestic Water Supply

Domestic water supply in the Study area is managed and maintained by Public Health Engineering Department (PHED), NWFP, and Rural Development Department (RDD), D. I. Khan. The PHED is substantial government agency for providing domestic water through construction and operation of the water supply schemes (WSS) which are normally composed by tube-wells, community tanks and distributaries. The domestic water supply in Tehsils related to the Study Area is as follows: