Coverage of Domestic Water Supply by PHED

| Tehsil | Nos of WSS | Nos of Vill. Completed | Population | Population Served | Expenditure | Coverage |
|---|---|---|---|---|---|---|
| D. I. Khan | 60 | 232 (597) | 497,666 | 329,402 | 75,603,100 | 25.7 |
| Kulachi | 43 | 77 (135) | 153,265 | 146,159 | 53,912,700 | 54.4 |

Note: Data as June 1993.

Figures in parenthesis are for all villages in the tehsil.

RDD has also supported domestic water supply, through such works as installation of surface open tanks or hand pumps etc.

## 3.6 Environment

### 3.6.1 Current Environment Status

Current environmental conditions of the Study Area are described as the result of study on each field. These conditions can be summarized as Site Description (SD) table to asses the environmental impact for the Project.

SD is as follows;

<Physical SD>

| Environmental Component | Site Description |
|---|---|
| Water | • Five (5) major and numerous number of inundation flows whose local name is "Zam" originated from the mountain range cross the site to the Indus.<br>• Flood damages occur in the site due to lack of proper distribution and cross-drainage facilities of flood flow.<br>• Both surface and groundwater quality indicate high density of salinity. |
| Land | • Almost soil of the site is formed by alluvial deposit transported from the mountain and hilly range.<br>• Sandy soil which occurs along the torrent beds and old river beds is developed at the northern part of the site.<br>• The land is mostly utilized for the cultivation and the livestock farming. The methods of the cultivation are flood irrigation, pump irrigation by tube-well, and rainfed. |
| Climate | • The climate of the site is semi-arid. Although the annual rainfall is low, high intensity rains of short duration is inferred by the hydrological data. |

<Biotic SD>

| Environmental Component | Site Description |
|---|---|
| Fauna/Flora | • Water birds which return seasonally to the flood area are recognized.<br>• Large-sized lizard species are still commonly seen, and other reptile species probably survive in the whole of the site.<br>• Threatened species of fauna and flora can not be recognized. |

<Human SD>

| Environmental Component | Site Description |
|---|---|
| Social | • The population of the site is very sparse and scattered.<br>• Agricultural land is unevenly distributed among land owner households in the site. The number of large land owner is limited, while they hold large share of it. On the other land, the situation in case of marginal and small owner is contrary<br>• Social cohesion regarding common system of Rod Kohi irrigation (flood irrigation) is informalityly formed.<br>• Different attitude is given regarding the water right of above mentioned system.<br>• Waterborne intestinal disease occurs frequently due to health and sanitary deterioration caused by the short of domestic water supply. |
| Human Use | • The cropping intensity is very low because of uncertain and uncontrolled water in summer season, and acute shortage and untimely availability of water in the remaining month of the year.<br>• Mainly goat and sheep are raised as livestock.<br>• Some agricultural processing facilities are operated as agro-industrial activity in the site.<br>• Improvement for the transport communications in the site gets behind.<br>• Domestic water is supplied by the groundwater and/or surface water stored in the small tank. The quantity is often short, while the quality is not so good.<br>• Recreation facilities are not founded in the site.<br>• The rate of electrical energy supply is recently raised due to progress of power plant projects. |
| Economic | • Agricultural labor force is predominant in the site.<br>• The share of farm income to the total income is increased with the scale of operating land size. Livelihood of marginal and small owners depend on casual labor employment. |

| Environmental Component | Site Description |
|---|---|
| Institution | • Participation rate of farmers' organization is very low, but other institutional activities are not formed also. |
| Culture | • One of the archaeological site inferred to have been in pre-Indus Valley Civilization exists in the site. However, it has not been preserved after excavated investigation.<br>• The good places of scenic quality can not be found because natural vegetation has already lost and topographical situation is very flat.<br>• Although the bare living is made, the quality of life hovers around the lower level. |

### 3.6.2 Environmental Impact Assessment (EIA)

The results of EIA study show that the project after completion will lead to numerous positive impacts on the people of the project area and the environment. It will increase income generation, provide employment opportunities and improve the life style of the people. Many other aspects also point to positive impact of the project. However, there are some components which may result into negative impact and therefore these need special considerations. Rise in groundwater level, soil salinity and dust/odor/noise which may result into potential negative impact, can neither be properly evaluated nor can be clearly recognized against present conditions. Other aspects such as health, domestic water supply and historical and archaeological sites will be the worst victims of the negative impacts of the project. Details of these negative impacts are as follows.

Groundwater Level/Soil Salinity

These two issues are mutually inter related. The problem regaling rise in groundwater and increase in soil salinity is always a source of public discussion and criticism by environmentalists whenever irrigation development is carried out. However, the results of study regarding geology and soil structure show that the groundwater level and soil conditions will not change suddenly by the implementation of the project. Therefore, it can be stated that the significant negative impact may occur due to in-appropriate water management for irrigation over along period of time.

The mitigatory measures against the potential negative impact is proper monitoring of the groundwater levels the method for which is given in para 6.1.7.

Dust/Odor/Noise

During the construction of the project to a large extant and during operation to some extant there will be increased human activity near the construction sites which will give rise to change of atmosphere caused by dust from soil movement, exhaust from heavy equipment and vehicles and the noise generated by such equipment. While it is not possible to totally eliminate such impact, it could be reduced through proper management of the activities.

Health/Domestic Water Supply

In some parts of the study area water born intestinal diseases have frequently occurred due to health and sanitary deterioration caused by unhygenic and short water supply. Implementation of the project will result into growth of population in the project area as some seasonal workers are expected to come from outside the area and settle in the villages as labor force. Since the provision of potent water supply is not made in the project to correspond with population growth, the change towards the worst because of such population pressure is expected aggravating the health and sanitation hazards. To mitigate such negative impacts proper supplemental measures for improvement of water supply will need to be taken by the Provincial Government.

Historical/Archaeological site

Finally, the environmental status of these issues is not described in other chapters and paragraphs. Therefore, the details will be introduced in this paragraph as follows.

Historically, the Gomal Plain occupied a strategic position in terms of caravan trade and interaction network among the Indus Plain, Baluchistan, Southern Afghanistan, Eastern Iran and Central Asia. Rehman Dheri, an archaeological site in the Study Area which is considered to be the first major city in South Asia was the main center for these activities.

The archaeological site named "Rehman Dheri" is situated 14 miles (23 km) north of D. I. Khan city about 1 mile (1.6 km) to the west of the D. I. Khan - Bannu highway. It dates from about 4,000 B. C. and seems to have been a fortified city of 10,000 - 15,000 people. It was excavated as a joint project by the Department of Archaeology, University of Peshawar and Department of Archaeology and Museum, Government of Pakistan, under the direction of Dr. F. A. Durrani, between 1976 and 1980. The evidence so far collected from excavations shows that initial attempts of town planning were made here some six hundred years earlier than that of Mohenjo-Dro.

In Pakistan, recognition of the importance of the culture, history and traditions is gaining momentum in the recent years and legislation has been enacted to recognize these concerns. "The Antiquities Act, 1975" prohibits the destruction, damage and defacement of antiquities and there is a provision of imprisonment up to three years. In section No. 22 of this legislation, execution of development schemes in proximity to immovable antiquity is specified. The provision is "Notwithstanding anything contained in any other law for the time being in force, no development plan or scheme or new construction on, or with in a distance of two hundred feet of, a prospected immovable antiquity shall be undertaken or executed except with the approval of the Director General." In the province of Punjab, "The Punjab special premises (preservation) ordinance, 1985" is designed to protect any premises of historical, cultural or architectural values declared as such by the Government. However, NWFP has not any provincial regulations for preservation of cultural heritage.

At present, this archaeological site of 'Rehman Dheri' has not been protected after excavation. The project would naturally exclude this site but it might not sustain the pressure of immigrated people and associated infrastructure.

## 3.7 Government Administration and Project Implementation

### 3.7.1 Present National Institutional Framework for Irrigated Agriculture

Institutionally the irrigated agricultural development is managed by two Ministries at the national level viz. the Ministry of Food & Agriculture and the Ministry of Water and Power. The Ministry of Food & Agriculture almost deals with all aspects of agriculture and food and their inputs and out puts including fertilizers, pesticides, marketing, price regulation, research and extension, land leveling on farm water management and farmers associations etc. except water.

Pakistan being in the semi-arid zone, its agriculture is dependent on artificial irrigation to the extant of 90 %. Any water resource development project both at the micro and macro level is therefore dealt with by a separate ministry viz the ministry of water and power quite independent of the ministry of agriculture. At the macro level it deals with the resource through an independent institution of WAPDA (Water and Power Development Authority) and at the micro level by coordinating the activities of the Provincial Irrigation Departments of the four provinces of NWFP, Punjab, Sindh and Balochistan.

The drainage problems created as a result of artificial irrigation are mostly handled by WAPDA through SCARP (Salinity Control and Reclamation Projects) Programme and large inter provincial drains such as Left Bank and Right Bank out fall drains. The flood control projects on the other hand are also dealt with by the Ministry of Water and Power through its Federal Flood Commission who normally coordinate the activities of Provincial Irrigation Departments and sanctions various flood protection projects. Both the Ministries are quite independent of each other with very little coordination.

At the provincial level also the position remains the same between the departments of food and agriculture and irrigation and power which position permeates down to the field level. The completely stratified vertical heir-archel system has an inbuilt disadvantage for integrated agricultural development and is one of the major factors in having much lower efficiency in terms of agriculture productivity per unit of water consumption. In almost all the new irrigation projects the Ministry of agriculture or the agriculture department of the provincial government comes into action only after the irrigation facilities have been completed and thus it takes a long time for the lands to develop their optimum production capacity even at much lower level of productivity.

The Ministry of water and power some times undertake irrigation projects even at the micro level within the provinces such as the Chashma Right Bank Gravity Canal, the Pat Feeder Canal and the Pehur High Level Canal and the provincial governments agree to such undertakings because of the incentive that these will be financed by the Federal Government. In such cases the coordination and investment efficiency further drops as is evident from the example given below in paragraph 3.7.3.

### 3.7.2 Present Institutional Framework at the District Level

The following organizations/development departments are currently busy in the development activities of D. I. Khan district:-

1. Irrigation Department

*Agriculture Department*

2. Agriculture Research
3. Agricultural Extension
4. Agricultural Engineering
5. On-Farm Water Management
6. Soil Conservation
7. Animal Husbandry
8. Cooperative

9. Agricultural Supply
10. Fruit and Vegetable Development Board

*Forest Department*
11. Forest
12. Wildlife
13. Fisheries

14. Food Department
15. Building Department
16. Highway Department
17. Public Health Engineering Department
18. Health Department
19. Department of Industries and Mineral Development
20. Education Department
21. Population and Welfare
22. Local Government and Rural Development
23. Revenue Department
24. Dera Development Authority
(25.) Water and Power Development Authority (WAPDA)
(26.) Agricultural Development Authority

Besides these departments some NGOs and missionary institutions are also working in the area in the field of education, health, women in development etc. but their contribution in view of their small scale is not significant to deserve elaboration. These are at the preliminary stages of inception and will need time to mature.

Among the above development organizations the most closely related with the project are the following departments:

(1) Water and Power Development Authority of the Federal Government

This is the largest single Federal organization which as agent of the provincial government is constructing the Chashma right Bank Gravity canal at the eastern periphery of the project area. The Water and Power Development Authority is charged with the construction of main canal and most of the distribution system of Chashma Right Bank Gravity Canal having a capacity of 140 cubic meters per second at its head and irrigating a culturable commanded area of 230,000 ha. (141,000 ha. in D. I. Khan district of NWFP and 89,000 ha. in D. G. Khan district of Punjab province). This being an inter-provincial project had to be constructed by a federal agency to avoid disputes between the provinces.

WAPDA is currently employing 113 engineers and equivalent, 90 sub-engineers and equivalent and 511 support staff besides full time consultants for the construction supervision and canal command area development of Chashma right bank gravity canal. The administrative expenses including utilities and overheads from 1990-91 to 1992-93 have been as follows:

| | 1990-91 | 1991-92 | 1992-93 |
|---|---|---|---|
| Administrative expenses & overhead (Rupees in millions) | 32.548 | 50.828 | 52.105 |

(2) The Provincial Irrigation Department

The provincial irrigation department has one circle and three divisions for operation and maintenance of old Paharpur canal now a part of gravity canal and operation & maintenance of new distribution system upto Phase II of the gravity canal. In addition they provide technical assistance to the Deputy Commissioner for distribution and regulation of hill torrents flood flows. The irrigation department is also doing the water rates assessment of the areas irrigated. The assessed water rate are collected by the revenue department and credited to the provincial revenue account as revenue receipts. The operation & maintenance costs are allocated by the finance department on annual basis without any reference to the revenue receipts. The two cross streams of funds from and to the finance department of the province have no co-relation between the costs and revenues. The provincial irrigation department is thus responsible for the maintenance of canal system, assessment of crop based water rates, distribution of supply based water according to the land holdings of the farmers, and do not go beyond this mandate. The department has a strength of 29 technical and 411 support staff.

(3) The Department of Agriculture

This department has 10 branches working in D. I. Khan. Some of these are agriculture research, Agriculture extension, animal husbandry and livestock, the agriculture marketing, agriculture engineering, on-farm water management, soil conservation, agriculture supplies, horticulture and fruits and vegetables.

1) Agriculture Research Wing

The biggest wing of the agriculture department is the agriculture research directorate with the highest qualified manpower. It employees 189 experts and staff - out of which 45 are postgraduate agricultural experts and have an area of about 200 ha. for carrying out the necessary research on various crops, seeds and pest control etc.

2) Agriculture Extension

The 2nd largest wing of the agriculture department is the agriculture extension which is designed to provide in field advice on all kinds of agricultural inputs and practices, advice on pesticides, credits and marketing facilities. This wing too has a large staff of 148 with 30 as technical experts. Their training and knowledge of advance science of agriculture is inadequate and therefore can not resolve the day to day problems of the farmers. The result is that the department has gradually lost the trust and respect of the farmers. Some of the other reasons for unsatisfactory working of this department are lack of finances for field work, low salaries, inadequate training, frequent transfers and political interference.

3) On-Farm Water Management

This is a recently introduced organization to improve the irrigation efficiency through improvement of field water courses and precision land leveling. Where as the water course improvement, because of large subsidy by the Government (80 % of the cost) has found acceptability with the farmers, the precision land leveling has not been able to impress the farmers particularly because such leveling is expensive and is needed almost every 2nd year. In the case of water course improvement the additional condition has been the formation of farmers' association which too disintegrated once the water course was completed as no further incentive was available to them - the water regulation being the job of the Government functionaries. With regard to irrigation efficiency improvement many experts are of the opinion that it is not commensurate with the financial expenditure. However, it has reduced the farmers labor to maintain and operate the water course. In the long run it may help in reducing the problem of waterlogging and salinity.

4) Agriculture Engineering

This wing supplies heavy equipment on highly subsidized rates to those farmers who wish to reclaim their lands which have hitherto remained barren or were above the command of irrigation system. They also help in restoring flood damages, construction of tubewells etc. The heavy machinery is poorly maintained and the units very rarely complete their prescribed life hours. Further it is generally complained that this equipment with heavy subsidy is available to the influential farmers only.

5) Agriculture Supply, Soil Conservation, Cooperative, Livestock and Dairy Development Departments, Fruit & Vegetable Board, Wildlife Department

These Department have very little contribution due to lack of coordination with the farmers, long line of bureaucratic control, frequent transfers resulting into absence of continuity and lack of availability of funds for projects works.

(4) Forest Department

The forest department has two professional and about 78 support staff. It normally helps the farmers to supply root stock of trees from their nurseries at nominal prices. Although they could have a large contribution in converting the near desert conditions into dry land forests but because of their lack of coordination with the farmers their contribution is also not commensurate with their strength. They, however, carry out plantation along the roads and canals.

(5) Communication and Works Department

Within their mandate of construction and maintenance of main highways district and tehsil roads they are working reasonably well although the quality remains poor. With regard to rural roads development they have neither any coordination with the beneficiaries nor with the other departments resulting into improper planning.

(6) Public Health Engineering

The main task assigned to this department is the provision of potable water to the rural population. Over the last 20 years their performance could be termed as satisfactory but still more than 60 % of the population has no access to clean potable water supply mainly because of lack of finances and dispersal of population away from the sources of perennial water channels.

(7) Local Government and Rural Development Department.

This department is supposed to work in close association with the union councils and distract council and is responsible for organizing and implementing development projects according to the needs of the people at gross root level. However, they are allocated very little founds directly to carry out organized and planned development according to the socio-economic requirements of the people. The funds are mostly allocated to members of the national assembly, members of the provincial assembly and senators and therefore the development funds are supposed to be used by this department according to their directions and advice. Since such an advice is mostly politically oriented without any integrated planning, the economic effect of such projects is only marginal. The quality of work due to low technical input and thin spreading of the funds is also not satisfactory.

Staff Strength of Federal & Provincial Agencies at D. I. Khan

| Item | No. of Agencies | Technical | Administrative | Total |
|---|---|---|---|---|
| Federal | 2 | 217 | 516 | 733 |
| Provincial | 24 | 495 | 3,999 | 4,494 |
| Total | 26 | 712 | 4,515 | 5,227 |

Excludes health (except D. I. Khan hospital) and teachers in education department.

It can be seen from the above table that technical staff is limited to 11% and 89% is administrative staff out of which about 52% is grade 4 and below.

The Provincial budget excluding education is spent as follows (1992/1993)

Rs. in Million

| | Revenue | Development | Total |
|---|---|---|---|
| .Establishment | 135.7 | 13.3 | 149.0 |
| | (72.76%) | (19.1%) | (58.2%) |
| Utilities | 11.3 | 1.8 | 13.1 |
| Others | 39.5 | 54.4 | 93.9 |
| | (21.2%) | (78.3) | (36.7%) |
| Total | 186.5 | 69.5 | 256.0 |

The detailed activities of the provincial organizations is given in Table 3.8.2 whereas details of staff and budget is at Table 3.8.9 and 3.8.11. The organization charts can be seen at Fig. 3.8.1 to 3.8.24.

### 3.7.3 Project Implementation under the Present Administrative Framework

The project implementation under the present framework is most likely to follow the example of Chashma Right Bank Gravity Canal already under construction and is likely to be executed by WAPDA as agent to the Provincial Government. It will follow the typical pattern of irrigation projects which even at the planning stage aims at construction of conveyance system only and do not include the development of farm land, the formation of farmers associations, the training of the farmers for irrigated agriculture, the development of infrastructure facilities and other agriculture inputs as these are considered to be carried out by the respective departments.

It was therefore essential to study the behavior of the present project i.e. Chashma Right Bank Gravity Canal, the various constraints experienced, and to make concrete recommendations for institutional set up for C.R.B. lift irrigation project.

(1) Implementation Schedule and Progress of C.R.B. Gravity Canal

The present gravity canal which is quite similar to the lift canal was started in 1978 with a schedule for the construction of water conveyance system only and was to be completed by 1985. Because of various constraints such as in-adequate financial allocations by the federal government due to competing demand, lack of coordination among the various provincial and federal institutions, complicated procedure in loan agreement, appointment of consultants and contractors, and lack of interest by the provincial government departments considering the project to be the federal responsibility, only stage I and stage II of the project have been completed till 1992. These two stages constitute 50% of the work and will irrigate only 27% of the new area. The stage III is now scheduled to be completed in 7 years starting from fiscal year 1994-95. However looking at the past record and the progress since 1991, it is likely to take at least 10 years taking the completion target to 2004-2005. Thus the project which was scheduled to be completed in 7 years will be taking 26 years. Besides the delays in completion of the project, cost has increased from Rs. 1,500 million to Rs. 12,000 million almost eight times.

(2) Constraints in the Project Implementation.

1) Financial

The major constraint in the timely completion of the canal and distribution system has been the lack of timely availability of financial resources for the project. This problem is not only specific to this project but is common to most of the projects in the country. The scheduled provision of finances is never provided in the annual budget because of the gape between resources and demand at the time of budget preparation. Even after the budget, when the ways and means position can not provide the funds according to budget or some emergency like flood or draught occurs requiring diversion of resources, an ad- hoc cut to all the projects is applied which further reduces the funds availability and affects the progress.

The international financial agencies also split the project in stages and for each stage separate financial agreements are signed requiring separate appointment of consultants, preparation and updating of feasibility studies, detailed designs and a long procedure of tendering and appointment of consultants. C.R.B. gravity canal is a typical victim of such delays. The financial institutions also demand that 20 % of the project cost should be contributed by the Government of Pakistan. When such a contribution is not available the corresponding loan facility is also cut down resulting into total disruption of the construction schedule.

2) Lack of Coordination

Coordination is probably one of the most important factor in development of agricultural projects. It needs coordination of the implementation agency primarily with the department of irrigation and agriculture research and extension. It also needs coordination with the beneficiaries, credit agencies, forestry, fisheries, agricultural supply organizations, marketing institutions, rural development organizations & communication etc. to optimize benefits and to develop the lands to its optimum production in the minimum possible time. Unfortunately the water and power development authority (WAPDA) a Federal agency did not have any significant coordination despite the fact that four coordination committees at the federal, provincial, divisional and district level were instituted. The lack of coordination is inherent in the vertical heirarchel system and centralized decision making. For example a decision at the divisional committee level could not be implemented because it had to be ratified by the concerned department at the provincial/federal government level who either delayed the decision or differed with it resulting into non implementation of the decision.

3) Institutional Inefficiency and Lack of Interest

C.R.B. gravity canal project is being implemented by WAPDA - a federally controlled statutory organization which is not directly responsible to the provincial government. This project was one of the medium priority project for the WAPDA and therefore proper attention could not be paid by them. There were design delays, contractual delays, approval delays, delays in appointment of consultants and contractors and frequent changes in management and staff. Further since the beneficiaries belonged to a province who did not have a strong voice at the federal level, the timely completion of the project was only of secondary priority to the federal institution. Since the provincial irrigation department was weak in qualified and experience manpower , the provincial government had no alternative but to let WAPDA be the executing agency besides the incentive of federal budgeting. In future, however, the federal budgeting will no longer be available for the provincial projects as stated by the Planning Commission.

(3) Proposed Countermeasures

Besides the construction of water conveyance system, an agricultural development project needs land leveling, provision of farm inputs, rural infrastructure development, availability of machinery and farm labor, institution of farmers' organization etc. which are lagging far behind and therefore maturing the project to obtain full benefits will take at least 20 years after the completion of the canal and distribution system.

Considering the above it is evident that the C.R.B. lift irrigation project should not follow the dismal example of the gravity flow canal and therefore alternative arrangements have to be suggested to respond to the following requirement.

1) Draw up a schedule in consultation with the farmers for an integrated development of the irrigable area in conformity with the construction of the canal and distribution system.

2) Make arrangements to over come the problem of coordination between the development agencies and the beneficiaries and among the development agencies themselves to develop the project in an integrated manner.

3) Make arrangements for training of farmers to inform them about irrigated agriculture and to respond to the use of water according to crop requirement.

4) Fix and realize water charges to make the project self sustaining after its completion.

5) Develop farmers associations at water course/minor level and at distributary level and transfer the responsibility of operation & maintenance of the facility to the farmers and also the distribution of water among the farmers and collection of water charges.

### 3.7.4 Coordination Committees

The four coordination committees viz PSCC (Project Supervision and Coordination Committee) at the federal level, PCC (Project Coordination Committee) at provincial level, PMC (Project Management Committee) at divisional level and DPCC (District Project Coordination Committee) at district level are given in Table 3.8.1 along with their basis of establishment and their aims and objectives. These committees have been established since 1985 and earlier and have hardly achieved any meanful coordination as can be seen from subsequent response of the 24 coordinating departments.

## CHAPTER IV BASIC CONCEPT FOR THE PROJECT DEVELOPMENT

### 4.1 Development Potential

To formulate the development plan, potentialities of the Study area need to be identified to determine the possibility and scope of development. In contrast with depressed present conditions in the area, potentialities to achieve great strides are available. Major potentialities in the Study area are summarized as follows:

(1) Land availability

The total acreage of the Study Area is 141,700 ha. Based on the land classification, 4,810 ha (3.4% of the total area) is classified as unproductive land, and 1,450 ha (1%) has been reserved for residential needs in the irrigable land. The area of 9,210 ha (6.5%) is classified as marginal land for cultivation mainly because of geological condition of dune. It is estimated that the gross cultivable command area (GCA) is 135,440 ha or 95.6% of the total area. The marginal land is included in the GCA as certain countermeasures in irrigation could reclaim this land.

(2) Water availability

The source of irrigation water for this Project is the surface water of Indus River and the amount of available water is subject to the Water Accord concluded in March 1991. Both groups of the Japanese Study team and Pakistan counterpart personnel recognize that there is a discrepancy between the water requirement as indicated in PC-I 1973 of CRBC Project and the 10 daily breakdown of the Water Accord. It was concluded that the season wise figures and not the 10 daily figures of the PC-I 1973 should be used for the Project as the 10 daily figures can be adjusted with in the overall allocations of the province. This Project has therefore the freedom to charge 10 daily requirements as long as the total Kharif requirements remains less than 0.639 MAF (787.9 million cu.m.) and Rabi requirements less than 0.547 MAF (674.5 million cum.) .

(3) Labor force availability

The Study Area is sparsely populated at present due to less availability of water for irrigation and for domestic use. Labor shortage seems to be one of the apparent constraint for the implementation of the Project. However, considering the high unemployment rate in and around the Study Area, low density of population is not a substantial constraint for the Project development but a potentiality for attracting the labor.

(4) High farmers' volition for agriculture

According to aerial photography, the entire Study Area is closely filled up by numerous number of farm plots surrounded by embankments (bunds) which require continuous efforts to construct and maintain. This fact gives evidence to the farmers endeavor and desire for agricultural development. During the interview survey with farmers, they expressed their strong desire for the Project. One hundred percent of interviewees agreed to pay costly *abiana* for lift irrigation contrary to the views of the officials that farmers hesitate to consent to the Project. These show high farmers' volition for agriculture.

(5) Electricity availability

Chashma hydropower project has been initiated including the construction of 184 Mw low head hydropower plant at the existing Chashma barrage. Rough estimation of the electricity demand for the pump station of the Project will be about 22 Mw at peak. Assuming that the output of the Chashma hydropower plant can be utilized for the 1st lift project through the national grid, the electricity consumption by the pump station will not hinder the local electricity supply.

## 4.2 Constraints for the Project Development

The major economic activity in and around the study area is agriculture. Agriculture is also sluggish with low productivity and is performed over a small area due to compound bottle necks of low rainfall, limited and uncertain water availability from the hill torrents, high temperature, high frequency of sand storms, immature/non existent farmers organization and low income caused by small employment opportunity. These are noticeable constraints for the improvement of economic conditions of the people and need to be over come. Constraints in each field given in the previous chapters are summarized as follows.

(1) Low Agricultural Productivity

In view of scarce and uncertain water availability and very low rainfall, the agricultural productivity is very low per unit of land in the project area. Improved varieties of seeds, fertilizers, agrochemicals etc. are not used mainly due to the risk of crop failure and farmers financial inability to pay the costs.

Resident farmers have insufficient knowledge and experience on intensive forming except in the very small tube well irrigated area of 940 ha. Main farm income accrues from live stock production. Live stock grazing in cultivable waste land and feeding fodder crops are important production activities both for home consumption and cash income. Under drought conditions the population become nomadic and start shifting in search of grazing grounds and drinking water for domestic and animal use. Cattle and camels also play an important role in draft power and transportation. Failure of crops and drought conditions are common and do happen for two to three successive years every now and then.

(2) Shortage of Water Resources

Annual average rainfall in the study area is less than 279 mm which is in adequate to supply the required soil moisture even for one crop in Rabi/winter season. In addition, the erratic rainfall and its irregular distribution over the year has forced the agricultural production activities to be primitive and extensive. Supply of water is essential to introduce modern parennial farming and increase crop productivity.

(3) Cultivating under Extensive Irrigation

Hill torrent cultivation (Rod Kohi) using flood water has long been practiced in the Study Area. On the other hand, canal irrigated cultivation has different characters from Rod Kohi cultivation and requires regular farming practices according to water distribution schedule and cropping pattern. Farmers in the Study Area have no experience on the canal irrigated farming.

(4) Unregulated Markets and Inadequate Marketing Facilities

The district wholesale markets in D. I. Khan are not declared as a regulated market under a provincial government notification. No market committees are functional. The middlemen and merchants are not controlled and the market margin seems to be higher than that of the regulated markets. Only the committee undertakes collection and dissemination of market information and regulation of sale and purchase of agricultural produce.

Growers in villages do not have appropriate storage facilities with adequate capacity. The loss between growers and markets and between markets and consumers is not small. There is only one cold storage for fruits and vegetables in D. I. Khan district. Transportation facilities such as parking lots at the market are not developed. Processing facilities of the perishables do not exist in the district. There is no efficient system for grading and standardization of agricultural produce, either.

In accordance with the farm survey results the linkage of farm-to-market and market-to-market (village market to inter-union market or inter-union market to inter-union market in particular) are weak due to poor road network.

(5) Small Employment Opportunity

There are no substantial industrial factories to generate employment opportunity excluding agriculture. Small employment opportunity in the Study area due to dull activities in agriculture, force the farmers to have low standard of life and limited financial capacity for the Development. Income and expenditure balance, especially for marginal and small owners, is negligibly small (less than Rs. 600 per year). Capital formation of these farmers are primitive at present and financial assistance will be essential for the irrigation development in the Study Area.

(6) Severe Natural Condition

Climate in the Study area is hot and arid. Such severe natural condition along with lack of adequate infrastructure restrain the population from development. Severity of the natural state is tough to overcome, but can be mitigated through development of this Project.

(7) Low Versatility of Irrigation System

Low versatility of the existing irrigation system on the periphery of the project area and in the country is a major constraint for implementing and operating the project. All the existing irrigation projects have rigid operational criteria in view of their fixed capacities according to supply based irrigation systems and have therefore no flexibility to respond to crop water requirements resulting into either lower intensity or lower productivity of crops due to moisture stress at critical stages.

The second aspect is that the existing irrigation department has a long experience on supply based system and have neither any knowledge nor experience to operate crop based system. Since crop based irrigation system require strong farmers associations to pursue good water management, their non-existence is a major constraint in realization of full benefits from the project.

The new Chashma Right Bank Gravity Canal is although designed according to crop water requirements yet it is being operated as a supply based irrigation system because of lack of adequate institution. To over come this constrain and to resolve the conflict between demand and supply, suitable organizational changes have to be brought about by creating farmers associations and giving them the responsibility to manage the system at their level.

(8) Lack of Farmer's Organization Activities

Except for the tube well irrigated area of 940 ha, there are no farmers organizations for operation and maintenance of irrigation facilities, water distribution or collection of water rates. This is so, not only in the project area but perhaps in the entire country. There are 26 cooperative societies in the 104 related mouzas covering the study area but these are in-active and dormant. The house hold participation rate is only 5 % and these are also mostly family members groups. How ever these cooperative societies have no relationship with the irrigation activity.
Since the project under development is based on crop water requirement, it will be difficult, perhaps impossible for the irrigation department to operate and distribute the water under their direct control because the discharge of the system will be varied on 10 daily basis against the present six monthly variation. It is therefore obvious that the water distribution should be done by the farmers themselves. For this propose it may be necessary to create and organize farmers associations at the water course/minor and distributary level.
Experience has shown that mono-decipline farmers association without long term physical and financial responsibility, have rarely succeeded and therefore along with the distribution of water they may be given the responsibility of collection of water charges from the farmers and maintenance and operation of the distribution system beyond the distributary head regulator.

(9) Complicated Institutionalization

Even in the existing CRBC gravity irrigation area, support services for on-farm development, such as management of irrigation water distribution, extension of agricultural technology, farmer's organization set-up, distribution of institutional credit are insufficient to accrue the prospective irrigation development benefits. There are no effective support service organizations and activities for promotion of irrigation development in the Study Area.
Several independent institutions are concerned with for the operation and maintenance of CRBC irrigation system. Their functions are set up by the level of irrigation facilities from Chashma barrage to the tail water courses. Major institutions and their functions are summarized as follows:

*WAPDA*

- Construction of main canal, distributaries and their related structures,
- O&M of main canal, distributaries and their related structure,
- Intake irrigation water from the Chashma barrage and

- Water distribution from main canal to distributaries.

*Irrigation Department*

- Construction of minor/sub-minor canals and their related structures,
- O&M of distributaries, minor/sub-minor canals, and their related structures,
- Water distribution from distributaries to minor/sub-minor canals and water courses,
- Coordination and consultation for rotation of water by command area of water course, and
- Monitoring of crop production to assess water rate.

*On Farm Water Management (Agriculture Department)*

- Promotion of water users association set-up,
- Improvement and construction of water courses, and
- Demonstration of precision land leveling.

In addition the agriculture research, agriculture extension, forest, local government & rural development agriculture credit and supply organizations are also working in the area. Despite these organizations there are several constraints encountered for O&M of the CRBC gravity system. These are low density of minor/sub-minor canals and water courses, disorganized water distribution, disordered cropping pattern to the original plan, improper and wasting water use at farm lot, low participation of farmers to water user's association, etc. Coordination committees for the CRBC gravity project are organized at the federal, provincial, divisional and distract level, while the constrains at field level could not be properly recognized. The existing institutional arrangement and their functional set up by the level of irrigation facilities seem to be unsuitable and ineffective to solve the constraints. Institutional re-arrangement may be one of countermeasures for effective implementation of the Project, proper O&M activities and early realization of development benefit.

The C.R.B. lift irrigation system is very expansive both on capital cost and operational cost because of a long feeder canal having no irrigation and pump house needing costly energy to pump the water. This project will therefore either need a high level of subsidy or realization of much higher water charges than the other canals.

The Provincial Government have indicated that they are not willing to give any subsidy and that all operational costs must be realized from the beneficiaries. In order to realize such operational costs from one particular project the irrigation department, having no such rules, will find it almost impossible to do so as per existing conditions of C.R.B. gravity canal stage I & II. It is therefore obvious that different institution with legal power along with farmers association will be needed to operate & maintain the system on sustainable bases.

(10) Socio-Economical Constraints

Agricultural land is unevenly distributed among land owner households in the Study Area. The number of marginal and small land owner households below 3 ha accounts for around 74% of total land owner households, while their share of registered agricultural land area is limited at 9% of total area.

The absentee land holding, prevailing in the Study Area have a share of around 17% of the registered agricultural land. Around 33% of the registered agricultural land are tenanted. Social status of lessees are low and bound to owners mainly because of debts and social convention.

Population density in the Study Area is estimated at 56 person per $km^2$ or 0.56 person per ha. Half of population at most will contribute as labor forces at present. Labor force will be increased as irrigated agriculture develops. However, for the initial stage of irrigation development, supplemental supply of laborer and/or extension of farm mechanization will be indispensable.

## 4.3 Strategy for Development

With the formulation of Eighth Five Year Plan of Pakistan (EFYP), a fifteen years long term socio-economic vision of the economy is being evolved which will be realized through medium term (five year) plans. The perspective Plan (1993-2008) has been conceived in the light of (a) lessons from the past, (b) present policies of privatization, deregulation, and market orientation of domestic economy, and (c) imperatives arising from emerging global environment.

While the enhancement of social and economic welfare of the people is still pivoted, the EFYP strengthen most notably the redefinition of the government's role in the economy, being pursued at a time of fundamental change in 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. Furthermore, the policy concretely derives major objectives, namely, self reliance, poverty alleviation, employment, environment, expansion in energy and physical infrastructure, rural development, stimulating private investment and social sector improvement.

Considering the development potential of the Study area mentioned before, constraints shall be overcome to achieve the development objectives of the Project through a well formulated strategy for development. The development objectives of the Project are condensed as follows:

- to realize large-scale agricultural development
- to facilitate basic social infrastructure
- to conserve and ameliorate environment
- to meet with crop-based irrigation
- to promote farmers organization
- to set up effective institutions

These strategies and objectives of the Project just meet with national policy which is clearly defined in EFYP. The relation of both streams is schematically shown in Fig. 4.3.1. In order to realize such development objectives through the Project, components highlighted on the Project are made up as follows:

- Attractive Agricultural Development Plan
- Appropriate Irrigation System
- Appropriate Drainage System
- Adequate Road Network and Social Infrastructure
- Careful Monitoring on Environment
- Well Facilitating for O&M, and Elaborate Water Management Schedule
- Realizable Farmers Organization Plan
- Sustainable Institutional Development Plan

## 4.4 Optimum Scale and Scheme for Irrigation

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

A project must be effective at its maximum. It is most important to set forth the optimum scale and scheme for irrigation so that the Project realizes the highest benefits. There are arguments as to how the benefit is defined. Shall it be defined at the maximum point of benefit to cost ratio, or maximum amount of net benefit? This Project aims at optimizing both definitions.

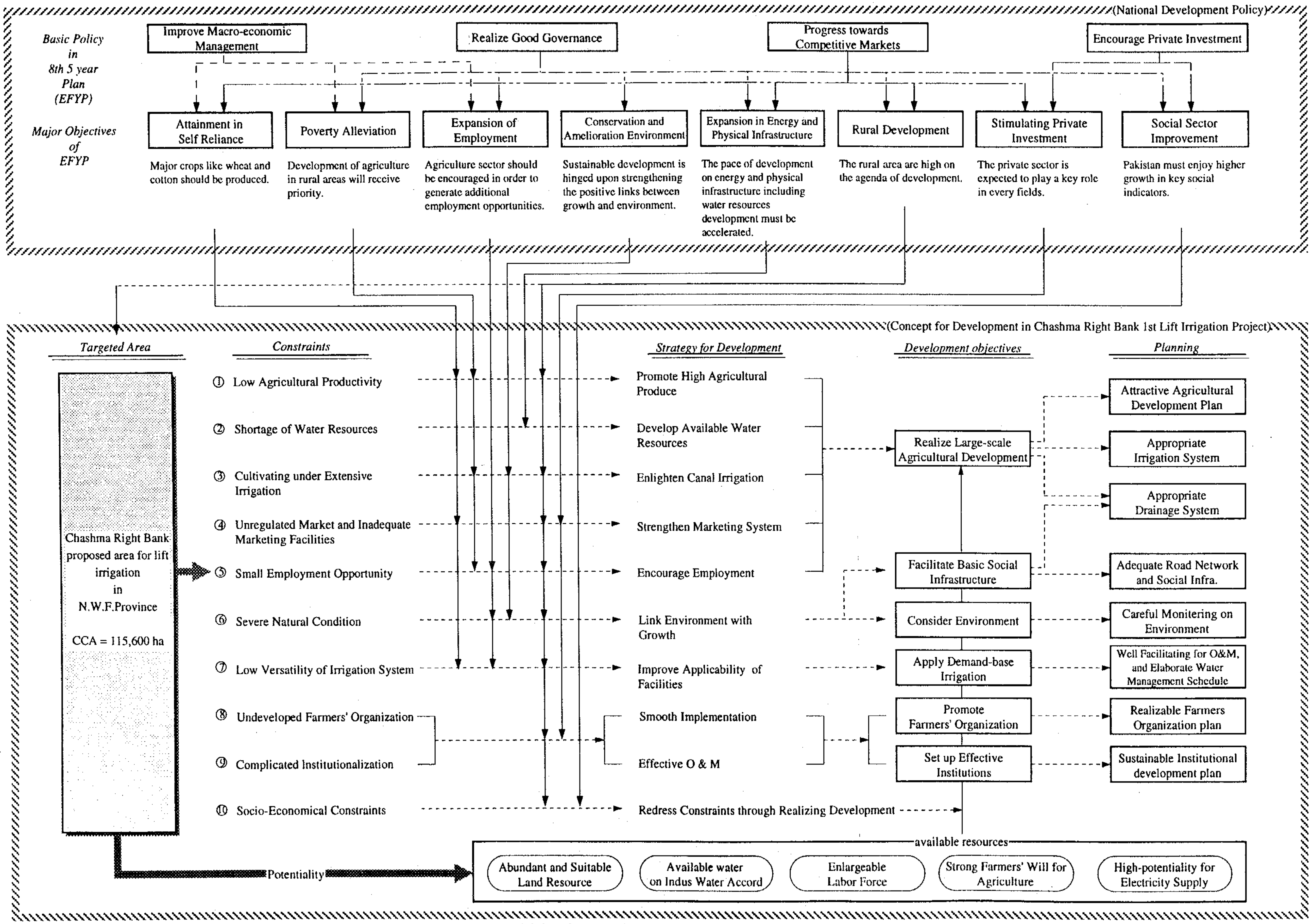



**Fig. 4.3.1 Concept for Development Planning**

### 4.4.1 Assumptions for the Project Development

In order to carry out alternative study on optimum scale and scheme for irrigation, some assumptions are needed. The assumptions mean basic preconditions in agriculture and irrigation, on which the alternative study is based. The assumptions have been fed back from the sectional development plans described in Chapter 5. Assumptions fed back are herein briefly mentioned (Detail description of the conditions will be made with conclusion of this alternative study on optimum scale and scheme.).

(1) Preconditions in agriculture

Uniform cropping pattern is applied for whole project area. Applied cropping pattern is with cropping intensity for season of:

| | | |
|---|---|---|
| Kharif | 60% | Cotton, Pluses, Maize, Fodder, Sugarcane etc. |
| Rabi | 90% | Wheat, Oilseed, Gram, Fodder, Sugarcane etc. |
| (Spring) | (10%) | Maize, Sunflower |

Rice is eliminated in view of economy and environment. Spring maize and sunflower are newly introduced. (refer **5.2 Agricultural development plan**).

(2) Irrigation

1) Irrigation method

Furrow irrigation method and/or border irrigation method is the most suitable method for the Study area so as to save water and be easily adopted by the farmers themselves.

2) Irrigation efficiency

An irrigation efficiency of 0.58 is proposed for land with ordinary soil with the following break up. In the case of land with sandy soil, an efficiency of 0.30 is applied using a factor of 0.40 for the field efficiency.

| | | |
|---|---|---|
| Conveyance efficiency | = | 0.90 |
| Distribution efficiency | = | 0.86 |
| Field efficiency | = | 0.75 |

3) Effective rainfall

The effective rainfall is estimated through a water budget calculation considering holding capacity of soil and soil moisture when rain occurs. Annual effective rainfall is 239.2 mm (Kharif 160.5 mm; Rabi 78.7 mm), at 86% of actual rainfall in volume.

4) Water requirement

Water requirement for irrigation is calculated on 10 daily bases applying proposed cropping pattern, analyzed $ET_0$, FAO's Kc, proposed irrigation efficiency and analyzed effective rainfall for ordinary land and sandy land, respectively. Unit water requirement is as follows:

Unit Water Requirement

(million cum)

| Results | Ordinary land | Sandy land |
|---|---|---|
| Kharif for 1,000 ha | 5.700 (0.583) | 11.020 (1.127) |
| Rabi for 1,000 ha | 5.010 (0.527) | 9.684 (1.018) |

Figures in parenthesis are peak discharge at cum.s.

(3) Conveyance system

Through independent comparative study on conveyance system, the Feeder Canal (about 58.5 km in length) is proposed to connect the Intake and Pumping Station, taking alignment parallel to the existing CRBC on its right side. Due to adoption of smallest longitudinal slope of 1/14,000 and concrete lining, the reach of proposed feeder canal gain hydraulic head of 2.0 meter over CRBC canal at the entrance of the Study area. Alternative study herein should be independently carried out only for irrigation scheme with due regard to such hydraulic head gain.

### 4.4.2 Optimum Irrigation Scheme

Three comparative plans for basic irrigation scheme of this Project, Type A, Type B and Type C are conceived as illustrated in Fig. 4.4.1. Type A is the most suitable plan in which the irrigation water is pumped with one big pump station, and flows by gravity through main canal located along the highest edge of the area. Location of the pump station on Type A was selected to have short distance to the beginning point of elevated main canal to reduce the length of the delivery pipes, and topographically favorable conditions for construction.

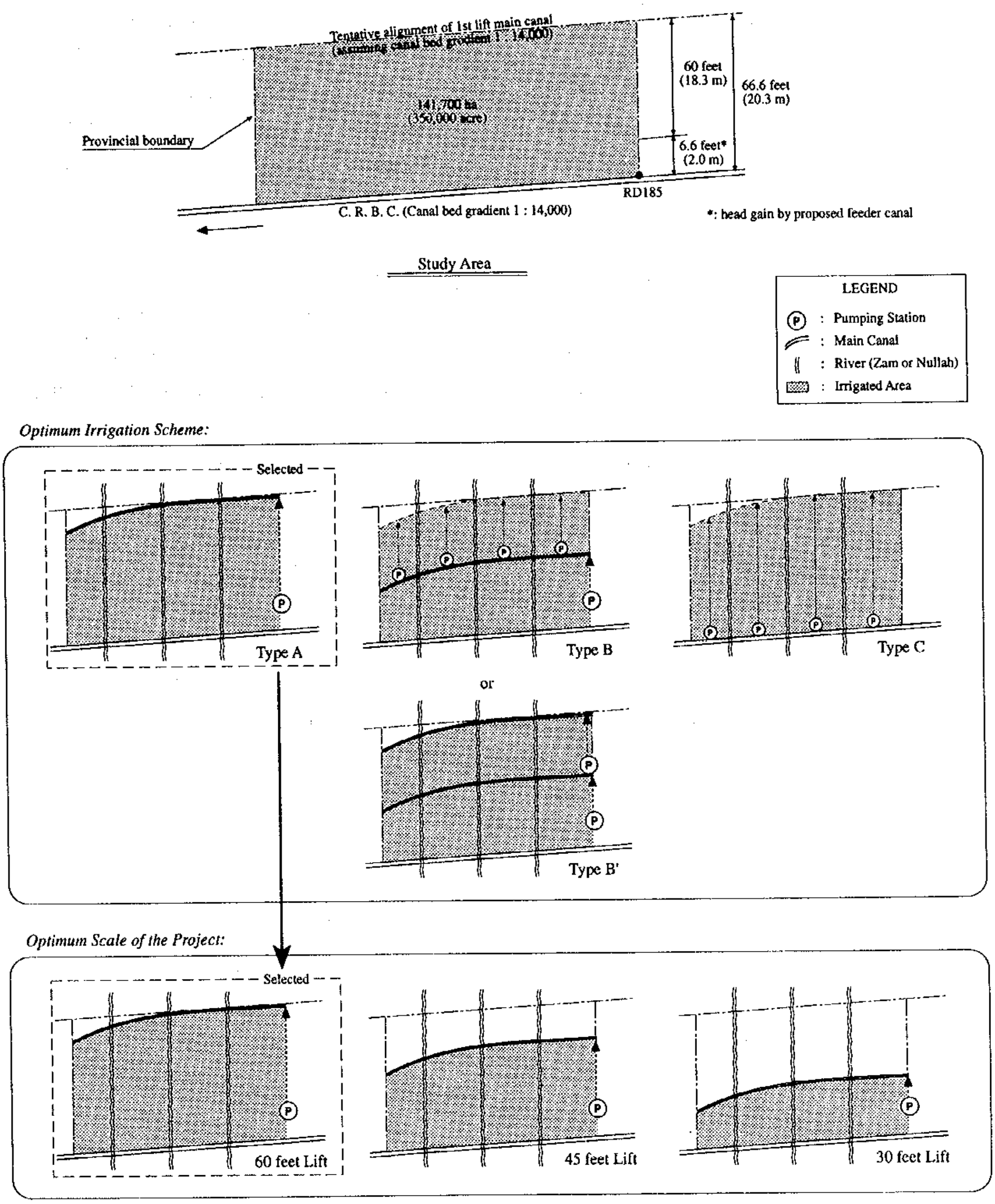


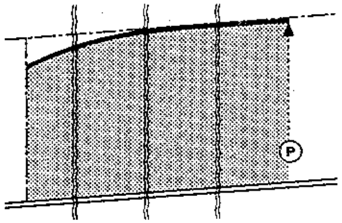
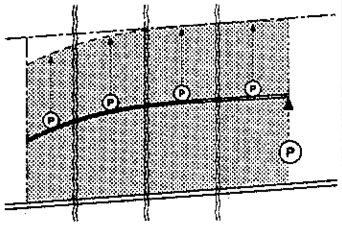
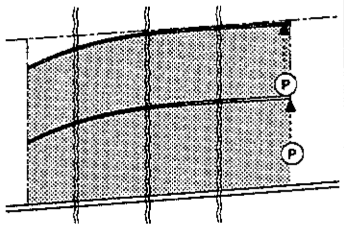
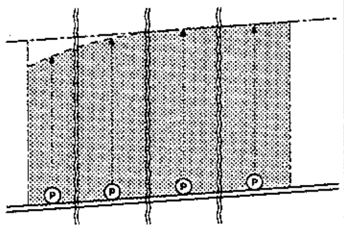

**Fig. 4.4.1 Flow Diagram of Alternative Study for Optimization**

Type C is to irrigate each irrigation block separated by notable Zams through number of pump stations constructed independently. This plan lays stress on points that easy water management can be expected through separating irrigation blocks independently. No huge drainage facilities at crossing with big Zams are required. However, this plan is physically unfeasible because of no room for existing CRBC's canal capacity to accommodate the irrigation water of this Project in addition to its own requirement.

Type B is a compromised plan with Type A and Type C, having irrigating areas separated as same as Type C, and an area singularly irrigated as same as Type A. On this plan, operation cost of pumps can be expected smaller than Type A because the lower potion of irrigated area can be supplied by low head pump only. Main canal proposed at about center of the Project area has also a function as huge regulating reservoir. In connection with Type B, similar plan Type B' is conceived, which proposes another main pump station and main canal instead of the booster pumps. Type B' is considered inferior to Type B on economical considerations because of construction of two lines of main canals. Type B, therefore, is regarded as a plan to be evaluated on this study.

Merits and demerits for each comparative plans are summarized in Table 4.4.1. Rough cost estimates were carried out for each plan. Estimated costs for each plan as of March 1994 are listed below.(Type C is not compared in construction cost because of physical unfeasibility of the alternative)

## Table 4.4.1 Comparative Table for Irrigation System

| Irrigation Scheme | Characteristics | | Facilities | | | | |
|---|---|---|---|---|---|---|---|
| | | | Pumping Station | | | | Main Canal |
| | Merits | Demerits | Pumping Equipment | Delivery Pipes | Civil Structures | Engergy Comsumpt | |
| Type A<br> | Most simple lifting and water divering system. | Well functioned O & M organization is required. | Full height & full discharge by main pumps<br>(72 $m^3/s$ x 23.0 m x 21,600 kw) | Full height & full discharge pipelines<br>ø3,200mm x 3lines<br>684m long | Stilling basin<br>Escape facility<br>Suction pit<br>Pump house<br>Delivery tank | Statical head: 18.3m<br>Pump losses: 1.5m<br>Pipe losses: 1.2m<br>Others: 2.0m<br>Total 23.0m | One (1) line main canal at highest level |
| Type B<br> | (upper portion)<br>Most simple O & M system owning of independent operation for each irrigation block.<br>(lower portion)<br>Much economic due to being supplyed low pressured water. | Much costly and complicated system. | Half height & full discharge by main pumps<br>12 nos. of boaster pumping stations with 2.8 $m^3/s$ discharge each.<br>Power supply line along canal for boosters | Half height & full discharge pipelines<br>ø3,200mm x 3lines<br>300m long<br>12 nos. of boosters Pipelines<br>ø1,000 - 2,000mm<br>5,000 - 10,000m long | At main station same as above<br>At boosters stations<br>Farm pond with 1 - 3 hours capacity<br>Booster pump houses | (upper portion)<br>Statical head: 9.0m<br>Pump losses: 1.7m<br>Pipe losses: 2.0m<br>Sub-Total 12.7m<br>(lower portion)<br>Statical head: 8.9m<br>Pump losses: 1.0m<br>Pipe losses: 1.0m<br>Others: 2.0m<br>Sub-Total 12.9m<br>Total 25.6m | One (1) line main canal at middle level |
| Type B'<br> | (upper portion)<br>Most simple lifting and water divering system.<br>(lower portion)<br>Much economic due to being supplyed low pressured water. | Much costly and complicated system due to constructing two lines of main canal and pumping stations. | Half height & full discharge by 1st stage pumps<br>Rest of height & half discharge by 2nd stage pumps | Half height & full discharge pipelines<br>ø3,200mm x 3lines<br>300m long<br>Rest of height & half discharge<br>ø3,700mm x 1line<br>380m long | Same as Table A<br>Plus;<br>Farm pond<br>2nd stage pump house<br>Delivery tank | (upper portion)<br>Statical head: 9.4m<br>Pump losses: 1.0m<br>Pipe losses: 1.0m<br>Others: 2.0m<br>Sub-Total 13.4m<br>(lower portion)<br>Same as Type B<br>Sub-Total 12.9m<br>Total 26.3m | Two (2) lines main canal at highest and middle level |
| Type C<br> | Most simple O & M system owning of independent operation for each irrigation block. | It is physically impossible to enlarge CRBC canal so as to meet for flowing irrigation water of this Project. | | | (Technically unfeasible) | | |

Comparative Table for Optimum Irrigation Scheme

| | | Type A | Type B |
|---|---|---|---|
| (Major Future) | | | |
| | Command area | 115,600 ha | 115,600 ha |
| | Main canal | 113 km | 98 km |
| | Pumping station | 1 no. | 1 no. |
| | | 72 cum.s | 72 cum.s |
| | | 21,600 kw | 12,300 kw |
| | Sub-pumping st. | - | 12 nos. |
| | | - | 2.8 cum.s |
| | | - | 600 kw |
| (Construction Cost) | | (Unit: '000Rs.) | |
| I. | Direct cost | | |
| | Preparation | 262,012 | 254,144 |
| | Feeder canal | 2,347,416 | 2,347,416 |
| | Pump station | 1,602,844 | 2,461,455 |
| | Main canal system | 2,168,582 | 1,870,651 |
| | Distributary system | 829,316 | 3,772,588 |
| | Others | 3,176,626 | 3,176,626 |
| | Sub-total | 10,386,796 | 13,882,880 |
| II. | Indirect cost | 1,661,887 | 2,221,261 |
| III. | Contingency | 1,038,680 | 1,388,288 |
| | Total | 13,087,363 | 17,492,429 |
| (Annual cost) | | | |
| | O & M cost | 293,320 | 322,319 |
| | Net Present Value | 15,995,572 | 20,688,157 |
| | Cost ratio * | 1.0 | 1.29 |

Note:
1) Command area as CCA is 115,600ha for all alternative Types above. CCA is multiplied gross area by 0.92 which is estimated through on-farm designing in sample area.

2) Unit cost for each work is quoted from the result mentioned in Chapter VI.

3) Item of Others are drainage works, On-farm etc.

4) Indirect cost consists of engineering services and administrative investment at 16% of the direct cost.

5) Physical contingency is applied at 10% of the direct cost.

6) O&M cost is composed of electricity and other expenses for pump operation, and expenses for major canal and water courses maintenance.

7) Project life is assumed at 50 years.

8) On the calculation of Net Present Value, discount rate of 10% is applied.

*: Cost ratio is (NPV of each plan)/(NPV of Type A).

Same benefit area of irrigation is assumed in each plan. The cost ratio given in the cost comparison table indicates the unit cost to gain same benefit in each alternatives. Type A resulted the lowest cost ratio and therefore, it is concluded as the optimum irrigation scheme.

### 4.4.3 Optimum Scale of the Project

Though Type A was selected as the optimum irrigation scheme, the optimum scale of the project area must be pursued furthermore. Among irrigation plans in each scale as illustrated in Fig. , the plan lifting at 60 feet ( lifting height measures from tail height of the feeder canal ) should be confirmed to indicate the highest value of economic indicator through comparative study, though having the widest irrigation area. In this section, the optimum scale of project that is synonymous with how much lifting height of pump will be installed, is decided. On the analysis, economic indicator of the construction cost per unit irrigation area was applied to compare with alternatives.

Three plans having each scaled irrigation area namely 60 feet, 45 feet and 30 feet lift, were compared. The results of this study are summarized below.

Comparative Table for Optimum Scale of Project

| | 60 feet lift | 45 feet lift | 30 feet lift |
|---|---|---|---|
| Command area | 115,600 ha | 95,000 ha | 68,500 ha |
| Pump | | | |
| Discharge | 72 cum.s | 60 cum.s | 43 cum.s |
| Power | 21,600 kw | 13,550 kw | 6,500 kw |
| Main canal | | | |
| Total length | 113 km. | 107 km. | 98 km. |
| Disty canal | | | |
| Total length | 443 km. | 364 km. | 263 km. |
| (Construction Cost) | (Unit: '000Rs.) | | |
| I. Direct cost | | | |
| Preparation | 262,012 | 215,321 | 155,258 |
| Feeder canal | 2,347,416 | 2,122,015 | 1,530,085 |
| Pump station | 1,602,844 | 1,295,405 | 893,456 |
| Main canal system | 2,168,582 | 1,891,818 | 1,350,266 |
| Distributary system | 829,316 | 681,531 | 491,420 |
| Others | 3,176,626 | 2,610,549 | 1,882,343 |
| Sub-total | 10,386,796 | 8,816,639 | 6,302,828 |
| II. Indirect cost | 1,661,887 | 1,410,662 | 1,008,453 |
| III. Contingencies | 1,038,680 | 881,664 | 630,283 |
| Total | 13,087,363 | 11,108,965 | 7,941,564 |
| (Annual cost) | | | |
| O & M cost | 293,320 | 244,433 | 175,177 |
| Net Present Value | 15,995,572 | 13,532,469 | 9,678,409 |
| Cost ratio * | 138.0 | 142.4 | 141.3 |

*: Cost ratio is (NPV)/(Command area) in '000Rs./ha.

According to the comparative study above, the plan with 60 feet lift was the most feasible among other lower lift plans.

### 4.4.4 Conclusion for the Optimizing Study

The results of the optimizing study are summarized as follows:

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).

Type C is excluded from the construction cost estimates due to technically unfeasible plan. The cost estimations for both plans of Type B at 45 feet lift and at 30 feet lift were not carried out, as it was considered their cost ratio be more than 1.45 based on the results in Type A. It is concluded that the Project area should be taken as wider as possible within the Study Area. The irrigation method of Type A at 60 feet lift is proposed the best for the Project.

## CHAPTER V THE PROJECT

### 5.1 The Project Area

Through the alternative study in **Chapter IV**, it is concluded that the optimum irrigation scheme is with 18.3 meters (60.0 feet) pumping cum. The Project area, irrigable area including covered area by 2.0 meters water head gained by feeder canal, is 134,600 ha as follows:
Accordingly, CCA becomes 115,600 ha listed below.

| | | |
|---|---|---|
| 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.

Sampling study for the actual relation between GIA and CCA have been carried out in typical distributary. The conversion ratio has resulted at 0.92.
Considering the facts that sand soil land is cultivated, and physical characteristics have been improved after irrigation under gravity canal, marginal land with sandy soil shall be included to the command area.

### 5.2 Agricultural Development Plan

#### 5.2.1 Future Land Use

The total acreage of the Project Area is 134,600 ha of which cultivated area is 101,800 ha consisting 1,000 ha of irrigated area, 27,100 ha of Rod Kohi area and 73,700 ha of Barani area. The future cultivated area under the "Without Project (WO)" condition is considered same as the present. The remaining cultivable land (26,900 ha) is scattered on grazing and/or wasted which will be irrigated by the Project. Under the "With Project (W)" condition, cultivable command area (CCA) will be 115,600 ha which comprises the present irrigated, Rod Kohi, Barani, grazing and cultivable waste areas as follows :.

| Description | Without Project | With Project | Increment |
|---|---|---|---|
| Cultivated Area : | | | |
| - Irrigated area (CCA) | 1,000 | 115,600 | 114,600 |
| - Rod Kohi area | 27,100 | 0 | -27,100 |
| - Barani area | 73,700 | 0 | -73,700 |
| Grazing / Cultivable waste land : | 26,900 | 0 | -26,900 |
| Uncultivated area : | | | |
| - Housing, road and others | 1,400 | 4,400 | 3,000 |
| - Gullies and torrent beds | 4,500 | 4,500 | 0 |
| Irri. canals, farm roads, field borders | | 10,100 | 10,100 |
| Total Project Area | 134,600 | 134,600 | 0 |

Note : C.C.A. ; Cultivable Commanded Area, Irr. ; Irrigation and drainage canals

### 5.2.2 Proposed Crops and Cropping Pattern

(1) Selection of crops

Based on the basic strategies for the development, food grains (wheat, maize and pulses), cash crops (sugarcane, oilseeds, cotton), fodder crops, fruits and vegetables were selected as proposed crops for making a future cropping pattern. These crops are widely grown, and the farmers have long experience in the Kharif and Rabi season cultivation. Profitability and marketability for new crops such as fruits and vegetables are limited in the Project area, hence their introduction in the proposed cropping pattern with a large area is not recommendable. Their large production aiming at cash crops will require new development measures such as introduction of additional new farming technologies, development of new markets including foreign countries, establishment of cold storage facilities, etc. New crop production in the Project area should be limited at local consumption level.

Comparative studies were made on the basis of climatic condition, crop suitability of soil, profitability and marketability, labor requirement and water requirement for selection of crops. The profitability of each crop was calculated at the farm gate prices in 1994 as follows ::

| Crops | Soil Suitability | Market-ability | Profitability Net Return (Rs./ha) | Labor (Rs./M.D.) | Water (Rs./$m^3$) | Total Score |
|---|---|---|---|---|---|---|
| Kharif Season Crops : | | | | | | |
| Maize | B | C | 9,200 | 230.0 | 1.37 | B |
| Paddy | C | A | 3,500 | 58.3 | 0.24 | C |
| Pulses (mung bean) | B | A | 13,250 | 331.3 | 1.87 | A |
| Cotton | C | B | 12,500 | 227.3 | 1.14 | B |
| Fodder (millet) | B | B | 5,750 | 191.7 | 1.05 | B |
| Vegetables, others | B | B | 21,220 | 303.1 | 3.08 | B |
| Rabi Season Crops : | | | | | | |
| Wheat | A | A | 8,550 | 213.8 | 1.16 | A |
| Pulses (gram) | B | A | 14,010 | 350.3 | 2.42 | A |
| Oil Seeds(mustard) | B | A | 13,230 | 264.6 | 2.50 | A |
| Fodder (berseem) | B | B | 8,640 | 216.0 | 1.66 | B |
| Sugarcane | C | A | 12,700 | 158.8 | 0.60 | B |
| Fruits | C | C | 16,440 | 121.8 | 0.91 | B |
| Vegetables, others | B | B | 38,150 | 448.8 | 8.12 | B |
| Spring Season Crops : | | | | | | |
| Maize (seed) | B | B | 10,280 | 257.0 | 1.39 | A |
| Oil Seed (sunflower) | B | A | 12,630 | 315.8 | 2.11 | A |

Note : M.D. ; man-day, Ref. : Table 5.2.1

(2) Crop rotation

Keeping in view the soil and climatic conditions of the Project area as well as market availability for the farm produce and fodder availability for the animals, the following three (3) crop rotations will be adopted in the Project area :

| Year/ Seasons | Type- I | Type - II | Type - III |
|---|---|---|---|
| 1st Year: | | | |
| Rabi season | - | Wheat/fodders | Fodders |
| Spring season | Maize/oilseeds | - | Sugarcane (April) |
| Kharif season | Fallow/fodders | Maize/pulses | Sugarcane (September) |
| 2nd Year : | | | |
| Rabi season | Wheat/pulses | Oilseeds/pulses | Sugarcane (ratoon) |
| Spring season | - | - | Sugarcane (ratoon) |
| Kharif season | Maize/pulses | Maize/fodders | Sugarcane (ratoon) |
| 3rd Year : | | | |
| Rabi season | Wheat/oilseeds | Wheat/fodders/oilseeds | - |
| Spring season | - | - | Maize/oilseeds |
| Kharif season | Cotton | Maize/pulses | Fallow |

(3) Proposed cropping pattern and cropping intensity

The cropping area for each crop is planned on the basis of the following conditions :

a) Production of food grains and cash crops is planned to meet home consumption and domestic market demand which will increase substantially due to growing population and rural development,

b) Production of fodder crops is planned basically to meet home consumption by livestock and to contribute to the farm economy with some marketable surplus, and

c) Fruits and vegetables are kept at the present proportion of the irrigated area.

Based on the cropping patterns proposed by WAPDA (PC-I proforma, 1973) and the feasibility reports for CRBC Stage I, II and III, the following three (3) alternative cropping patterns were studied :

a) Pattern-A ; Proposed by WAPDA PC-I Proforma, 1973
b) Pattern-B ; Proposed by CRBC Stage III. 1990
c) Pattern-C ; Proposed by the JICA Study Team

(Unit :%)

| Seasons/ Crops | Pattern-A (proposed by PC-I) | Pattern-B (CRBC Stage III) | Pattern-C (proposed by JICA) |
|---|---|---|---|
| Kharif Season | 60 | 62 | 60 |
| Rabi Season | 90 | 83 | 90 |
| Spring Season | 0 | 5 | 10 |
| Annual Cropping Intensity | 150 | 150 | 160 |

The future proposed cropping pattern was selected on the basis of net return (net crop production value), water requirement and maximum irrigable area. Pattern-C is superior to other two patterns and is recommended for the Project as follows (Ref. Fig. 5.2.1):

| Crops | Pattern-A (proposed by PC-I) | Pattern-B (CRBC Stage III) | Pattern-C (proposed by JICA) |
|---|---|---|---|
| Net Return per Ha (Rs./ha) : | | | |
| Kharif season crops | 6,480 | 5,700 | 6,890 |
| Rabi season crops | 9,380 | 8,690 | 10,100 |
| Spring season crops | 0 | 630 | 1,140 |
| Total | 15,860 | 15,020 | 18,130 |
| Water Requirement per Ha ($m^3$/ha) : | | | |
| Kharif season crops | 6,030 | 6,190 | 5,420 |
| Rabi season crops | 5,870 | 5,460 | 5,750 |
| Spring season crops | 0 | 300 | 670 |
| Total | 11,900 | 11,950 | 11,840 |
| Max. Irrigable Area (ha) : | | | |
| Kharif and spring season crops | 130,600 | 121,400 | 129,300 |
| Rabi season crops | 115,000 | 123,600 | 117,400 |
| Total | 245,600 | 245,000 | 246,700 |

### 5.2.3 Proposed Farming Practices, Farm Inputs and Labor Requirement

For proper seed bed preparation, land should be ploughed once with a tractor mounted disc or mould-board plough. A tractor mounted harrow can break clods and level by blade. After irrigation, it should be tilled twice with a tractor mounted tiller and/or a rotavator used for breaking the clods.

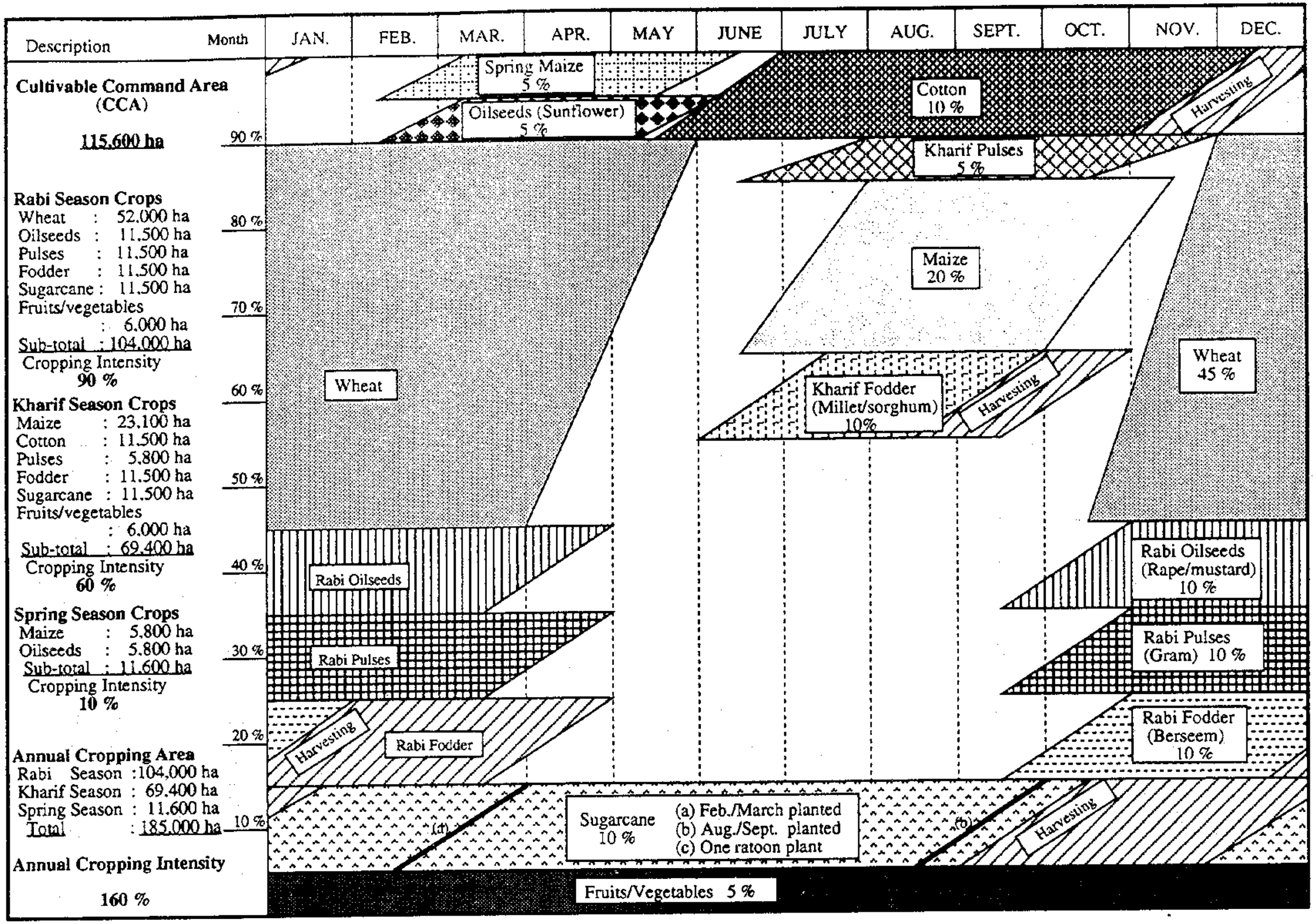



Fig. 5.2.1 Proposed Cropping Pattern

As for fertilizers, Urea, DAP (Di-ammonium Phosphate), TSP (Triple Super Phosphate) and SOP (Sulphate of Potash) will be recommended. Fertilizer application is by broadcasting in the field and mixing it well with the soil by tillage operation. Farmyard manure (FYM) should be applied evenly at least one month before the field operation.

A large number of agro-chemicals are recommended for use in various crops depending upon the insect species and other vertebrate pests such as rats, porcupine, wild pig, etc. In order to get maximum benefit from the crops, control of weeds is very important. It has been estimated that crop yields are reduced by 20 - 30 % due to weeds infestation. Weed control should be done by the following methods ; a) crop-rotation, b) mechanical control, c) manual control and d) chemical control. In case of crop rotation, different crops should be grown on the same piece of land to control weeds. The above three methods do not cause any environmental pollution. At present, a large number of herbicides are available in the market for weed control.

Water management methods in the field vary with cultivating crops such as cereals, fodders, vegetables and fruits. In case of field crops and fodders, water should be applied by using border (basin) irrigation method. For vegetables and fruits, furrow irrigation is recommended for judicial use of water. To get maximum benefit from irrigation water, the field should be well leveled in case of border irrigation and the furrows be kept clean in case of furrow irrigation. Trickle (drip) irrigation for fruits can be introduced in the future. Excessive or too little irrigation reduces yields, therefore, water should be applied in optimum quantity whenever it is needed.

According to labor requirement for recommended farming practices, maximum labor requirement per ha for the proposed cropping pattern under "With Project" condition are 3.70 man-day.

### 5.2.4 Anticipated Crop Yields and Crop Production

It is considered that the present constraints of water shortage, traditional farming practices and poor agricultural supporting services remain unchanged. Future anticipated unit yields of crops under "Without Project" condition are set at the levels of the present unit yields which are estimated on the five (5) years average of 1987/88 to 1992/93 in D. I. Khan District.

After completion of the Project, it is expected that the unit yields of crops be stabilized and increased on account of increasing irrigation water and introduction of improved farming practices. The anticipated unit yields under "With Project" condition are estimated with reference to the present unit yields and target yields of CRBC Stage III in the feasibility study report, 1990. The target yields of other crops are projected at nearly the same level of present averaged crop yields under full irrigation condition in CRBC Stage I area. The anticipated unit yields under "Without and With Project" conditions are estimated as follow :

(Unit : t/ha)

| Crops | Without Project* | With Project | Increment |
|---|---|---|---|
| Kharif Season Crops : | | | |
| Maize | 0.63 | 3.50 | 2.87 |
| Pulses (Mung beans) | 0.52 | 2.00 | 1.48 |
| Cotton | 1.36 | 2.00 | 0.64 |
| Fodder (Millet, Sorghum) | 11.86 | 45.00 | 33.14 |
| Vegetables (Eggplant) | 2.80 | 10.00 | 7.20 |
| Rabi Season Crops : | | | |
| Wheat | 1.04 | 4.00 | 2.96 |
| Pulses (Gram) | 0.60 | 2.50 | 1.90 |
| Oilseeds (rape/Mustard) | 0.52 | 2.50 | 1.98 |
| Fodder (Berseem) | 13.30 | 55.00 | 41.70 |
| Sugarcane | 35.55 | 70.00 | 34.45 |
| Ratoon | - | 40.00 | - |
| Fruits (Mango) | 3.00 | 10.00 | 7.00 |
| Vegetables (Cauliflower) | 5.50 | 15.00 | 9.50 |
| Spring Season Crops : | | | |
| Maize (seed) | 0.60 | 3.50 | 2.90 |
| Oilseeds (Sunflower) | 0.80 | 2.50 | 1.70 |

Note : (*); Unit yields are estimated based on weighted average of present irrigation, Rod Kohi and Barani area.

In order to achieve the anticipated unit yields under "With Project" condition, it is necessary that the farmers be informed and trained on the improved farming practices supported by the Project organization on agricultural research and extension. The unit yields will be increased gradually from the present level and reach the target yield in the 7th year after the completion of the irrigation and drainage facilities.

Total production of the crops was estimated by multiplying the target unit yield with the future cultivable commanded area (CCA) as follows :

| Crops | | Without Project | | With Project | | Increment | |
|---|---|---|---|---|---|---|---|
| Kharif Season Crops : | | | | | | | |
| Sorghum | : P.A. (ha) | 2,440 | | 0 | | -2,440 | |
| | : Prod. (tons) | 1,760 | | 0 | | -1,760 | |
| Millet | : P.A. (tons) | 2,390 | | 0 | | -2,390 | |
| | : Prod. (tons) | 1,810 | | 0 | | -1,810 | |
| Maize | : P.A. (ha) | 20 | | 23,100 | | 23,080 | |
| | Prod. (tons) | 15 | | 80,850 | | 80,835 | |
| Pulses | : P.A. (ha) | 10 | | 5,800 | | 5,790 | |
| | Prod. (tons) | 5 | | 11,600 | | 11,595 | |
| Cotton | : P.A. (ha) | 60 | | 11,500 | | 11,440 | |
| | Prod. (tons) | 80 | | 23,000 | | 22,920 | |
| Fodder | : P.A. (ha) | 10 | | 11,500 | | 11,490 | |
| | Prod. (tons) | 120 | | 517,500 | | 517,380 | |
| Guara | : P.A. (ha) | 210 | | 0 | | -210 | |
| | : Prod. (tons) | 330 | | 0 | | -330 | |
| Vegetables | : P.A. (ha) | 30 | | 3,000 | | 2,970 | |
| | Prod. (tons) | 85 | | 30,000 | | 29,915 | |
| Rabi Season Crops : | | | | | | | |
| Wheat/ | : P.A. (ha) | 8,500 | | 52,000 | | 43,500 | |
| Barley | Prod. (tons) | 8,870 | | 208,000 | | 199,130 | |
| Pulses | : P.A. (ha) | 4,280 | | 11,500 | | 7,220 | |
| | Prod. (tons) | 2,575 | | 28,750 | | 26,175 | |
| Oilseeds | : P.A. (ha) | 2,400 | | 11,500 | | 9,100 | |
| | Prod. (tons) | 1,240 | | 28,750 | | 27,510 | |
| Fodder | : P.A. (ha) | 60 | | 11,500 | | 11,440 | |
| | Prod. (tons) | 800 | | 632,500 | | 631,700 | |
| Sugarcane | : P.A. (ha) | 30 | | 11,500 | | 11,470 | |
| | Prod. (tons) | 1,070 | | 632,500 | | 631,430 | |
| Fruits | : P.A. (ha) | 15 | | 3,000 | | 2,985 | |
| | Prod. (tons) | 50 | | 30,000 | | 29,950 | |
| Vegetables | : P.A. (ha) | 15 | | 3,000 | | 2,985 | |
| | Prod. (tons) | 80 | | 45,000 | | 44,920 | |
| Spring Season Crops : | | | | | | | |
| Maize | : P.A. (ha) | 0 | | 5,800 | | 5,800 | |
| | Prod. (tons) | 0 | | 20,300 | | 20,300 | |
| Oilseeds | : P.A. (ha) | 0 | | 5,800 | | 5,800 | |
| | : Prod. (tons) | 0 | | 14,500 | | 14,500 | |
| Annual Cropping Area : | | | | | | | |
| Kharif Season Crops | | 5,200 | 5% | 69,400 | 60% | 64,200 | 55% |
| Rabi Season Crops | | 15,300 | 15% | 104,000 | 90% | 88,700 | 75% |
| Spring Season Crops | | 0 | | 11,600 | 10% | 11,600 | 10% |
| Total | | 20,500 | 20% | 185,000 | 160% | 164,500 | 140% |

Note : P.A; Planted Area, Prod ;Production (Ref.: Table E.5.4.2, 5.4.3 and 5.4.4)

### 5.2.5 Marketing Forecast

(1) Support Price Policy

The federal government has taken support price policy with a view to provide economic incentives to the farmers. Since this support program is positively evaluated by the government in general, this policy will be maintained in the future. Wheat, rice (paddy), sugarcane, cotton, gram, onion, potatoes, and non-traditional oil seeds, namely sunflower, safflower, and soyabean are designated as crops for support price program at present.

In D. I. Khan district, wheat, sugarcane and sunflower are outstanding in terms of actual application to the policy. Sunflower, in particular, is the target crop of the National Oilseeds Development Program, and procurement by support prices are conducted although the quantity procured is very little.

(2) Food Balance in NWFP

At present, the estimated deficit of wheat and other coarse grains, from the point of the total requirement and the total production in NWFP, amounts to 900,000 tons. According to the estimation in 1993-2020, this gap will not be filled. As for oil seeds, the deficit will be larger than the present level. Maize itself will have a surplus in terms of per capita requirement basis, but will be utilized as a substitute for wheat and as raw material for concentrated feed. Rice and pulses are likely to have a deficit in NWFP. Refined sugar will be deficit for the time being although the production of sugarcane will increase and a utilization rate of it by sugar mills will be higher. Fruits and vegetables are highly seasonal and the balance will fluctuate.

(3) Processing and Storage Facilities

As for wheat, the processing capacities seems to be almost sufficient in the D. I. Khan district since processing capacities are larger by about 257,000 tons than present production, while the incremental production by the Project will be 200,000 tons approximately. Capacities of public storage for wheat, on the other hand, may not be enough for the incremental production.

In terms of oil seeds, one solvent oil extraction plant with the installed capacity of 14,000 tons in a year (70 tons per day times 200 days) in D. I. Khan can take the almost incremental production of sunflower (14,500 tons). Rape and mustard seeds can be processed in oil mills in D. I. Khan district and the surplus will be transported to other oil mills in surrounding districts in NWFP and Punjab.

According to Chashma and Fecto sugar mills, the crushing capacity of each mill will be increased from 3,000 to 6,000 tons per day in the 1994/95 season. Therefore, total incremental capacities, which is 900,000 tons in both mills, can absorb the incremental sugarcane production (690,000 ton) by the Project.

Seed cotton will be processed in ginning factories in Bhakkar or other districts in Punjab. A portion of pulses will be processed (split and washed) in millers in Punjab. Incremental production of fresh fruits and vegetables by the Project will be basically marketed in D. I. Khan, surrounding districts and other provinces, but some portions may be processed in D. I. Khan in the future.

(4) Future market conditions

Since procured and open marketed wheat in D. I. Khan is sold to flour millers and then marketed to other districts such as Kohat and Bannu in NWFP and FATA area as well as D. I. Khan district at present, this marketing network will function in the future. Maize will be marketed in neighboring districts and FATA area, where food grain as a whole have a deficit, as a cereal and raw material for concentrated feed. Other cereals and pulses will be also marketed in D. I. Khan and other districts in NWFP.

Rape and mustard seeds will be marketed according to the present system in D. I. Khan or neighboring districts in NWFP and Punjab. Sunflower seed can be openly marketed in D. I. Khan market to private millers and oil extraction plants, or can be procured by PASSCO. Since the installed capacities of two sugar mills within and adjacent to the district of D. I. Khan will increase from the crushing year of 1994/95, the incremental production in the Project will be fully marketed. Seed cotton will be marketed through dealers in D. I. Khan and shipped to ginning factories in Punjab.

Fodder is short in D. I. Khan district at present. Since it is estimated that the demand of fodder for livestock will reach 1.4 million tons in 2003 in this district, the incremental quantity (1.1 million tons approximately) by the Project can be taken in this market. Fruits and vegetables will be seasonally marketed in D. I. Khan district, neighboring districts and other provinces.

## 5.3 Irrigation and Drainage Plan

### 5.3.1 Irrigation Plan

(1) Irrigation method

Stage I, stage II and also stage III of CRBC are based on a border flood irrigation method. The border irrigation is a method of controlling surface flooding. The field is divided into strips or basins by parallel bunds or border ridges. Each strip is irrigated separately. The level border irrigation method is more suitable for the family of soils with low intake rate of less than 1 cm. In the case of soils having intake rate greater than 1 cm, furrow irrigation is recommended to save water. Considering the lack of familiarity of farmers with canal irrigation it appears to be easy for them to adopt surface irrigation. After taking stalk of all the given conditions and with a view to achieve the highest efficiency in terms of saving water, furrow irrigation method - one of the surface irrigation methods is the most suitable method for the project.

A uniform irrigation efficiency has been adopted for the whole of project area except sandy soils. For the sandy soils, however, a lower field efficiency is recommended due to higher percolation particularly in the initial stages. The efficiency will improve with passage of time.

(2) Irrigation efficiency

For the purpose of planning, the irrigation efficiencies used by the C.R.B. gravity canal have been adopted with some modification. These modifications have been necessitated due to some difference in the physical conditions between the areas of lift canal and gravity canal and the experience gained from actual measurements of efficiency during the past few years of operation of the gravity command system.

Transfer efficiency for main canal is adopted at 0.90 in comparison with 0.86 in CRBC gravity canal, considering the fact that actual seepage losses of CRBC canals measured by ADB and IIMI are smaller than the designed figures. Conveyance efficiency for distribution system should be adopted at 0.86 considering the ratio of proposed figure to former CRBC's figure for the case of main canal. Field application efficiency is adopted at 0.75. Though the efficiency can be taken greater than CRBC's figure of 0.75 due to proposed furrow irrigation method instead of the level border irrigation method yet 0.75 (same as CRBC) is proposed considering small percentage of area applying precision land leveling to the CCA and adopting furrow irrigation.

Therefore, an initiation efficiency of 0.58 (conveyance: 0.90 x delivery: 0.86 x application: 0.75) is proposed for area having ordinary soil.

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

(3) Effective rainfall

Actual irrigation requirement is the quantity of water required to produce a crop minus effective rainfall. Effective rainfall should be estimated based upon rainfall records considering other physical factors such as water holding capacity of soil, soil moisture and rainfall intensity and so on.

The water budget calculation taking into account of holding capacity of soil and soil moisture when rain occurs are carried out for estimation of effective rainfall. Notation of the water budget calculation is explained as follows:

- Holding capacity of soil is generally given at 30 mm
- Initial soil moisture is set at same as holding capacity
- Soil moisture is calculated by subtracting crop water requirement equivalent to evapotranspiration from the previous soil moisture content
- When it rains, rainfall supplements water to soil depend upon empty room of the holding capacity of soil. The volume of rainfall to hold water to the soil is an effective rainfall. If soil moisture contents at the time of rainfall equals or is more than the holding capacity, rainfall flows away ineffectively.
- The calculation is conducted on daily bases.

Such calculations for the project area indicate that the effective rainfall will be 239.2 mm (Kharif 160.5 mm; Rabi 78.7 mm) at 86 % of actual rainfall in volume.

(4) Water requirement

Applying proposed cropping pattern, effective rainfall and parameters for irrigation, water requirement for irrigation is calculated on 10 daily basis. Conditions and assumptions for calculation are enumerated below.

- Evapotranspiration for each crop requirement is based upon ETo estimated in this Study.
- Crop coefficient (KC) is with reference to FAO technical paper, as shown in the

results of calculation.

- For each upland crop, preplanning water of 50 mm is required during 10 days before cropping.
- Effective rainfall mentioned above is applied over the entire irrigable area.
- Irrigation efficiency computed by assuming conveyance losses, operation losses and application losses for different soil textures as explained above is applied.

Applying proposed cropping patterns, water requirements is calculated as attached Table 5.3.1, 5.3.2 and 5.3.3. The results are summarized below.

| Land category | Area (CCA) | Volume of water requirement Kharif | Rabi | Peak discharge |
|---|---|---|---|---|
| **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.

(5) Distribution system

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 major facility and other related structures.

Institutional set up for implementation of the Project should be conducted through the authority and farmers organization newly established so that crop-based irrigation is introduced. Along with the institutional preparation, irrigation system which consists of the above components shall be devised for responding to water without waste of water and time.

- Intake structure shall be independent of existing intake gate for the C.R.B. gravity system, avoiding rivalry of both water uses.
- Combination of pump shall be decided so 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 velocity of water to be self cleansing and give prompt response to request of each distributary.
- Regulating pond adjusting water supply to actual water requirement shall be provided at the head of each distributary (The regulating pond should be multipurpose , such as water regulation, domestic water supply, environment improvement etc.)

Irrigation diagram is shown in Fig. 5.3.4, and facility plan of the structures for the components is explained in **Chapter VI.**

(6) Command area development (CAD) system

Command area development (CAD) system includes all aspects downstream of the *mogha.* Diverted water at the *mogha* flows into main watercourse, and finally flows into each field at *pucca nacca* .

Command area of the *mogha* is determined on the basis of the capacity of *mogha.* Capacity of main watercourse should be smaller than 2.5 -3.0 cfs (0.071 - 0.085 cms) so that farmers can easily do water management by themselves. The command area of *mogha* is, therefore, decided at 160 ha at best, applying specific peak discharge per ha of irrigation of 0.525l/s. GCA of command area is worked out to be 174 ha which is obtained dividing 160 by 0.92 of conversion factor between CCA and GCA.

After flowing into the main watercourse, water, furthermore, diverts to several watercourses. Command area of *mogha* is divided into modal farm units which be commanded by *pucca nacca* . The *pucca nacca* locates along the watercourse. Consulting the information regarding turning irrigation so that numbers of the modal farm units is recommended to be multiples of six, modal farm unit is laid down around 7.25 ha obtained dividing 174 by 24.

Typical layouts should be divided into two groups, one is the case where *mogha* takes off from down distributary directly (distributary to water course [DTW] system and another is the case that a minor takes off from Distributary and Mogha takes off from minor (minor canal to watercourse [MTW] system). Concept of layout of DTW and MTW systems are schematically explained in Fig. 5.3.5.

(7) Introduction of Crop-based Irrigation

1) Definitions

'**Demand**' irrigation comprises operation of farm offtakes by farmers, such that they can turn on, adjust or turn off their water supply without giving notice or having to obtain permission. A demand system must respond automatically to user demands (like a town drinking water supply), right back to the headworks with no constraint on cropping pattern.

'**Semi-demand**' is a demand system modified to avoid a 'free-for-all'; e.g. such a system could limit the number of farmers taking water simultaneously.
In a '**Supply-based irrigation**' system, deliveries are controlled by the Department of Irrigation in line with their schedule and canal capacity. The releases may be in response to farmer's request, or may be at the discretion of the supply authority.

'**Crop-based irrigation**' comprises water supply to the crop in accordance with, or close to, actual crop water requirement at the particular stage of growth achieved, Thus minimizing moisture stress and the corresponding yield reductions.
Where there are constraints on farmer ability to determine accurately the crop water requirements, or constraints upon the maximum discharge available, a semi-demand and/or crop-based system is recommended to be applied based on calculated or indented crop water requirements.

2) Necessity to Change Supply-based Irrigation to Crop-based Irrigation

During field survey for C.R.B Lift Irrigation Project it was revealed that Pakistan irrigated agriculture is suffering from lower productivity per unit of area and per unit of water application. The productivity per unit of area is one of the lowest in the world. Among other reasons, the moisture stress at critical demand period of the crops due to non-availability of water in the canal systems stands out. This is because all the canal systems in the country are supply based and the capacities and availability of water is far lower than the crop water requirement at such critical periods. In order to overcome this constraint the Chashma Right Bank Gravity Canal was designed on the basis of crop water requirement.

During the same field survey a series of interviews were made with the farmers in order to know farmers opinion and inventions about the project. The farmers expressed a strong desire for the project and also agreed to pay comparatively higher Abiana for the project provided water was available when they needed it. Since farmers' consent and their self reliance effort is essential for the project, it is important to respond to their desire of providing water when the crops need such water and as a consequence the farmers full cooperation and consent to the project will be ensured.

It is, therefore, necessary to plan C.R.B. List Irrigation Project on crop based irrigation system.

3) Basic concept of Crop-based Irrigation

Farmer can not always be provided water 'free-for-all' at any time and as much as he likes, because of limitation of resources and sense of economy. User demands of water supply can not exceed certain limitation, for instance, irrigation water releases for the Project must be within Water apportionment accord of Indus river. In view of this limitation, it is necessary to introduce a crop-based irrigation that is a semi-demand irrigation in line with crop-demand. Proposed crop-based irrigation is not demand-based system under which farmer turn on and off his water supply freely, but an irrigation system in which water supply is made in accordance with actual crop water requirement. Further, the farmer or a group of farmers will have to follow a certain cropping pattern which responds to the water releases in confirmity with the water accord.

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 easily supply water to any farmer in accordance with proposed crop water requirement.

### 5.3.2 Drainage Plan

(1) Basic concept for drainage planning

Basic concept for drainage planning for the Project are:
to drain flood water crossing the proposed main canal promptly through existing CRBC cross drainage structures.
and, not to allow excees flood flowing into the Project area through proposed cross drainage structures in the proposed main canal. Capacity of the proposed cross drainage in the main canal should be related with the capacity of existing CRBC cross drainage (40 years return period). Excessive flood water coming from zams in excess of such capacity shall be inundated upstream of the project area and made to drain out in an allowable short term.

In accordance with this basic concept, four (4) components of drainage are conceived as follows:

1) *Cross drainage structures* in the proposed main canal so as to drain flood water safely

2) *Flood carrier channel* to carry flood to the outlets of cross drainage in CRBC. Existing Nullah will be utilized as the channel with remodeling if necessary.

3) *Supplemental flood drainage channel* to lead flood water to drainage structures of gravity canal. It is newly constructed.

4) *Open collector drain* upstream of and along the next water course to drain ordinal flood water caused in the project area.

(2) Design capacity for proposed drainage facilities

1) Cross drainage structure

Design discharge for cross drainage structure is estimated in accordance with 40 years return period. Run-off discharge for nullah is given at two points, (i) upstream of proposed site of cross drainage structure and (ii) crossing point with CRBC. Design discharge of the proposed cross drainage structure located between points is estimated considering flood wave reduction as flood is flowing down. As such flood wave reduction can be assumed to be represented by an exponential function, the discharge at both points has been estimated in accordance with such exponential function. To estimate the discharge for structure on main canal the runoff from plain area should be substracted from discharge assumed for gravity canal. Table 5.3.5 is a summary for this estimation.

For the case of existing cross drainage outlets of C.R.B. gravity canal concerning Gomal zam that is the biggest zam having time of peak flood of more than 50 hours, run-off component from plain area may be overlooked because of no overlapping of both peak discharges. However as to medium and small zams having time of peak flood from 2 hours to 10 hours, both peak discharges flooding from such zams and from plain must overlap at the outlets of C.R.B. gravity canal.

Accordingly, the capacities of cross drainage structures in the main lift canal, for zams excluding Gomal zam, may be designed as the capacity discharge of the corresponding structure of C.R.B. gravity canal less peak discharge of plain area between the two canals pertaining the same basin.

2) Flood carrier channel and supplemental flood drainage channel

Flood carrier channel links the proposed cross drainage structure of lift main canal with the existing cross drainage facilities of CRBC. Though both structures were designed at 40 years return period flood, design discharge of both don't always coincide due to flood wave reduction and increasing of discharge from plain area during flowing down. Furthermore, considering that command area can endure controlled inundation, flood carrier channel may have flowing capacity with return period of less than 40 years. Considering present condition of existing nullah, design discharge for the flood carrier channel is decided at 2 years return period.

Estimated discharge in each year return period utilizing observed data is available in Tank Zam and Gomal Zam only. Other information regarding probable discharge besides these is required. For this purpose, an attempt to obtain such information by rainfall data is made. Utilizing the rainfall intensity curve analyzed in the Study, magnitude of peak discharge in each return period can be compared with. Following is calculation of probable effective rainfall.

According to the result above, effective rainfall of 2 years return period is assumed at 35.2% of the same of 40 years return period. As peak discharge having good relation with such effective rainfall, peak discharge of 2 years return period can regard as 35.2% of the peak discharge of 40 years return period.

Therefore, design capacity of flood carrier channel is proposed at 35.2% of the design discharge of related cross drainage structure in lift main canal.

3) Open collector drain

This should be draining excess irrigation water without flooding or waterlogging. Peak discharge of irrigation water at the related *mogha* is applied as the design capacity of the open collector drain.

When rain occurs, excess rain will be drained through the open collector drain if it is less than the design capacity of the drain. If heavy rain comes, rain will inundate on the field for a short time.

## 5.4 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 proposed canals will be appropriated to domestic water use to residents who have desire to be supplied. Population will increase along the proposed regulating pond at the head of distributary. Facilities of domestic water supply for the population shall be given in the Project.

## 5.5 Farm Road Network Plan

The lower intensity of road network in the project area is a major constraint for speedy development of lands and the marketing system. It is, therefore, essential to include a network of farm to market road development as an integral part of the project. Since all the distributaries and minors will be having roads along their banks, the same should be open to public transport. Additional 32.5 km will be needed.

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 more than 500 meter/km$^2$ road density in the Project area (The figure is a national target in the 8th 5 year plan in Pakistan).

## 5.6 Institutional Improvement Plan

### 5.6.1 Institutional Study Activities

During the presentation of phase I field progress report to the provincial government, the constraints given in Paragraph 3.7.3 and Paragraph 4.2 were highlighted by the study team. The provincial government after accepting the view point of Study Team on these issues requested the Government of Japan to undertake further study in this regard as a part of the Feasibility Study for the Project to enable them to improve the institutional framework both for the construction and operation of the Project. The Government of Japan responded positively and provided the institutional expert for the Study. The institutional study was designed to be undertaken in three steps. In step I, a preliminary concept of an institution for the Project was conceived and a questionnaire was prepared before the start of the study. The questionnaire along with summary of the Project and constraints as given above were circulated to various federal and provincial departments as well as private institutions dealing with the management aspects of the development in the country.

Meetings were arranged with top bureaucrats and professors of these institutions. The following departments and agencies were contacted by writing letters to them giving details :

1. Ministry of Water and Power, Government of Pakistan
2. Organization and Methods division of the Government of Pakistan
3. Establishment Division of Government of Pakistan
4. Planning Division of Government of Pakistan
5. World Bank (Consultants)
6. Asian Development Bank (Consultants)
7. Lahore University of Management
8. WAPDA
9. Irrigation Department of Government of Punjab
10. International Irrigation Management Institute currently working on the possibility of crop based irrigation management in Pakistan (CRBC and Swat canal system)
11. Irrigation Department of NWFP
12. Agriculture Department of NWFP
13. Planning, Development & Environment Department of NWFP
14. Pakistan Academy of Rural Development
15. Finance Department of NWFP
16. Services and General Administration Department of NWFP
17. Chief Secretary, NWFP
18. Senior Member, Board of Revenue, NWFP
19. Commissioner, D. I. Khan District Division
20. Deputy Commissioner, D. I. Khan District

21. Two members of provincial assembly from D. I. Khan District
22. President, Chamber of Farmers, D. I. Khan District
23. International Consultants on water sector development
24. Asian Development Bank, Islamabad Office
25. World Bank, Islamabad Office

On arrival of the JICA Team for the phase II field study, the step II of the institutional study was commenced through physical contracts by the Study Team with the above departments and their views obtained.

In the step III of the institutional study, two questionnaires were designed and distributed among the farmers and the district level development departments. Separate meetings were held with farmer beneficiaries, chairman and members of the twelve union councils of the benefited area at Chahkan, Gara Isa Khan and Yarik etc.

The meetings, attended by a large number of big and small farmers and chairman of the union councils, were given a briefing about the Project, its economic effects on their future and their liabilities towards operation and maintenance cost of the Project. They were also briefed about the questionnaires and the proposal for proposed institution.

The 24 district level development departments were called for joint meetings under the chairmanship of Deputy Commissioner (the over all administrative head of the district) on two consecutive days.

They were given a briefing about the scope of the project, the preliminary layout of the feeder canal, the pumping site and the main canal with its distribution system and its drainage problems. They were also informed that this being a very expansive project involving 60 feet lift (20 meters including friction losses) will result into high water rates per acre of irrigation than gravity canal (gravity canal rates are estimated at Rs. 138 per acre of cropped area). Thus the O&M costs, which have to be paid by beneficiaries, would be almost twice or thrice of the gravity flow canal. Because of such high costs the water under this project has to be used judiciously and therefore high delta crops such as rice will have to be avoided. Instead, crops with high profitability and low water consumption have to be encouraged. This will only be possible if water rates per unit of water consumption are introduced instead of present rates per unit of crop area. The introduction and realization of such rates would be possible if operation of the distribution system at distributary head is transferred to the farmers association. They were also informed about the delay in the completion of C.R.B. gravity canal and the lack of coordination between the various departments.

They were then requested that in view of their experience they should give their independent views irrespective of their departmental policy on the questionnaire already distributed among them. Beside, they may give their departmental strength at the district level along with their annual revenue and development budget. Subsequently detailed meetings were held with each of the provincial departments and the questionnaire retrieved from 36 respondents.

### 5.6.2 Findings

(1) Views of National and International Experts

The interviews with about 25 national and international experts including bureaucrats, academicians, politicians, World Bank and ADB consultants revealed that 90% of them were in favor of associating the farmers and beneficiaries with all the stages of the project including planning, implementation, operation and maintenance of the project.

It is also the view expressed in the recent World Bank study for Pakistan "Irrigation & Drainage: Issues and Options" of August 31, 1993 which strongly advocated the formation of farmers organizations and public utility around a canal command area as a unit and such a system be spread over the entire country turning each canal command area into independent utility with farmers associations as their clients. However on a new project like the one under subject it will not be possible to have public utility also in the private sector as no development has taken place as yet and therefore a mix of the public and private sector will be more appropriate.

Regarding the coordination between various departments it was strongly felt that such coordination is absent and it will be very hard to achieve the same in the present vertical hierarchical system. To over come this constraint 90% of the experts including the departments of provincial agriculture and irrigation, were of the opinion that a strong independent authority to be set up under provincial legislation would be extremely effective to develop the project in the shortest possible time and operate the same efficiently with the help and cooperation of the farmers associations. By and large they agreed with the concept of the authority to be called Chashma Right Bank Development Authority.

(2) Views of the Provincial and District Level Agencies

From the meetings with the distract level agencies and their response to the questionnaire that of the 24 departments 11 departments showed no coordination interest with any irrigation project. Of the remaining 13 departments 7 coordinated with C.R.B. Lift Irrigation Project only. 5 departments stated to have coordinated with C.R.B. gravity canal, 4 with on-farm water management and 7 with Chashma command area management project. The interesting aspect is that agriculture research organization and the Local Government & Rural Development Department coordinated with the C.R.B. Lift Irrigation Project only because the JICA consultants strongly associated them with their work as their counterparts.

The usual coordination instrument used is personal contact 64%, liaison officer 11% and committees 14%. This clearly shows that the coordination committees have not been a success on the C.R.B. gravity canal project.

69% of the respondents stated that they were dissatisfied with coordination committees because such committees could neither give any solution nor they could make any implementable decision.

In suggesting counter measures for effective and integrated approach for C.R.B. 1st lift irrigation project 69% of the respondents showed the establishment of an autonomous new body as their first priority and 17% as their second priority. Only 17% showed strengthening of the existing department and 14% strengthening of the coordination activity as their 1st priority.

It is clear that most of the district level departments do not consider that the C.R.B. lift canal and the irrigated area under the same could be developed on fast track basis under the existing institutional framework. It was felt that presently each department is working independent of the other having no consultation and very little contact with the other departments at the time of planning and implementation of the projects under them. In addition most of the district agencies are having neither any program nor any plan for the development of the Project Area in their respective jurisdiction.

They were also of the opinion that the operation of the canal according to crop water requirements would not be possible under existing institutional arrangements nor it would be possible to realize much higher water rates from the farmers of C.R.B. gravity and lift canal as against other canal systems in the province. Some of them felt that the water rates have to be rationalized on the overall provincial basis to meet the operation and maintenance charges for the canal system put together which was of course a difficult task to perform in the present political system. Majority was of the view that the beneficiaries should pay the O&M costs and therefore higher *abiana* should be charged. The view at the provincial level was that the project should be financially viable and should not be subsidized from other provincial revenues. To achieve this objective it would be necessary that a separate independent institution is set up for the project to deal with it quite independent of other canal systems. To ensure the rationalization of higher water rates the authority has to go into individual agreements with all the farmers, before the construction of the project, that they would pay for operation and maintenance cost of the system. The consensus of opinion was that in order to develop the project in the fastest possible manner, distribute the water according to crop water requirements and realize the *abiana* according to rationalized rates through farmers' associations, the setting up of an independent institution to be called Chashma Right Bank Development Authority would be the only solution.

(3) Farmers' Concern

Through the meetings with farmers and union councilors the following issues were observed :

1) The majority of the farmers were not satisfied with working of the nation building departments and complained that they (the farmers) were never consulted about the development activity by these departments in their villages.

2) Complaints about the wastage and pilferage of funds were common.

3) A change from the existing system of independent approach by line departments to a comprehensive integrated approach for development of the C.R.B. lift irrigation project area was welcome by the farmers. They totally agreed with the concept of creation of an independent body to be called Chashma Right Bank Development Authority.

4) The farmers very much wanted to be made a part of the development planning and implementation at all levels.

5) Contrary to the irrigation department view that farmers will not pay higher water charges, the farmers fully agreed and were prepared to sign agreements in advance to pay the water charges for the operation and maintenance of the project despite the fact that the lift canal water charges will be much higher than gravity flow canal charges. They however emphasized that water availability should be ensured to mature the crops.

6) The farmers agreed that the formation of farmers association at distributary/minor level will be useful and could work with the support of the government to operate the distributary.

7) The farmers when questioned about the collection of water rates with technical support of administrative authorities of the project on the crop basis had mixed feeling as they could not comprehended the volume and type of work.

8) The farmers and even union council members were strongly of the view that the farmers associations should be non political and should be independent of the union councils as it was an economic activity in the interest of all the farmers where as the union councils were divided between various political parties.

9) The formation of the executive committees of the farmers associations should be by consensus of all the big and small farmers under the distributary/minor irrespective of the size of their holdings. However it will be more appropriate to organize farmers association at the water course level and at minor level and these association should send their chief representatives to the distributary level farmers association.

### 5.6.3 Future Institutional Plan

(1) Concept

From the constraints and findings given above it is evident that the present institutional system can not respond to the requirements of the project with particular reference to the following four issues :

1) Development of the project in an integrated manner within the scheduled time and estimated cost.

2) Operating the system in response to the crop water requirements against the present supply based practices.

3) Making the farmers and the beneficiaries to participate in the planning, development and operation of the project through water course and distributary level farmers' association.

4) Recovery of much higher water charges (on the basis of water consumption)

against the present nominal charges on the other irrigation systems.

It is therefore proposed that the C.R.B. lift irrigation project should be handled through a different approach then the present line departments. The most acceptable approach is that there shall be an independent statutory authority created through an act of the provincial government to carry out the planning, development and operation of the project through the involvement of farmers association. The farmers' associations will need a strong technical and legal support in terms of advisory services on the one hand and implementation of their decision through legal framework on the other. The authority should be responsible for most of the development activity in the project area including construction of canal, distribution system, infrastructure facilities, land leveling , drainage system, agricultural research and extension, provision of inputs such as fertilizers and pesticides development of marketing system, marketing growth centres, availability of credit facilities etc. directly or through farmers' associations and other agencies. The farmers should be associated in all decision making and should have a very close liaison with the experts of the authority. It is proposed that the authority should be set up before detailed design of the project is taken up so that the farmers' associations could be consulted during such detailed design.

(2) Outline of 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 for the integrated development of the Chashma Right Bank 1st lift irrigation project with the following composition :

1) Chairman
2) Member Irrigation
3) Member Agriculture
4) Member Socio-Economic Development
5) Advisor Farmers' Representative
6) Advisor Financial Institute's Representative

Under each of the members for irrigation, agriculture and socio-economic development there shall be a department set up to be manned by experts from open market and or selected from amongst the experts of provincial/federal departments for a period of five years. The terms and conditions of service in the authority should be far more lucrative than the department so as to attract the best manpower. Once they join the authority they should have no choice to return to the department without the express permission of the authority for a period of five years.

The authority should have the minimum key staff only. During development stage they should mostly utilize the services of consultants so that they do not carry surplus staff to operation stage. The authority should be funded by the provincial government by passing the international loan directly to the authority and making provision for social welfare program in the provincial budget. The funds for development should be provided 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 performance of their duties such as power under land acquisition and revenue acts for acquisition of land and collection of revenues etc. Proposed plan along with organization chart and staff strength is given at Annex III Attachment I to this report.

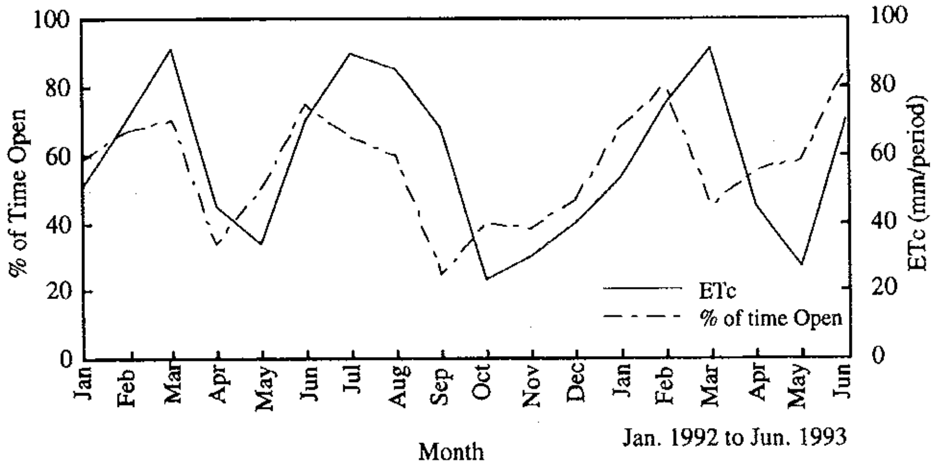
Although the authority would be set up for the development of C.R.B. lift irrigation project, the legislation should be so drafted that it can take over the development operation and maintenance of the distribution system under gravity flow canal at a later stage. On its success it shall also be able to replace the relevant nation building departments for D. I. Khan district and take over their activities. List of the departments along with their staff strength is given in Table 5.7.1 and Fig. 5.7.2.

(3) Operating the System According to Crop Water Requirements

As stated elsewhere currently all canal systems in the country are operated on supply based system irrespective of crop water requirements. Consequently the existing irrigation departments are accustomed to supply based irrigation system and it is not possible for them to organize the utilization of frequently varying water supply in C.R.B. gravity canal to satisfy the crops demand. International Irrigation Management Institute (IIMI) on the request of Government of Pakistan carried out some studies in C.R.B. gravity canal area and upper swat canal area. Due to shortage of time and some lack of coordination they could not make conclusive recommendations.

The one conclusion that has been clearly drawn is that the demand based irrigation system can be operated by the farmers themselves. According to (IIMI) "In an attempt to asses how much farmers understand the water requirements of their crops the close/open outlet behavior has been correlated with the crop evapotranspiration. This result can be seen in the Fig. below. The match presented is rather remarkable underscoring once again that farmers are well aware of their needs and therefore could make a significant contribution towards the improvement of system operation in its quest for seeking a better match between the supply and demand for water."

Watercourses Open Records: Disty No.3
Comparison of ETc with Farmers Behavior




Although such a small sample can not be considered to prove the success of such an approach but the examples of other countries such as Japan and even the central Asian countries show that the best way of water utilization according to the crop water requirements would be through farmers' associations.

The C.R.B. development authority will therefore have to give high priority to organize farmers' association at the distributary and water course level. To train such associations, advisory services should be provided by the authority to help them in devising a cropping pattern among the farmers and making a water budget for each six months or for the year. Once the budget is approved by the authority in the light of overall water availability, the supply of water on terminal dates has to be ensured. The distributary level farmers' association will then be responsible for further distribution among the water course associations which in turn will be responsible for water distribution among the farmers.

To operate this system the most important role will be played by the agricultural advisor at the distributary level and therefore he has to be a highly qualified and well trained person.

In order to involve the farmers fully and to give them a sense of ownership, the operation and maintenance of the distributary should be completely transferred to the distributary association with the authority only controlling the head gates.

Further the association may be charged on the basis of water released from the head gate of the distributary and they may fix the water rates for each crop according to its consumptive use. For example the water rates for sugarcane using 81" of water may be 4 1/2 times the water rates for wheat using 18" of water only. In this way they will be able to control the cropping pattern to low delta crops.

(4) Social Mobilization of Farmers and Their Close Association with the Development under the Project

In view of the conflict of interest inherent in creating farmers organization as a safe guard against the traditional practice of unilateral management by irrigation department and the colonial practice of governing the masses and regulating their behavior through government institutions, far more hard work will be needed to make a break through in organizing the unit farmers association and the distributary farmers association and educating them to look after their own interests in self governing style. The failure of the cooperative societies and the associations recently farmed by the "On-Farm Water Management Organization" is usually quoted against such a venture. However, it is easy to see that in both these cases they were given neither any powers nor any resource around which they could remain organized. In this case, however, the farmers are being given the powers to distribute the water as they wish, maintain and operate the distributaly 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.

The following guidelines for the election of UFA, DFA and the farmers representative on the authority are proposed.

1) Unit Farmers' Association (UFA)

There should be a farmers' association at the water course/minor level. Each and every farmer irrespective of the size of his farm should be the member of the water course/minor association to be called unit farmers' association (UFA) and all such members should have equal voting rights. The UFA will elect, by secret ballot, a management composed of a UFA Member, UFA Accountant and UFA Water Coordinator.

2) Distributary Farmers' Association (DFA)

All the managers of the water courses/minors associations should become member of the DFA. These members should also elect from among themselves a management committee of DFA composed of DFA Manager, Accountant, Water Coordinator and Marketing Coordinator.

3) Farmers Representative on the Authority

The farmers' representative on the authority should be elected through secret ballot by the managers of the DFAs. The qualification for election of such representative should be that he should:

i) Be an active farmer under the authority (not absentee farmer).

ii) Be an educated person who could read and write. Preferably he should be having a degree or diploma in agriculture/irrigation engineering.

iii) May or may not be a member of the management committee of the distributary/unit farmers' association.

iv) Be non-political like other members of the authority. Any political activity nepotism, favoritism or corruption shall disqualify him to sit on the authority. The final decision to disqualify him shall lie with the members of the authority by 3 to 1 votes. In such cases the authority may call for fresh elections.

4) Functions of the Farmers Representative

The farmers representative should attend all or at least 50 % meetings of the authority in any given year. He should be provided with an office, a stenographer and a chauffeur driven field vehicle to tour the area and meet the farmers on a regular scheduled basis. He must also attend meeting of the each distributary water associations at least once in six months to know the farmers' problems, solve some of such problems and raise the remaining at the authority level.

## 5.7 Land Conservation Plan

The main subjects with regard to Land/Soil conservation in the study area are considered to be the following three, from the geomorphologic matter and the characteristic semi-arid climate of this area.

- Erosion, sedimentation and inundation caused by sheet flow.
- Wind erosion in dune sand area.
- Salinity and waterlogging in the command area.

These three subjects are explained as follows:

(1) Erosion, Sedimentation and Inundation

The sedimentation transported from mountainous area are estimated at approx. 9 million $m^3$/year of suspended sediment and about 1 million $m^3$/year of traveling sand at Kot Murtaza (located about 100 km upstream of the Study area) in the Gomal Zam which covers 88% of catchment area covering the Study area. In the case of the Gomal zam, most of the sand transported from maintainous area deposit in the upstream side around Kot Murtaza, the volume of transported sedimentation up to the crossing point with proposed lift main canal alignment is estimated at only 20 ~ 30 thousand $m^3$/year (a few percent of the whole volume of sediment). The sedimentation of traveling sand from mountainous area may therefore be very small in the Project area and canal. The case of other main tributaries such as zams would be the same. The problem of sedimentation expected in the project will therefore cause much less anxiety.

Erosion has been found in the Study Area, which caused mainly by sheet flow during flood. Recommendable major erosion control methods to be applied in such study area of the Project will be summarized below.

Summary of Erosion Control Methods Classified by Function

| Function | | Methods |
|---|---|---|
| A. | to improve existing plant *cover* on | |
| (i) | through village organizations | 1. partition of shamlat (common) land. |
| | | 2. co-operative management of grasslands. |
| (ii) | through forest protection and .afforestation | 3. better management of existing forests. |
| | | 4. village plantations. |
| B. | to build up *soil fertility* in ploughed land. | 5. manuring and green manuring. |
| | | 6. preserve stubble and crop residues. |
| | | 7. consolidation of holdings. |
| C. | to *reduce the exposure of bare soil* during monsoon. | 8. choice of crops and crop particularly rotations. |
| | | 9. strip cropping. |
| | | 10. reduce bare fallow. |
| | | 11. restrict cultivation of steep slopes. |
| D. | to increase *surface storage and infiltration.* | 12. cover crops and mulching. |
| | | 13. contour ploughing. |
| | | 14. contour ridging. |
| | | 15. bench terraces. |
| E. | to increase infiltration into the *deeper layers.* | 16. subsoiling. |
| | | 17. trenching. |
| | | 18. basin listing. |
| F. | to prevent run-off gaining a *cumulative velocity.* | |
| (i) | by control of *field drainage.* | 19. grassed ditches. |
| | | 20. masonry outlets in field bunds. |
| | | 21. contour bunds set out with a side slope so that water is led off fields quickly. |
| | | 22. live hedges & contoured hedgerows. |
| (ii) | by control of *drainage outside fields* | 23. gully plugging & check dams. |
| G. | to divert *excess water* out of natural channels. | 24. diversion bunds. |
| | | 25. diversion ditches. |
| | | 26. deliberate water-spreading by flooding of overflow meadows. |
| | | 27. water tanks. |
| | | 28. road drainage control & recovery of landslips. |
| H. | to head back *accumulations of water* river bed itself. | 29. small water-holding bunds in the multiple along torrent beds. |
| | | 30. major reservoirs. |
| I. | to confine the torrent or river to a *channel* | 31. canalizing smaller torrents by planned vegetational . control. |
| | | 32. river bank consolidation in major streams |

These proposed measures should be taken on On-farm works, and some of them will be applied by farmers themselves after completion of the Project.

(2) Wind Erosion in the Dune Sand Area

In the some sand dune portions of north and south of the Project area, enlargement year by year of area of sand dume is worrying. With erosion control in such sand dune area is essential for soil conservation from the standpoint of farmland conservation and canal facility conservation against sedimentation. With wind erosion control methods, the next three titles should be coped.

1) Fixation of shifting sand

For fixation of sand dune and reducing wind erosion, vegetation was in the end the surest defense. The use of annual leguminous crop plants is a simple mean of establishing plant growth on dunes. It is therefore generally worth while to take some extra trouble over securing some more permanent plant cover by hedging systematically the grass grownable in the very few moistured sandy areas. For this purpose, cane grasses and anjan grass etc. are very useful. These hedging serve the following twofold purpose:

- by covering the fallow land with a mat of vegetation it reduces surface sheet-wash to a minimum.
- it provides a mass of vegetable matter which when ploughed under, helps to build up a far better tilth, particularly where sheet-wash has already swept away the top-soil and left only a clay or kankar subsoil exposed.

2) The shelterbelts and wind-breaks.

The wind directions in D. I. Khan are statistically reported that the usual winds in this district may be considered from E, and few strong winds from N or W.
The shelterbelts and wind-breaks in this area should be proposed to be aligned as main wind direction is N against strong ones and the secondary is E against usual wind shifting sand. From the view point of matters mainly protecting such important facilities as canal and pumping station and around irrigated area in the sand dune, main point in this project is making shelterbelts and wind-breaks around the important facilities.

The direction of facilities from pumping station to main canal is approximately E-W in dune sand area. The shelterbelts and wind-breaks in this area should be proposed to be aligned as main wind direction is N against strong ones and the secondary is E against usual wind shifting sand. Then shelterbelts and wind-breaks should be aligned mountain side of bank effectively defending from strong wind. Further it also seems to be better that the secondary will be planted and hedged to east side of pumping station and line's length 50 m and line's interval 50 m to crossing direction to main canal.

3) Improve Dry-Farming Practice.

The first essentials in dry farming are to have terracing the fields for reducing the loss of surface water, to subsoil and deep plough for moisture conservation in the deeper layers, and to make contour bund and contour hedge for working the surface soil to make and keep it more absorptive and effective water-catching.

The first consideration in the barani cultivation of crops in sandy area is the storage and effective utilization of water in the soil. Careful matter is especially that in areas of exceptionally low rainfall in the pre-monsoon period ploughing or otherwise stirring of the soil may be actually harmful as it is liable to aggravate erosion by wind. The safest way, therefore, would be to open up the land with the first monsoon shower and a deep loose fine soil should be overlaid by a dry surface mulch. The most desirable method is vegetation cover. Recommendable cropping methods in sandy area are proposed as following:

- When possible, green manuring rather than the production of fodder crops is to be advocated. In the use of green manure the main essentials are quick production of a large bulk of vegetable fiber, quick rotting of this fiber, and moisture storage.
- Such crops as juar, maize and bajra make heavy demands on stores of plant nutrients and transpire more water per unit of dry matter produced that any rabi crop it is possible to grow on barani land in this country.
- If fodder crops as must be grown it is better to keep to finer-leafed rabi crops such as gram, oats, barley or wheat and lift the crop before the grain begins to form.
- Of the kharif fodder crops the best for soil improving is guara which could be pasture.
- The seed bed should be moist, deep, firm and fine. Mulch is necessary in order to prevent loss of moisture.

(3) Salinity and Waterlogging in the Command Area

The followings were ascertained from the test result in this study.

| | |
|---|---|
| Water of Indus river | Very good quality for irrigation. |
| Water derived from western mountain | Relatively low salinity as of |
| Groundwater of abandoned flood plain of Indus River | Relativelyordinary type of quality |
| Groundwater from the other locations | Utterly unsuitable for irrigation |

The water from canal will be provided with no relation to surrounding weather condition and the cropping is in general carried out during dry and hot season in arid area aiming to increase the efficiency of photosynthesis. In this season, the direction of soil water predominant to upward rather than downward, salinization may be at least going through the following three processes.

- Ground surface salinization on due course of groundwater including high ratio of soluble salts going upward by capillary
- Irrigating water adds salts to soil
- Augmentation of salt including ratio in soil by leaching fraction declining

In the study area, the salinity in sand dune area is not significant problem because the sand is very permeable and the salts in the soil are easily leached even by means of very few rainfalls. On the other hand, in the area of clayey soil, especially just after rainfall, some white powdery which seem to be calcium carbonate, calcium sulphate or partly sodium chloride can be found to and fro. This is considered that the salts in the soil accumulated at groundsurface by suction caused by capillary action, because intake rate of the clayey soil is remarkably low and momentary groundwater table was formed at very shallow depth, so that the capillary fringe connected to groundsurface. As saline control on the Project, three measures such as controlling the use of chemical fertilizer, preventing of occurrence the momentary groundwater table, and controlling the level of groundwater table are proposed.

Main canal and distributaries are designed lining by concrete in this project. Furthermore, drainage is accelerated by means of equipping of 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 waterlogging.

Because of both points of supplying good qualified water from Indus river, and scarce outbreak of injury of salt, salinity will be not significant problem after completion of the Project. Therefore, it s not necessary to take positive countermeasures immediately such as installing of sub-surface drain and controlling groundwater stage by pumping. Monitoring is however required so as to watch the salinity situation.

## 5.8 Environmental Management Plan

Environmental management and monitoring plan should be identify during Detailed Design Stage of the Project. In the Study the draft plan for them will be shown as the recommendation.

(1) Institutional Aspects

The responsibility for the long-term environmental management of this project could be given to the following institutions, (i) the Environmental Section of the NWFP Planning, Environment and Development (PE & D) Department, (ii) the NWFP Environmental Protection Agency (EPA), and (iii) the WAPDA Environmental Cell (WEC), based in Lahore

EPA and WEC have assigned substantial activities for environmental management. The EPA in NWFP has been brought within the PE & D department, at least for the next few years, and acts under the auspices of the Secretary, PE & D. Although at present the EPA, NWFP lacks any real capability and resources to take such a responsibility, but keeping in view the institutional strengthening programs, it is expected that until the completion of this lift irrigation project the agency will be well equipped and fully staffed to take the responsibility.

The EPA is receiving institutional strengthening under the World Bank project "Institutional strengthening of NWFP, EPA"(1993-1998). This project will not only increase the EPA staffing but also supply the mobile laboratory and other equipment required for monitoring, and establish the regional offices. D. I. Khan is the most probable place to be chosen as one of the regional offices.

While, the WEC is probably not a feasible choice due to the policy and the inconvenience in the long-term project operation caused by the location in Lahore.

Therefore, it is likely to the appropriate choice of EPA.

(2) Preliminary Monitoring and Evaluation

The objectives of initial environmental monitoring and evaluation is to evaluate the environmental aspects and the impacts caused by the change of the aspects with the lapse of time and to certify the significant negative or unexpected impacts at the earliest.

The components of the environmental monitoring and evaluation should include the guideline of working, general plan of monitoring, evaluation and reporting and action plan against unexpected and sudden environmental hazards at the future stage of detail design of this Project.

Therefore, in this Study the draft plan of the environmental monitoring and evaluation is considered in order to show the tendency of them.

1) The guideline of working

Monitoring and the required procedures for them had better be conducted for the issues selected in EIA. However, it seems that the issues may as well choose indispensable issues to the monitoring of the Project if it is difficult to manage the working schedule, the cost and so on. The selection of monitoring items does not entirely have to adhere to the evaluation value of EIA.

2) The general plan of monitoring

The general plan of monitoring for each environmental component or issues shown in Annex J. More important component or issues are groundwater level, soil salinity and human use. Especially, as for human use component, it is very difficult to evaluate the monitoring. The socio-economical data, which will be collect for the monitoring and evaluation component regarding project benefit planned at the detail design stage, should be used fully. Besides, these data have to be analyzed as occasion demand.

3) Evaluation and reporting

The evaluation of monitoring should be reported at least once a year as a summary of the monitored environmental components.
The component for the evaluation process of monitoring and reporting is shown in Annex J. The most important component of them is warning system against the urgent occurrence of significant negative impacts. The procedure needs the quantitative and reliable background which can certainly recognize these adverse impacts. Therefore, the report of the monitoring should be constituted by the change of data, the result of some analyses and moreover the discernment of the experts.

4) Action plan

The action plan mostly means early warning system. The system is action plan to predict quickly the unexpected remarkable negative environmental impacts, caused suddenly by the implementation of the Project. It is important that the specialists of monitoring can recognize the significant negative impacts, have the ability to implement promptly the system, and obtain supports from other organizations. To fulfill these requirements, some specific training for monitoring would be necessary for the specialists to understand the necessity and importance of the monitoring system.

# CHAPTER VI PROJECT COMPONENTS AND COST ESTIMATE

## 6.1 Project Components

### 6.1.1 Conveyance System

Conveyance system for the Project consists of an intake and a feeder canal to lead the maximum flow of 74 cum.s from the Indus to the proposed pumping station.

(1) Intake

Location of the intake has been decided at about 1.5 km on the right side of the barrage and about 200m in the left side of the Right Spur Dike No. 1, beside the Low Hydropower Plant site. However, WAPDA has an intention to negotiate with the Power Plant project whether the intake structure of the 1st Lift Irrigation Project can be jointly provided at the head race of the plant or not. This alternative plan by WAPDA is not included in the Scope of Work in this JICA Study because it would require a long time for re-arrangements of financial, design and construction schedules. Major design conditions of proposed intake to be independently constructed are as follows:

| | |
|---|---|
| Designed discharge: | 74 cum.s |
| Designed minimum water level: | WL 195.68 m (642 ft) |
| | (equal to N.W.L. of Chashma Pond as Fig. 6.1.1) |
| Designed maximum water level: | WL 197.82 m (649 ft) |
| Top elevation of side wall: | EL 199.40 m (same as that for Power Plant) |
| Cill elevation of gate: | WL 192.06 m |
| Intake gate: | Electric driven radial gate (4.8 m x 6.0 m x 4 gates) |

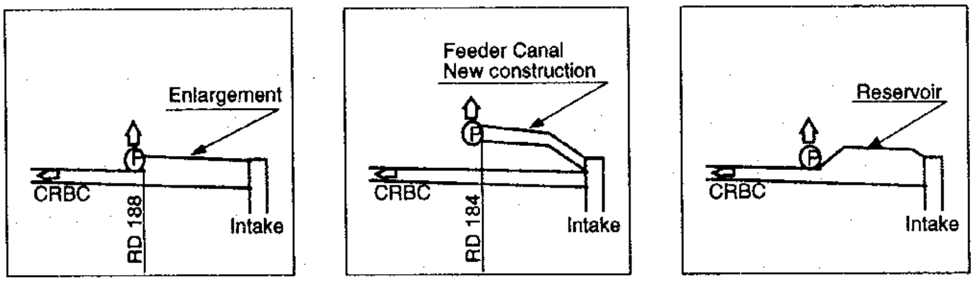
An approach channel in the Chashma Pond shall be dredged 700 m from the upper end of the guide bank to the inlet of the intake. The dredged soil can be used for land reclamation between the hydropower plant and the intake.

The intake structure is of reinforced concrete consisting of an inlet, a gate portion, a transition and a flume part, and is connected to a box culvert under-crossing the Chashma Dike. Total length of the structure is approximately 70 m, and the widths at the gate and the flume portion are 21 m and 16.5 m, respectively.

Four radial gates are to be installed to regulate the intake discharge. Size of each gate is 4.8 m in width and 6.0 m in height. Radial gate has been found advantageous due to low height of operation platform, lighter load to foundation and less driving power requirement. The gates are electric-driven and operated only at gate site. No remote control of the gates from the pumping station is provided because of difficulty in maintenance and operation . Wireless telephone is to be provided instead.

(2) Feeder canal

Following three alternative approaches have been studied for planning of the feeder canal.




(A) CRBC Widening (B) New Canal Parallel (C) Reservoir Construction

The alternative-B has been selected after detailed examination of the engineering and economic feasibility. Accordingly, a 58.5 km long feeder canal, aligned almost parallel to the existing CRBC and keeping distance from residential areas, connects the intake and the pumping station. Standard radius of curvature of the canal have been selected from 500 m, 1,000 m, and 2,000 m.

Whether or not to line the canal with concrete is one of most important issues for the project , and therefore a careful examination has been made. Advantages of concrete lining are, reduced hydraulic head loss and seepage, prevention of growth of weeds, economy in maintenance and structural safety, etc. On the other hand, it requires increased construction cost and precise control and management of construction engineering and quality. In order to decide the type and thickness of lining, the construction economy, volume of work, construction methodologies, conditions of construction sites, capability of field engineers, staff and laborers, etc. have been studied and evaluated. It has finally been decided that the canal should be lined with 8 cm-thick concrete by use of slip-form screed.

Structures appurtenant to the feeder canal are eleven numbers of super passage, one cross drainage structure, one escape cum silt ejector and 29 bridges. Water additionally taken for silt ejectors doesn't infringe on the Indus water right due to being escaped back into Indus river. However, no additional water is proposed at a term of maximum discharge because it will not be silted due to adequate velocity.

Cross-section of the canal has been designed for stability and to minimize the earth work and to balance cut and fill. Design conditions are as follows, and the cross section is as presented in Fig. 6.1.2.

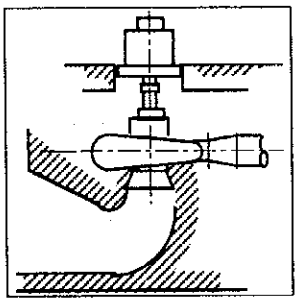
| | |
|---|---|
| Concrete lining | 8 cm-thick |
| Flow formula | Manning's formula |
| Manning's coeff. of roughness | n = 0.016 |
| Longitudinal gradient | 1/14,000 |
| Design discharge | 74 cum.s |
| Design velocity | 1.0 m/s |

### 6.1.2 Pumping Station

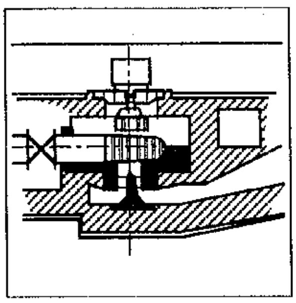
Location of the pumping station has been selected a sandy hill near CRBC/RD/184 for shorter length of delivery pipeline and to reserve land for settling basin and escape facilities. Design conditions for the pumping station are as follows.

| | |
|---|---|
| Design capacity : | Max. 72 cum.s , Min. 20 cum.s |
| | Regular operation 30 - 50 cum.s |
| Actual head: | 18.3 m (suction WL 190.70, delivery WL 209.00) |

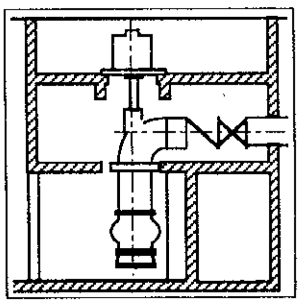
The most appropriate type of pump has been studied and determined to be vertical mixed flow pump by taking account of per-unit capacities at 6 cum.s or 10 cum.s (4 - 15 cum.s in the alternative study) and total heads of 22 - 23 m due to its advantageous pump efficiency, suction efficiency and O&M. This type can be further classified into standard type and volute type, and furthermore, the volute type is classified into umbrella suction type and bend-suction type. Comparing these alternatives, as illustrated below, vertical volute type mixed flow pump with umbrella-type suction has been selected.



Vertical Mixed
(Standard Suction)



Vertical Volute Mixed
(Umbrella Suction)



Vertical Volute Mixed
(Bend Suction)

Table 6.1.1 Alternatives of Pump Combinations

| Case | Capacity per unit ($m^3/s$) | No. of units | Capacity per unit ($m^3/s$) | No. of units |
|---|---|---|---|---|
| I-1 | 14.40 | 5 | - | - |
| I-2 | 12.00 | 6 | - | - |
| I-3 | 9.00 | 8 | - | - |
| I-4 | 6.00 | 12 | - | - |
| II-1 | 15.00 | 4 | 6.00 | 2 |
| II-2 | 12.00 | 5 | 6.00 | 2 |
| II-3a | 10.00 | 6 | 6.00 | 2 |
| II-3b | 10.00 | 6 | 4.00 | 3 |
| II-3c | 10.00 | 5 | 5.50 | 4 |

The number of pump unit to share the required pumping load affects much on operational cost. Therefore, altogether nine alternative cases have been studied; four cases of 5-12 units of equal capacity pumps and five cases of 4-6 units of larger capacity pumps combined with 2-4 units of smaller capacity pumps as presented in Table 6.1.1. For each case, construction and equipment costs and annual operational costs have been evaluated in terms of net present value, wherein operational costs have been estimated in three ways to make use of storage function of regulating ponds at 100%, 50% or 10%. The following combination of pumps has been found the most economic case and therefore employed.

| | |
|---|---|
| Larger capacity pumps | 10 cum.s pump (bore 2,000 mm, 3,000 kw) x 6 units and |
| Smaller capacity pumps | 6 cum.s pump (bore 1,650 mm, 1,800 kw) x 2 units |

As for a 700 m-long pipeline from pumping station to the beginning point of the main canal, inner coated steel pipe has been selected considering possible sizes of pipes to carry the delivery discharge and minimum frictional head losses. And for physical security, the pipeline is to be embedded underground.

An alternative study of nine cases has been made on the combination of three flow velocities as 3.5, 3.0 and 2.5 m/s and three number of series as 1, 2 and 3. The evaluation has been made in terms of their net present values of initial and operational costs.

It has been found that there is no substantial difference in terms of economy among the alternative cases. Judging from the other factor such as project implementation schedule and construction workability, the 3-series pipeline is more realistic and advantaged by construction of a single-series pipeline in Phase implementation and less financial requirement in the Phase. As for the velocity, the most economic velocity among the three, 3.0 m/s, has been selected. Consequently, a 3-series pipeline of steel pipe ø 3,200 mm has been selected and thus decided.

Water in the feeder canal includes suspended and sedimented loads entering from the Indus and picked up from the land along the canal. It is generally accepted that sand particles of 0.5 mm or more in diameter damage the pump impellers and turbines, while those of 0.2-0.3 mm or less cause no substantial damage to these ports. Accordingly, scale and dimensions of a settling basin has been designed as follows to settle down the sand particles of 0.3 mm or more.

| | |
|---|---|
| Width | 37.5m x Length 100m x Depth 7.0m x 2 lanes |
| Gate | 4.8m x 4.0m x 4 units |

As for foundation of pumping station, the elevations of pump bases are 8-10m below the ground surface. The foundation stratum shows insufficient bearing capacity as N-values are only 20-30, and the texture is homogeneous fine sand. This will affect degradation of the stability during earthquakes. Accordingly, reinforced concrete pile cast-in-situ ø 800 have been selected to bear the loads of pumping machineries and building.

Major facilities other than the afore-mentioned are as follows.

| | |
|---|---|
| Pump house: | Length 76.0m x Width 32.5m, reinforced concrete |
| Electric Substation | Capacity 30 MVA |
| Suction tank | Length 76.0m x Width 13.0m |
| Delivery tank | Length 25.0m x Width 24.0m |
| Spillway cum escape channel | Bed width 9.0m x Depth 4.6m x Length 4.0 km (2 km concrete-lined) |
| Drain conduit | Width 1.2m x Height 1.5m x 2 series concrete box Length 90m and 190m |

Pump operation during season of low water demand has to be managed in ways not to run small number of pumps concentratedly but to rotate large number of pumps in order. Furthermore, in order to prevent any default of functions upon the full water demand, maintenance work of the machineries and discharge pipes of the settling basin have also to be managed during the season.

### 6.1.3 Main Canal

Beginning point of the main canal has been selected at N 876631.11, E 3020 135.00 about 2 km north-west from RD 185 where the ground level is slightly lower than the delivery FSL 209.00 but the length of delivery pipeline becomes short.

Discharges in the canal depend on the flow sections. However velocity not to allow siltation of suspended load throughout the sections has been studied. The velocity to suspend sand particles of 0.3 mm or less, which could not be removed in the settling basin before pumping, even during the low water demand season, has been studied and found that 1.0 m/s to the design discharge is sufficient. Consequently, 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. The Manning's Flow formula used for hydraulic calculations of the feeder canal has also been sued for the main canal and the sections and F.S.L's have been calculated.

Canal alignment has been studied on the 4-inch 1-mile topo-maps (scale 1/15,840) of 1958-1961 edition. Curve-setting of the alignment has been made to employ the raddi as long as possible in the topography and not less than 10 times of the canal bed widths.

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, the same as in CRBC. The slope on top of concrete lining upto dowel is to be protected from rain wash and inflow of soil by stone pitching. Two rows of drains are to be installed on both sides of the canal invert, and weepholes are to be at 3m interval at 0.4m-high positions from the invert. Standard cross-sections of the canal thus designed are five, sections 1 to 5, as presented in Table 6.1.2 and Fig. 6.1.3.

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 diversion.

Cross drainage structures are to be provided at the crossings of major drainage channels and Nullahs for safe cross-passing of flood water. Two types of cross drainage structures are selected; one is culvert super passage to cross above the main canal at 9 places and another is Nullah culvert to cross underneath at 10 places. By construction of cross drains, water level in the drainage channel or Nullah in the upstream side becomes higher and therefore construction of flood dikes has also been planned to protect right bank of the main canal. Furthermore, in order to protect the canal from incidental high flow conditions inside the canal, five escape structures have been planned.

24 Head regulators are required to divert water to 25 irrigation districts and 21 bridges of four types depending on importance of the traffic are provided to cross the main canal.

### 6.1.4 Distributary

Distributaries are branches of the main canal to lead water to their command areas, and therefore the total command area has firstly been demarcated into 25 command areas before aligning them. This demarcation has been made by taking account of the present river system and location of the existing CRBC cross-drains. All routes of Nullah have been used as the boundaries. Details of the command areas are presented in Table 6.1.3.

Manning's formula has been used for hydraulic calculations. The section is concrete lined with the same coefficient of roughness (0.016) as for main canal. Design velocity, is also the same as in the main canal that is 1.0 m/s approximately but less than 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 the same as in CRBC system and thickness of concrete lining is 5 cm.

Canal cross-sections have been selected from the standardized cross-section of given design discharges and longitudinal gradient, to allow the required velocity. Top width of left bank of all distributaries is designed 4.5m to be used as maintenance road.

Appurtenant structures for the distributaries are drop with village road bridge, canal culvert for road crossing, head regulator for Minor, side spillway with wasteway, Mogha (offtake to watercourse), tail cluster, etc. Canal culverts for canal crossing is at crossings of existing or planned roads by distributaries or Minors, head regulators consisting of gates both in distributary and Minor at the beginning point of Minors, side spillway with wasteways are at upstream side of head regulators to Minor, Moghas are for each on-farm irrigation block, village road bridges are also provided along distributary or Minor at interval of 5 km or more where there are no existing roads, aqueducts and siphons are at crossings of Nullah by distributary or Minor, and tail clusters are at the end of distributaries or Minors.

### 6.1.5 Command Area Development

Command area under the Project is 134,600 ha as GCA. and 115,600 ha as CCA. consisting of 25 independent command areas. Along the main canal, partially elevated land higher than FSL of distributary may not be irrigated by gravity but be irrigable 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.

Irrigation, drainage and other related facilities are to be planned in each of 25 command areas. However, since planning facilities for the entire area would involve a large volume of work, typical two command areas have been selected for the detailed planning since the necessity of the Study is to find outlines of the total facilities.

By taking account of alignment of main canal, topography, adjacent river system, locational conditions with CRBC, sizes of command areas, drainage conditions, etc., two command areas No. 6 and No. 18 have been selected as typical areas representing relatively large and small command areas respectively.

Required facilities in the command areas No. 6 and No. 18 have been planned in the details. Based on 1 to 50,000 topo-maps, alignments of distributaries have been made to run along the center of the command area as straight as possible if topography allows. Minors have been planned if distance from a distributary to an end of farm plots exceeds 3 km.

A distributary starts from a head regulator in the main canal and runs in the center of the command area crossing counterlines perpendicularly. Therefore, slope of ground surface along a distributary may be steeper than the designed hydraulic gradient and accordingly drop structures may be required. Drop structures have been planned at some appropriate places wherein FSL exceeds NSL by 1.0m or more. Drop height has been standardized to 1.0 m and the structure has been designed to serve also for village road bridge for farming convenience.

In order to protect the canal from erroneous operation of gates or accidents, side spillways and wasteways have been planned at the upstream side of head regulators to Minor. Moghas have been planned to take water from distributary or Minor to watercourses to lead to each of corresponding irrigation blocks. Maximum capacity of each Mogha has been set 85 l/s (3.0 cfs) to allow farmers capability for the control. At the ends of distributaries and minors, tail clusters have been planned to release excessive or unnecessary water to the drainage system.

Method of alignment planning for Minors is same as that for distributaries and components of the planned facilities in the command areas No. 6 and No. 18 are as presented in Table 6.1.4.

Table 6.1.4 Outline of Command Areas No. 6 and No. 8

| Item | | D-6 | D-18 |
|---|---|---|---|
| 1. Gross Command Area (GCA). | (ha) | 11,470 | 3,010 |
| 2. Gross Irrigable Area (GIA.) | (ha) | 11,030 | 2,790 |
| 3. Cultivable Command Area (CCA) | (ha) | 10,150 | 2,560 |
| 4. Discharge | ($m^3/s$) | 5.33 | 1.34 |
| 5. Structures | | | |
| a. Length of Distributary | (km) | 10.707 | 7.680 |
| b. Length of Minor | (km) | 20.85 | - |
| c. Head Regulator for Minor | (nos.) | 3 | - |
| d. Mogha | (nos.) | 37 | 18 |
| e. Fall with V.R. Bridge (Drop Structures) | | | |
| Type - I | (nos.) | 3 | - |
| Type - II | (nos.) | 4 | - |
| Type - III | (nos.) | 2 | 5 |
| f. Side Spillway | (nos.) | 3 | - |
| g. Culvert Road Bridge | (nos.) | 3 | 1 |
| h. Village Road Bridge | (nos.) | 1 | - |
| i. Tail Cluster | (nos.) | 4 | 1 |

### 6.1.6 Regulating Pond

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, a 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 by taking account of the followings.

1) In case of incidental functional troubles in intake, pumps, gates, etc., it would take one day at minimum to take some necessary measures.
2) It would take one day at minimum to take some measures in case of erroneous operation of gates or some facilities by farmers.
3) Water at the beginning of main canal takes 1.3 days to run 113 km until arriving at the end of the canal. Therefore, in case of no demand due to rains it should be able to store the extra water already lifted.

Regulating ponds have been designed to be 3.0 m for effective water depth, 0.5 m for dead water depth, 1.0 m for freeboard and stone pitching for revetment. Major dimensions of regulating ponds are as shown in Table 6.1.5

### 6.1.7 Drainage Facilities

The proposed drainage system consists of flood carrier channels, interceptor surface drains, open collector drains and surface drains. Flood carrier channels requiring training of existing channels are the most important drainage facilities for the Project to minimize severe damage by floods.

In order to pass floods safely through the Project area located between the main canal and CRBC, existing Nullahs shall be trained to pass once-in-40-year floods. Flow capacity of the existing Nullahs is mostly insufficient, and therefore river training works such as excoriation of channel prism and new embankment of dikes shall be carried out in most cases. Outline of the works is as follows.

| | |
|---|---|
| Channel gradient | 1:1,000 (approx. same as ground slope) |
| Side slope of channel | 1:1.5 (same for cut or fill slope) |
| Coefficient of roughness | 0.03 for cut surface |
| | 0.035 for untreated channel surface |
| Depth of channel excavation | 3.0 m |
| New dike | Height 1.5-2.0 m, berm width 6 m |

Twenty flood carrier channels cross the main canal and the total length for training amounts to 322 km. Most parts of the existing rivers and zams are to be trained accordingly. Outline of these are presented in Fig. 6.1.4.

Each of 25 command areas is demarcated by flood carrier channels, and drainage system inside the command area has been planned. Surface drains receive drainage from farm plots, open collector drains receive drainage from surface drains, and interceptor drains receive drainage from open collector drains. Interceptor drains or open collector drains are connected to flood carrier channels at the downstream ends.

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

### 6.1.8 Communication System for Water Management and O&M

The area to be covered for water management is extended upto 170 km-length from Chashma Intake to the downstream end of main canal via pumping station. Major facilities of water management to be provided with communication system are a central O&M office, an intake, a pumping station and 25 branch offices at offtake sites of every distributary. An adequate communication system shall be provided for water management at each of them. Following three general communication systems have been examined.

(1) Metallic cable telephone system:

This is a simple telephone communication system connecting metallic cable between stations, providing cable lines along the feeder and the main canals. Two types of cable line, areal cable system and embedded cable system, are applicable. Boosters for amplification of electrical signals shall be provided every 20 km of the cable. Installation cost of the cable is very high due to long distance. But installation and maintenance cost may be saved by use of power line poles in case WAPDA installs their power transmission lines along the canals. Security and maintenance of the facilities also pose a problem in future especially damages by thunderbolts are foreseeable.

(2) Wireless telephone system:

A central master (key) station and many slaver (fixed) stations shall be provided at

every site. Moreover, one or two relay stations are necessary. The construction cost is cheaper than the cable system. Periodical inspections by special technicians and renewal of instruments are necessary. Exclusive experts shall be employed for the operation and maintenance of the equipment.
If this system is introduced in the early stage of the Project implementation, it is very convenient for construction management also. Mobile stations mounted on vehicles are more useful if they are provided.

(3) Fiberglass cable telephone system:

This system is completely free from thunderbolts. The cable is embedded along the canal as well as a metallic cable, but a booster is not necessary on the line within a distance of 100 km or more. The cost of the cable and instruments is high, and special technologies are required for installation and connections of instruments and cables.
But for the high cost this would have been a convenient system for introduction of data communication system in future O&M.

Comparing the above three systems, the wireless telephone system has consequently been found most suitable by taking account of local situations and utilization of the system throughout the periods of construction and the Project operational activities. Network of stations is as follows.

| | |
|---|---|
| 1) Center station in Water management Authority | 5 channels |
| 2) Chashma Intake station | 2 channels |
| 3) Pumping Station | 2 channels |
| 4) Branch stations (25 O&M offices) | 2 ch. w/ call sign |

The Center Station shall be equipped with a wireless telephone system to have one channel exclusively for simultaneous instructions to all other stations, two channels exclusively for direct communication with intake and pumping station, and two channels for direct communication with 25 branch stations by use of call signs. Among the two channels for stations other than the center station, one channel is a common channel to all other stations exclusively for receiving direct and simultaneous instructions (one-way communication) from the center station and another channel is direct two-way communication to the center.

In order to avoid any disorder in water management and O&M and to prevent any activities other than those instructed, direct two-way communications between stations except with the center station are not in the system. Thus all information and activities are to be managed by the center station.

### 6.1.9 Supplemental Domestic Water Supply System

Relatively high-elevated land near offtake of each distributary has been reserved for a residential area. This is because that water in the distributary and regulating pond necessarily makes the land to be a center of farmers living, the land may not be irrigated by gravity when water level in the regulating pond is low, and some portion of the land may not be irrigated by gravity even by water from the distributary due to the partial topography.

Residential area is generally the high land above the command of canal system. To the farmers who live there, stable and dependable supply of domestic water is to be supplemented by installation of shallow wells for drinking water and sump pits and watercourses from the distributaries or regulating pond for other domestic water uses at necessary places.

### 6.1.10 Farm Road System

Besides existing road and farm market road being under construction in the Project area, inspection road to be constructed along proposed main canal, distributary and minor canal will be available for public traffic. The inspection road is not for canal maintenance purpose only but for multipurpose including public transportation. Length of inspection road will be constructed along canals in the Project, is as follows:

| Canal type | Length of inspection road (km) |
|---|---|
| Main Canal | 113.3 |
| Distributary | 275.6 |
| Minor Canal | 167.0 |
| Total | 555.9 |

Furthermore, farm road to link with such inspection road and existing road is necessary to be constructed. New farm road for create certain road network is proposed to be constructed as follows:

| | | |
|---|---|---|
| New Farm Road | Type: | Gravel paving |
| | Width: | effec. 3.0 m total 4.5 m |
| | Length: | 32.5 km |

Road density of the network of the Project area including these proposed roads will be 702m/km$^2$.

## 6.2 Project Cost

Appraisal of the Project cost has been worked out by dividing each of the cost components into foreign currency portion and local currency portion so as to serve for the project evaluation and financial planning.

### 6.2.1 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, and (5) interest and service charges. (1) Direct construction cost is the cost for construction works and (2) indirect construction cost is composed of consultancy service cost and construction implementation cost.

(1) Direct construction cost consists of costs for an intake, a feeder canal, a pumping station, a main canal, distributaries, regulating ponds, river treatment and drainage canals, commercial roads, on-farm development, sump well and domestic water supply and other miscellaneous works. The cost amounts to 10,120 million Rupees in total.

In the (2) indirect construction cost, consultancy service cost and implementation cost including procurement of office and O&M equipment have been estimated at 10% and 6% of the (1) direct construction cost, respectively. (3) Physical contingencies are at 10% of (1), while (4) price contingencies are at 29% (7-year-average 4.5% per anum) and 37% (7-year-average 5.5% per anum) to (1) + (2) + (3) for foreign and local currency portions, respectively. (5) Interest and service charges are at 3% (5-year 1% per anum).

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 as presented in Table 6.2.1.

## Table 6.2.1 Project Cost

| Project Cost Component | Working Volume | unit | Foreign Currency (1,000 Rs.) | Local Currency (1,000 Rs.) | Total Cost (1,000 Rs.) |
|---|---|---|---|---|---|
| **I. Direct Construction Cost** | | | | | |
| a) Land Acquisition, Compensation & Preliminary | | | 35,604.8 | 226,407.2 | 262,012.0 |
| Land Acquisition | 3,200.0 | ha | 0.0 | 97,850.0 | 97,850.0 |
| Compensation(House) | 130 | nos | 0.0 | 75,000.0 | 75,000.0 |
| Preliminary(Construction Camp) | | L.S. | 35,604.8 | 53,557.2 | 89,162.0 |
| b) Feeder Canal | | | 1,479,685.8 | 808,072.7 | 2,287,758.4 |
| Earthwork | 58.6 | km | 1,080,540.4 | 281,637.3 | 1,362,177.7 |
| Structure | 241 | nos | 399,145.3 | 526,435.4 | 925,580.7 |
| c) Pump Station | 1 | sta. | 1,193,602.8 | 395,015.2 | 1,588,618.0 |
| Pump Equipment | | set | 909,964.7 | 162,494.9 | 1,072,459.5 |
| Other Works*1 | | set | 283,638.1 | 232,520.3 | 516,158.5 |
| d) Main Canal | | | 1,084,801.2 | 1,044,497.6 | 2,129,298.8 |
| Earthwork | 113.3 | km | 453,934.3 | 219,631.6 | 673,565.9 |
| Structure | 463 | nos | 630,866.9 | 824,866.0 | 1,455,732.9 |
| e) Distributory Canals | | | 413,238.5 | 402,778.4 | 816,016.8 |
| Earthwork | 442.6 | km | 272,449.2 | 179,933.3 | 452,382.5 |
| Structure | 1,093 | nos | 140,789.3 | 222,845.1 | 363,634.4 |
| f) Regulation Pond | 25 | nos | 330,307.0 | 265,176.4 | 595,483.5 |
| h) River Treatment & Drainage Canals | 579.5 | km | 1,247,968.5 | 273,147.7 | 1,521,116.2 |
| i) Commercial Roads | 32.5 | km | 11,014.5 | 7,045.6 | 18,060.1 |
| j) On-farm Development Cost | 115,600.0 | ha | 346,915.6 | 292,202.0 | 639,117.6 |
| k) Sump Well & Domestic Water Supply | | nos | 10,915.6 | 9,244.5 | 20,160.2 |
| l) Other and Miscellaneous Works | | L.S. | 97,104.0 | 145,656.0 | 242,760.0 |
| **Sub-total** | | | **6,251,158.3** | **3,869,243.3** | **10,120,401.6** |
| **II. Indirect Construction Cost** | | | | | |
| a) Consultancy Service Cost(10% to D.Cost) | | L.S. | 625,115.8 | 386,924.3 | 1,012,040.2 |
| b) Implementation Cost(6% to D.Cost) | | L.S. | 375,069.5 | 232,154.6 | 607,224.1 |
| - Procurement of Office and O&M Equipment | | | 208,500.0 | | 208,500.0 |
| - Administration Cost | | | 166,569.5 | 232,154.6 | 398,724.1 |
| **Sub-total** | | | **1,000,185.3** | **619,078.9** | **1,619,264.3** |
| **III. Physical Contingency** | 10% | | **625,115.8** | **386,924.3** | **1,012,040.2** |
| **Total Base Construction Cost** | | | **7,876,459.4** | **4,875,246.6** | **12,751,706.0** |
| **IV. Price Contingency*2** | 29%<br>37% | F.C.<br>L.C. | **2,281,201.8** | **1,779,755.1** | **4,060,956.9** |
| **V. Interest and Service Charge** | | | **218,907.1** | **134,183.2** | **353,090.3** |
| a) Interest During Construction Period (No interest for GOP is proposed) | | | | | |
| b) Bank Service Charge(1 %) | 3% | | 218,907.1 | 134,183.2 | 353,090.3 |
| **GRAND TOTAL COST** | | | **10,376,568.4** | **6,789,184.9** | **17,165,753.3** |

Note; *1: Construction cost of the substation is counted within the Other Works.

However counteraction work of transmission line is not considered because installation of transmission line for the Project should be done by the GOP in consideration of nationwide facilitating plan of national grid of electricity supply.

*2:with annual escalating of 4.5% for F.C. and 5.5 % for L.C.

### 6.2.2 Replacement Cost

After the Project is implemented, some equipment and facilities should be replaced during project life. The facilities to be replaced are:

- pump with related equipment (25 year life)
- gate in intake, feeder canal, main canal, distributary, and regulating pond (25 year life)
- vehicles, office equipment, O&M equipment (10~25 year life)

The replacement cost of the above is estimated as follows:

Replacement Cost ('000 Rs)

| Item | L.C. | F.C. | Total |
|---|---|---|---|
| (Public Expenses) | | | |
| Pump | 170,000 | 910,000 | 1,080,000 |
| Irrigation Facilities | 49,500 | 21,000 | 70,500 |
| Others | 16,760 | 67,040 | 83,800 |
| (Associations' Expenses) | | | |
| Irrigation Facilities | 24,500 | 10,500 | 35,000 |
| Others | 4,190 | 16,760 | 20,950 |
| TOTAL | 264,950 | 1,025,300 | 1,290,250 |

### 6.2.3 O&M Cost

O&M cost is the cost for proper and continuous operation, maintenance and management of the Project facilities and their functions after completion or partial completion of the project construction. Therefore it may be said to be the cost for achievement of the project objectives and materialization of the project benefits.
The annual operation and maintenance cost at full development stage is estimated at 293.3 million Rs. as below table.

Annual O&M Cost ('000 Rs)

| Item | L.C. | F.C. | Total |
|---|---|---|---|
| (Public Expenses) | | | |
| Administration Staff | 59,130 | - | 59,130 |
| Office Operation Cost | 700 | 700 | 1,400 |
| O&M Cost for Pump | 18,800 | 169,200 | 188,000 |
| Others | 17,440 | 4,360 | 21,800 |
| (Associations' Expenses) | | | |
| Manpower * | [23,760] | - | [23,760] |
| Office Operation Cost | 650 | 650 | 1,300 |
| Others | 17,350 | 4,340 | 21,690 |
| TOTAL | 114,070 | 179,250 | 293,320 |

*: Unit electric fee is applied at 1.45 Rs/kwh.

**: "Manpower" is an equivalent cost of farmers activities , excluding in the above table.

# CHAPTER VII PROJECT IMPLEMENTATION

## 7.1 Implementation Schedule

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

The construction period is divided into two phases. In the Phase I stage with 4 years 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 with 3 years 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. General features of phasewise construction plan is shown in Fig. 7.1.1.

Construction schedule of the Project is given in Fig. 7.1.2 Both phases consist of detail design period and construction period, will be taken in turn with one and half years overlapping. In one year before of the commencement of the construction work, institutional arrangement such as establishment of the CRBDA shall be completed (preparation of the establishment of CRBDA will be started one more year before). Financial arrangement should be consummated by the commencement of the construction work. Land acquisition will be done after commencement of the construction period with 5 years period.

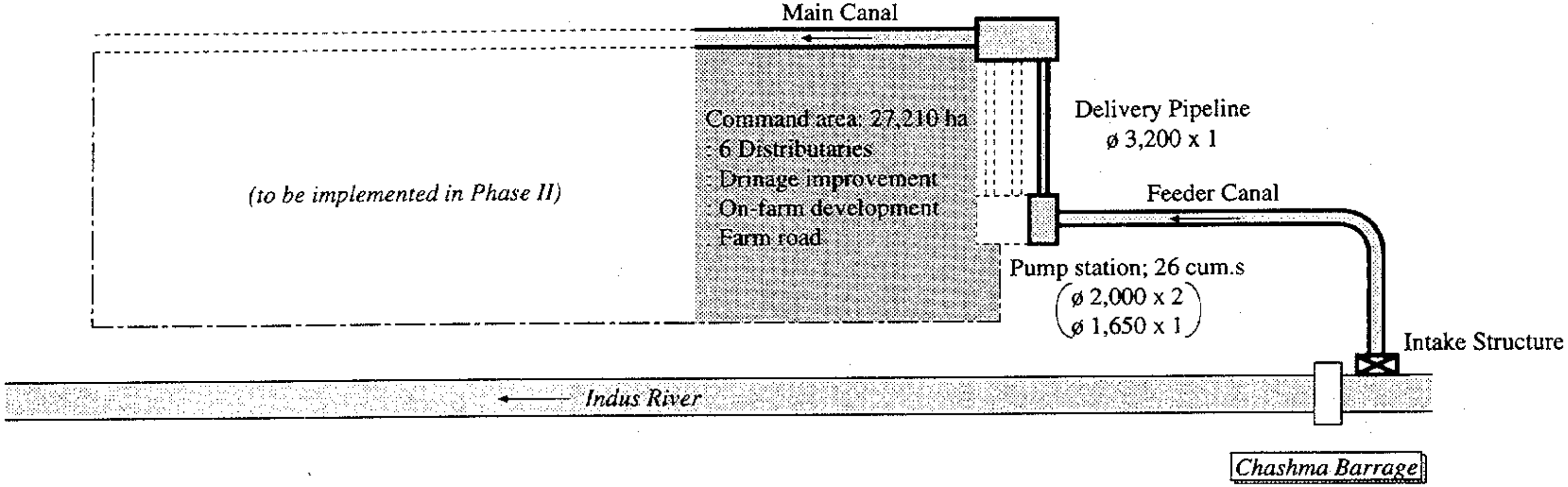
Project cost of each phase is 8,841.9 million Rs. for Phase I, and 8,323.8 million Rs., respectively (Table 7.1.1). Disbursement shedule of the Project is shown in Table 7.1.2.

## 7.2 Institutional Arrangement

(1) Drafting and passing of act by the Parliament

Soon after the conceptual approval of the project, the act should be drafted for setting up of the Chashma Right Bank Development Authority on the lines of the Water and Power Development Authority and Thal Development Authority. The mode and tanure of appointment of chairman and members, financial powers and functions and responsibilities of the authority both during development and operational stages should be clearly defined.

***Phase I:***




***Phase II:***

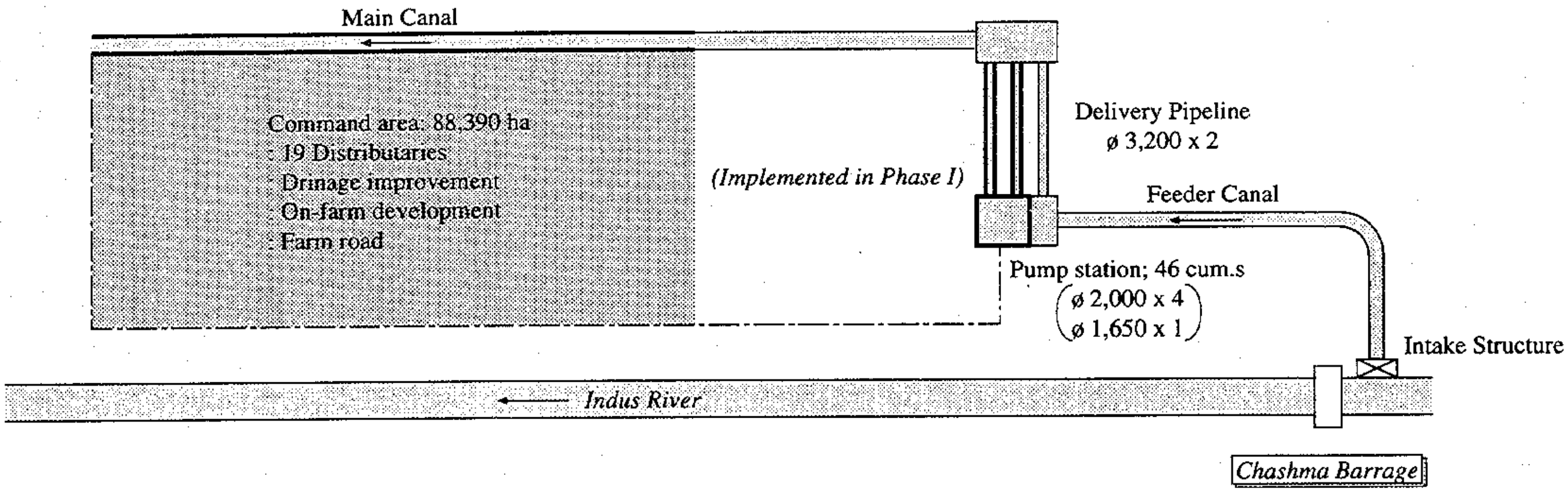
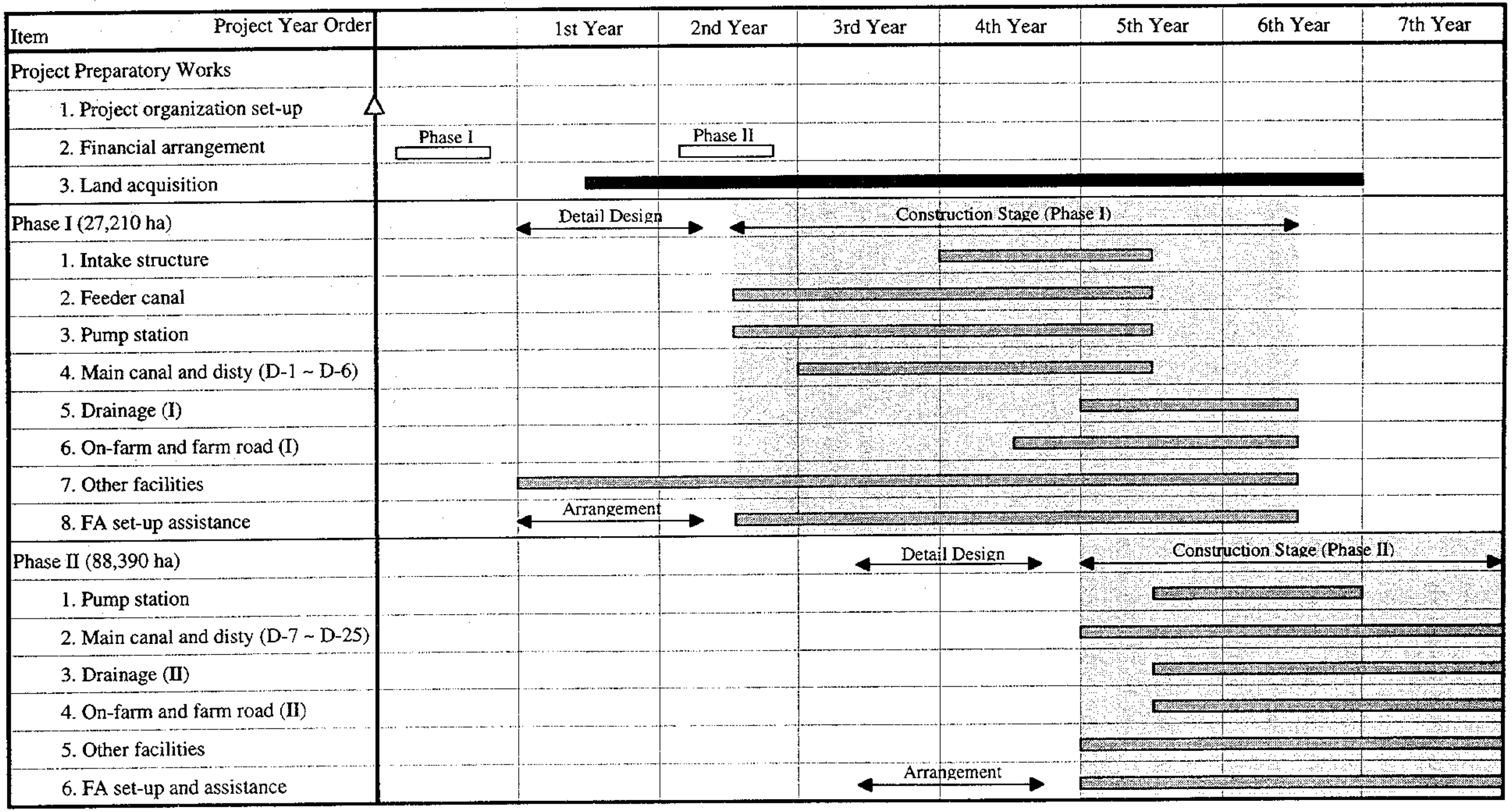



**Fig. 7.1.1 Phasewised Construction Works**

## Fig. 7.1.2 Implementation Schedule for the Project




Note: Other facilities comprise O&M, FA offices, support facilities, etc.

(2) Authority Core Body

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 infrastructure facilities. The core body of the authority should be :

1) Chairman
2) Members irrigation, agriculture and infrastructure development and finance.
3) Superintending engineer design and planning with 4 senior engineers.
4) Directors adoptive research and seed development, infrastructure.
5) Land acquisition collector.
6) director finance.
7) Assistant Director extension with five extension advisors.

As the work picks up, the authority should gradually expand and appoint advisor from farmers associations after first five distributary level farmers' associations of 25 associations have been organized and an advisor from financial institution after the loan has been sanctioned.

(3) Schedule of transfer of existing department duties

Ideally the functions, duties, assets and responsibilities of all the relevent 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. This may, however, not be possible and therefore, a gradual transfer of functions in a smooth manner to help the authority to establish on sound footing on the one hand and disperse the surplus staff of the departments in other districts on the other, may be desirable. The mode of transfer should be that those existing departments which are purely developmental in nature may be transferred much earlier than those which have operational responsibilities. Such departments would be agriculture research and extension along with their assets including offices, residences, and research farms to be used by the authority. Other departments such as wild life, fisheries, Dera Development Authority, rural development, fruit and vegetable board, agricultural development authority, soil conservation etc. which are not very active at present could be taken over in the second stage when the C.R.B. development authority has sufficiently strengthened itself to take these responsibilities. Departments like irrigation, on-farm water management, animal husbandry, cooperative, forest, public health engineering, industries, population welfare etc. should be taken over in the third phase so that 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.

The Water and Power Development Authority should transfer the operation of distributary head regulators upto Stage II of the gravity canal to C.R.B. Development Authority to rationalize the water supply in accordance with the crop water requirements on 10 daily basis and enforce the cropping pattern given in the project document. any slackness in such rationalization will not only distort the cropping pattern and the inherent disadvantages but will also create shortages at the tail after the completion of the gravity canal project. In the long run the control gates of all distributaries should be transferred to C.R.B. Development Authority with WAPDA to oversee that these are operated according to their share and that the province of Punjab gets its share at the provincial boundary.

(4) Transfer of Rod Kohi System

In order to optimize the utilization of water resources, the rod Kohi system, currently operated by the district administration through irrigation department, should also be transferred to the authority so as to utilize this resource in conjunction with the two canals and also plan for its utilization on upstream areas beyond the lift canal boundary as the existing rights are surrendered in favor of parennial irrigation system. The authority will not only plan utilization of Rod Kohi water for irrigation but will also plan and implement the flood control measures which will become all the more necessary when the lands utilizing this water come under parennial irrigation.

(5) Setting up of Special Project Unit for Distributary Development Programme

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. This unit will not only test the viability of the new approach but will also be of great help to implement the new development approach over the whole of the Chashma Right Bank Lift Irrigation Project in the 1st instance and over the Chashma