

Right Bank Gravity Canal when it is taken over in stages

7.3 Operation and Maintenance

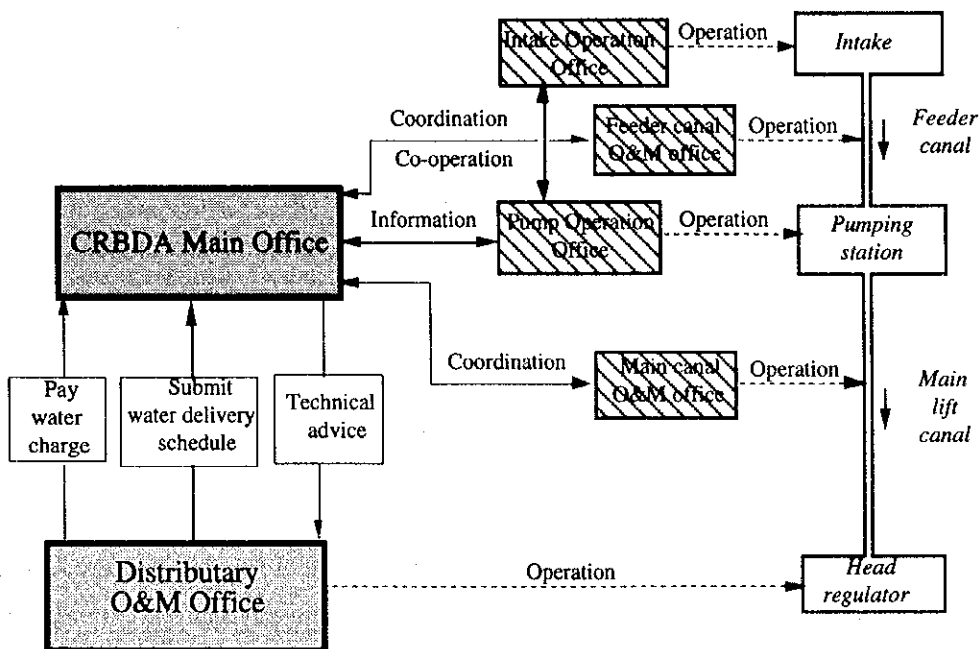
7.3.1 Organization for O&M

According to the description on institutional situation, many agencies are involved in each work for operation and maintenance(O&M). Its constraint is an essential cause for wishes for innovation of present institution on O&M in irrigation as described in the paragraph. **5.7 Institutional Improvement Plan**. Planning of O&M in this Project shall be devised in line with proposal on the institutional issues.

Basic strategy for O&M is simply defined as follows:

- Proposed CRBDA Main Office shall handle and manage all administrative matters as well as technical supporting with full responsibility.
- Actual operation and maintenance for the facilities downstream of head regulator shall be subject to the Distributary O&M Office which is an active body for O&M of a proposed Distributary Farmers Association(DFA). The office will plan water management in accordance with farmer's request for irrigation water supply.
- CRBDA Main Office and Distributary O&M Office shall function harmoniously in order to realize "Crop based irrigation".

Location of the proposed O&M offices is shown in Fig. 7.3.1. The relation among proposed offices on the operation and maintenance are schematically presented as follows:



Relation among Proposed Offices on Operation and Maintenance

7.3.2 O&M for Irrigation

(1) O&M with Crop-based Irrigation

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

- Establishment of a realistic cropping pattern
- Elaborate water delivery schedule
- Systematic and well-trained operation
- Closed communication on operation
- Accurate and timely measurement of discharge
- Reasonable water charge system and fair collection
- Adequate and useful technical advice system

Basic institutional organization of the Project is proposed in paragraph 5.6. Every functions above should be facilitated in line with the proposed organization.

"Water delivery schedule" will be made in consideration with proposed cropping schedule prepared by each DFA through Distributary O&M Office keeping in view of the overall cropping pattern for the Project. CRBDA will analyze water requirement of whole project area, and make operation schedule. After the yearly schedule is

approved, CRBDA will watch and accept alternation if absolutely necessary of water requirement of each DOMO on monthly, and weekly basis.

"Operation" within command area of a distributary including head regulator operation will be done by DFA under the support of CRBDA. Each proposed office will be equipped with communication system so as to communicate adequately among the organizations.

"Measurement of discharge" will be done by means of facilitating necessary measuring devices and deployment of necessary staff.

"Water fee (Abiana)" is collected by CRBDA through DFA. Abiana will be appropriated directly to O&M expenditure. Payment for water use as Abiana is on a volume basis because other criteria for determining payment (e.g. per cropped acre, as at present), will not motivate the farmer to limit his water uptake to the requirements of his crops.

"Technical advice" will be given to DFA by CRBDA through Agriculture Extension Advisor assigned to each DFA.

(2) O&M plan

For elaborate water delivery schedule:

Water delivery schedule must be based upon farmers desires of cultivation. A month before the start of hydrological year (from April to March), DFA shall submit yearly cropping schedule for their distributary command through collecting and summing up cropping schedule of each farmer along with estimate of water requirement for the distributary. The CRBDA will check the discharge of water requirement with the available water taking from Indus river, and flowing capacity of facilities of the Project. If it is excessive, the proposal on cropping schedule and water demand will be sent back to DFA. After fixing yearly cropping schedule in whole project area, yearly water delivery schedule will be made in CRBDA.

During the month, the DFA could ask for modification which should be considered by the CRBDA and accommodate the demand, If possible within the overall system. Water delivery is basically constant in each 10 daily period. A few days before the next period, CRBDA will inform the DFA of any negative change. Similarly, the DFA can request CRBDA to change the discharge of their distributary. Response for the request on the change of discharge will be expected immediately, depending upon

the distance between intake and head gate of requesting distributary. The flow on confirmation of water delivery schedule is shown in Fig. 7.3.2

For systematic and well-trained operation

Operation of major facilities such as pumping station, facilities on main canal etc. shall be done by CRBDA staff. They will be trained in their duty through CRBDA's original training program.

Facilities downstream of head gate of distributary, shall be operated and maintained by DOMO staff. CRBDA shall train farmers through DFA, providing operation manual and holding training seminar.

For closed communication on operation

Transmission of information such as cropping schedule, water delivery schedule, and alternation of discharge shall be smoothly and correctly done through communication system. Wireless system is provided in the Project. All proposed offices in the Project will be linked with the wireless system.

In case of stoppage of the wireless system, vehicles equipped in each office is available for the communication use.

For accurate and timely measurement of discharge

Measurement of discharge for delivered water must be done at predetermined important points and on scheduled time. Staff gauge shall be installed at the point of gates. Personnel who have the duty reading such staff gauge are trained for handling the staff. On the other hand, rating curve which can change the stage to discharge at the staff gauge, must be provided through measuring discharge at several water stage. For reasonable water charge system and fair collection

Farmers can select cultivating crop in accordance with information for adaptability of their fields, latest market price, water consumption, and required labor force etc., as far as peak discharge is less than the flowing capacity of facilities, and total volume of water is available for taking from Indus river.

Water fee shall be charged to farmers on a volume basis which relate with crop variety farmers chose. Abiana price at cubic meter is decided in consideration with all expenditure for operation and maintenance.

Abiana shall be collected by CRBDA through DFA from every beneficiaries on the

basis of consumed water recorded by DOMO staff.

For adequate and useful technical advice system

Farmer will play the leading role on management, operation and maintenance of the Project. Farmers association named Distributary Farmers Association is an acting body such activities. CRBDA shall fully support and train the association so as to function well. Agricultural extension advisor who is assigned to every DFA will act a leader and technical supporter for the DFA. The agricultural extension advisor should be an agronomist or a senior engineer to be able to deal with any matters regarding farmers association.

Technical support on irrigation practice and facilities repairing can be given by CRBDA through despatching engineer from the authority.

7.3.3 O&M for Drainage

There is no heavy task on operation and maintenance for drainage. Major expected works on operation and maintenance are dredging on the cross drainage structures in the main canal, rehabilitation of embankment of flood carrier channel, and emergency measures when flood breaks out.

The O&M task for drainage concerning the Project directly shall be taken by the Direction of Infrastructure and Socio-economic Development of CRBDA, with budget of the Authority. Tough drainage task concerning whole region will be conducted by the Communication and Works Department (C&W) in D. I. Khan.

7.3.4 O&M for Farm Road and Others

Operation and maintenance of proposed inspection road along feeder canal and main canal should be carried out by the Operation and Maintenance Offices of CRBDA, and Farmers Association under the control of Distributary O&M Office of CRBDA will do for roads along distributaries, within their duties of maintenance for canal.

Operation and maintenance of farm road in the Project area will be handled by the C&W and Rural Development Department (RDD) in D. I. Khan in cooperation with the Direction of Infrastructure and Socio-economic Development of CRBDA. National road will be managed by the National Highway Authority (NHA) and C&W.

Domestic water supply shall follow the Public Health Engineering Department's (PHED) management. When water supply is delayed or insufficient in the Project

area, the Direction of Infrastructure and Socio-economic Development of CRBDA will take measure with Authority's budget.

7.4 Project Monitoring and Evaluation

The monitoring and evaluation of the Project are to obtain a better understanding of as-built operation in the Project area, and to develop better predictive ability concerning future problems.

A monitoring and evaluation program of the Chashma Right Bank 1st Lift Irrigation Project would be required to prove the Project impact on :

- 1) behavior of new institution, and farmer's association,
- 2) agricultural output and farm incomes, and these distribution between distributaries, between farm size classes, and men and women,
- 3) benefits and disbenefits owing of the Project,
- 4) level of success in creating new socio-economic structures,
- 5) collection of abiana,
- 6) fixation of crop-based irrigation,
- 7) adaptation of surface irrigation in sandy area,
- 8) physical impacts on depth of groundwater, drainage discharge, water quality, and soil salinity,
- 9) and environmental changes.

Socio-economic impacts of such as 1), 2), 3), 4), and 5) will be investigated and assessed through baseline institutional, socio-economic, and environmental survey which is recommended to be conducted by the P.E. & D. Department of NWFP in cooperation with CRBDA and hired consultants. For Impacts of 6),7), and 8), routine survey including data collection will be carried out by staff of CRBDA. Analysis and evaluation for the survey result will be periodically conducted by the CRBDA office. Environmental impact of 8) and 9) should be monitored by the Environmental Protection Agency of NWFP in line with the environmental manage plan proposed para. **5.8** of this report.

The monitoring and evaluation of the project impacts are planned as follows:

Impact	Concerned agency	Operation schedule	remarks
1) Institution aspects	PE&D	each 10 year	
2) Agricultural outputs and farm incomes	PE&D	each 10 year	
3) Benefits and disbenefits	PE&D	each 10 year	
4) Socio-economy	PE&D	each 10 year	
5) Abiana collection	PE&D	each 5 year	
6) Crop-based irrigation	CRBDA	each 5 year	constantly watched
7) Irrigation in sandy area	CRBDA	each year within first 5 years	constantly watched
8) physical impacts	CRBDA EPA	seasonally each 1 year	
9) Environmental change	EPA	each 1 year	
10) Overall evaluation	PE&D	each 10 year	associated with CRBDA

CHAPTER VIII PROJECT EVALUATION

8.1 Economic Evaluation

8.1.1 Basic Assumption

The basic assumptions applied for economic evaluation of the Project are summarized as follows :

- 1) The economic useful life of the Project is 50 years,
- 2) All prices are expressed at March 1994 prices in Rupee,
- 3) The exchange rate of US\$ 1.00 = Rs. 30.0 = Yen 107.1 as of average during July to March, 1993/4 is applied,
- 4) A standard conversion factor (SCF) with 0.9 is applied to domestic cost elements such as transport, handling and processing for estimation of economic value,
- 5) The transfer payment such as tax, duty, subsidy and interest are excluded for the estimation of economic costs and prices,
- 6) Economic prices of farm inputs (urea, triple super phosphate and muriate potash) and tradable farm produce (wheat, maize, sugar cane, cotton, cotton seed, and sunflower) are estimated on the basis of IBRD projection of world market prices for 2005 in constant 1994 terms. Economic prices of other non-tradable farm outputs and farm inputs are set at same financial prices.
- 7) The part of unskilled labor is converted to the economic value applying the conversion factor of 0.88, and
- 8) The construction components are converted to economic value applying Construction Conversion Factors (CCFs) which are calculated on the basis of proportions of local and foreign costs, and transfer payment, unskilled labor and other local costs at the local portion.

8.1.2 Economic Benefit

Economic evaluation of the Project covers the following six (6) development benefits taking the present less development progress on socio-economic infrastructure and

severe environmental condition into consideration.

- 1) Crop production benefit
- 2) Farm road development benefit
- 3) Benefit from transfer of Rod Kohi water right to upper hill torrent
- 4) Water resource development benefit for domestic water supply
- 5) Benefit from reduction of seasonal migration mainly due to lack of water, no farming activities, and no feed for livestock
- 6) Environmental improvement benefit

(1) Crop Production Benefit

Crop production benefit could accrue from the pumping irrigation water supply to rainfed and barani area, organized irrigation activities by farmer associations, and improvement of farming practices and productivity. Economic net crop production value (ENCPV) per ha under the future without (WO) and with (W) project conditions is estimated on the basis of the present and proposed cropping patterns and cropping intensities (Ref. Table 8.1.1). Incremental ENCPV is calculated as follows:

Item	Cropping Area (ha)	Economic Net Crop Production		
		Total (Rs.'000)	Per Cropping Area (Rs./ha)	Per Project Area (Rs./ha)
1. Without Project Condition (WO)	20,470	86,540	4,228	749
2. With Project Condition (W)	170,500	2,592,619	15,206	22,428
3. Incremental (W) - (WO)	150,030	2,506,080	10,978	21,679

It is assumed that the built-up period to achieve full benefit is seven (7) years after the completion of physical works.

(2) Other development benefits

Traffic volume covering the future crop production, required farm inputs and consumer goods are estimated on the basis of the future crop production plan and crop budgets. Transport cost savings between the future (WO) and (W) project conditions are assessed by mode of transportation (vehicle and animal) and estimated at Rs. 92/ton per 6 km which is average distance from farm or farm gate to local markets. The farm road development benefit is estimated at Rs. 224,154 thousand including cost saving for passenger traffic.

After the commissioning of 1st lift irrigation canal, 27,100 ha of Rod Kohi area in the Project area will come under the irrigation. This area will no more require flood water irrigation. Therefore, the water rights in the CCA area will be transferred and reallocated to the non-command area. Benefit accrued by the transfer of Rod Kohi water right to the upper stream is considered as the net production value in the present Rod Kohi area under the Project area. Of the Rod Kohi area, 10,700 ha is harvested in a normal year and produces the economic net production value of Rs. 43,729 thousand. The transferable value is assumed at 60% of the total value, hence the annual water right benefit will be Rs. 26,237 thousand.

Domestic water supply facilities in the Project area are less developed and their water quality, especially shallow tube well (less than the depth of 91.4 m), is usually saline. Actual beneficiary population by the tube wells is limited at around 25% in 104 mouzas concerned the Project area. Utilization of irrigation canal water as domestic water is prevailing in the villages under the gravity irrigation system. This phenomena will accrue in the Project area after the commencement of lift canal irrigation. The water resource development benefit for domestic water supply through the irrigation development accounts for alternative development cost for deep tube wells and their O&M cost including domestic water charges. Total economic domestic water supply benefit is estimated at Rs. 42,754 thousand.

Based on the farm survey, around 18% of household in the Project area migrate to other area during March to June, when are most dried and hot season, mainly due to shortage of water and feed for livestock. Migrants spent additional livelihood and feed expenditures which were estimated at Rs. 9,902 thousand/year. After the Project completion, these cost will be never required for the villagers and be considered as the Project benefit.

The survey on villagers' concerns on environmental conditions and residential land prices was implemented in the developed area (stage I area), newly developed area (stage II area) under the gravity irrigation system, and the Project area during July to August in 1994. As for the environmental factors, five major items covering water supply, road/accessibility, medical care, education and communication, which were considered major elements for village livelihood improvement, were evaluated by the respondents' scoring from zero (0) to five (5). There was significant correlation between the sum of environmental scoring of the respective respondents and their residential prices. The residential land prices were obviously reflected by the villagers' evaluation on the environmental factors covering the above five items. The difference of residential land prices between the Project area and the stage II area

(Rs. 11,000/ha) is evaluated as environmental improvement benefit by the Project. The environmental benefit is estimated at Rs. 44,000 thousand. Other development benefits are summarized as follows :

Benefit Item	Contents			Economic Benefit (Rs.'000)
1. Farm road	Distance	:	6 km	224,154
	Reduction of cost	:	Rs. 92/ton/6 km	
	Agricultural production	:	2,303,000 ton	
	Farm inputs	:	143,000 ton	
	Consumer goods	:	14,000 ton	
2. Water right	Cropping area	:	10,700 ha	26,237
	Net crop production value	:	Rs. 43,729,000	
3. Domestic water	Additional deep tube well alternatively required (66)			42,754
	Construction cost	:	Rs. 39,600,000	
	Annual O&M cost	:	Rs. 2,640,000	
	Annual charges	:	Rs. 5,264,000	
4. Migration	Share of migrated households (18%)			9,902
	Migration costs (additional costs)			
	Living expenses	:	Rs. 5,213,000	
	Farm expenses	:	Rs. 5,789,000	
	Total	:	Rs. 11,002,000	
5. Environment	Area	Environmental	Residential	44,000
	Factors	Land Price		
		(Average)	(Rs.'000/ha)	
	Project area	6.3	371	
	Gravity area			
	Newly developed	6.6	382	
Developed	14.2	1,932		

8.1.3 Economic Cost

The economic costs for the project, annual O&M and replacement are calculated applying Construction Conversion Factors (CCFs) to those financial costs as follows (Ref. Table 8.1.2) :

Item	Financial Cost (Rs.'000)	Economic Cost (Rs.'000)
1. <u>Project Cost</u>	<u>12,751,706</u>	<u>11,727,250</u>
Construction	10,120,402	9,292,282
Engineering/Administration	1,619,264	1,498,831
Physical contingency	1,012,040	936,137
2. <u>Annual O&M Cost</u>	<u>317,080</u>	<u>266,664</u>
3. Replacement Cost		
Pump	1,080,000	1,042,200
Gate	105,500	91,363
Others	4,655	4,747

8.1.4 Economic Evaluation

Economic evaluation is made through the estimation of (i) Economic Internal Rate of Return (EIRR), (ii) Net Present Value (NPV) and (iii) Benefit-Cost Ratio (B/C) both at the discount rate of 10% as shown in Table 8.1.3. The project benefits on farm road development, water right transfer, domestic water, reduction of migration and environmental improvement are included in the crop production benefit one by one for the evaluation as follows :

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

In order to evaluate soundness of the project against possible adverse changes in the future, sensitivity analysis is made for the following cases :

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

8.2 Financial Evaluation

In order to evaluate the Project from the financial aspect of the farmers, the farm budget analysis on different sizes of farms are made under the representative crop rotation systems in the future (W) project condition. For the assessment of farmers' capacity to pay by the respective farm budget surplus (balance of gross income and expenditure covering non-farm expenditures), water charges and replacement costs for the Project are estimated on the basis of crop water requirement to the total O&M costs from the intake to on-farm level and replacement facilities (pumps are excluded due to their heavy burden to the farmers). The replacement cost will be collected from the farmers according to the crop water requirement and amortized in 25 years by the interest rate of 10 %/year. The assessment results are summarized as follows :

Item	Small (2.31 ha)	Medium (4.70 ha)	Large (18.89 ha)	Average (12.94 ha)
I. Crop Rotation-I (Maize-Fodder-Wheat-Maize-Wheat-Cotton)				
a) Farm Budget Surplus	15,680	39,550	208,040	138,390
b) Water Charge	4,750	9,670	38,870	26,620
c) Replacement Charge	1,370	2,780	11,170	7,650
Share of (b+c) to (a)	(39%)	(31%)	(24%)	(25%)
II. Crop Rotation-II (Wheat-Maize-Oilseeds-Maize-Wheat-Maize)				
a) Farm Budget Surplus	24,580	57,650	280,810	188,240
b) Water Charge	5,250	10,670	42,890	29,380
c) Replacement Charge	1,510	3,070	12,320	8,440
Share of (b+c) to (a)	(28%)	(24%)	(20%)	(20%)
III. Crop Rotation-III (Fodder-Sugarcane-Sugarcane-Maize)				
a) Farm Budget Surplus	11,600	31,320	174,620	115,500
b) Water Charge	8,040	16,360	65,740	45,030
c) Replacement Charge	2,310	4,700	18,890	12,940
Share of (b+c) to (a)	(89%)	(67%)	(48%)	(50%)

Based on the assessment on the future farm budget surplus, water charges and replacement cost, the followings could be clarified :

- 1) Crop rotation-II is most suitable for small scale farmers holding 2.3 ha and the water charges and replacement costs will be within 30% of the future farm budget surplus,
- 2) Crop rotation-I and II are economical for medium scale farmers with 4.7 ha and the water charges and replacement costs will be around 30% of the future farm budget surplus,
- 3) Crop rotation-III including sugarcane production is not economically suitable for any scale of farmers due to the high water consumption of sugarcane compared to its low profitability. Sugarcane production in the Project area could be manageable by the commercialized farming through reduction of crop production costs beside the water charges, and
- 4) Appropriate crop rotation systems according to the scale of farms should be introduced and rational irrigation water allocation not only at the distributary and water course levels but also among the farmers be practiced.

8.3 Social Impact Assessment

(1) Increase in employment opportunity

The project implementation will increase employment opportunity at several phases in the Project area. The increase in cropping area and agricultural productivity will require more farm labor inputs of which annual incremental requirement in the future (W) project condition will be estimated at 7.37 million man-day (additional 24,600 persons' employment as for 300 working days). The project works will accrue construction labor employment of 8.6 million man-day in seven years (1.23 million man-day per year). In addition, increased production will accelerate agro-based industries and marketing activities which will increase employment opportunity.

(2) Improvement of regional transportation

Beside the direct benefit from farm road development, traffic condition outside the Project area will be improved by easy accessibility to D. I. Khan city and other regional markets and prospective road network linked with the project road along the main canal.

(3) Alleviation of income differentials

Income differentials depend upon operating size of farm have been found in the Project area. Crop-based irrigation is introduced into the Development plan so that farmers can select crop rotation freely in view point of farm economy. Farmer will have income uplift according to his scale of operation farm through his original contrivance, under well water management carried out by the Farmers Association in which farmer is not given discriminative treatment to scale of farm size. As the result of this, income differentials will be expected to alleviate.

(4) Increase in land value and enlargement of income disparity

Financial value of farm and residential land will be suddenly increased by the Project implementation. It will increase the value of land assets as a mortgage and the large land owners will have more monetary power in the future. On the contrary, small farmers will be hard to acquire farm lands due to increase in land prices. It is assumed that income disparity between small and large farmers be enlarged. Promotion of agrarian reform, especially the land transfer of absentees to small and tenant farmers, improvement of leasehold tenancy (change from present share tenancy

to fixed rent), increase in non-agricultural year-round employment, etc. will be indispensable for the Project implementation. In order to assure status and rights of tenant and small scale farmers as members of farmer association and to be fully involved in the association's activities, special support services are also important.

8.4 Water Charge

The financial evaluation in para. 8.2 is conducted on condition that beneficiaries bear all expenditure for operation and maintenance and replacement cost in their water charge. According to the result, residual farm budget surplus subtracted such water charge will be 60 ~150 thousand Rs./year (2 thousand Rs./year at present). The amount to be borne by farmers is however rather expensive especially for small scale farmers if taking fluctuation of price agricultural products into account. Subsidy on the O&M expenditure, and on electric charging should be given.

The table below is a result of study on water charge for several subsidizing cases.

Without subsidy:	Water charge covers all expenditures.
Case 1:	Water charge covers expenditures excluding farmers contribution on O&M works.
Case 2:	Subsidy for replacement cost is considered in the water charge of Case 1.
Case 3:	Subsidy for staff salary is furthermore considered in the Case 2.
Case 4:	Reduction of electric charge is given in the Case 3. Electric fee is 50% of the above.

(Unit: Rs.)					
Items	Without subsidy	Case 1	Case 2	Case 3	Case 4
(Crop Rotation-I)					
Farm Budget Surplus	138,390	138,390	138,390	138,390	138,390
O&M Expenditures	26,620	24,630	24,630	19,660	11,770
Replacement Cost	7,650	7,650	0	0	0
Bearing Ratio	24.8%	23.3%	17.8%	14.2%	8.5%
(Crop Rotation-II)					
Farm Budget Surplus	188,240	188,240	188,240	188,240	188,240
O&M Expenditures	29,380	27,180	29,380	21,700	9,590
Replacement Cost	8,440	8,440	0	0	0
Bearing Ratio	20.1%	18.9%	15.6%	11.5%	5.1%
(Crop Rotation-III)					
Farm Budget Surplus	115,500	115,500	115,500	115,500	115,500
O&M Expenditures	45,030	41,660	45,030	33,260	19,910
Replacement Cost	12,940	12,940	0	0	0
Bearing Ratio	50.2%	47.3%	39.0%	28.8%	17.2%
Water Charge (Rs/'000m ³)	594.9	560.3	427.5	341.3	204.3

According to the result above, water charge when replacement cost and staff salary are subsidized, is 57% of the case without subsidy. Furthermore, the parentage becomes 34% if reduction of electric charge is given besides such subsidies.

The final rate of water charge should be decided in consideration with these results and financial situation of nation and province.

CHAPTER IX RECOMMENDATIONS

9.1 Recommendation for Project Implementation

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

- Crop production will greatly increase at about 200,000 tons of wheat, 1,150,000 tons of fodder, 40,000 tons of oilseeds, and 40,000 tons of pulses. This amounts of incremental farm products will highly affect not only crop valance of NWFP but also national economy.
- Since the proposed irrigation command area is very wide as much as 115,600 ha, which is equivalent to about 15 % of the present irrigation area in NWFP, the Project impact will be very large on regional economy and employment situation.
- During the construction stage, a number of new labor forces will be required as much as 1.23 million man-day per annum. This creation of employment opportunity will give great impacts on the regional economy.
- The various social circumstance is expected to be improved through the Project implementation, such as agricultural infrastructure, road network, domestic water supply and farmers' organization.
- The semi-arid rainfed area shall be transformed into the stable irrigated farmland. At the same time, the environment such as vegetation and water resources around the Project area will be improved.

9.2 Recommendation for Preparatory Works

1) Establishment of Chashma Right Bank Development Authority

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

2) Establishment of Water Users' Associations

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

3) Secure of Project Budget

Prior to the commencement of the Project, the Project budget must be prepared securely. The smooth operation of loan management and preparation of necessary local budget is definitely required by each phase of the Project.

4) Preservation of Stable Power Source

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

5) Relationship with Other Projects

The government of NWFP promotes "Development of Rod Kohi Schemes in D.I. Khan" aiming flood control and flood irrigation development. The C.R.B. Lift Irrigation Project will cover the Rod Kohi areas, this Rod Kohi development plan shall need to be greatly revised.

9.3 Recommendation for Detailed Design and Construction

1) Preparation of Topographic Maps for the Project Area

It is necessary to prepare the topographic maps covering the whole Project area at a scale of 1:5,000 prior to the detailed design.

2) Preparation of Cadastral Maps and Inventories

It is recommended to collect the cadastral maps and inventories for the Project area in order to make land acquisition and land reclamation successful.

3) Land Acquisition and Compensation

In parallel to the detailed design, the necessary lands shall be acquired smoothly. Since the land value of the Project area may go up significantly, the land acquisition shall be done in the early phase.

4) Water Accord of the Indus River

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

5) Installation of Power Supply

The electric power supply line to the proposed transformer substation attached to the pump station is required to be installed by Pakistan side prior to the commencement of the construction.

9.4 Recommendation for Maximization of Project Benefits

1) Implementation of Monitoring and Evaluation of the Project

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

2) Establishment of Monitoring System for Salinity

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

3) Survey for Evaluation of Crop-based Irrigation

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

4) Selection of Crop Rotation System

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

5) Financial Support for Operation and Maintenance

Charging all expenditures and replacement cost seems to be considerably high burden especially small scale farmers. It is recommended to subsidize replacement cost, staff salary and electric expenditures through reducing electric charge rate.

TABLES

Table 3.3.1 Cropped Area, Unit Yield and Production in the Study Area

Crops	Irrigated Area			940 ha			27,100 ha			Barami Area			78,600 ha			106,640 ha		
	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)
A. KHARIF SEASON CROPS																		
Sorghum (Jowar)	10	0.79	8	1,310	0.74	969	1,210	0.70	847	2,530	0.72	1,824						
Millet (Bajra)	5	0.78	4	1,010	0.77	778	1,455	0.75	1,091	2,470	0.76	1,873						
Maize	10	0.63	6							10	0.63	6						
Pulses (Mung beans)	5	0.52	3							5	0.52	3						
Sugarcane	30	35.55	1,067							30	35.55	1,067						
Cotton	45	1.54	69	15	1.00	15				60	1.41	84						
Fodder	10	11.86	119							10	11.86	119						
Guara	10	1.90	19	75	1.63	122	145	1.50	218	230	1.56	359						
Vegetables, Fruits, others	5	2.40	12	20	3.00	60				25	2.88	72						
Total Sown Area	130			2,430			2,810			5,370			5,370					
	0.1%			2.3%			2.6%			5.0%			5.0%					
B. RABI SEASON CROPS																		
Wheat	600	2.02	1,212	4,660	0.97	4,520	3,280	0.95	3,116	8,540	1.04	8,848						
Barley	10	0.90	9	240	0.76	182	150	0.75	113	400	0.76	304						
Pulses (Gram)	160	0.64	102	1,970	0.60	1,182	2,290	0.60	1,374	4,420	0.60	2,658						
Oilseeds / Lentil	10	0.54	5	1,380	0.53	731	1,190	0.50	595	2,580	0.52	1,332						
Fodder	60	13.30	798							60	13.30	798						
Vegetables, Fruits, others	10	4.20	42	20	4.20	84				30	4.20	126						
Total Sown Area	850	(880)*		8,270			6,910			16,030			16,030					
	0.8%	0.9%		7.8%			6.5%			15.1%			15.1%					
Annual Sown Area	980	(1,010)*	0.9%	10,700	10.0%		9,720	9.1%		21,400	20.1%		21,400	20.1%				

Source : Revenue Office D. I. Khan, August 1993, Ref: Table E.3.5.1

Note : *); including 30 ha of sugarcane area

Table 3.8.1 Coordination Committees for CRBC Area Development

Name of Committee	Basis of Establishment	Aims/Objectives	Frequency of Meeting
<p>1. Project Supervision and Coordination Committee (PSCC) Chaired by Secretary, Ministry of Water and Power. (Comprise ranking executives of Ministry of Food, Agriculture and Cooperatives, NWFP, WAPDA and other concern agencies)</p>	<p>Agreed upon in the memorandum of understanding, signed by: 1. Authorized Representatives of Asian development Bank 2. Authorized Representatives of WAPDA 3. Authorized Representatives of Govt. of NWFP</p>	<p>1. To ensure the provision of all necessary inputs for the project and project related activities 2. To take up problems that have not been solved by the Project Coordination Committee</p>	<p>Meet as required but not less frequently than quarterly</p>
<p>2. Project Coordination Committee (PCC) Chaired by Additional Chief Secretary NWFP. (Members, ranking executives of concerned Provincial Agencies, Project Director CRBIP, Commissioner D.I.Khan)</p>	<p>-do-</p>	<p>1. To ensure that the activities of various provincial agencies related to Agriculture development are properly coordinated 2. That these activities are carried out complementary to the implementation of the Drainage component 3. To take up problems not solved by PMC</p>	<p>-do-</p>
<p>3. Project Management Committee (PMC) Chaired by Commissioner D.I.Khan Members: 1. Chairman District Council D.I.Khan 2. Deputy Commissioner D.I.Khan 3. Executive Engineer Irrigation D.I.Khan 4. Project Director On Farm Water Management, D.I.Khan 5. Director Agriculture(Extension) D.I.Khan 6. Director Agriculture Research D.I.Khan 7. Deputy Registrar Cooperative Societies D.I.Khan 8. Regional Manager Agriculture Development Bank of Pakistan</p>	<p>PC.1 of the project decision of PCC meeting held on 7/4/1985 in civil secretariat Peshawar</p>	<p>1. To coordinate the implementation of the project component 2. To monitor the progress of physical works as well as expenditure related to these works 3. To report the progress of implementation of various project component and expenditure, on them to see. PCC, CRBC, NWFP, P&D Department on quarterly basis or earlier if directed by PCC. NWFP on the existing progress report forms or on such forms as may be devised later on to meet requirement of ADB 4. To help PCC, NWFP in monitoring and evaluation of the project when ever required. 5. Any other function assigned by PCC, NWFP</p>	<p>-do-</p>
<p>4. District Project Coordination Committee (DPCC) Chaired by Deputy Commissioner, D.I.Khan Members: 1. Project Director On Farm Water Management D.I.Khan 2. Executive Engineer Irrigation D.I.Khan 3. Deputy Director Agriculture(Extension) D.I.Khan 4. Director Agriculture Research D.I.Khan 5. Agriculture Engineer D.I.khan 6. Deputy Registrar Cooperative Societies D.I.Khan 7. Manager Agriculture Development Bank of Pakistan</p>	<p>Agreed upon in the memorandum of understanding, signed by: 1. Authorized Representative ADB 2. Authorized Representative WAPDA 3. Authorized Representative Govt. of NWFP</p>	<p>1. To coordinate project related activities with in the project area 2. To identify and eliminate problems relating to Paharpur project implementations 3. To report progress to the project steering committee at Federal level and in the event a problem exists which cannot be resolved by the project coordination committee the same shall be submitted to the project steering committee for final decision</p>	<p>-do-</p>

Table 5.2.1 Profitability of Crops per ha

Items	Gross Return (Rs.)	Production Cost (Rs.)	Net Return (Rs.)	Score	Labor Requirement		Water Requirement		Score	
					Amount (man-day)	Profit (Rs./man-day)	Amount (m ³)	Profit (Rs./m ³)		
Kharif Season Crops										
Maize	15,120	5,920	9,200	III	40	230.0	III	6,700	1.37	III
Paddy	11,340	7,840	3,500	IV	60	58.3	V	14,300	0.24	V
Pulses (Mung Bean)	19,150	5,900	13,250	II	40	331.3	II	7,100	1.87	III
Cotton	19,850	7,350	12,500	II	55	227.3	III	11,000	1.14	III
Fodder (Millet)	9,000	3,250	5,750	III	30	191.7	IV	5,500	1.05	III
Vegetables (Eggplant)	31,700	10,480	21,220	I	70	303.1	II	6,900	3.08	I
Rabi Season Crops										
Wheat	16,200	7,650	8,550	III	40	213.8	III	7,400	1.16	III
Pulses (Gram)	20,040	6,030	14,010	II	40	350.3	II	5,800	2.42	II
Oilseeds (Rape/ Mustard)	19,000	5,770	13,230	II	50	264.6	III	5,300	2.50	II
Fodder (Berseem)	13,750	5,110	8,640	III	40	216.0	III	5,200	1.66	III
Sugarcane	24,500	11,800	12,700	III	80	158.8	IV	21,200	0.60	IV
Fruits (Mango)	21,580	5,140	16,440	II	135	121.8	III	18,100	0.91	III
Vegetables (Cauliflower)	50,400	12,250	38,150	I	85	448.8	I	4,700	8.12	I
Spring Season Crops										
Maize (seed)	16,200	5,920	10,280	II	40	257.0	III	7,400	1.39	III
Oilseeds (Sunflower)	17,500	4,870	12,630	II	40	315.8	II	6,000	2.11	II

Note : C.I. ; Cropping Intensity, Ref. ; TABLES E.5.2.1 and E.5.6.2

Table 5.2.2 Incremental Crop Production without and with Project

Crops	Without Project 101,800 ha			With Project 115,600 ha			Increment 13,800 ha		
	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)	Sown Area (ha)	Unit Yield (t/ha)	Production (tons)
A. Kharif Season Crop									
Sorghum	2,440	0.72	1,760				-2,440		-1,760
Millet	2,390	0.76	1,810				-2,390		-1,810
Maize	20	0.63	15	23,100	3.5	80,850	23,080	2.87	80,835
Pulses	10	0.52	5	5,800	2.0	11,600	5,790	1.48	11,595
Cotton	60	1.36	80	11,500	2.0	23,000	11,440	0.64	22,920
Fodder	10	11.86	120	11,500	45.0	517,500	11,490	33.14	517,380
Guara	210	1.56	330				-210		-330
Vegetables, others	30	2.80	85	3,000	10.0	30,000	2,970	7.20	29,915
Total Sown Area	5,170			54,900			49,730		
	** (5,200)	5%		** (69,400)	60%		** (64,200)	55%	
B. Rabi Season Crops									
Wheat / Barely	8,500	1.04	8,870	52,000	4.0	208,000	43,500	2.96	199,130
Pulses	4,280	0.60	2,575	11,500	2.5	28,750	7,220	1.90	26,175
Oilseeds	2,400	0.52	1,240	11,500	2.5	28,750	9,100	1.98	27,510
Fodder	60	13.30	800	11,500	55.0	632,500	11,440	41.70	631,700
Sugarcane	30	35.55	1,070	11,500	55.0 *	632,500	11,470	19.45	631,430
Fruits	15	3.00	50	3,000	10.0	30,000	2,985	7.00	29,950
Vegetables, others	15	5.50	80	3,000	15.0	45,000	2,985	9.50	44,920
Total Sown Area	15,300			104,000			88,700		
		15%			90%			75%	
C. Spring Season Crops									
Maize				5,800	3.5	20,300	5,800	3.50	20,300
Oilseeds				5,800	2.5	14,500	5,800	2.50	14,500
Total Sown Area				11,600			11,600		
					10%			10%	
Annual Sown Area	20,470			170,500			150,030		
	*(20,500)	20%		**(185,000)	160%		**(164,500)	140%	

Note : (*) : including 30 ha of sugarcane area. (**) : including 11,500 ha of sugarcane area and 3,000ha of fruits area
 Target unit yield of sugarcane is average of 2 years included ratoon.
 (%): Cropping Intensity

Table 5.3.1 Result of Water Requirement (1 of 4)

Crop No. 1 (Cotton 10 %)

		(Unit : mm/day)																										
Month		May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.					
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
							0.35	0.35	0.37	0.44	0.59	0.78	0.94	1.08	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.10	1.05	0.94	0.83	0.72	
						0.35	0.37	0.44	0.59	0.78	0.94	1.08	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.10	1.05	0.94	0.83	0.72				
				0.35	0.37	0.44	0.59	0.78	0.94	1.08	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.10	1.05	0.94	0.83	0.72					
		0.35	0.37	0.44	0.59	0.78	0.94	1.08	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.10	1.05	0.94	0.83	0.72					
		0.35	0.36	0.39	0.44	0.51	0.58	0.70	0.82	0.94	1.03	1.08	1.11	1.12	1.11	1.08	1.03	0.96	0.93	0.89	0.83	0.78	0.72					
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17				
ET (mm)		6.75	6.75	7.10	7.10	7.10	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57					
Req. (1)		0.39	0.81	1.37	2.07	2.99	3.76	4.55	5.35	5.46	5.98	6.31	5.44	5.45	5.40	3.93	3.76	3.51	1.91	1.46	1.03	0.41	0.19					
Soaking	0.83	0.83	0.76	0.83	0.83	0.83																						
Eff. rain	0.57	0.63	0.42	0.26	0.55	0.51	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24				
Req. (2)	0.03	0.06	0.11	0.19	0.24	0.33	0.24	0.31	0.36	0.37	0.47	0.50	0.46	0.50	0.52	0.39	0.35	0.32	0.19	0.13	0.10	0.02	0.00					

632mm

Crop No. 2 (Pulses 5 %)

		(Unit : mm/day)																					
Month		Jun.			Jul.			Aug.			Sep.			Oct.			Nov.						
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1				
							0.35	0.35	0.37	0.48	0.66	0.87	1.05	1.09	1.10	1.10	1.10	1.06	0.85				
						0.35	0.37	0.48	0.66	0.87	1.05	1.09	1.10	1.10	1.10	1.10	1.06	0.85					
				0.35	0.37	0.48	0.66	0.87	1.05	1.09	1.10	1.10	1.10	1.10	1.10	1.06	0.85						
		0.35	0.37	0.48	0.66	0.87	1.05	1.09	1.10	1.10	1.10	1.10	1.06	0.85									
		0.35	0.36	0.40	0.47	0.55	0.63	0.75	0.88	0.98	1.05	1.08	1.05	1.04	1.03	1.00	0.96	0.85					
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17			
ET (mm)		7.10	7.10	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48					
Req. (1)		0.41	0.85	1.30	2.01	2.96	3.67	4.39	5.10	4.78	5.14	5.30	3.84	3.18	2.51	1.24	0.79	0.35					
Soaking	0.83	0.83	0.83	0.83	0.83	0.83																	
Eff. rain	0.26	0.55	0.51	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05					
Req. (2)	0.03	0.03	0.06	0.04	0.07	0.10	0.09	0.16	0.19	0.20	0.23	0.25	0.19	0.15	0.11	0.06	0.03	0.02					

205mm

Crop No. 3 (Maize 20 %)

		(Unit : mm/day)																					
Month		Jun.			Jul.			Aug.			Sep.			Oct.			Nov.						
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1				
							0.35	0.35	0.37	0.52	0.74	0.95	1.07	1.10	1.10	1.10	1.08	0.85					
						0.35	0.37	0.52	0.74	0.95	1.07	1.10	1.10	1.10	1.10	1.10	1.08	0.85					
				0.35	0.37	0.52	0.74	0.95	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.08	0.85						
		0.35	0.37	0.52	0.74	0.95	1.07	1.10	1.10	1.10	1.10	1.10	1.08	0.85									
		0.35	0.36	0.41	0.50	0.59	0.67	0.79	0.91	1.01	1.07	1.05	1.05	1.03	1.01	0.97	0.85						
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17					
ET (mm)		7.10	7.10	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	4.89	3.66	3.66	3.66	2.48	2.48						
Req. (1)		0.41	0.85	1.34	2.14	3.17	3.89	4.62	5.32	4.94	5.22	5.13	3.19	2.52	1.85	0.80	0.35						
Soaking	0.83	0.83	0.83	0.83	0.83	0.83																	
Eff. rain	0.26	0.55	0.51	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05					
Req. (2)	0.11	0.14	0.23	0.16	0.30	0.44	0.42	0.67	0.81	0.83	0.94	0.98	0.63	0.46	0.32	0.15	0.05						

390mm

Crop No. 4 (Kharif Fodder 10 %)

		(Unit : mm/day)														
Month		Jun.			Jul.			Aug.			Sep.			Oct.		
10 Days		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
							0.79	0.96	0.95	0.95	0.95	0.95	0.77	0.00	0.00	0.00
						0.79	0.96	0.95	0.95	0.95	0.95	0.77	0.00	0.00	0.00	
				0.79	0.96	0.95	0.95	0.95	0.95	0.95	0.77	0.00	0.00	0.00		
				0.79	0.96	0.95	0.95	0.95	0.95	0.95	0.77	0.00	0.00	0.00		
		0.79	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.77	0.00	0.00	0.00			
		0.79	0.88	0.90	0.91	0.92	0.93	0.92	0.91	0.91	0.89	0.86	0.77	0.00	0.00	0.00
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	0.83	0.67	0.50	0.33	0.17	0.00	0.00	0.00
ET (mm)		7.10	7.10	7.10	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	3.66	3.66	3.66	
Req. (1)		0.93	2.07	3.20	3.95	4.98	6.01	5.37	4.42	3.54	2.18	1.40	0.63	0.00	0.00	0.00
Soaking	0.76	0.83	0.83	0.83	0.83	0.83										
Eff. rain	0.42	0.26	0.55	0.51	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.21	0.27
Req. (2)	0.03	0.15	0.24	0.35	0.34	0.43	0.43	0.36	0.32	0.23	0.14	0.09	0.04	0.00	0.00	0.00

321mm

Table 5.3.1 Result of Water Requirement (2 of 4)

Crop No. 5 (Sugarcane 10 %)

(Unit : mm/day)																		
Month	Jan.			Feb.			Mar.			Apr.			May			Jun.		
10 Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	0.72	0.72	0.72	0.70	0.66	0.62	0.58	0.57	0.58	0.58	0.59	0.66	0.73	0.79	0.86	0.92	0.98	1.04
	0.72	0.72	0.72	0.70	0.66	0.62	0.58	0.57	0.58	0.58	0.59	0.66	0.73	0.79	0.86	0.92	0.98	1.04
Area %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ET (mm)	1.92	1.92	1.92	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	6.75	6.75	6.75	7.10	7.10	7.10
Req. (1)	1.38	1.38	1.38	1.76	1.66	1.56	2.14	2.10	2.14	3.08	3.13	3.50	4.93	5.33	5.81	6.53	6.96	7.38
Eff. rain	0.21	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	0.94	0.87	0.51	0.57	0.63	0.42	0.26	0.55	0.51
Req. (2)	0.00	0.11	0.12	0.09	0.14	0.08	0.09	0.09	0.09	0.21	0.23	0.30	0.44	0.47	0.54	0.63	0.64	0.69

Month	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
10 Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	1.07	1.10	1.13	1.15	1.15	1.15	1.15	1.15	1.15	1.14	1.09	1.04	0.99	0.94	0.88	0.83	0.77	
	1.07	1.10	1.13	1.15	1.15	1.15	1.15	1.15	1.15	1.14	1.09	1.04	0.99	0.94	0.88	0.83	0.77	
Area %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ET (mm)	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57
Req. (1)	6.96	7.15	7.35	6.70	6.70	6.70	5.62	5.62	4.21	4.17	3.99	2.58	2.46	2.33	1.38	1.30	1.21	
Eff. rain	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43
Req. (2)	0.56	0.57	0.56	0.49	0.55	0.54	0.48	0.51	0.54	0.42	0.40	0.37	0.25	0.23	0.23	0.12	0.11	0.08

1,229mm

Crop No. 6 (Fruits/Vegetable 5 %)

(Unit : mm/day)																		
Month	Jan.			Feb.			Mar.			Apr.			May			Jun.		
10 Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Area %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ET (mm)	1.92	1.92	1.92	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	6.75	6.75	6.75	7.10	7.10	7.10
Req. (1)	1.44	1.44	1.44	1.89	1.89	1.89	2.77	2.77	2.77	3.98	3.98	3.98	5.06	5.06	5.06	5.33	5.33	5.33
Eff. rain	1.25	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51	0.57	0.63	0.42	0.26	0.55
Req. (2)	0.00	0.06	0.06	0.05	0.07	0.05	0.06	0.10	0.08	0.08	0.15	0.16	0.17	0.22	0.22	0.23	0.25	0.24

Month	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
10 Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Area %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ET (mm)	6.50	6.50	6.50	5.83	5.83	5.83	4.89	4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57
Req. (1)	4.88	4.88	4.88	4.37	4.37	4.37	3.67	3.67	3.67	2.75	2.75	2.75	1.86	1.86	1.86	1.18	1.18	1.18
Eff. rain	1.37	1.47	1.74	1.80	1.25	1.26	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43
Req. (2)	0.18	0.17	0.16	0.13	0.16	0.16	0.14	0.16	0.17	0.13	0.13	0.12	0.09	0.09	0.09	0.05	0.05	0.04

954mm

Crop No. 7 (Wheat 45 %)

(Unit : mm/day)																								
Month	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.			Apr.			May		
10 Days	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
							0.35	0.41	0.57	0.79	0.99	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.07	1.00	0.79	0.56	0.32	0.00
Area %	0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33
ET (mm)	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57	1.92	1.92	1.92	2.52	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	6.75	6.75	6.75
Req. (1)	0.21	0.46	0.55	0.88	1.29	1.09	1.29	1.47	1.97	2.07	2.10	2.76	2.72	2.59	3.46	2.98	2.31	2.37	1.49	0.78	1.44	0.00	0.00	0.00
Soaking	0.83	0.83	0.76	0.83	0.83	0.83																		
Eff. rain	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51	0.57	0.63	0.43
Req. (2)	0.35	0.38	0.43	0.60	0.72	0.93	0.41	0.47	0.47	0.76	0.84	0.71	1.06	0.85	0.84	1.21	0.78	0.49	0.64	0.28	0.12	0.00	0.00	0.00

297mm

Table 5.3.1 Result of Water Requirement (3 of 4)

Crop No. 8 (Oil Seeds 10 %)

		(Unit : mm/day)																									
Month		Sep.			Oct.			Nov.			Dec.			Jan.			Feb.			Mar.			Apr.				
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1		
								0.35	0.35	0.36	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.09	1.06	0.86	0.60
					0.35	0.35	0.36	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.10	1.10	1.10	1.10	1.09	1.06	0.86	0.60	0.60		
						0.35	0.36	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.10	1.10	1.09	1.06	0.86	0.60					
							0.35	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.09	1.06	0.86	0.60							
								0.35	0.35	0.36	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.09	1.06	0.86	0.60				
											0.35	0.35	0.36	0.39	0.45	0.58	0.76	0.90	1.03	1.07	1.10	1.10	1.09	1.06	0.86	0.60	
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17
ET (mm)		4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57	1.92	1.92	1.92	1.92	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	5.31	5.31
Req. (1)		0.29	0.57	0.65	0.88	1.16	1.03	1.19	1.42	1.08	1.25	1.42	1.91	2.02	2.08	2.76	2.75	2.65	3.57	2.90	2.22	2.23	1.29	1.29	1.29	0.53	0.53
Soaking	0.83	0.83	0.83	0.83	0.83	0.76																					
Eff. rain	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51			
Req. (2)	0.00	0.06	0.12	0.14	0.15	0.16	0.10	0.11	0.14	0.09	0.10	0.10	0.16	0.18	0.16	0.23	0.19	0.19	0.28	0.16	0.10	0.13	0.04	0.00			

312mm

Crop No. 9 (Rabi Pulses 10 %)

		(Unit : mm/day)																									
Month		Sep.			Oct.			Nov.			Dec.			Jan.			Feb.			Mar.			Apr.				
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1		
								0.35	0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0.99	0.85	
					0.35	0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0.99	0.85	
						0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	0.99	0.85			
							0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	1.10	1.10	0.99	0.85				
								0.35	0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	0.99	0.85				
											0.35	0.35	0.37	0.42	0.53	0.66	0.80	0.93	1.05	1.08	1.10	1.10	1.10	1.10	0.99	0.85	
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17
ET (mm)		4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57	1.92	1.92	1.92	1.92	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	5.31	5.31
Req. (1)		0.29	0.57	0.65	0.91	1.23	1.11	1.29	1.53	1.15	1.32	1.47	1.94	2.04	2.09	2.76	2.77	2.73	3.84	3.16	2.48	2.60	1.63	1.63	1.63	0.75	0.75
Soaking	0.83	0.83	0.83	0.83	0.83	0.76																					
Eff. rain	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51			
Req. (2)	0.00	0.06	0.12	0.14	0.15	0.17	0.11	0.12	0.15	0.10	0.11	0.10	0.17	0.18	0.16	0.24	0.19	0.20	0.31	0.19	0.13	0.17	0.08	0.02			

337mm

Crop No. 10 (Rabi Fodder 10 %)

		(Unit : mm/day)																								
Month		Sep.			Oct.			Nov.			Dec.			Jan.			Feb.			Mar.			Apr.			
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	
								0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
								0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
						0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
							0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
								0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
											0.76	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Area %		0.17	0.33	0.50	0.67	0.83	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ET (mm)		4.89	4.89	3.66	3.66	3.66	2.48	2.48	2.48	1.57	1.57	1.57	1.92	1.92	1.92	1.92	2.52	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	5.31
Req. (1)		0.62	1.43	1.65	2.23	2.81	2.30	2.38	2.36	1.43	1.18	0.93	0.84	0.54	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soaking	0.83	0.83	0.83	0.83	0.83	0.76																				
Eff. rain	0.81	0.50	0.25	0.05	0.21	0.27	0.05	0.12	0.05	0.18	0.24	0.43	0.27	0.20	0.52	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51		
Req. (2)	0.00	0.10	0.20	0.24	0.29	0.33	0.22	0.23	0.23	0.13	0.09	0.05	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

224mm

Crop No. 11 (Oilseeds 5 %)

		(Unit : mm/day)																						
Month		Feb.			Mar.			Apr.			May			Jun.										
10 Days		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1								
					0.35	0.42	0.66	0.93	1.08	1.10	1.10	1.10	1.10	0.85										
					0.35	0.42	0.66	0.93	1.08	1.10	1.10	1.10	1.10	0.85										
						0.35	0.42	0.66	0.93	1.08	1.10	1.10	1.10	0.85										
							0.35	0.42	0.66	0.93	1.08	1.10	1.10	0.85										
								0.35	0.39	0.48	0.59	0.77	0.94	1.05	1.10	1.04	1.02	0.98	0.85					
Area %		0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50	0.25										
ET (mm)		2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	6.75	6.75	6.75	7.10											
Req. (1)		0.22	0.49	1.32	2.18	2.85	5.00	5.59	5.81	7.00	5.15	3.29	1.51											
Soaking	1.25	1.25	1.56	1.25																				
Eff. rain	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51	0.57	0.63	0.42	0.26											
Req. (2)	0.04	0.03	0.07	0.09	0.05	0.08	0.20	0.24	0.27	0.32	0.23	0.14	0.06											

365mm

Table 5.3.1 Result of Water Requirement (4 of 4)

Crop No. 12 (Spring Maize 5 %)

(Unit : mm/day)													
Month	Feb.			Mar.			Apr.			May			Jun.
10 Days	2	3	1	2	3	1	2	3	1	2	3	1	
				0.36	0.45	0.74	1.01	1.10	1.10	1.10	0.98	0.57	
				0.36	0.45	0.74	1.01	1.10	1.10	1.10	0.98	0.57	
		0.36	0.45	0.74	1.01	1.10	1.10	1.10	0.98	0.57			
	0.36	0.45	0.74	1.01	1.10	1.10	1.10	0.98	0.57				
	0.36	0.41	0.52	0.64	0.83	0.99	1.08	1.07	0.94	0.88	0.78	0.57	
Area %	0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50	0.25	
ET (mm)	2.52	2.52	3.69	3.69	3.69	5.31	5.31	5.31	6.75	6.75	6.75	7.10	
Req. (1)	0.23	0.51	1.43	2.36	3.04	5.24	5.72	5.68	6.33	4.47	2.62	1.01	
Soaking	1.25	1.25	1.56	1.25									
Eff. rain	0.41	0.83	0.71	0.76	1.25	1.22	0.94	0.87	0.51	0.57	0.63	0.42	
Req. (2)	0.04	0.03	0.07	0.10	0.06	0.09	0.22	0.24	0.26	0.29	0.19	0.11	
												0.04	

347mm

Table 5.3.2 Result of Water Requirement: (per 1,000 ha of ordinary land) (1/2)

(Unit : m³/s)

Month	10 Days	Kharif					Rabi					Total	
		Cotton 100ha	Pulses 50ha	Maize 200ha	Fodder 100ha	Sugarcane 100ha	Fruits 50 ha	Wheat 450 ha	Oil Seeds 100ha	Pluses 100ha	Fodder 100 ha		Oilseeds 50ha
Jan.	1					0.022	0.012	0.152	0.033	0.033	0.011		0.264
	2					0.024	0.012	0.168	0.036	0.037	0.007		0.283
	3					0.017	0.009	0.142	0.031	0.031	0.000		0.231
Feb.	1					0.027	0.015	0.211	0.047	0.047	0.000	0.008	0.363
	2					0.017	0.011	0.169	0.038	0.039	0.000	0.006	0.287
	3					0.017	0.012	0.169	0.039	0.040	0.000	0.013	0.303
Mar.	1					0.028	0.020	0.242	0.056	0.061	0.000	0.018	0.444
	2					0.017	0.015	0.155	0.033	0.038	0.000	0.009	0.279
	3					0.018	0.015	0.098	0.020	0.025	0.000	0.016	0.211
Apr.	1					0.043	0.030	0.129	0.026	0.033	0.000	0.041	0.344
	2					0.045	0.031	0.055	0.008	0.015	0.000	0.047	0.251
	3					0.060	0.035	0.024	0.000	0.005	0.000	0.053	0.228
May	1	0.005				0.087	0.045	0.000				0.064	0.259
	2	0.012				0.094	0.044	0.000				0.045	0.233
	3	0.023			0.007	0.107	0.046	0.000				0.029	0.234
Jun.	1	0.039	0.006	0.023	0.030	0.125	0.051					0.012	0.293
	2	0.047	0.007	0.028	0.047	0.128	0.048						0.304
	3	0.066	0.012	0.047	0.070	0.137	0.048						0.380
Jul.	1	0.048	0.008	0.032	0.068	0.111	0.035						0.302
	2	0.061	0.014	0.060	0.087	0.113	0.034						0.369
	3	0.072	0.020	0.088	0.085	0.112	0.031						0.408
Aug.	1	0.073	0.019	0.083	0.071	0.098	0.026						0.370
	2	0.094	0.031	0.134	0.063	0.109	0.031						0.463
	3	0.101	0.038	0.162	0.045	0.109	0.031						0.486
Sep.	1	0.092	0.040	0.165	0.027	0.096	0.029	0.000	0.000	0.000	0.000		0.449
	2	0.099	0.046	0.188	0.018	0.102	0.032	0.012	0.012	0.019	0.019		0.529
	3	0.103	0.050	0.195	0.007	0.107	0.034	0.023	0.023	0.040	0.040		0.583
Oct.	1	0.078	0.038	0.125	0.000	0.083	0.027	0.029	0.029	0.049	0.049		0.527
	2	0.071	0.030	0.092	0.000	0.079	0.025	0.075	0.031	0.057	0.057		0.490
	3	0.065	0.022	0.063	0.000	0.074	0.025	0.086	0.033	0.066	0.066		0.468
Nov.	1	0.037	0.012	0.030		0.050	0.018	0.120	0.019	0.045	0.045		0.353
	2	0.027	0.007	0.009		0.047	0.017	0.143	0.021	0.023	0.045		0.339
	3	0.020	0.003			0.046	0.018	0.186	0.027	0.030	0.046		0.375
Dec.	1	0.005				0.024	0.010	0.082	0.018	0.019	0.025		0.183
	2	0.000				0.021	0.009	0.094	0.020	0.022	0.019		0.185
	3					0.016	0.007	0.093	0.020	0.021	0.010		0.167

Irrigation efficiency of 58% is applied.

Table 5.3.2 Result of Water Requirement: (per 1,000 ha of sandy land) (2/2)

SUMMARY TABLE:		Kharif										Rabi					Total
Month	10 Days	Cotton 100ha	Pulses 50ha	Maize 200ha	Fodder 100ha	Sugarcane 100ha	Fruits 50 ha	Wheat 450 ha	Oil Seeds 100ha	Pulses 100ha	Fodder 100 ha	Oilseeds 50ha	Maize 50ha	Total			
Jan.	1					0.043	0.023	0.295	0.063	0.064	0.022			0.510			
	2					0.046	0.024	0.324	0.070	0.071	0.013			0.548			
	3					0.033	0.018	0.275	0.060	0.061	0.000			0.446			
Feb.	1					0.052	0.029	0.408	0.090	0.091	0.000	0.016	0.016	0.702			
	2					0.032	0.020	0.328	0.074	0.075	0.000	0.012	0.012	0.554			
	3					0.033	0.023	0.326	0.075	0.078	0.000	0.026	0.026	0.586			
Mar.	1					0.053	0.039	0.468	0.109	0.119	0.000	0.035	0.037	0.859			
	2					0.033	0.029	0.300	0.064	0.074	0.000	0.018	0.021	0.539			
	3					0.036	0.030	0.189	0.039	0.049	0.000	0.031	0.035	0.408			
Apr.	1					0.083	0.059	0.249	0.050	0.064	0.000	0.078	0.083	0.665			
	2					0.087	0.060	0.107	0.016	0.029	0.000	0.091	0.094	0.485			
	3					0.116	0.067	0.047	0.001	0.009	0.000	0.102	0.100	0.441			
May	1	0.010				0.168	0.087	0.000				0.124	0.111	0.500			
	2	0.023				0.181	0.086	0.000				0.087	0.074	0.451			
	3	0.044			0.013	0.208	0.090	0.000				0.055	0.042	0.453			
Jun.	1	0.075	0.011	0.044	0.058	0.242	0.098					0.024	0.015	0.566			
	2	0.091	0.013	0.054	0.091	0.247	0.092							0.588			
	3	0.128	0.023	0.090	0.136	0.265	0.093							0.735			
Jul.	1	0.092	0.015	0.062	0.132	0.215	0.068							0.584			
	2	0.119	0.027	0.116	0.168	0.219	0.066							0.714			
	3	0.139	0.038	0.169	0.165	0.216	0.060							0.788			
Aug.	1	0.141	0.036	0.161	0.138	0.189	0.050							0.715			
	2	0.182	0.061	0.260	0.122	0.210	0.060							0.896			
	3	0.195	0.074	0.314	0.088	0.210	0.060							0.940			
Sep.	1	0.178	0.077	0.319	0.053	0.186	0.055		0.000	0.000	0.000			0.869			
	2	0.191	0.090	0.364	0.035	0.198	0.061		0.024	0.024	0.037			1.023			
	3	0.199	0.097	0.377	0.014	0.207	0.066		0.044	0.044	0.078			1.127			
Oct.	1	0.150	0.073	0.242	0.000	0.160	0.052	0.136	0.055	0.055	0.094			1.018			
	2	0.137	0.057	0.178	0.000	0.153	0.049	0.145	0.058	0.059	0.110			0.947			
	3	0.125	0.043	0.122	0.000	0.143	0.048	0.166	0.064	0.066	0.127			0.904			
Nov.	1	0.072	0.023	0.058		0.098	0.035	0.231	0.038	0.041	0.087			0.682			
	2	0.052	0.013	0.018		0.090	0.034	0.276	0.041	0.045	0.087			0.656			
	3	0.038	0.006			0.088	0.035	0.359	0.053	0.057	0.089			0.725			
Dec.	1	0.009				0.046	0.019	0.159	0.035	0.037	0.048			0.353			
	2	0.000				0.041	0.018	0.182	0.039	0.042	0.036			0.358			
	3					0.030	0.014	0.181	0.038	0.040	0.019			0.323			

Unit: m³/s

Irrigation efficiency of 30% is applied.

Table 5.3.3 Total Water Requirement of the Project

Month	10 Days	Ordinary Land	Sandy Land	Total	
				(m ³ /sec)	(MCM)
	1	28.639	3.547	32.186	27.81
Jan.	2	30.771	3.811	34.582	29.88
	3	25.089	3.108	28.197	26.80
	1	39.468	4.888	44.356	38.32
Feb.	2	31.139	3.857	34.995	30.24
	3	32.939	4.080	37.018	25.59
	1	48.286	5.981	54.266	46.89
Mar.	2	30.262	3.748	34.010	29.38
	3	22.924	2.839	25.764	24.49
	1	37.376	4.629	42.006	36.29
Apr.	2	27.230	3.373	30.603	26.44
	3	24.805	3.072	27.877	24.09
	1	28.095	3.480	31.575	27.28
May	2	25.347	3.139	28.487	24.61
	3	25.429	3.150	28.578	27.16
	1	31.819	3.941	35.761	30.90
Jun.	2	33.023	4.090	37.114	32.07
	3	41.278	5.113	46.391	40.08
	1	32.795	4.062	36.857	31.84
Jul.	2	40.114	4.968	45.083	38.95
	3	44.299	5.487	49.786	47.32
	1	40.182	4.977	45.159	39.02
Aug.	2	50.327	6.233	56.561	48.87
	3	52.841	6.545	59.386	56.44
	1	48.809	6.045	54.855	47.39
Sep.	2	57.460	7.117	64.577	55.79
	3	63.328	7.844	71.171	61.49
	1	57.224	7.088	64.312	55.57
Oct.	2	53.205	6.590	59.795	51.66
	3	50.817	6.294	57.111	54.28
	1	38.300	4.744	43.044	37.19
Nov.	2	36.864	4.566	41.429	35.80
	3	40.729	5.045	45.774	39.55
	1	19.844	2.458	22.302	19.27
Dec.	2	20.139	2.494	22.633	19.55
	3	18.147	2.248	20.395	19.38
					1,307.7

Table 5.3.5 Design Discharge at Proposed Cross Drainage Structures

No of Cross Drainage	Name of Crossed River	Q1 (Discharge at upper measured point)	Q2 (Discharge at CRB Canal)	L1 (Dist between points of Q1 and CRB:km)	L2 (Dist between points of Q1 and Lift canal:km)	Catchment Area (km ²)	Pattern of Run-off for Plain area *	q (Discharge from Plain Area: cfs)	Q ² (=Q ² -q)	a (=1/L1.L2(Q ² - Q1))	Q (=Q1exp(-aL2))	Proposed Design Discharge (cfs)	Proposed Design Discharge (cms)
1	Paniala River	-	12,500	-	-	64.5	B	1,685	10,815	0.000	10,815	10,800	306
2	Hauz Khud	52,000	28,000	23.2	11.0	109.3	B	2,856	25,144	0.031	36,975	37,000	1,048
3	Takwara N.	54,600	21,600	68.5	47.6	147.0	B	3,841	17,759	0.016	25,494	23,500	722
4	Gomal diversion	5,000	5,000	-	-	57.6	B	1,505	5,000	0.000	5,000	5,000	142
5	Gomal N.	21,000	18,500	23.0	10.7	97.3	-	-	18,500	0.006	19,691	19,700	558
6	Luni Noath (1)	7,000	7,000	-	-	77.5	-	-	7,000	0.000	7,000	7,000	198
7	Luni Noath (2)	2,500	2,500	-	-	29.8	-	-	2,500	0.000	2,500	2,500	71
8	Luni Noath (3)	5,500	5,500	-	-	82.4	-	-	5,500	0.000	5,500	5,500	156
9	Luni South (1)	32,200	32,200	-	-	117.2	-	-	32,200	0.000	32,200	32,200	912
10	Luni South (2)	24,900	12,200	16.0	6.0	59.6	-	-	12,200	0.045	19,008	19,000	538
11	Tea N.	17,800	17,800	-	-	21.9	B	572	17,228	0.000	17,228	17,200	487
12	Daraban Zam	35,800	35,800	-	-	49.7	B	1,299	34,501	0.000	34,501	34,500	977
13	Chaudwan Zam	60,200	41,200	-	-	99.3	B	2,594	38,606	0.040	43,889	43,900	1,243
14	Khad Waraki	4,850	4,850	11.6	7.9	29.8	A	1,957	2,893	0.000	2,893	2,900	82
15	Kaura Khad	8,820	8,820	-	-	19.9	A	1,307	7,513	0.000	7,513	7,500	212
16	Velheri N.	8,520	5,960	34.0	23.6	64.6	A	1,200	4,760	0.017	5,704	5,700	161
17	Gajistan N.	13,220	15,000	-	-	69.5	A	4,565	10,435	0.000	10,435	10,400	295
18	Sherana N.	14,460	14,460	-	-	34.8	A	2,286	14,460	0.000	14,460	14,500	411
19	Ramak diversion	8,000	2,540	19.2	14.6	24.8	A	1,629	911	0.113	1,540	1,500	42
20	Ramak N.	24,000	19,000	20.4	13.8	59.5	A	3,908	15,092	0.023	17,473	17,500	496

* : Specific discharge of plain area of pattern A, B are applied at 1.86 m³/s/km² and 0.74 m³/s/km², respectively.

Table 5.6.1 Organization of Chashma Right Bank Development Authority

(Implementation Stage)

(Operation & Maintenance Stage)

C.R.B.D.A. MAIN OFFICE

Item	Number of Staff
I. Board Members	4
Chairman (Grade 21/22)	1
Members (Grade 20/21)	
1. Irrigation	1
2. Agriculture	1
3. Socio-Economic Development	1
Advisor	(2)
II. Technical Staff (Grade 17-19)	71
1. Irrigation	
1-1 Superintending engineer	1
1-2 Super intending engineer	1
1-3 Senior engineer	6
2. Agriculture	
2-1 Director, extension	1
2-2 Director, adaptive research and seed develop	1
2-3 Director, marketing and credit	1
2-4 AD, land develop. and water manage.	1
2-5 AD, Extension	1
2-6 AD, Seed	1
2-7 AD, adaptive research	1
2-8 AD, marketing	1
2-9 AD, agricultural credit	1
2-10 Extension advisor	25
2-11 Seed expert	6
2-12 Agronomist	3
2-13 Insecticide expert	1
2-14 Fertilizer expert	1
2-15 Soil expert	1
3. Socio-Economic Development	
3-1 Director, Infrastructure	1
3-2 Land acquisition collector	1
3-3 Senior engineer	2
3-4 Junior engineer	4
4. Finance	
4-1 G.M.finance	1
4-2 Director finance	1
4-3 Director, audit	1
4-4 Accounts officer	2
4-5 Auditor	4
III. Supporting Staff (Grade 1-16)	165
(Secretary, assistant, typist, drivers, etc.)	
Total	240

→
After completion
of construction
work, the organi-
zation will be
sifted.

C.R.B.D.A. MAIN OFFICE

Item	Number of Staff
I. Board Members	4
Chairman (Grade 21/22)	1
Members (Grade 20/21)	
1. Irrigation	1
2. Agriculture	1
3. Socio-Economic Development	1
Advisor	(2)
II. Technical Staff (Grade 17-19)	67
1. Irrigation	
1-1 Superintending engineer	1
1-2 Senior engineer	3
2. Agriculture	
2-1 Director, extension	1
2-2 Director, adaptive research and seed develop	1
2-3 Director, marketing and credit	1
2-4 AD, land develop. and water manage.	1
2-5 AD, Extension	1
2-6 AD, Seed	1
2-7 AD, adaptive research	1
2-8 AD, marketing	1
2-9 AD, agricultural credit	1
2-10 Extension advisor	25
2-11 Seed expert	6
2-12 Agronomist	3
2-13 Insecticide expert	1
2-14 Fertilizer expert	1
2-15 Soil expert	1
3. Socio-Economic Development	
3-1 Director, Infrastructure	1
3-2 Land acquisition collector	1
3-3 Senior engineer	2
3-4 Junior engineer	4
4. Finance	
4-1 G.M.finance	1
4-1 Director finance	1
4-2 Director, audit	1
4-3 Accounts officer	2
4-4 Auditor	4
III. Supporting Staff (Grade 1-16)	139
(Secretary, assistant, typist, drivers, etc.)	
Total	210

INTAKE OPERATION OFFICE

Item	Number of Staff
Officer in charge (Grade 18)	(1/3)
Gauge reader	3
Total	3

PUMP OPERATION OFFICE

Item	Number of Staff
Officer in charge (Grade 18)	(1)
Technical Staff (Grade 17)	
Mechanical engineer	3
Electrical engineer	2
Supporting Staff (Grade 1-16)	
Technical assistant	6
Others	15
Total	26

FEEDER CANAL O&M OFFICE (F-1-2)

Item	Number of Staff
Officer in charge (Grade 18)	(1/3)
Supporting Staff (Grade 1-16)	
Technical assistant	2
Driver	2
Others	4
Total	8

MAIN CANAL O&M OFFICE (M-1-6)

Item	Number of Staff
Officer in charge (Grade 18)	(1/6)
Technical staff (Grade 17)	1/2
Supporting Staff (Grade 1-16)	
Technical assistant	2
Driver	3/2
Others	6
Total	10

DISTRIBUTARY O&M OFFICE (D-1-25)

Item	Number of Staff
Extension advisor	(1)
Supporting Staff (Grade 1-16)	
Technical assistant	2
Driver	1
Others	2
Total	5

Table 6.1.2 Section Properties of Main Canal

Section No.	Design Discharge (m ³ /s)	Roughness Coefficient	Slope (1 :)	Area (m ²)	Wetted Perimeter (m)	Water Depth (m)	Base Width (m)	Velocity (m/s)	Freeboard (m)
1	72	0.016	14,000	70.57	26.21	3.94	12.00	1.02	1.21
2	53	0.016	14,000	55.76	23.23	3.53	10.50	0.95	1.22
3	30	0.016	9,000	30.94	17.37	2.60	8.00	0.97	1.20
4	20	0.016	7,000	20.78	14.22	2.14	6.50	0.96	1.06
5	10	0.016	4,000	10.04	9.87	1.49	4.50	1.00	0.91

Note : Canal Side Slope 1 : 1.5

Table 6.1.3 C.C.A and Discharge of Each Distributary

Disty No.	Name of Disty	G.C.A. (ha)	C.C.A.		Total (ha)	Discharge (m ³ /s)
			Good & Mod (ha)	Margi. (ha)		
D- 1	SAKHI MARDAN	1,930	0	1,700	1,700	1.72
D- 2	UMAR KHAN	2,770	400	2,030	2,430	2.27
D- 3	YARIK (1)	2,740	1,350	1,040	2,390	1.76
D- 4	YARIK (2)	1,480	1,260	0	1,260	0.66
D- 5	RODI KHEL	10,470	9,280	0	9,280	4.87
D- 6	REHMAN DHERI	11,470	10,150	0	10,150	5.33
D- 7	BUDH	2,720	2,410	0	2,410	1.26
D- 8	KOT ISA KHAN	8,090	7,060	0	7,060	3.70
D- 9	POTAH	13,430	11,400	0	11,400	5.98
D-10	SHAHID	3,130	2,380	0	2,380	1.25
D-11	SIKANDAR	3,120	2,660	0	2,660	1.40
D-12	MADDI	15,510	13,620	0	13,620	7.15
D-13	KOT ZAFAR	7,500	6,240	0	6,240	3.27
D-14	SWAN	4,470	3,630	0	3,630	1.90
D-15	GANDI ASHIQ	2,300	1,860	0	1,860	0.98
D-16	MOCHI WAL	6,900	5,910	0	5,910	3.10
D-17	GARAH ISA KHAN	11,000	9,150	0	9,150	4.80
D-18	ALI GARAH	3,010	2,560	0	2,560	1.34
D-19	BABRAN	3,060	2,560	0	2,560	1.34
D-20	GAJISTAN	2,800	2,440	0	2,440	1.28
D-21	KAURI HOT	4,110	3,650	0	3,650	1.92
D-22	SHAH GHARBI	3,760	2,750	500	3,250	1.95
D-23	SHERANNA	1,440	1,180	0	1,180	0.62
D-24	CHIRRI BHUHAR	3,370	2,700	250	2,950	1.67
D-25	JHANGI	4,020	2,040	1,440	3,480	2.53

(Note) C.C.A.(1) : Good & Moderate irrigable land (Ordinary Land)

C.C.A.(2) : Marginal irrigable land (Sandy Land)

Table 6.1.5 Capacity and Size of Regulating Pond in Distributary

Distributary	Capacity			Size (m)*(m)
	Dead (m3)	Effective (m3)	Total (m3)	
D- 1	23,600	148,600	172,200	230*230
D- 2	33,100	206,800	239,900	270*270
D- 3	25,800	162,200	188,000	240*240
D- 4	9,400	61,000	70,400	150*150
D- 5	71,200	439,000	510,200	390*390
D- 6	75,000	462,200	537,200	400*400
D- 7	17,500	111,200	128,700	200*200
D- 8	53,500	331,700	385,200	340*340
D- 9	87,000	535,600	622,600	430*430
D-10	17,500	111,200	128,700	200*200
D-11	19,500	123,100	142,600	210*210
D-12	104,500	641,800	746,300	470*470
D-13	47,200	293,000	340,200	320*320
D-14	28,100	176,500	204,600	250*250
D-15	14,000	89,300	103,300	180*180
D-16	44,200	274,600	318,800	310*310
D-17	67,400	416,300	483,700	380*380
D-18	19,500	123,100	142,600	210*210
D-19	19,500	123,100	142,600	210*210
D-20	17,500	111,200	128,700	200*200
D-21	28,100	176,500	204,600	250*250
D-22	28,100	176,500	204,600	250*250
D-23	9,400	61,000	70,400	150*150
D-24	23,600	148,600	172,200	230*230
D-25	35,700	222,800	258,500	280*280

(*)Size : Length of Top Bank
Side Slope : 1:1.5

Table 7.1.1 Phase Wise Base Construction Cost

Project Cost Component	Project Total			Phase I			Phase II		
	Foreign Currency	Local Currency	Total Cost	Foreign Currency	Local Currency	Total Cost	Foreign Currency	Local Currency	Total Cost
	(1,000 Rs.)	(1,000 Rs.)	(1,000 Rs.)						
I. Direct Construction Cost									
a) Land Acquisition, Compensation & Preliminary (3200ha) (I-Camp. 1,000ha and 72 houses II: 2,200ha and 58 houses)	35,604.8	226,407.2	262,012.0	35,604.8	119,407.2	155,012.0	0.0	107,000.0	107,000.0
b) Feeder Canal (58.6km)	1,479,685.8	808,072.7	2,287,758.4	1,479,685.8	808,072.7	2,287,758.4	0.0	0.0	0.0
c) Pump Station (1 station) (i: Major part of Pump equipment and Delivery Pipe)	1,193,602.8	395,015.2	1,588,618.0	679,383.4	282,032.4	961,415.8	514,219.3	112,982.8	627,202.1
d) Main Canal (113.3km) (i: Sta.6+Sta.32+800 II: Further to the End)	1,084,801.2	1,044,497.6	2,129,298.8	471,888.5	454,356.4	926,245.0	612,912.7	590,141.1	1,203,053.8
e) Distributory Canals (442.6km) (i: D-1 to D-6 II: D-7 to D-25)	413,238.5	402,778.4	816,016.8	97,111.0	94,652.9	191,764.0	316,127.4	308,125.4	624,252.9
f) Regulation Pond (25 nos) (Same as above)	330,307.0	265,176.4	595,483.5	77,622.2	62,316.5	139,938.6	252,684.9	202,860.0	455,544.9
h) Drainage Canals (579.5km) (Same as above)	1,247,968.5	273,147.7	1,521,116.2	293,272.6	64,189.7	357,462.3	954,695.9	208,958.0	1,163,653.9
i) Commercial Roads (32.5km) (Same as above)	11,014.5	7,045.6	18,060.1	2,588.4	1,655.7	4,244.1	8,426.1	5,389.9	13,816.0
j) On-farm Development Cost (32.5km) (Same as above)	346,915.6	292,202.0	639,117.6	81,525.2	68,667.5	150,192.6	265,390.4	223,534.5	488,925.0
k) Sump Well & Domestic Water Supply (L.S.) (Same as above)	10,915.6	9,244.5	20,160.2	2,565.2	2,172.5	4,737.6	8,350.5	7,072.1	15,422.5
l) Other and Miscellaneous Works (L.S.) (Same as above)	97,104.0	145,656.0	242,760.0	38,841.6	58,262.4	97,104.0	58,262.4	87,393.6	145,656.0
Sub-total of Direct Construction Cost	6,251,158.3	3,869,243.3	10,120,401.6	3,260,988.7	2,015,785.8	5,275,874.5	2,991,069.6	1,853,457.5	4,844,527.1
II. Indirect Construction Cost									
a) Consultancy Service Cost(10% to D.Cost)	625,115.8	386,924.3	1,012,040.2	326,008.9	201,578.6	527,587.5	299,107.0	185,345.7	484,452.7
b) Implementation Cost(6% of D. Cost)	375,069.5	232,154.6	607,224.1	195,605.3	120,947.2	316,552.5	179,464.2	111,207.4	290,671.6
Sub-total	1,000,185.3	619,078.9	1,619,264.3	521,614.2	322,525.7	844,139.9	478,571.1	296,553.2	775,124.3
III. Physical Contingency (10%)	625,115.8	386,924.3	1,012,040.2	326,008.9	201,578.6	527,587.5	299,107.0	185,345.7	484,452.7
Total Base Construction Cost	7,876,459.4	4,875,246.6	12,751,706.0	4,107,711.7	2,539,890.2	6,647,601.9	3,768,747.7	2,335,356.4	6,104,104.1
IV. Price Contingency*1	2,281,201.8	1,779,755.1	4,060,956.9	1,148,159.6	905,819.8	2,053,979.4	1,133,042.2	873,935.3	2,006,977.5
V. Interest and Service Charge	218,907.1	134,183.2	353,090.3	87,652.2	52,704.1	140,356.3	131,254.9	81,479.2	212,734.1
GRAND TOTAL COST	10,376,568.4	6,789,184.9	17,165,753.3	5,343,523.5	3,498,414.1	8,841,937.6	5,033,044.8	3,290,770.9	8,323,815.7

Note: *1: with annual escalation of 4.5% for F.C. and 5.5 % for L.C.

Table 7.1.2 Annual Disbursement Schedule

Unit: 1,000 Rs.

Project Cost Component	Project Total Cost			Annual Disbursement Schedule													
	FC	LC	Total Cost	1st(1996)		2nd(1997)		3rd(1998)		4th(1999)		5th(2000)		6th(2001)		7th(2002)	
				FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
I. Direct Cost																	
a) Land Acquisition	35,604.8	226,407.2	262,012.0	35605	20582	0	41165	0	41165	0	41165	0	41165	0	41165	0	0
b) Feeder Canal	1,479,685.8	808,072.7	2,287,758.4	0	0	246614	134679	269358	493229	269358	246614	134679	0	0	0	0	0
c) Pump Station	1,193,602.8	395,015.2	1,588,618.0	0	0	67938	28203	135877	56406	271753	112813	306659	107206	411375	90386		
d) Main Canal	1,084,801.2	1,044,497.6	2,129,298.8														
e) Distributory Canals	413,238.5	402,778.4	816,016.8														
f) Regulation Pond	330,307.0	265,176.4	595,483.5														
g) Drainage Canals	1,247,968.5	273,147.7	1,521,116.2														
h) Farm Roads	11,014.5	7,045.6	18,060.1														
i) On-farm Development	346,915.6	292,202.0	639,117.6														
k) Sump Well	10,915.6	9,244.5	20,160.2														
l) Miscellaneous	97,104.0	145,656.0	242,760.0														
Sub-total	6,251,158.3	3,869,243.3	10,120,401.6	49477	41390	328425	224855	387737	1059557	707124	1706786	1084188	1561968	858589	901262	565361	
II. Indirect Cost																	
a) Consultancy Service	625,115.8	386,924.3	1,012,040.2	131603	81458	82252	50911	98702	164504	101822	65802	40729	49351	30547	32901	20364	
b) Implementation	375,069.5	232,154.6	607,224.1	232296	33165	23796	33165	23796	23796	33165	23796	33165	23796	33165	23796	33165	
Sub-total	1,000,185.3	619,078.9	1,619,264.3	363892	114623	106048	84076	122498	188300	134987	89597	73894	73147	63712	56696	53522	
III. Physical Contingency	625,115.8	386,924.3	1,012,040.2	4948	4139	32842	22485	64298	38774	105956	70712	170679	108419	156197	85859	90197	56536
Base Cost	7,876,459.4	4,875,246.6	12,751,706.0	418323	160152	467315	331416	829773	1353813	912823	1266501	1791311	1008159	1048862	675426		
Price Contingency	2,281,201.8	1,779,755.1	4,060,956.9	38496	18101	65969	57746	159747	333284	280200	479805	646416	458389	442725	361141		
V. Service Charge	218,907.1	134,183.2	353,090.3	2092	801	6520	3259	13005	23923	14687	40528	25584	59319	36957	73520	45375	
TOTAL COST	10,376,568.4	6,789,184.9	17,165,753.3	458911	179054	539804	392422	1007525	1711020	1207711	2602154	1771890	2497046	1503506	1565108	1081942	
VI. Annual O&M	0.0	229,721.6	229,721.6	0	0	0	0	0	0	0	0	0	0	0	0	0	146802
TOTAL	10,376,568.4	7,018,906.5	17,395,474.9	458911	179054	539804	392422	1007525	1711020	1207711	2602154	1805100	2497046	1553215	1565108	1228744	
			FC: Foreign Currency, LC: Local Currency														
			Development Area(ha)	0	0	0	0	0	6,800	0	38,100	80,300	115,600	80,210	115,600	80,210	
			Area Under Irrigation(ha)	0	0	0	0	0	0	0	18,140	27,210	27,210	27,210	27,210	27,210	

Table 8.1.1 Incremental Economic Net Crop Production Value

Items	CCA 115,600 ha	Without Project			With Project			Incremental	
		Cropping Area (ha)	Net Production Value Per ha (Rs./ha) Total (Rs.'000)		Cropping Area (ha)	Net Production Value Per ha (Rs./ha) Total (Rs.'000)		Cropping Area (ha)	N.P. Value (Rs.'000)
Kharif Season Crops									
Sorghum		2,440	2,260	5,520				-2,440	-5,520
Millet		2,390	3,080	7,365				-2,390	-7,365
Maize		20	660	13	23,100	9,991	230,792	23,080	230,779
Pluses		10	2,460	25	5,800	13,040	75,632	5,790	75,607
Cotton		60	15,030	902	11,500	20,181	232,082	11,440	231,180
Fodder		10	640	6	11,500	5,662	65,113	11,490	65,107
Guara		210	4,270	896				-210	-896
Vegetables (Eggplant)		30	3,240	97	3,000	21,050	63,150	2,970	63,053
Sub-total		5,170		14,824	54,900		666,769	49,730	651,944
Rabi Season Crops									
Wheat		8,500	5,380	45,694	52,000	19,967	1,038,284	43,500	992,590
Pulses (Gram)		4,280	4,300	18,422	11,500	13,638	156,837	7,220	138,415
Oilseeds (Rape/Mustard)		2,400	2,970	7,121	11,500	13,009	149,604	9,100	142,482
Sugarcane		30	8,720	262	11,500	16,237	186,726	11,470	186,464
Fodder (Berseem)		60	960	58	11,500	8,428	96,922	11,440	96,864
Fruit (Mango)		15	3,670	55	3,000	15,947	47,841	2,985	47,786
Vegetables		15	6,910	104	3,000	38,075	114,225	2,985	114,121
Sub-total		15,300		71,715	104,000		1,790,438	88,700	1,718,723
Spring Season Crops									
Maize					5,800	11,181	64,850	5,800	64,850
Oilseeds					5,800	12,166	70,563	5,800	70,563
Sub-total					11,600		135,413	11,600	135,413
Kharif Season Crops		5,170		14,824	54,900		666,769	49,730	651,944
Rabi Season Crops		15,300		71,715	104,000		1,790,438	88,700	1,718,723
Spring Season Crops					11,600		135,413	11,600	135,413
Total		20,470		86,540	170,500		2,592,619	150,030	2,506,080
								(Rs./ha)	21,679

Table 8.1.2 Economic Cost Estimate and Annual Disbursement

Project Cost Component	Financial Cost (Rs. 000)	Construction Conversion Factor	Economic Cost (Rs. 000)	Annual Economic Cost Disbursement (Rs. 000)								Total
				1st	2nd	3rd	4th	5th	6th	7th	8th	
I. Direct Cost												
a) Land Acquisition	262,012.0	53.6	140,438.4	30,116.4	22,064.4	22,064.4	22,064.4	22,064.4	22,064.4	22,064.4	0.0	140,438.4
b) Feeder Canal	2,287,758.4	92.8	2,123,039.8	0.0	353,840.0	707,679.9	707,679.9	353,840.0	0.0	0.0	0.0	2,123,039.8
c) Pump Station	1,588,618.0	95.7	1,520,307.4	0.0	92,007.5	184,015.0	368,030.0	396,069.0	480,185.9	0.0	0.0	1,520,307.4
d) Main Canal	2,129,298.8	90.5	1,927,015.4	0.0	0.0	0.0	335,300.7	698,221.9	530,571.6	362,921.2	0.0	1,927,015.4
e) Distributory Canals	816,016.8	90.4	737,679.2	0.0	0.0	0.0	69,341.8	257,450.0	222,779.1	188,108.3	0.0	737,679.2
f) Regulation Pond	595,483.5	91.8	546,653.9	0.0	0.0	0.0	51,385.5	190,782.2	165,089.5	139,396.7	0.0	546,653.9
h) Drainage Canals	1,521,116.2	96.4	1,466,356.0	0.0	0.0	0.0	0.0	454,081.6	563,569.5	448,704.9	0.0	1,466,356.0
i) Farm Roads	18,060.1	92.5	16,705.6	0.0	0.0	0.0	981.5	4,518.9	6,093.4	5,111.8	0.0	16,705.6
j) On-farm Development	639,117.6	90.9	580,957.9	0.0	0.0	0.0	34,131.3	157,149.1	211,904.4	177,773.1	0.0	580,957.9
k) Sump Well	20,160.2	90.7	18,285.3	0.0	0.0	0.0	1,718.8	6,381.6	5,522.2	4,662.7	0.0	18,285.3
l) Miscellaneous	242,760.0	88.5	214,842.6	30,691.8	30,691.8	30,691.8	30,691.8	30,691.8	30,691.8	30,691.8	30,691.8	214,842.6
Sub-total	10,120,401.6	91.8	9,292,231.5	60,808.2	498,603.7	944,451.1	1,621,325.7	2,571,250.5	2,238,471.8	1,357,370.5	0.0	9,292,231.5
II. Indirect Cost												
a) Consultancy Service	1,012,040.2	92.6	937,149.2	197,294.6	123,309.1	147,970.9	246,618.2	98,647.3	73,985.5	49,323.6	0.0	937,149.2
b) Implementation	607,224.1	92.5	561,682.3	245,551.0	52,688.5	52,688.5	52,688.5	52,688.5	52,688.5	52,688.8	0.0	561,682.3
Sub-total	1,619,264.3	92.6	1,498,831.5	442,845.6	175,997.6	200,659.4	299,306.7	151,335.8	126,674.0	102,012.4	0.0	1,498,831.5
III. Physical Contingency												
Base Cost	12,751,706.0		11,727,250.2	512,059.0	725,779.7	1,240,451.6	2,084,050.4	2,980,751.4	2,589,047.3	1,595,110.8	0.0	11,727,250.2
IV. O & M Cost (Full Year)												
	317,080.0	84.1	266,664.3	0.0	0.0	0.0	0.0	27,929.6	41,806.1	123,460.5	0.0	266,664.3
V. Replacement Cost												
a) Pump/Equipment	1,080,000.0	96.5	1,042,200.0	0.0	312,660.0	312,660.0	416,880.0	0.0	0.0	0.0	0.0	1,042,200.0
b) Gate	105,500.0	86.6	91,363.0	12,297.2	12,297.2	36,978.2	14,895.2	14,895.2	0.0	0.0	0.0	91,363.0
c) Others	4,655.0	96.1	4,473.5	602.1	602.1	1,810.6	729.3	729.4	0.0	0.0	0.0	4,473.5

Table 8.1.3 Economic Cost and Benefit Stream for Economic Evaluation

(Unit: Rs.000)

No. of Year	Cost			Production Area Developed (ha)	Built-up Ratio	Benefit					
	Const-ru-ction	O&M	Replac-ment			Total	Crop Production Area(A)	Benefit Area(B)	Benefit (INR/ha)		
									Area(C)	Area(D)	Total
1	512,059	0	0	512,059	0	0	0	0	0		
2	725,780	0	0	725,780	0	0	0	0	0		
3	1,240,452	0	0	1,240,452	0	0	0	0	0		
4	2,084,050	0	0	2,084,050	0	0	0	0	0		
5	2,980,751	27,930	0	3,008,681	18,140 (A)	0.50	196,629	0	0	196,629	
6	2,589,047	41,806	0	2,630,853	9,070 (B)	0.65	255,617	98,314	0	353,931	
7	1,595,111	123,461	0	1,718,572	53,000 (C)	0.75	294,943	127,809	574,494	997,246	
8	0	266,664	0	266,664	35,390 (D)	0.85	334,269	147,471	746,842	1,612,192	
9	0	266,664	0	266,664	0	0.90	353,931	167,134	861,740	498,693	1,881,498
10	0	266,664	0	266,664	0	0.95	373,594	176,966	976,639	575,415	2,102,614
11	0	266,664	0	266,664	0	1.00	393,257	186,797	1,034,088	652,137	2,266,279
12	0	266,664	0	266,664	0	393,257	196,629	1,091,538	690,498	2,371,922	
13	0	266,664	0	266,664	0	393,257	196,629	1,148,987	728,859	2,467,732	
14	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
15	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
16	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
17	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
18	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
19	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
20	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
21	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
22	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
23	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
24	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
25	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
26	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
27	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
28	0	266,664	12,899	279,563	0	393,257	196,629	1,148,987	767,220	2,506,993	
29	0	266,664	325,559	592,123	0	393,257	196,629	1,148,987	767,220	2,506,993	
30	0	266,664	351,449	618,113	0	393,257	196,629	1,148,987	767,220	2,506,993	
31	0	266,664	432,505	699,169	0	393,257	196,629	1,148,987	767,220	2,506,993	
32	0	266,664	15,625	282,289	0	393,257	196,629	1,148,987	767,220	2,506,993	
33	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
34	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
35	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
36	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
37	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
38	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
39	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
40	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
41	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
42	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
43	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
44	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
45	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
46	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
47	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
48	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
49	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	
50	0	266,664	0	266,664	0	393,257	196,629	1,148,987	767,220	2,506,993	

No. Year	Benefit					Total	Crop Production	+ Road Development	Balance With			All Item
	Road Development	Water Right Transfer	Domestic Water Supply	Reduction/Seasonal Migration	Environment				+ Water Right Transfer	+ Domestic Water Supply	+ Reduction/Seasonal Migration	
1	0	0	0	0	0	0	-512,059	-512,059	-512,059	-512,059	-512,059	-512,059
2	0	0	0	0	0	0	-725,780	-725,780	-725,780	-725,780	-725,780	-725,780
3	0	0	0	0	0	0	-1,240,452	-1,240,452	-1,240,452	-1,240,452	-1,240,452	-1,240,452
4	0	0	0	0	0	0	-2,084,050	-2,084,050	-2,084,050	-2,084,050	-2,084,050	-2,084,050
5	18,582	2,059	3,544	821	3,648	225,283	-2,084,050	-2,084,050	-2,084,050	-2,084,050	-2,084,050	-2,084,050
6	32,149	3,705	6,132	1,420	6,311	403,648	-2,216,921	-2,216,921	-2,216,921	-2,216,921	-2,216,921	-2,216,921
7	89,197	10,440	17,013	3,940	17,509	1,135,345	-731,326	-632,129	-632,129	-632,129	-632,129	-632,129
8	144,200	16,878	27,504	6,370	28,306	1,835,458	1,345,528	1,489,728	1,506,606	1,534,110	1,540,480	1,568,786
9	168,288	19,098	32,098	7,434	33,034	2,142,050	1,614,834	1,783,122	1,802,820	1,834,918	1,842,352	1,875,386
10	188,065	22,013	35,871	8,308	36,916	2,393,787	1,835,950	2,024,015	2,046,028	2,081,899	2,090,207	2,127,123
11	202,704	23,726	38,663	8,954	39,790	2,580,116	1,999,615	2,202,319	2,226,045	2,264,708	2,273,662	2,313,452
12	212,153	24,832	40,465	9,372	41,644	2,700,388	2,105,258	2,317,411	2,342,243	2,382,708	2,392,080	2,433,724
13	220,723	25,835	42,100	9,750	43,326	2,809,466	2,201,068	2,421,791	2,447,626	2,489,726	2,499,476	2,542,802
14	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
15	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
16	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
17	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
18	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
19	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
20	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
21	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
22	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
23	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
24	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
25	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
26	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
27	224,154	26,237	42,754	9,902	44,000	2,853,140	2,239,429	2,463,583	2,489,820	2,532,574	2,542,476	2,586,476
28	224,154	26,237	42,754	9,902	44,000	2,853,140	2,226,530	2,450,684	2,476,921	2,519,675	2,529,577	2,573,577
29	224,154	26,237	42,754	9,902	44,000	2,853,140	1,913,870	2,138,024	2,164,261	2,207,015	2,216,917	2,260,917
30	224,154	26,237	42,754	9,902	44,000	2,853,140	1,887,980	2,112,134	2,138,371	2,181,125	2,191,027	2,235,027
31	224,154	26,237	42,754	9,902	44,000	2,853,140	1,866,924	2,031,078	2,057,315	2,100,069	2,109,971	2,153,971
32	224,154	26,237	42,754	9,902	44,000	2,853,140	1,847,868	2,011,922	2,037,559	2,080,513	2,090,415	2,134,415
33	224,154	26,237	42,754	9,902	44,000	2,853,140	1,829,812	1,992,866	2,018,502	2,061,054	2,070,956	2,114,956
34	224,154	26,237	42,754	9,902	44,000	2,853,140	1,812,756	1,974,810	1,997,046	2,039,106	2,049,008	2,093,508
35	224,154	26,237	42,754	9,902	44,000	2,853,140	1,796,700	1,956,754	1,979,090	2,019,150	2,029,052	2,073,552
36	224,154	26,237	42,754	9,902	44,000	2,853,140	1,780,644	1,938,698	1,961,034	1,999,194	2,009,150	2,053,650
37	224,154	26,237	42,754	9,902	44,000	2,853,140	1,764,588	1,920,642	1,942,978	1,981,138	1,991,200	2,035,700
38	224,154	26,237	42,754	9,902	44,000	2,853,140	1,748,532	1,902,586	1,924,922	1,963,082		

FIGURES

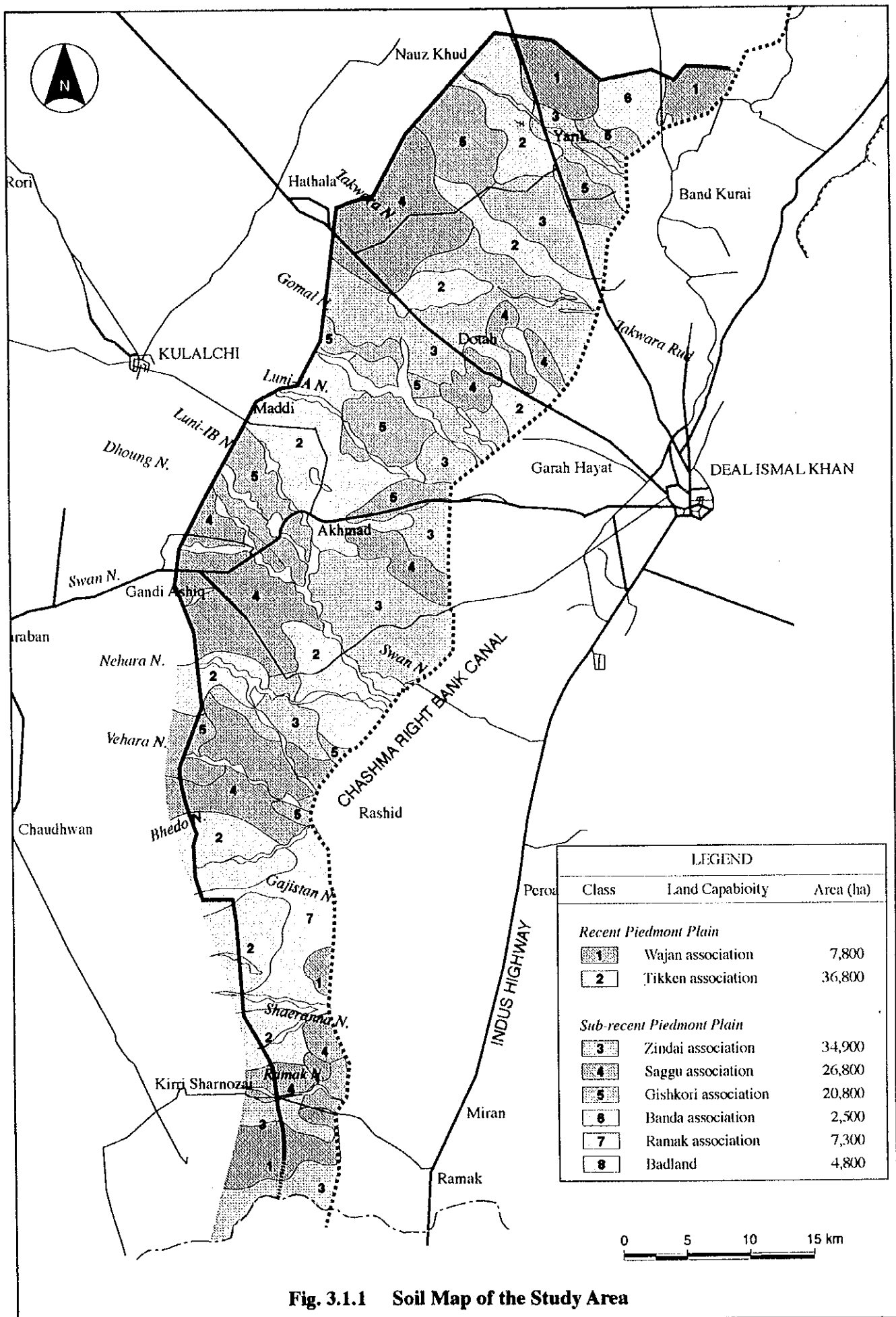


Fig. 3.1.1 Soil Map of the Study Area

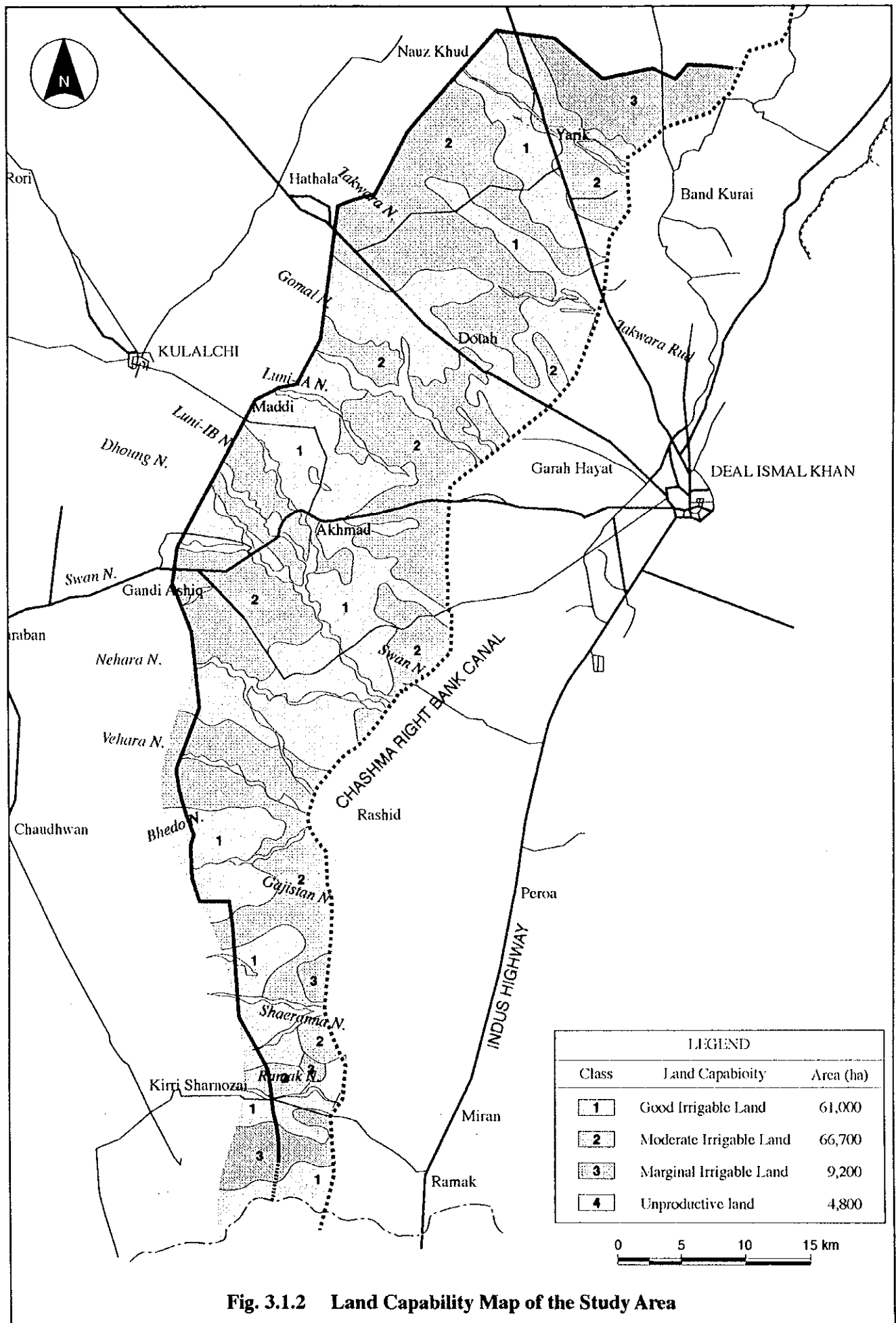


Fig. 3.1.2 Land Capability Map of the Study Area

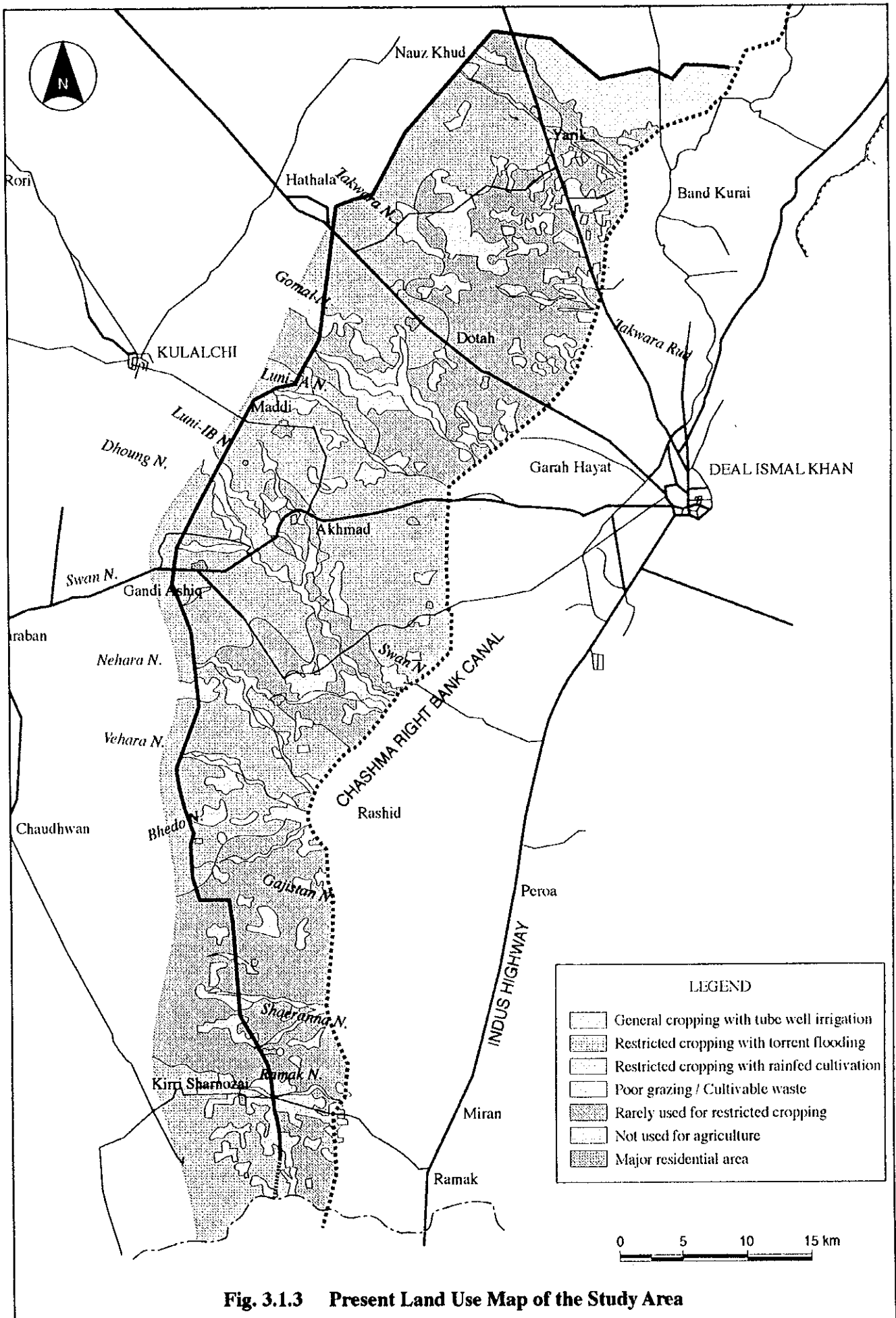
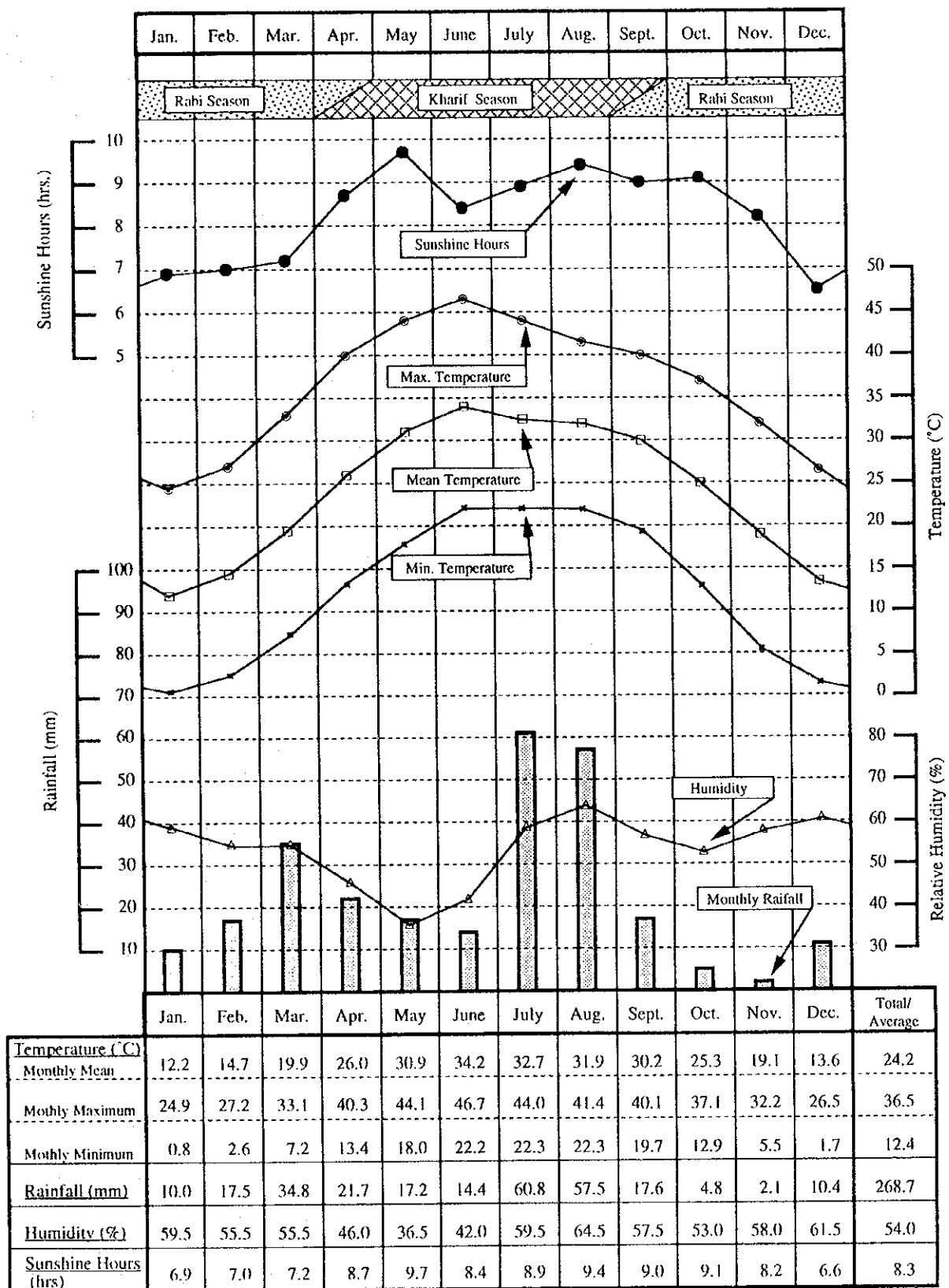


Fig. 3.1.3 Present Land Use Map of the Study Area



Source : D.I. Khan Meteorological Station, 30 years average from 1961 to 1990

Fig. 3.3.1 Meteorological Data in the Study Area

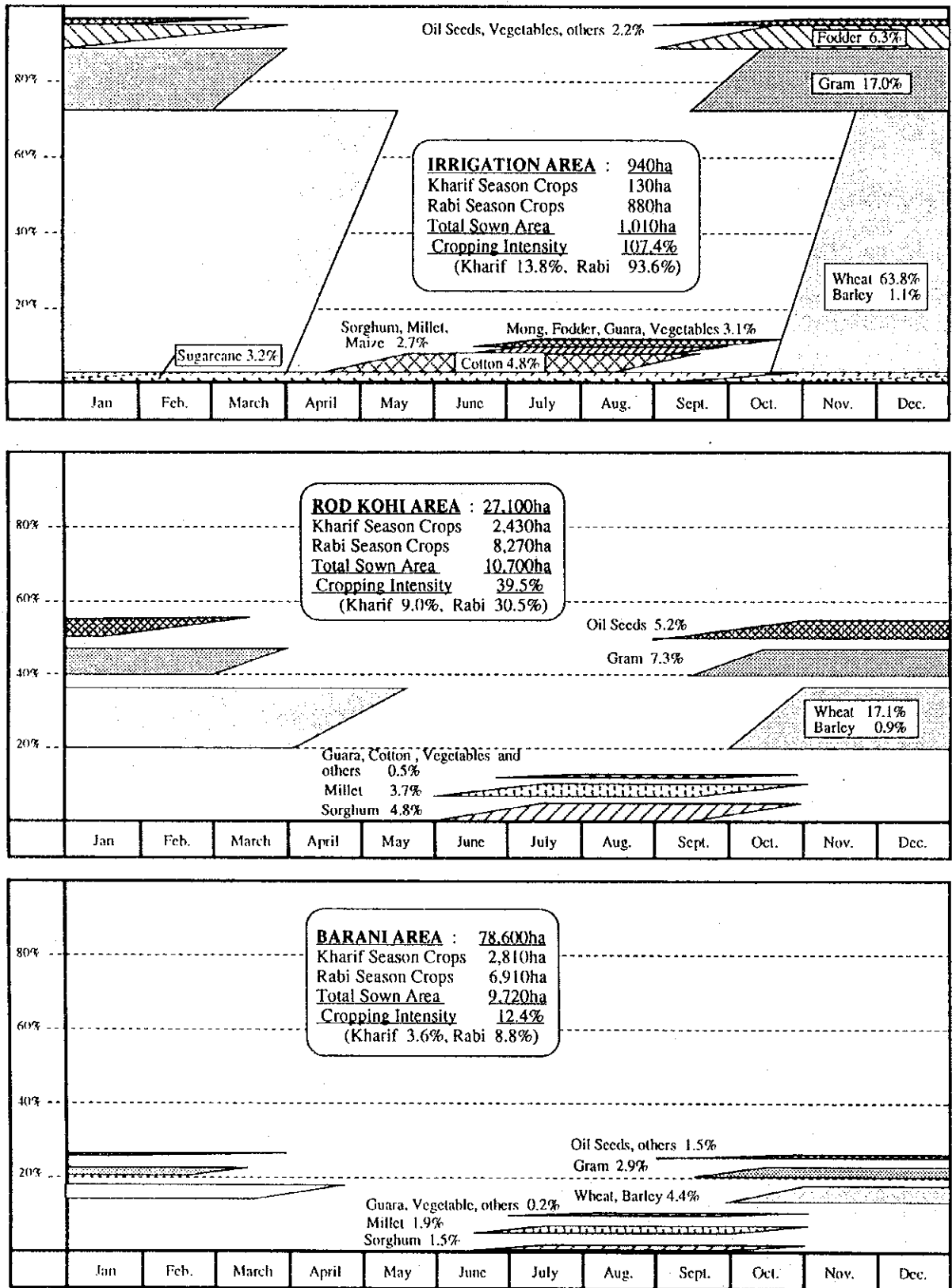
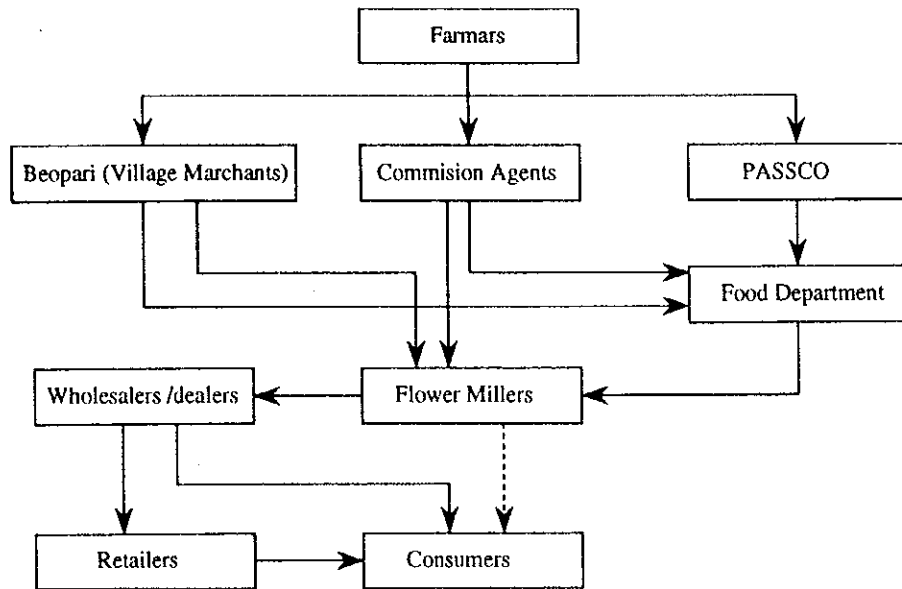
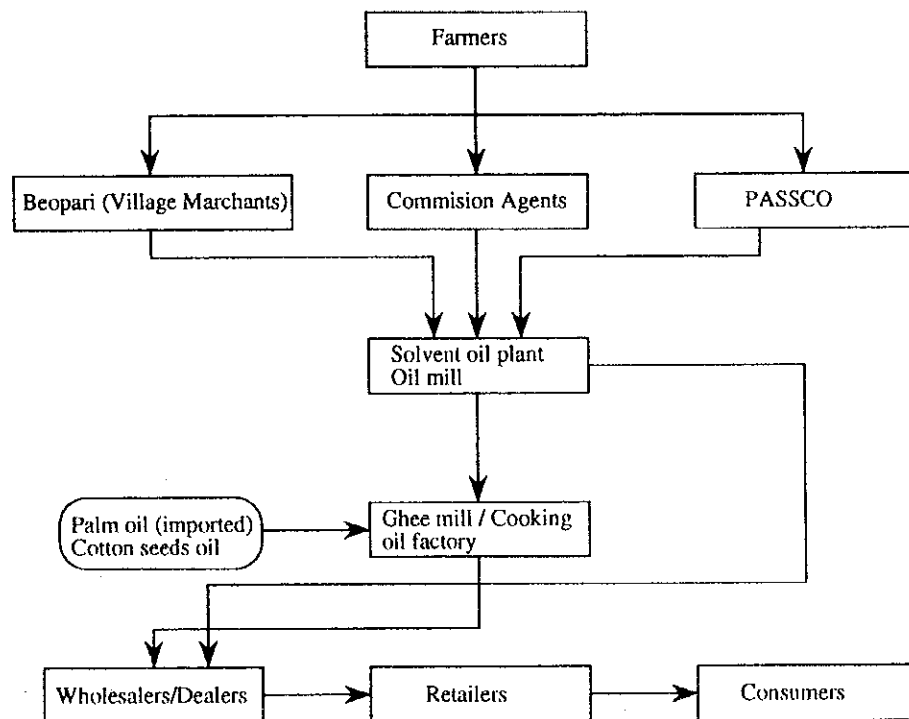


Fig. 3.3.2 Present Cropping Patterns in the Study Area



(a) Marketing Flow of Wheat

- (1) 58% and 64% of wheat production are marketed from farms in Study Area and CRBC area, respectively.
- (2) 65% and 94% of wheat marketed are through Beopari in Study Area and CRBC area, respectively.
- (3) Procurement is conducted through PASSCO by the Food Department in D.I. Khan.



(b) Marketing Flow of Oil seeds (Sunflower)

Fig. 3.3.3 Marketing Flow of Wheat and Oil Seeds (Sunflower)

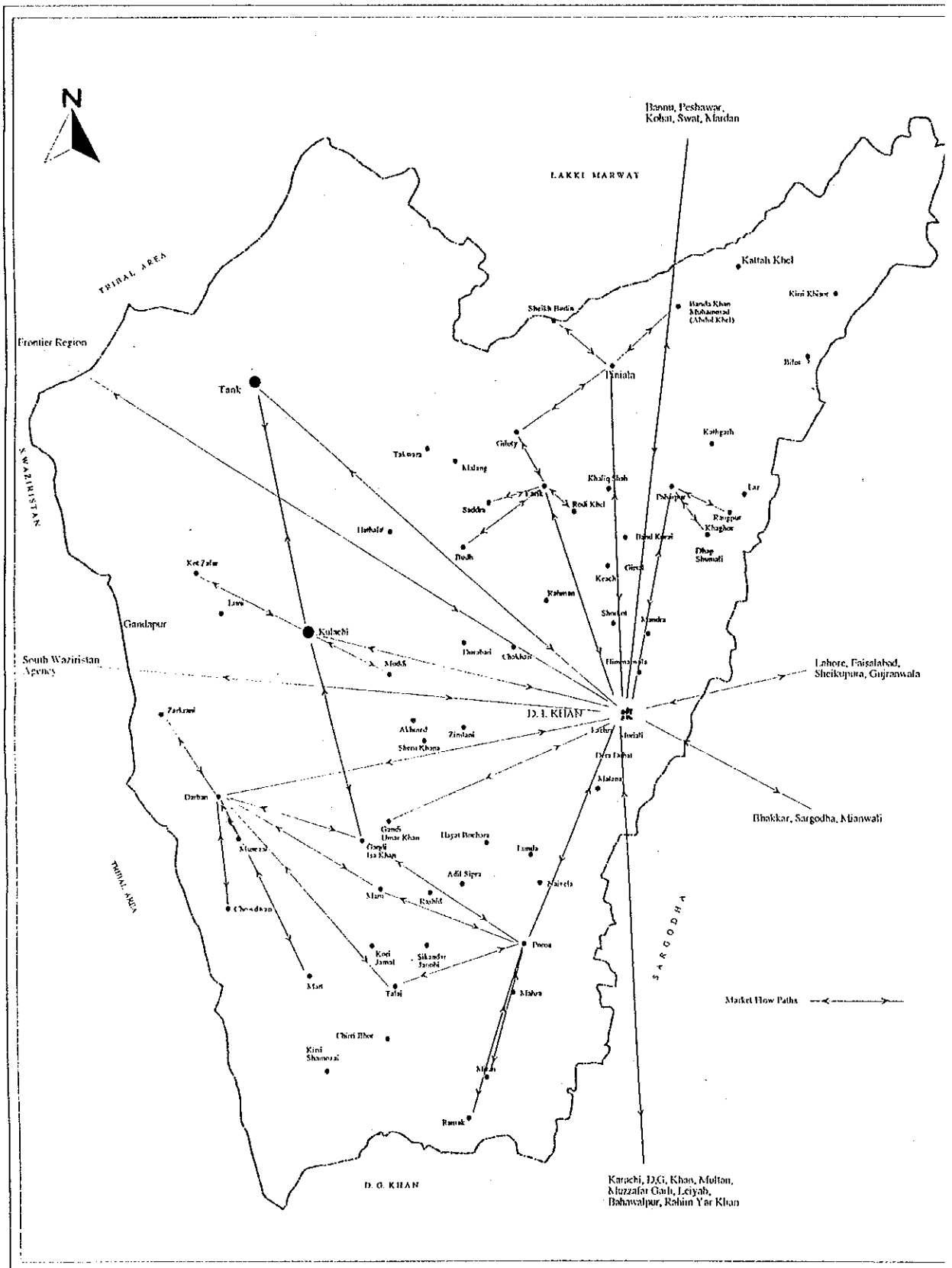
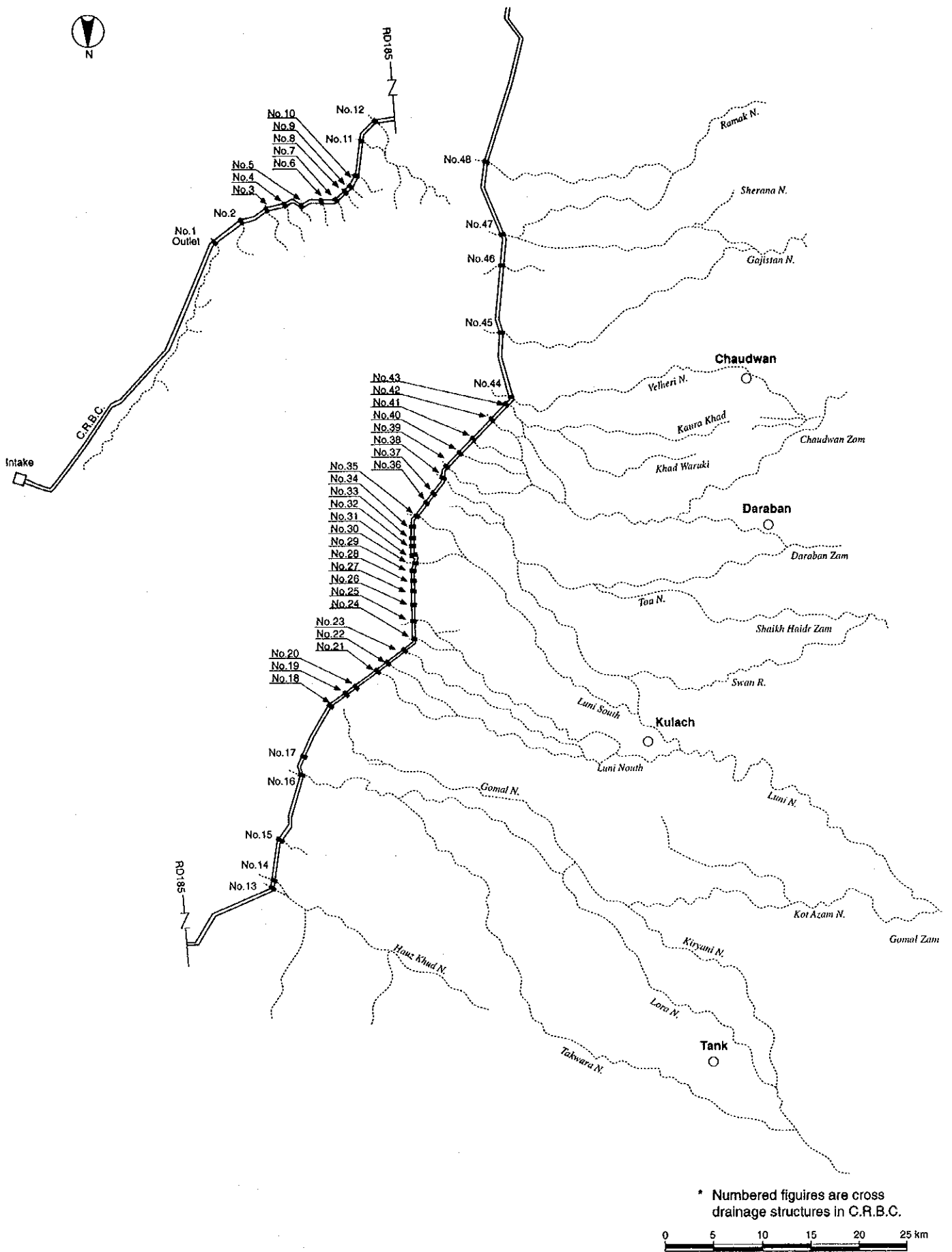


Fig. 3.3.4 Marketing Flow Paths in D.I. Khan



* Numbered figures are cross drainage structures in C.R.B.C.

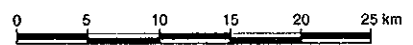


Fig. 3.4.1 Present River System
F - 11

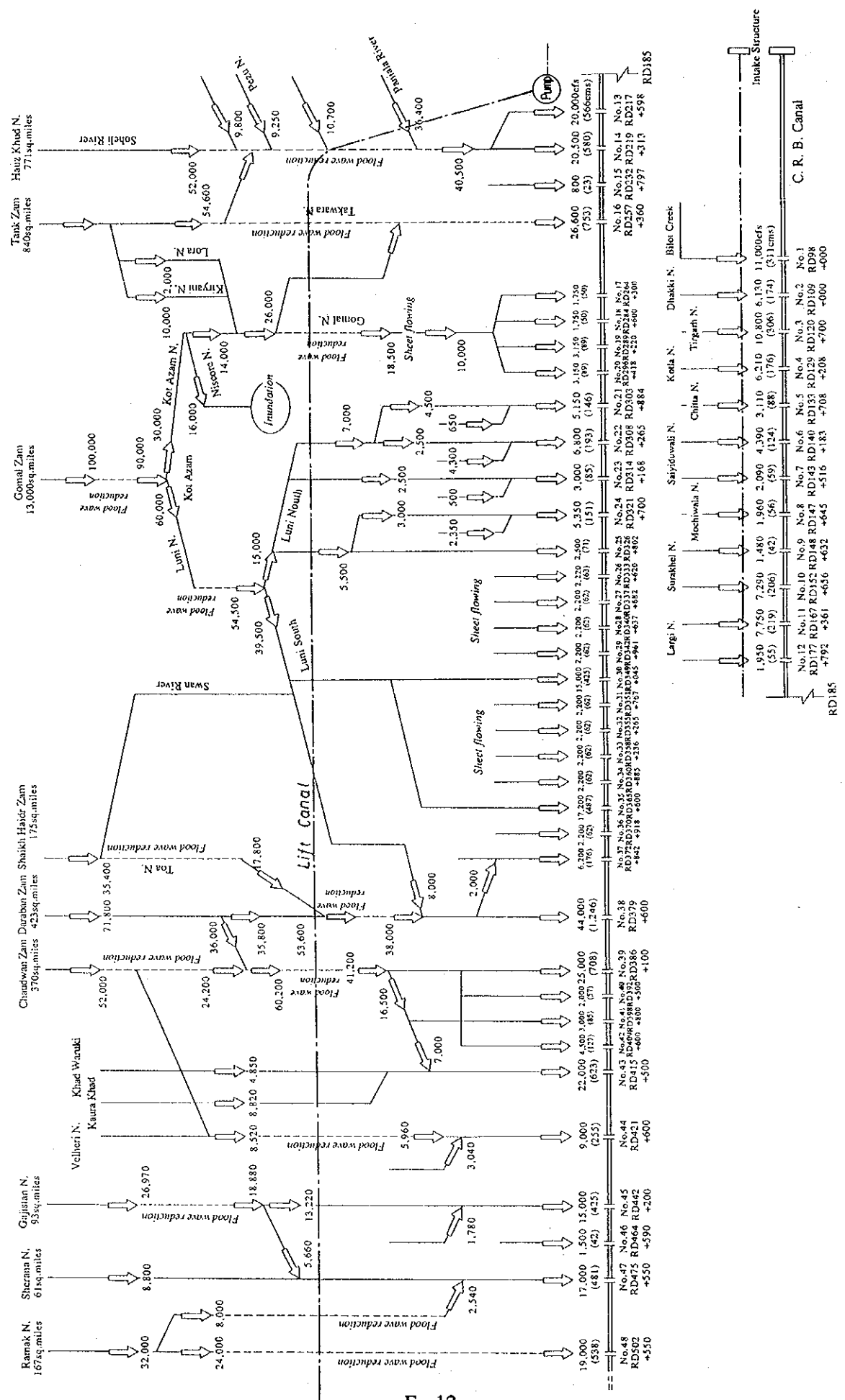


Fig. 3.4.2 Schematic Diagram of Present River System

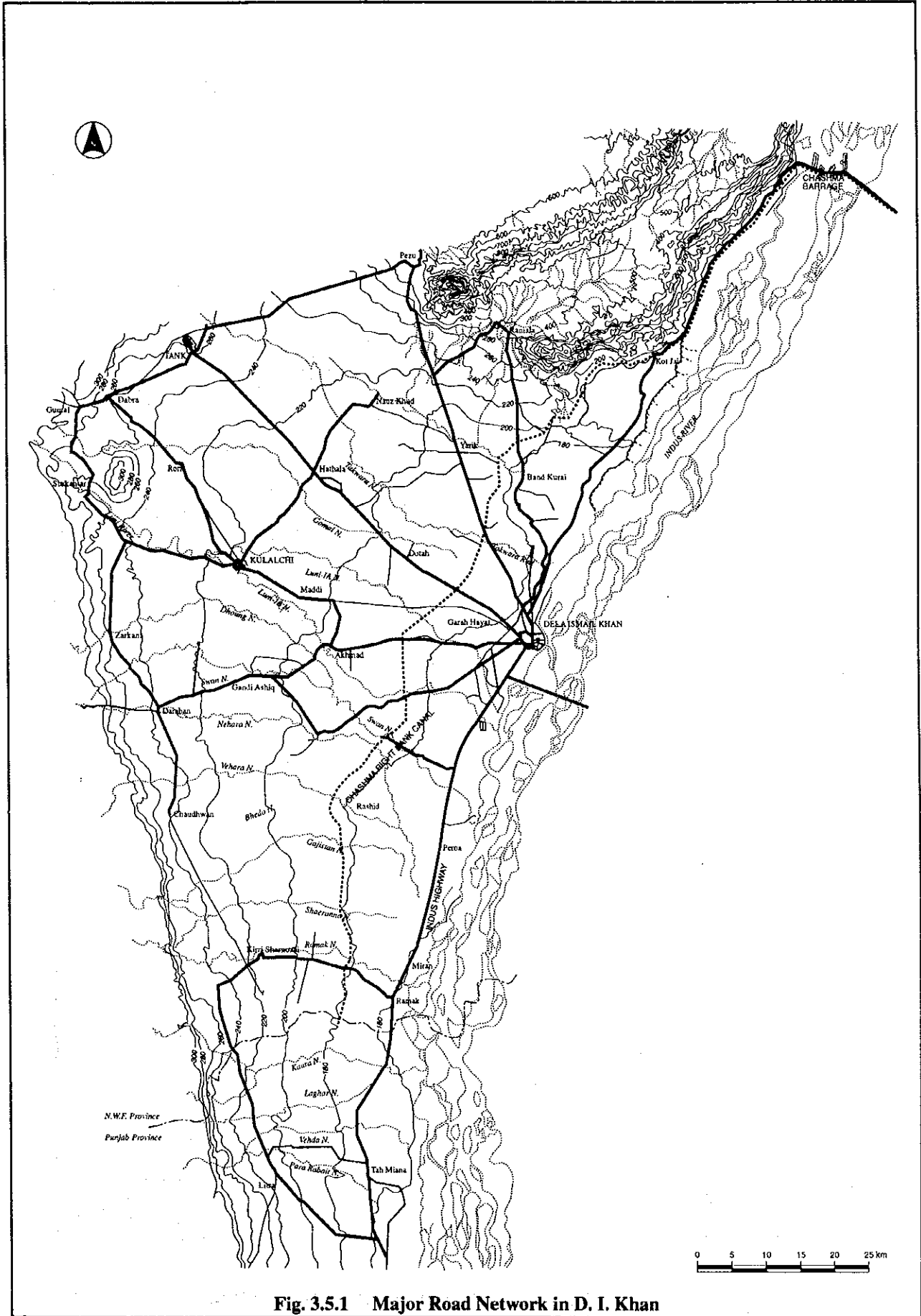


Fig. 3.5.1 Major Road Network in D. I. Khan

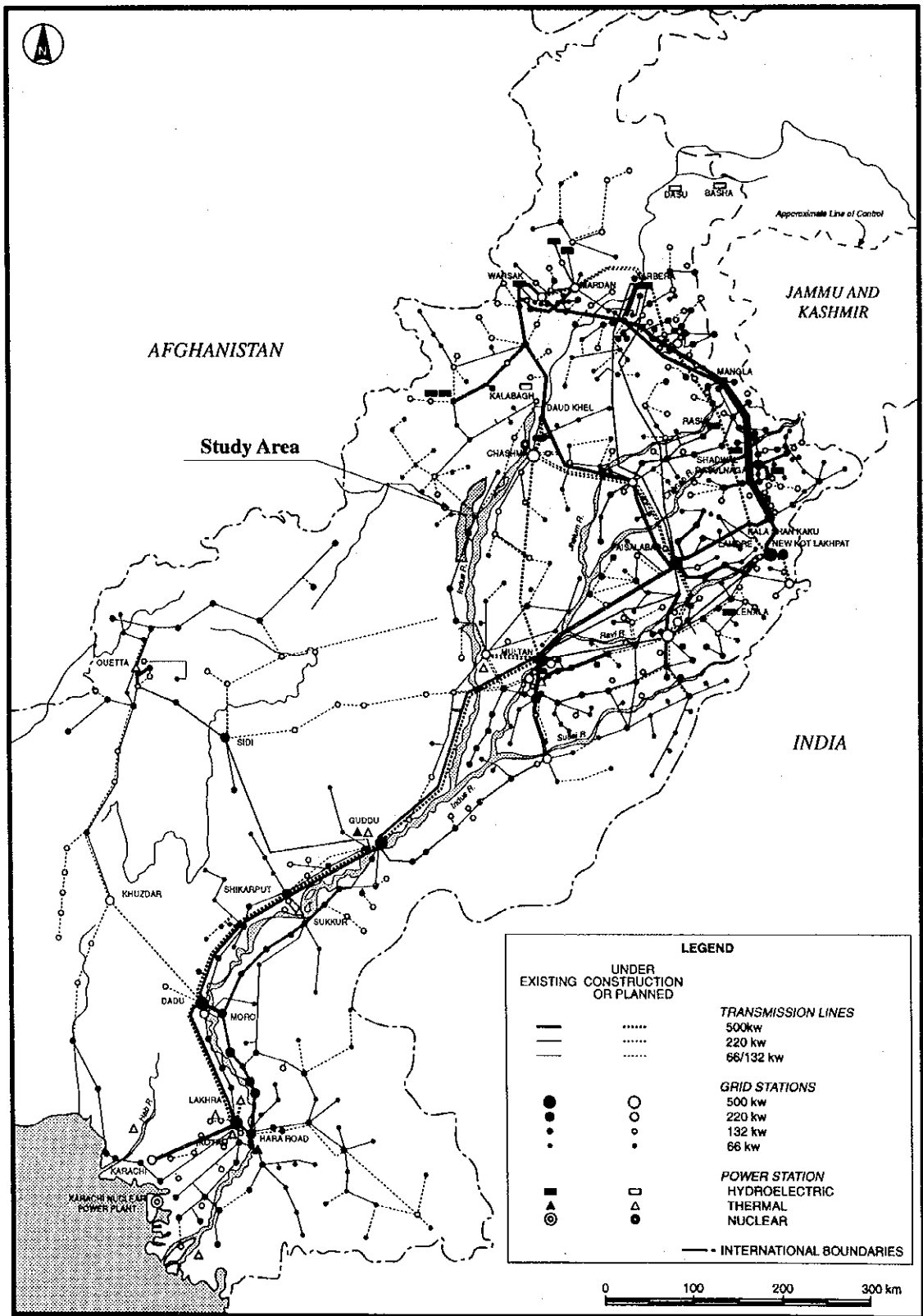


Fig. 3.5.2 National Grid of Power Transmission Line

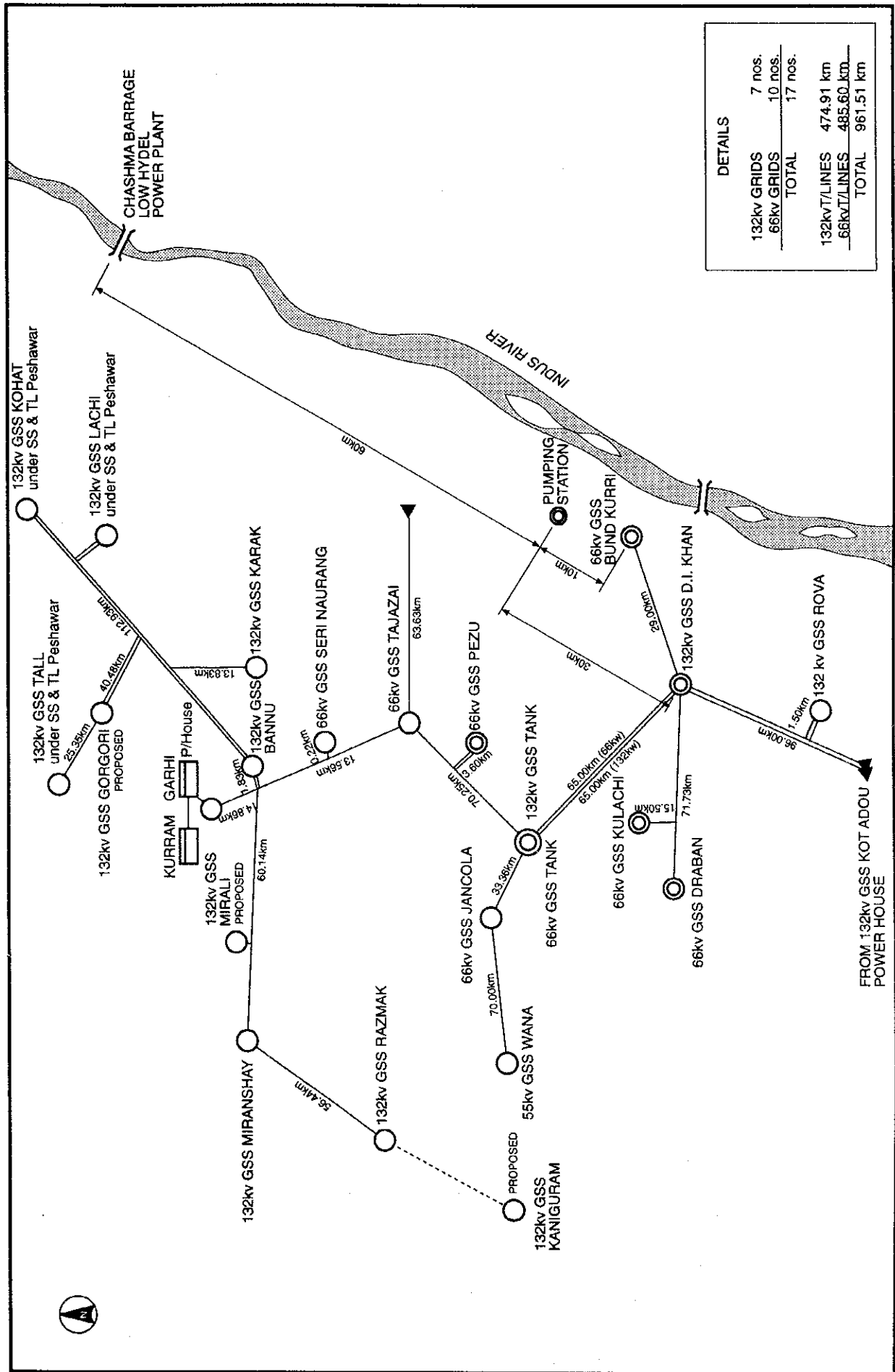
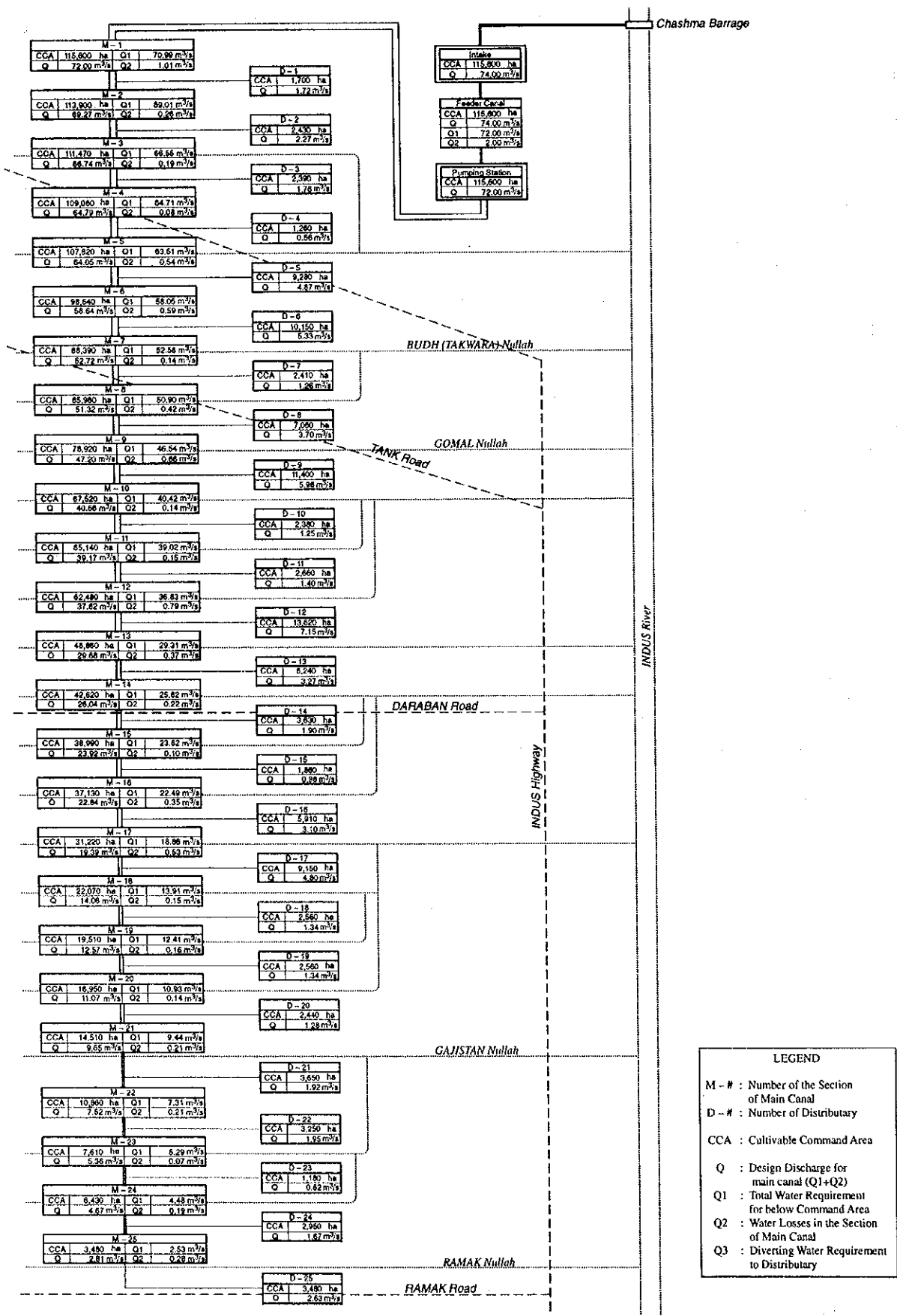


Fig.3.5.3 Geographical Map of SS & TL Division WAPDA Bannu



LEGEND

M - # : Number of the Section of Main Canal

D - # : Number of Distributary

CCA : Cultivable Command Area

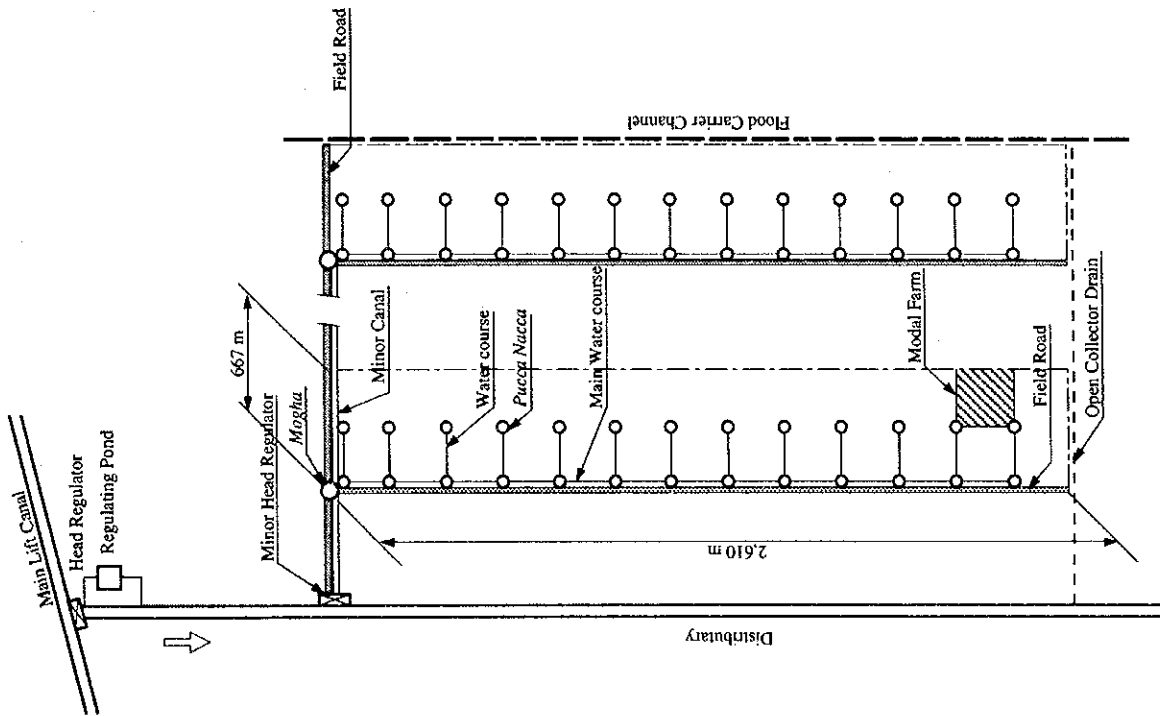
Q : Design Discharge for main canal (Q1+Q2)

Q1 : Total Water Requirement for below Command Area

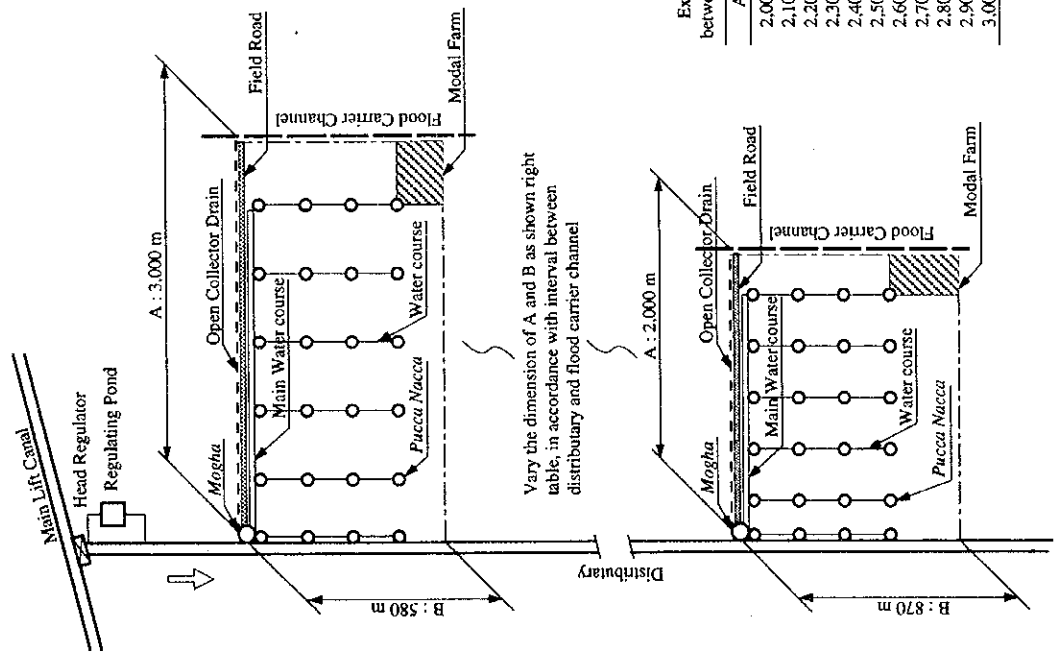
Q2 : Water Losses in the Section of Main Canal

Q3 : Diverting Water Requirement to Distributary

Fig. 5.3.4 Irrigation Diagram



MTW System Type



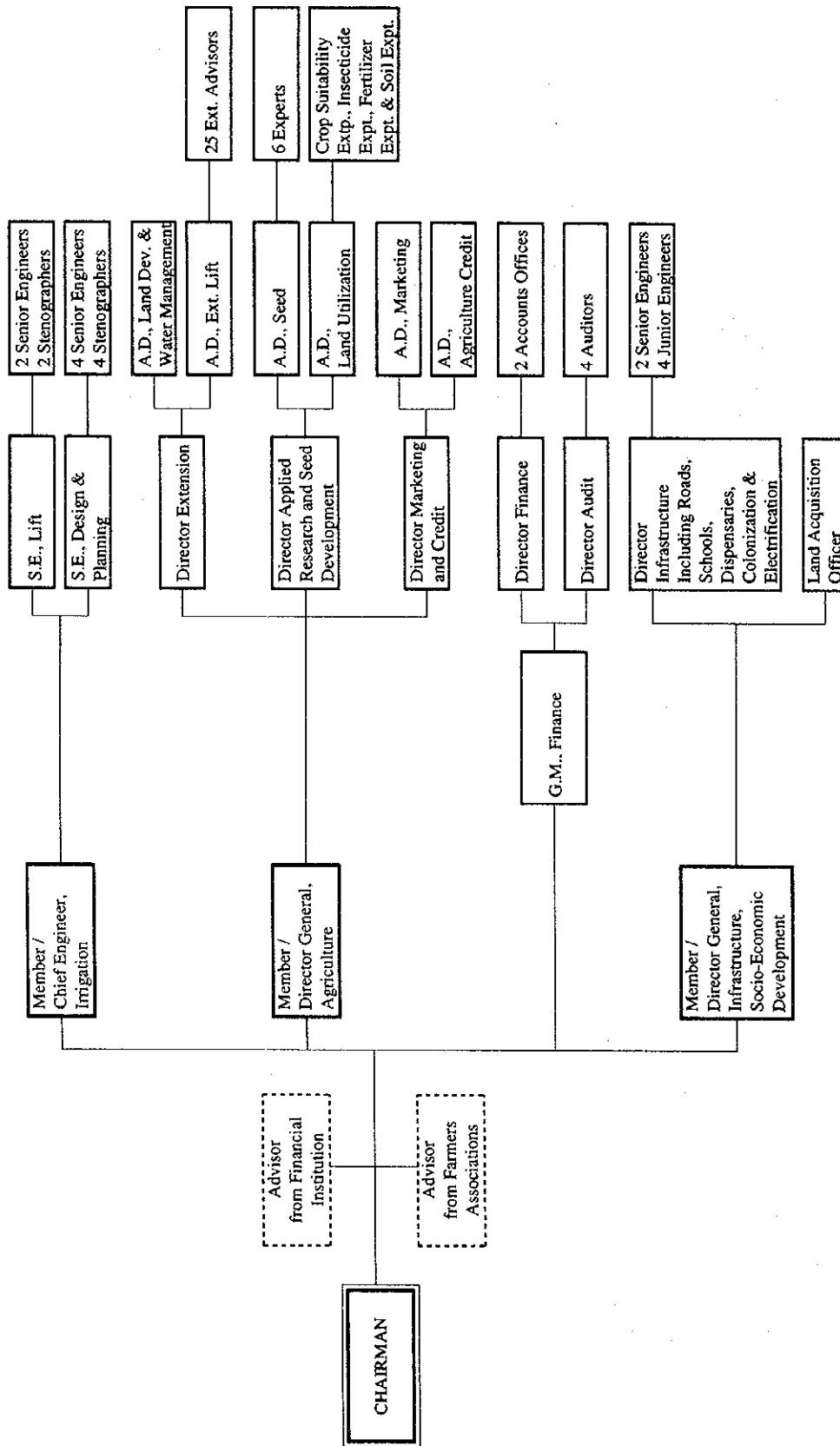
Vary the dimension of A and B as shown right table, in accordance with interval between distributary and flood carrier channel

Exemplified Table between length A and B

A	B
2,000 m	870 m
2,100	830
2,200	790
2,300	760
2,400	730
2,500	700
2,600	670
2,700	640
2,800	620
2,900	600
3,000	580

DTW System Type

Fig. 5.3.5 Typical Layout of Command Area Development System



Note: 1. Extension Advisors should be located in the field at the rate of one Advisor for each Distributary, 10 Advisor should be recruited each year and give specialized training with foreign exposure. They will be the key functionaries and coordinate between the farmers and authority. They will help the farmers in demand based irrigation system, lay out of water courses, preparation of check band and extension work.
 2. The construction staff should be gradually reduced as the canal goes to completion. Operational staff should simultaneously be increased for future operation.
 3. In the joint project with Punjab, the gravity canal may continue to remain with WAFDA. However, its Distribution System may be taken over by the Authority.
 4. During construction stage the design and construction supervision should be done by the consultants. The Authority will provide top supervision only.

Fig. 5.6.2 Organization of Chashma Right Bank Development Authority (Tentative)

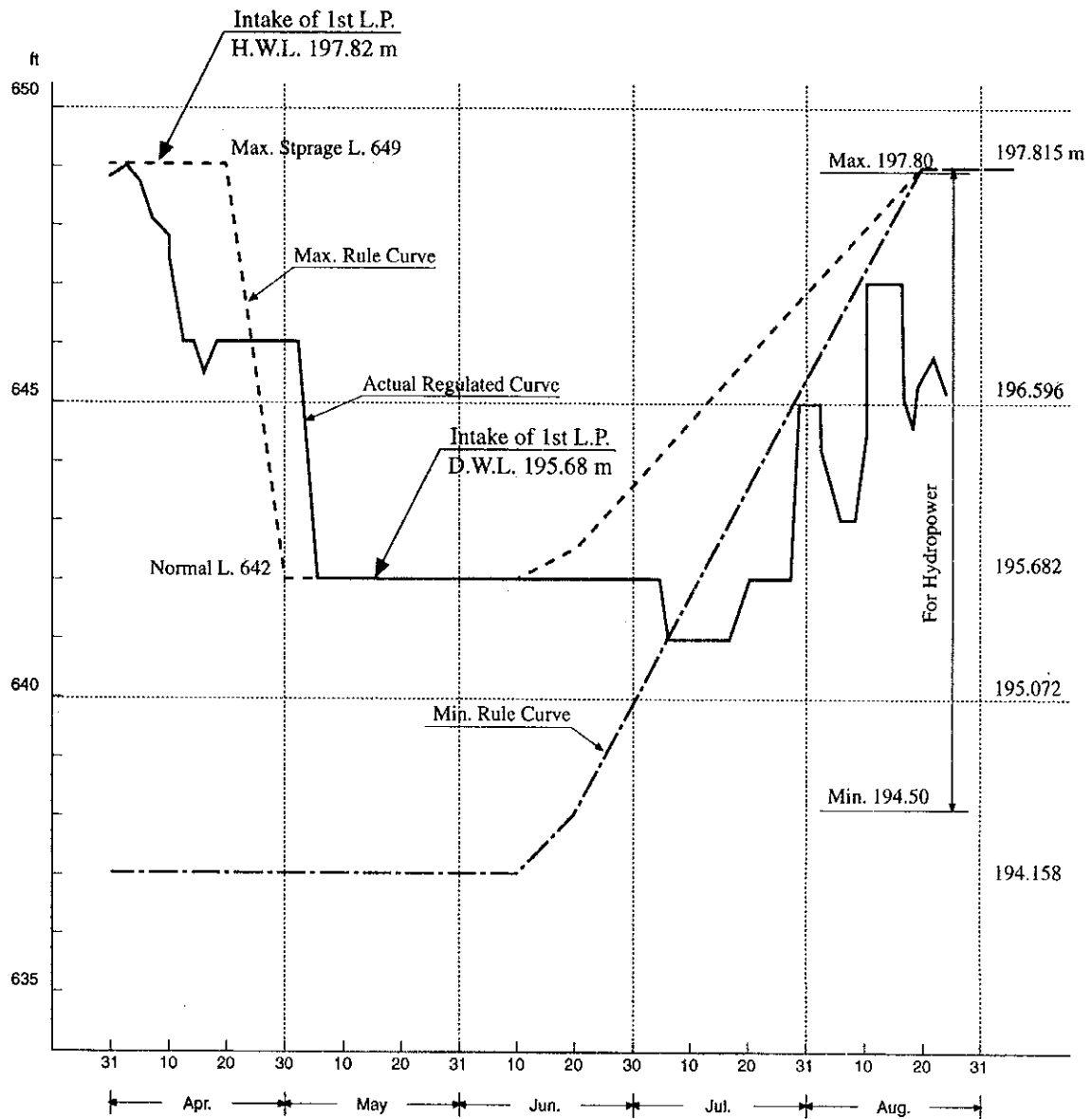


Fig. 6.1.1 Water Level of Chashma Pond

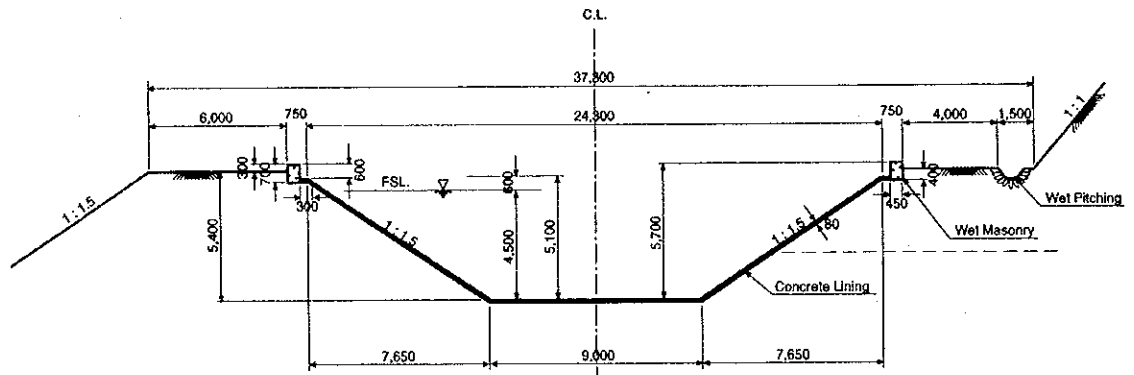


Fig. 6.1.2 Typical Cross-section of Feeder Canal

DIMENSION (Unit: mm)

	SECTION OF CANAL				
	1	2	3	4	5
B	12,000	10,500	8,000	6,500	4,500
D	3,940	3,530	2,600	2,140	1,490
Fb	1,200	1,200	1,200	1,050	900

B : BED WIDTH
D : WATER DEPTH
Fb : FREE BOARD

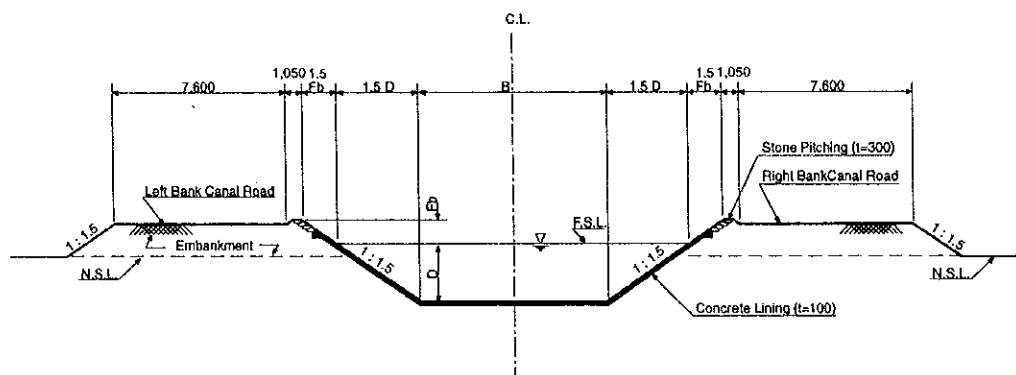
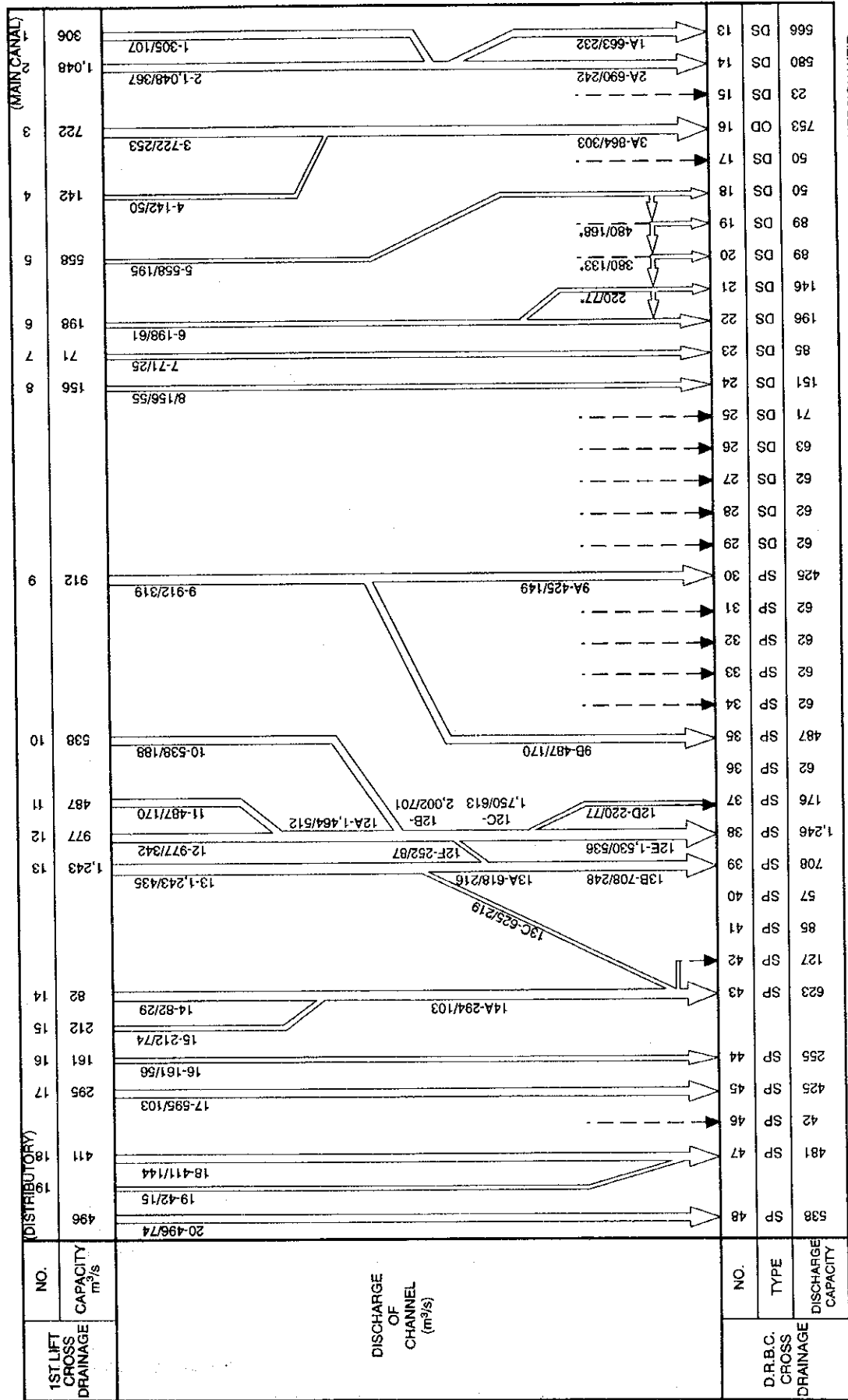


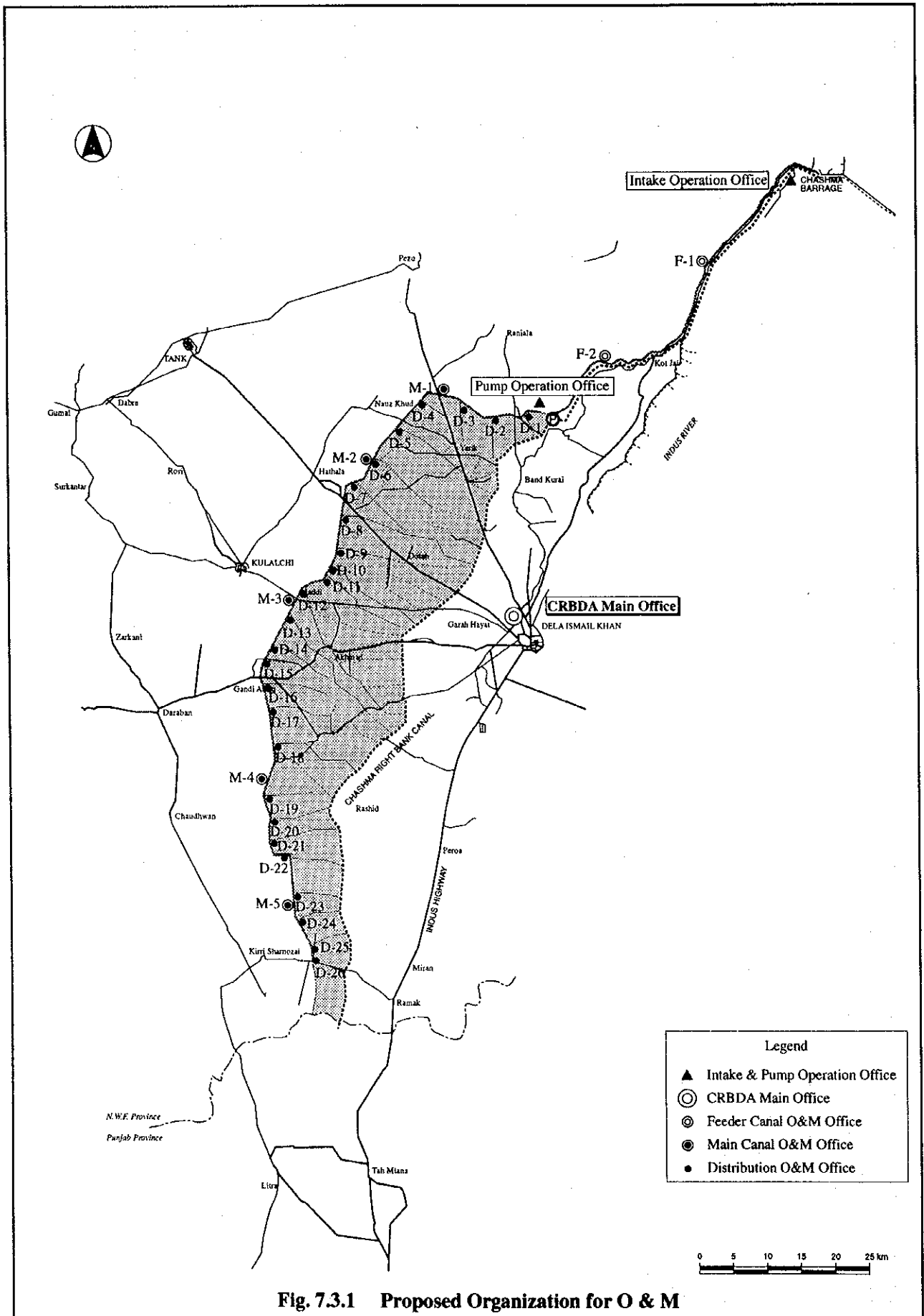
Fig. 6.1.3 Typical Cross-section of Main Canal

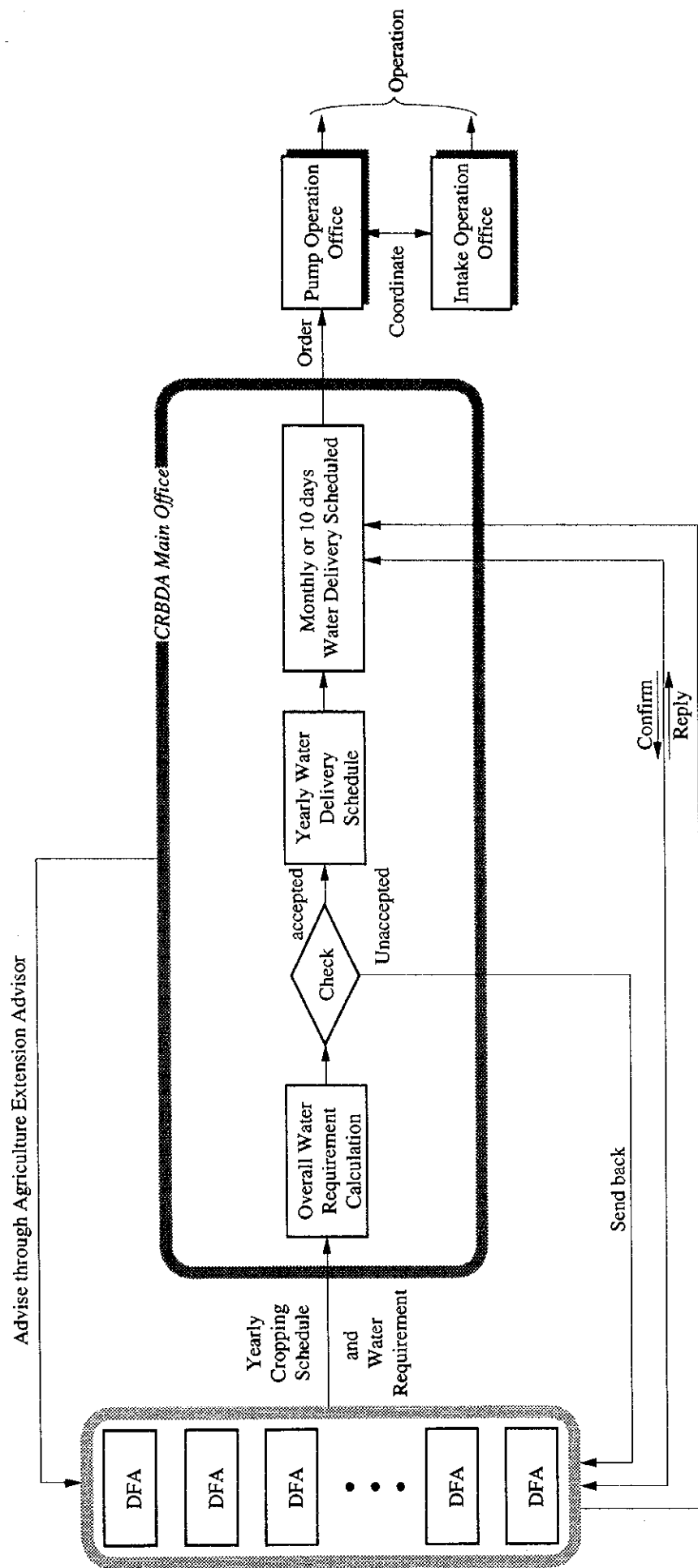


REMARKS DW : DIVERSION WEIR
 DS : DRAINAGE SYPHON
 SP : SUPER PASSAGE
 OD : OPEN DRAIN
 *: SUPPLEMENTAL DRAINAGE

INDEX 1-305/107
 35% OF FULL FLOOD DISCHARGE
 FULL FLOOD DISCHARGE
 NO. OF CHANNEL

Fig. 6.1.4 Network of Flood Carrier Channel





When sudden alternative happen, FDA request to change discharge

Fig. 7.3.2 Flow on Confirmation of Water Delivery Schedule

ATTACHMENTS

List of Participants in the Study

Name	Position
A. Advisory Committee	
Mr. Osamu Tuji	Chairman of Advisory Committee (MAFF)
Mr. Akira Hashimoto	Member, Irrigation and Drainage (MAFF)
Mr. Yoshizou Ichino	Member, Facilities and Structure (MAFF)
Mr. Akihiko Azumi	Member, Agriculture (MAFF)
Mr. Youichi Yamauchi	Member (MAFF)
Mr. Izumi Ohba	Member (MAFF)
Mr. Osamu Hotta	Member (Ministry of Foreign Affairs)
Mr. Yukio Okuda	Member (OECD)
B. Study Team	
Mr. Tadashi Otori	Team Leader
Mr. Chikaichi Takahashi	Co-Leader/Irrigation & Drainage Institution
Mr. Abdur Rahim Mahsud	Meteorology & Hydrology
Dr. Shuichi Matsushima	Land Use/Farm Road
Mr. Akira Koto	Geology/Land Conservation
Mr. Makoto Suga	Soil/Agriculture
Mr. Fumihiko Nagao	Marketing
Mr. Manabu Fujikawa	Agro-Economy/Project Evaluation
Mr. Yuichi Fukasaka	Environment
Mr. Keiji Tateyama	Facility Plan/Topo-survey
Mr. Motoo Taki	Mechanical Plan/Design
Mr. Akihiro Abe	Design/Cost Estimate
Mr. Koichi Yamamoto	
C. Counterpart Personnel	
Mr. Akhtar Ali Ismaili	Overall Supervision, Irrigation Department, NWFP
Mr. Parvez Khan	Irrigation/Drainage, Project Irrigation Circle D.I.Khan, NWFP
Mr. Zaman Khan	Irrigation/Drainage, P&I Division, WAPDA, Peshawar
Mr. Shaifullah Khan	Irrigation/Hydrology, Project Irrigation Div. D.I.Khan, NWFP
Dr. Gul Hassan	Meteorology/Agriculture, ARI, D.I.Khan
Dr. Ahmad Bakhsh	Land Use, ARI, D.I.Khan
Mr. Naeem Qasuria	Farm Road, Rural Development, D.I.Khan
Mr. Mehboob Alam	Geology/Land Conservation, P&I Division, WAPDA, Lahore
Dr. Nasir Ud Din	Agriculture, ARI, D.I.Khan
Mr. Inayat Ullah	Marketing, Agricultural Extension, D.I.Khan
Mr. Wahid Ud Din	Project Economy, P&I Division, WAPDA, Lahore
Dr. M. Bashir Khan	Environment, Environmental Protection Agency, Peshawar
Mr. Ghulam Abbas Virk	Design/Cost Estimate, P&I Division, WAPDA, Lahore
Mr. Shah Hussain Shah	Agro-Economy, ARI, D.I.Khan
Mr. Amir Reza	Facility design, P&I Division, WAPDA, Lahore
Mr. Syed Ahmed	Facility design, P&I Division, WAPDA, Lahore
Mr. Shafiq Ur Rehman	Mechanical design, HEPO, WAPDA, Lahore

MAFF: Ministry of Agriculture, Forestry and Fisheries

ARI: Agricultural Research Institute

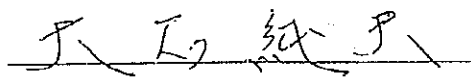
SCOPE OF WORK
FOR
THE FEASIBILITY STUDY
ON
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT

AGREED UPON BETWEEN
THE GOVERNMENT OF NORTH WEST FRONTIER PROVINCE,
THE ISLAMIC REPUBLIC OF PAKISTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

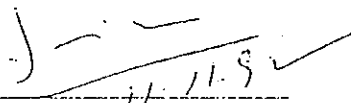
PESHAWAR, 11TH NOVEMBER, 1992



Mr. Inamullah Khan
Additional Secretary II
Planning and Development Department,
The Government of
North West Frontier Province



Mr. Sumio Oishi
Leader,
Preparatory Study Team,
Japan International
Cooperation Agency.



Mr. Faqir Ahmad Paracha
Secretary,
Irrigation and Public Health Department,
The Government of
North West Frontier Province

I. INTRODUCTION

In response to the request of the Government of the Islamic Republic of Pakistan (hereinafter referred to as 'GOP'), the Government of Japan (hereinafter referred to as 'GOJ') has decided to undertake the Feasibility Study on Chashma Right Bank 1st Lift Irrigation Project (hereinafter referred to as 'the Study'), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as 'JICA'), the official agency responsible for the implementation of the technical cooperation programmes of GOJ will undertake the Study, in close cooperation with the authorities concerned of the Islamic Republic of Pakistan (hereinafter referred to as 'Pakistan').

And as for the organizations concerned of Pakistan, the Irrigation & Public Health Engineering Department, the Government of North West Frontier Province (hereinafter referred to as 'IPHED'), will act as the counterpart agency to the Japanese study team as well as coordinating body in relation with other governmental and non-governmental organizations concerned for smooth implementation of the Study.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. To conduct the feasibility study on agricultural development for the Chashma Right Bank 1st Lift Irrigation Project (hereinafter referred to as 'the Project').
2. To carry out technology transfer to the Pakistani counterpart personnel through on-job training in the course of the Study.

III. STUDY AREA

The Study covers the Chashma Right Bank 1st Lift Irrigation Project area, which is approximately 110,000ha (see attached map).

IV. SCOPE OF THE STUDY

The Study will consist of two (2) phases and will cover the following:

R

V

1. Phase I

1-1 To collect and review existing data and information and to carry out field survey and investigation in the study area:

- natural condition
 - a. meteorology
 - b. hydrology
 - c. geology
 - d. soil
 - e. topography
 - f. others
- agriculture
 - a. land use and tenure
 - b. cropping pattern and yield
 - c. agro-economy and institution
 - d. others
- agricultural infrastructure
 - a. irrigation and drainage facilities
 - b. farm roads
 - c. others
- socio-economic situation
 - a. population
 - b. household and farmers
 - c. regional socio-economy and household economy
 - d. social and farmers organizations
 - e. historical right/costums regarding irrigational water usage
 - f. others
- other information related to the Project
 - a. administrative organizations related to the Project
 - b. environmental impacts
 - c. others

1-2 To carry out household survey

1-3 To review other projects related to the Project

1-4 To review topographic map covering the study area, which has already been made in Pakistan (scale: 4 inch = 1 mile).

2. Phase II

2-1 Based on the results of the Phase I study, Phase II study covers the following items:

pk

✓ 30

- additional field survey, data collection and analysis including:
 - a. hydrology and meteorology
 - b. geology and soil classification
 - c. land use and tenure
 - d. cropping pattern, and yeild
 - e. irrigation and drainage
 - f. hill torrent study for cross drainage, erosion and flood damages
 - g. reginnal socio-economy and farm household economy
 - h. social and farmers organjzations
 - i. environment
 - j. others
- 2-2 To formulate an irrigation and agricultural development programme for the Project
- 2-3 Preliminary design of the major structures of the Project
- 2-4 Preparation of the implementation schedule
- 2-5 Preparation of the operation and maintenance plan for major structures
- 2-6 Preparation of the environmental preservation plan
- 2-7 Estimate of the project costs and benefits
- 2-8 Recommendation

V. STUDY SCHEDULE

The study will be carried out in accordance with the attached tentative schedule.

VI. REPORTS

JICA shall prepare and submit following reports in English to GOP.

- (1) Inception Report
Twenty (20) copies at the commencement of the Study.
- (2) Progress Report (1)
Twenty (20) copies at the end of the Phase I Study in Pakistan.
- (3) Interim Report
Twenty (20) copies at the end of the Phase I study.

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- (4) Progress Report (2)
Twenty (20) copies at the end of the Phase II Study in Pakistan.
- (5) Draft Final Report
Twenty (20) copies at the end of the Phase II study.
GOP provides JICA with its comments on the Draft Final Report within one (1) month after receipt of the Draft Final Report.
- (6) Final Report
Fifty (50) copies within two (2) months after receiving GOP's comments on the Draft Final Report.

VI. UNDERTAKING OF THE GOVERNMENT OF PAKISTAN

1. To facilitate smooth conduct of the study, GOP shall take necessary measures:
 - 1-1 to secure the safety of the Japanese study team.
 - 1-2 to permit the members of the Japanese study team to enter, leave and sojourn in Pakistan for the duration of their assignment therein, and exempt them from foreign registration requirements and consular fees.
 - 1-3 to exempt the members of the Japanese study team from taxes, duties, fees and any other charges on equipment, machinery and other materials brought into of Pakistan for the conduct of the study.
 - 1-4 to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the Study.
 - 1-5 to provide necessary facilities to the Japanese study team for the remittance as well as utilization of the funds introduced into Pakistan from Japan in connection with the implementation of the Study.
 - 1-6 to secure permission for entry into private properties and other areas for the conduct of the Study as and when necessity arises.
 - 1-7 to secure permission for the Japanese study team to take all data and documents related to the Study including photographs and maps, also including aerial photographs necessary for the Study (excluding restricted areas), out of Pakistan to Japan, on case to case bases.
 - 1-8 to provide medical services as needed. Its expense will be chargeable on the members of the Japanese study team.
2. GOP shall bear claims, if any arises, against the members of the Japanese study team, resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese study team.

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3. IPHED shall, at own expense, provide the Japanese study team with the followings, in cooperation with the other authorities concerned:
 - 1) available data and information related to the Study.
 - 2) counterpart personnel.
 - 3) suitable office with necessary furniture in Peshawar and project sites.
 - 4) credentials or identification cards, and
 - 5) necessary number of vehicles with drivers.

IV. UNDERTAKING OF JICA

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

1. To dispatch study teams, at its own expense, to Pakistan, and
2. To conduct technology transfer to the Pakistani counterpart personnel in the course of the Study.

V. CONSULTATION

JICA and IPHED will consult each other in respect of any matter that may arise from or in connection with the Study.

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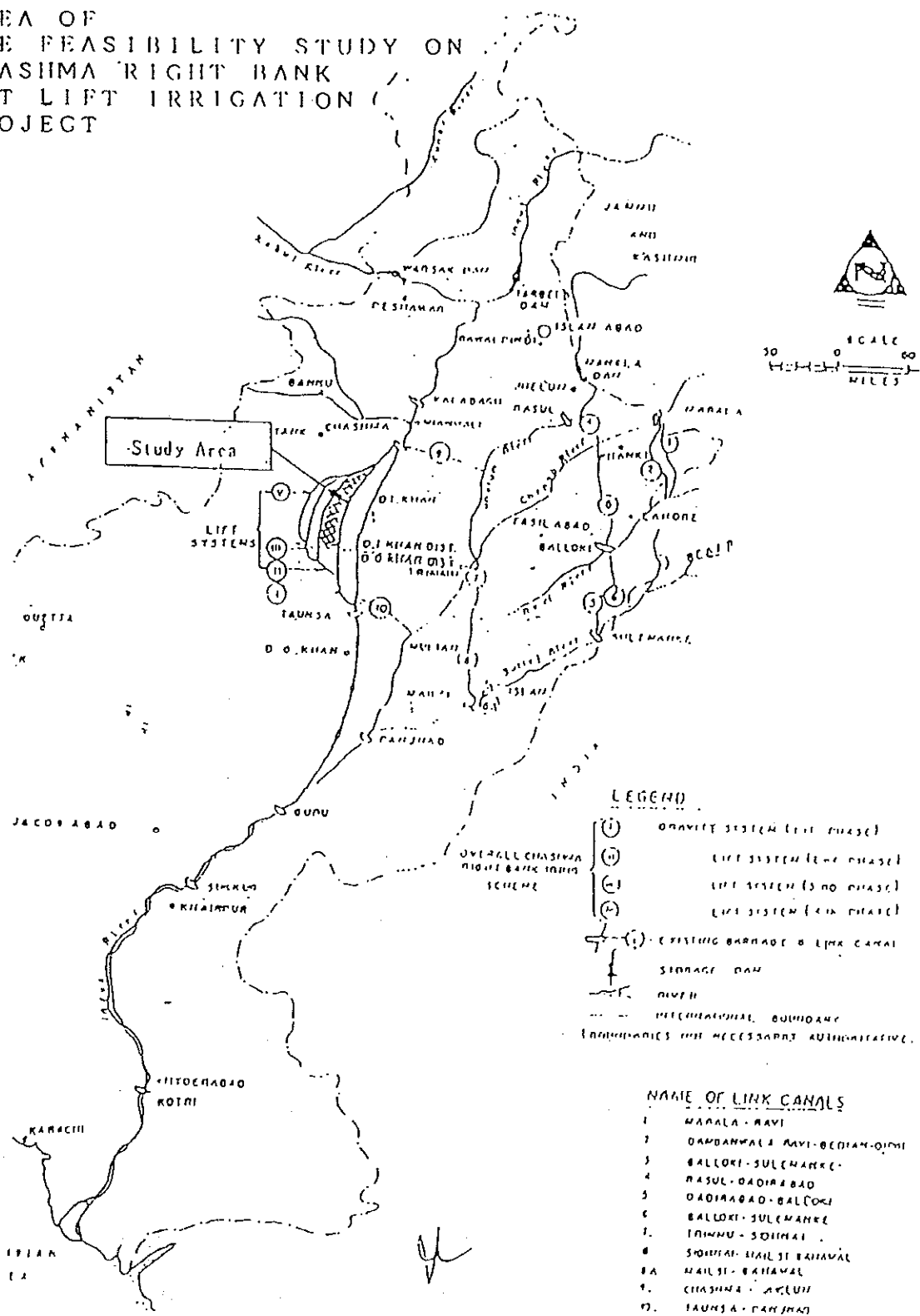
TENTATIVE SCHEDULE

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Item																												
Phase I																												
Phase II																												
Reports	△ IC/R					△ P/R(1)			△ IT/R									△ P/R(2)	△ DF/R			△ F/R						

(Remarks) △ : Inception Report P/R(1) : Progress Report(1)
 △ : Interim Report P/R(2) : Progress Report(2)
 △ : Draft Final Report F/R : Final Report

— : Work in Pakistan
 --- : Home Office Work in Japan
 © : Comments on DF/R by Pakistan side

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



MINUTES OF MEETING
ON
SCOPE OF WORK
FOR
THE FEASIBILITY STUDY
ON
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT

The preparatory study team (hereinafter referred to as 'the Team') organized by the Japan International Cooperation Agency (hereinafter referred to as 'JICA'), and headed by Mr. Sumio Oishi, visited the Islamic Republic of Pakistan from October 26 to November 13, 1992 for the purpose of discussing and confirming the Scope of Work for the Feasibility Study on the Chashma Right Bank 1st Lift Irrigation Project (hereinafter referred to as 'the Study').

The team had a series of discussions with the officials concerned of the Irrigation and Public Health Engineering Department, the Government of North West Frontier Province (hereinafter referred to as 'IPHED') on the Scope of Work for the Study. The list of participants in a series of meetings is attached in the Annex.


The following are the main issues discussed and agreed by IPHED and the Team.

1. IPHED and the Team both agreed on the issues mentioned in the Scope of Work.
2. IPHED shall provide the Japanese study team a set of topographic map (scale, 4 inch = 1 mile, contour, 5 feet) which covers the whole Study area before the commencement of the Study, and also will provide the one in scale, 1:5,000, contour, 0.25 metre, until 1(one) year after the commencement of the Study.
3. The Team has decided to conduct the Study according to the confirmation given by IPHED that there are sufficient amount of water and electricity available regarding the implementation of the Chashma Right Bank 1st Lift Irrigation Project.
4. IPHED shall provide the Japanese study team with offices which are equipped with electricity, city water, and telephones in Peshawar and the Study area.
5. IPHED requested that local consultants be associated with the Study to the extent possible. The Team noted this request, but observed that this would be determined by the Japanese study team.

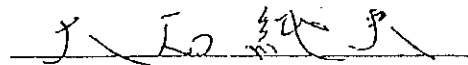
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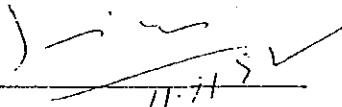
6. IPHED requested that the following equipments necessary for the Study be procured by JICA and be donated to IPHED after the termination of the Study. The Team promised to convey its request to the Government of Japan.
- vehicles
 - computers
 - copymachines
 - faxmachines
 - survey equipments
7. IPHED requested the counterpart training in Japan. The Team promised to convey its request to the Government of Japan.
8. The Government of North West Frontier Province noted that items mentioned in the Scope of Work, sub-paragraph 1-2 to 1-5, and 1-7 of paragraph III, would require clearance by the Federal Government.



Mr. Inamullah Khan
Additional Secretary II,
Planning and Development Department
The Government of
North West Frontier Province



Mr. Sumio Oishi
Leader,
Preparatory Study Team,
Japan International
Cooperation Agency




Mr. Faqir Ahmad Paracha
Secretary,
Irrigation and Public Health Engineering Department,
The Government of
North West Frontier Province

LIST OF PARTICIPANTS

ANNEX

PAKISTAN SIDE

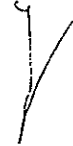
1. Mr. Mohammad Saleem Khan	Secretary	Planning and Development Department. The Government of NWFP
2. Mr. Inamullah Khan	Additional Secretary II	Planning and Development Department. The Government of NWFP
3. Mr. Faqir Ahmad Paracha	Secretary	Irrigation and Public Health Engineering Department. The Government of NWFP
4. Mr. Muhammad Munir	Chief Engineer (P&I)	WAPDA, Lahore
5. Mr. M. Ishhaq Shinwari	Project Director (P&I) North	WAPDA, Lahore
6. Mr. Nawab Khan Masood	Chief Engineer Water Sector Investment Planning	Planning and Development Department. The Government of NWFP
7. Mr. Akhtar Ali Ismaili	Chief Engineer (Development)	Irrigation and Public Health Engineering Department. The Government of NWFP
8. Mr. Jan Sardar Gul	General Manager	WAPDA, North
9. Mr. Mohammad Zaman Khan	Director (P&I)	WAPDA, Peshawar
10. Mr. Habibullah Khan	Project Director. D. I. Khan	Irrigation and Public Health Engineering Department. The Government of NWFP
11. Mr. Abdul Wasai	Director	WAPDA, Peshawar
12. Dr. Abdul Waheed	Chief Planning Officer	Food, Agriculture and Cooperative Department. The Government of NWFP
13. Mr. Mohammad Yousef	Director. Water Management	Agriculture Department. The Government of NWFP
14. Mr. Attaullah Khan	Director, Planning	Agriculture Extension Department. The Government of NWFP
15. Mr. Amjad Shahid Afridi	Chief (Water & Power) 	Planning and Development Department. The Government of NWFP

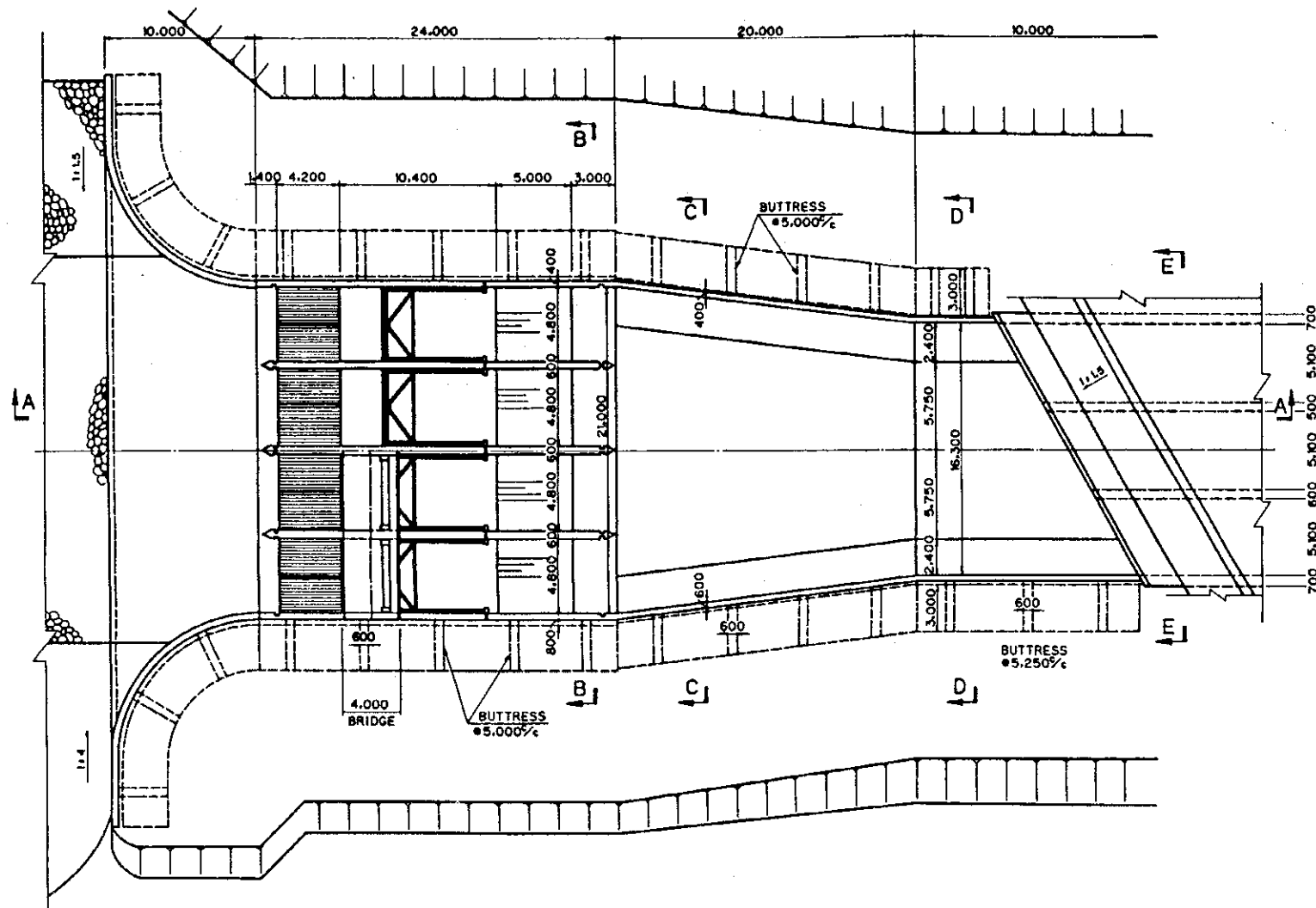


- | | | |
|---------------------------|--|--|
| 16. Mr. Ahmad Samad | Project through
Secretary of
Agriculture | Agriculture Extension
Department,
The Government of NWFP |
| 17. Mr. Muhammad Zulfiqar | Planning Officer | Agriculture Extension
Department,
The Government of NWFP |
| 18. Mr. Khan Said | Director,
Technical | Area Electricity Board,
WAPDA, Peshawar |

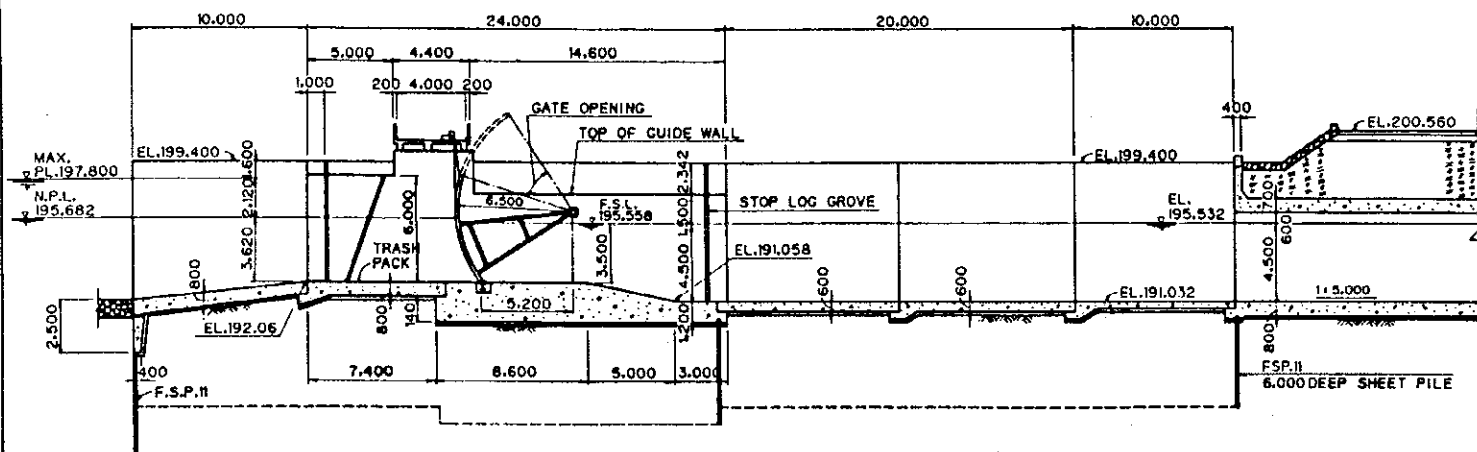
THE TEAM

- | | |
|---------------------------|----------------------|
| 1. Mr. Sumio Oishi | Leader |
| 2. Mr. Takanobu Kobayashi | Irrigation Engineer |
| 3. Mr. Akihiko Azumi | Agronomist |
| 4. Dr. Katsumi Chida | Environmental Expert |
| 5. Mr. Akira Shimizu | Coordinator |

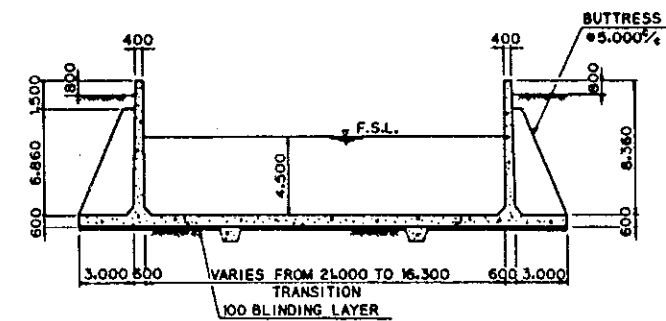



PLAN
SCALE B

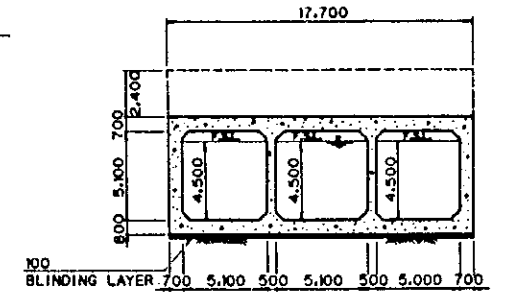


SECTION A-A
SCALE B

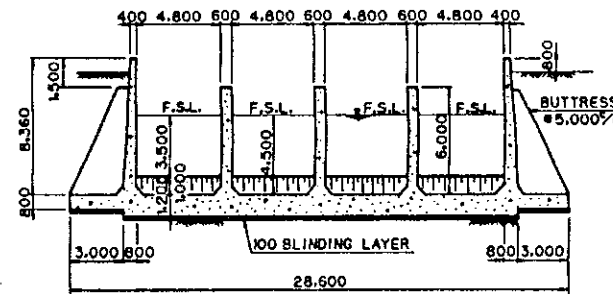
(*) MAX.P.L. : MAXIMUM POND LEVEL
N.P.L. : NORMAL POND LEVEL



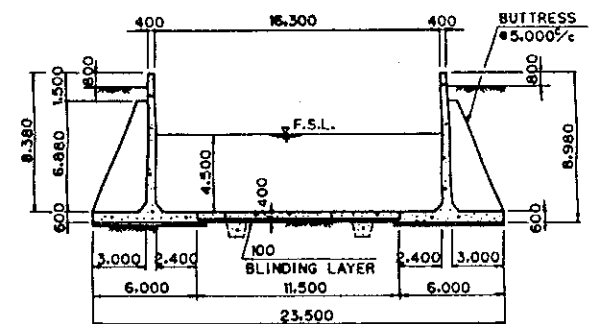
SECTION C-C
SCALE B



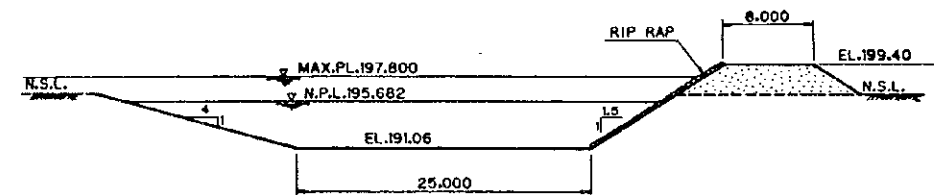
SECTION E-E
SCALE B



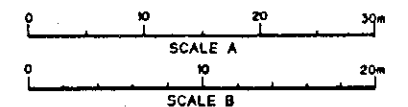
SECTION B-B
SCALE B



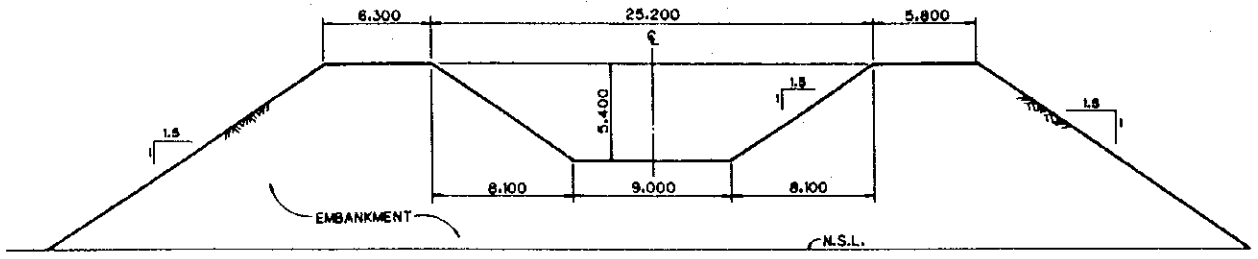
SECTION D-D
SCALE B



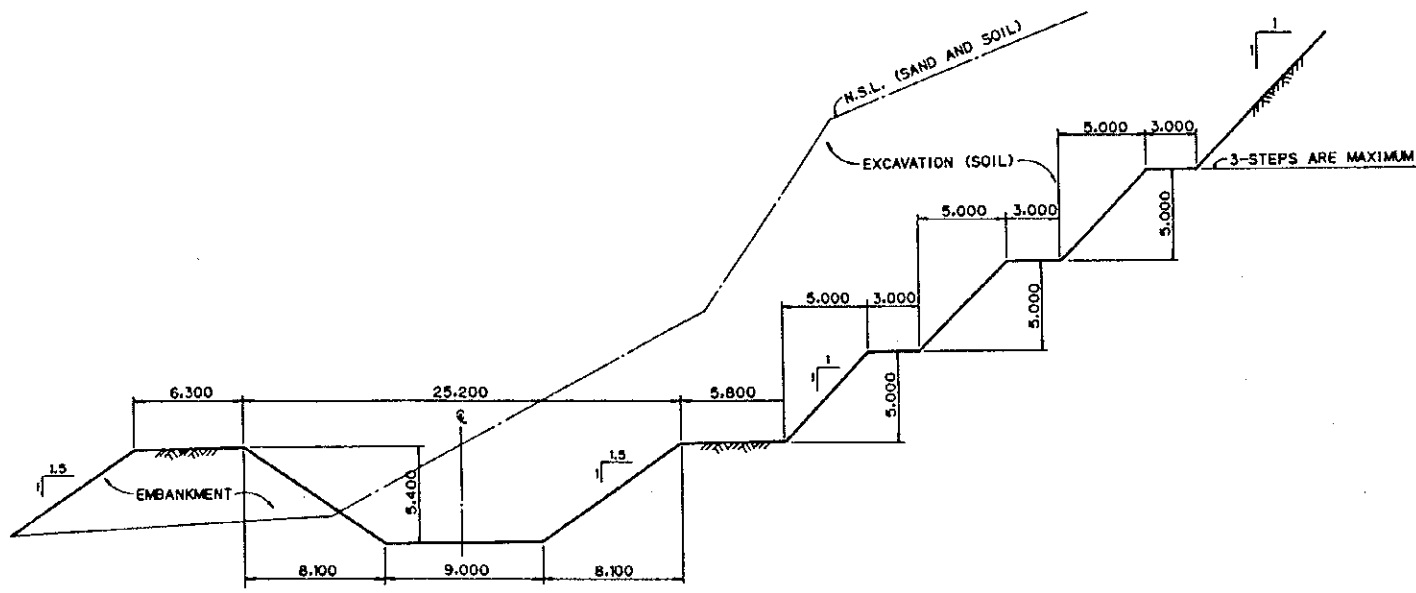
SECTION OF HEAD RACE DRADGING
SCALE A



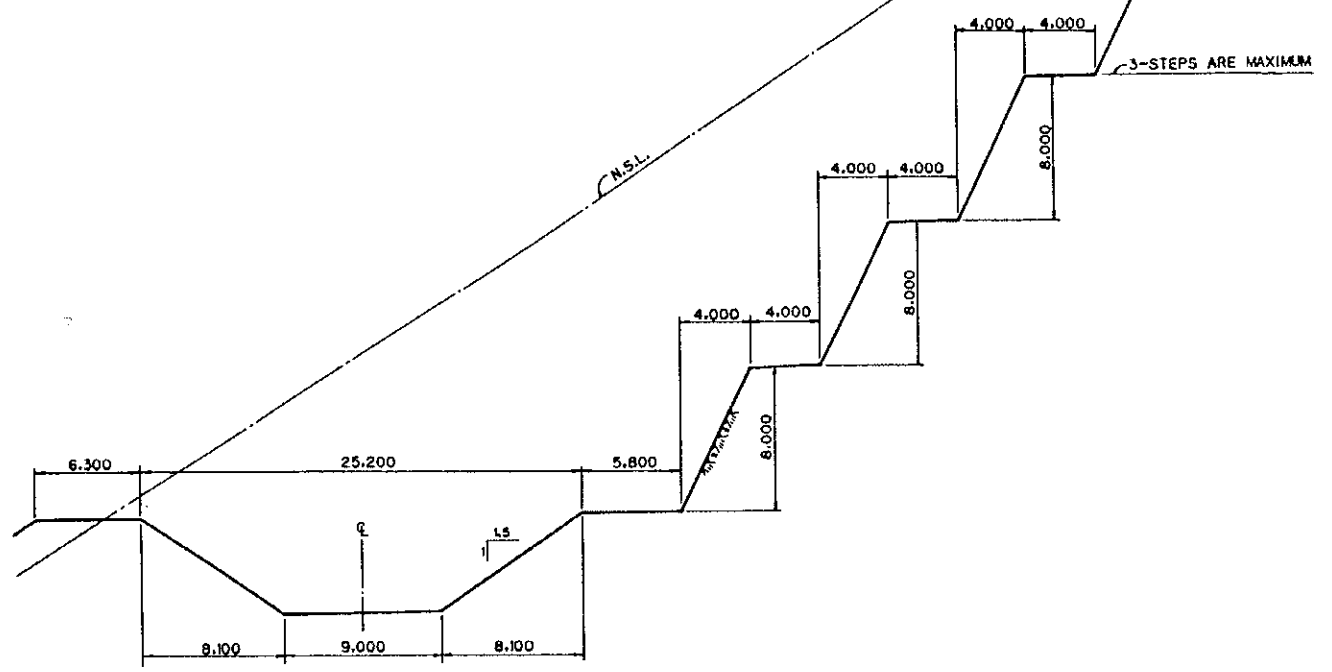
ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF NORTH WEST FRONTIER PROVINCE
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT
INTAKE STRUCTURE WITH CROSSING OF DIKE
OF CHASHMA BARRAGE
JAPAN INTERNATIONAL COOPERATION AGENCY D.W. NO.



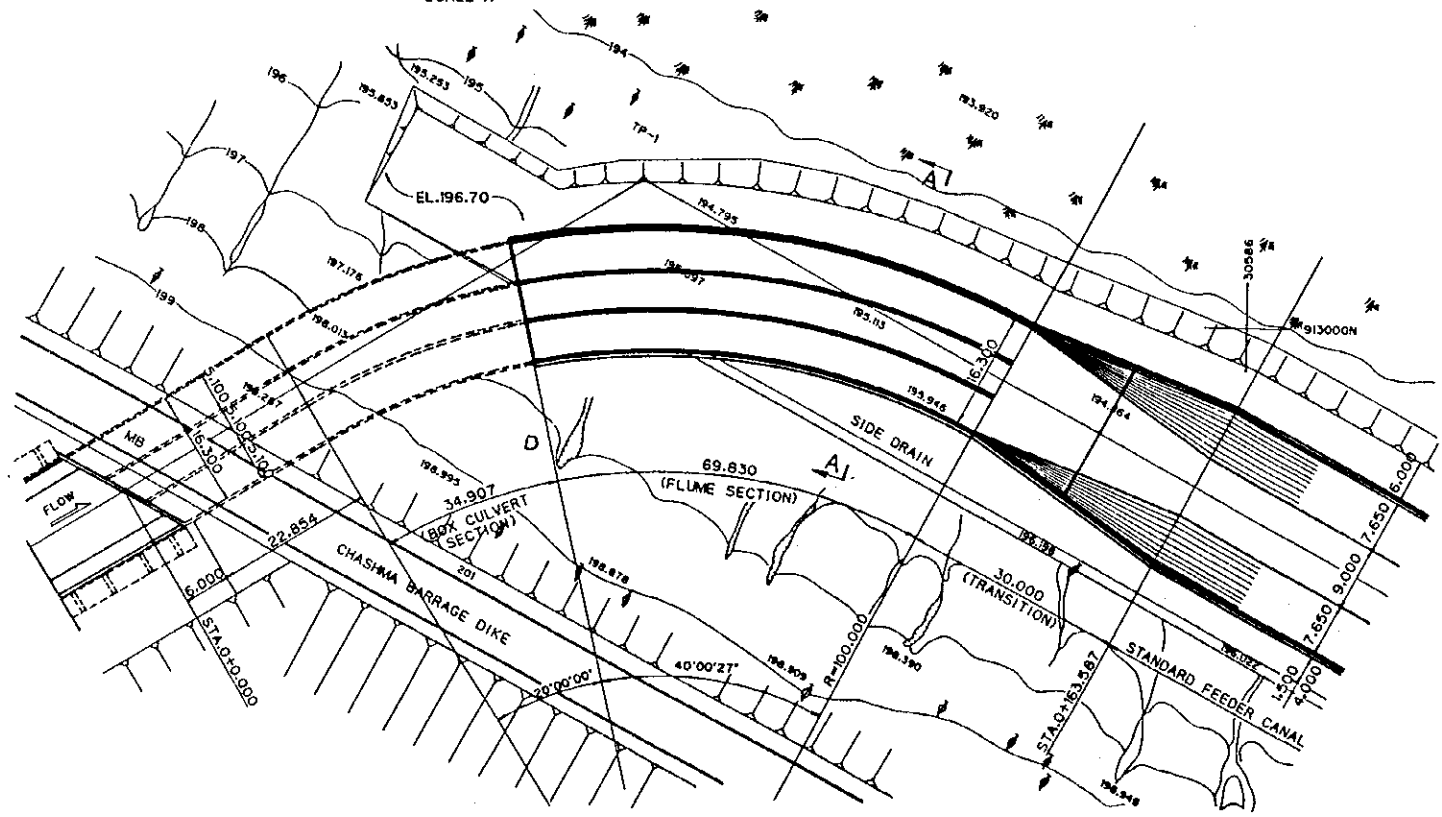
FULL EMBANKMENT SECTION
SCALE A



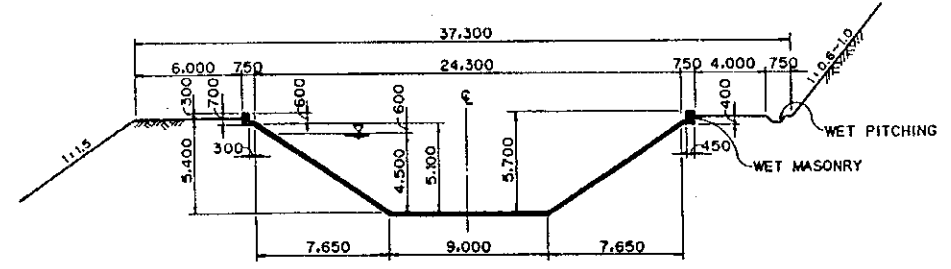
CUTTING WITH PARTIAL EMBANKMENT SECTION
SCALE A



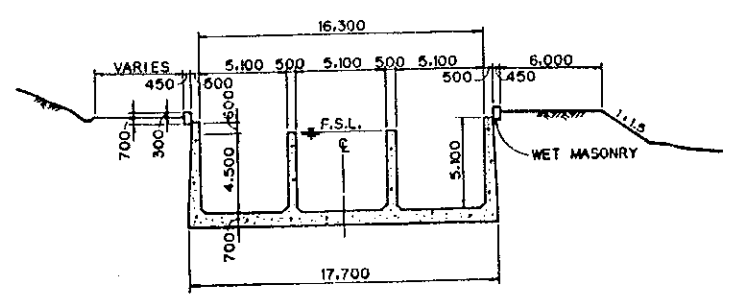
ROCK EXCAVATION SECTION
SCALE A



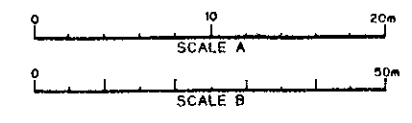
PLAN OF CULVERT & FLUME SECTION AT BEGINNING POINT OF FEEDER CANAL
(STA.0+0.000—STA.0+163.587)
SCALE B



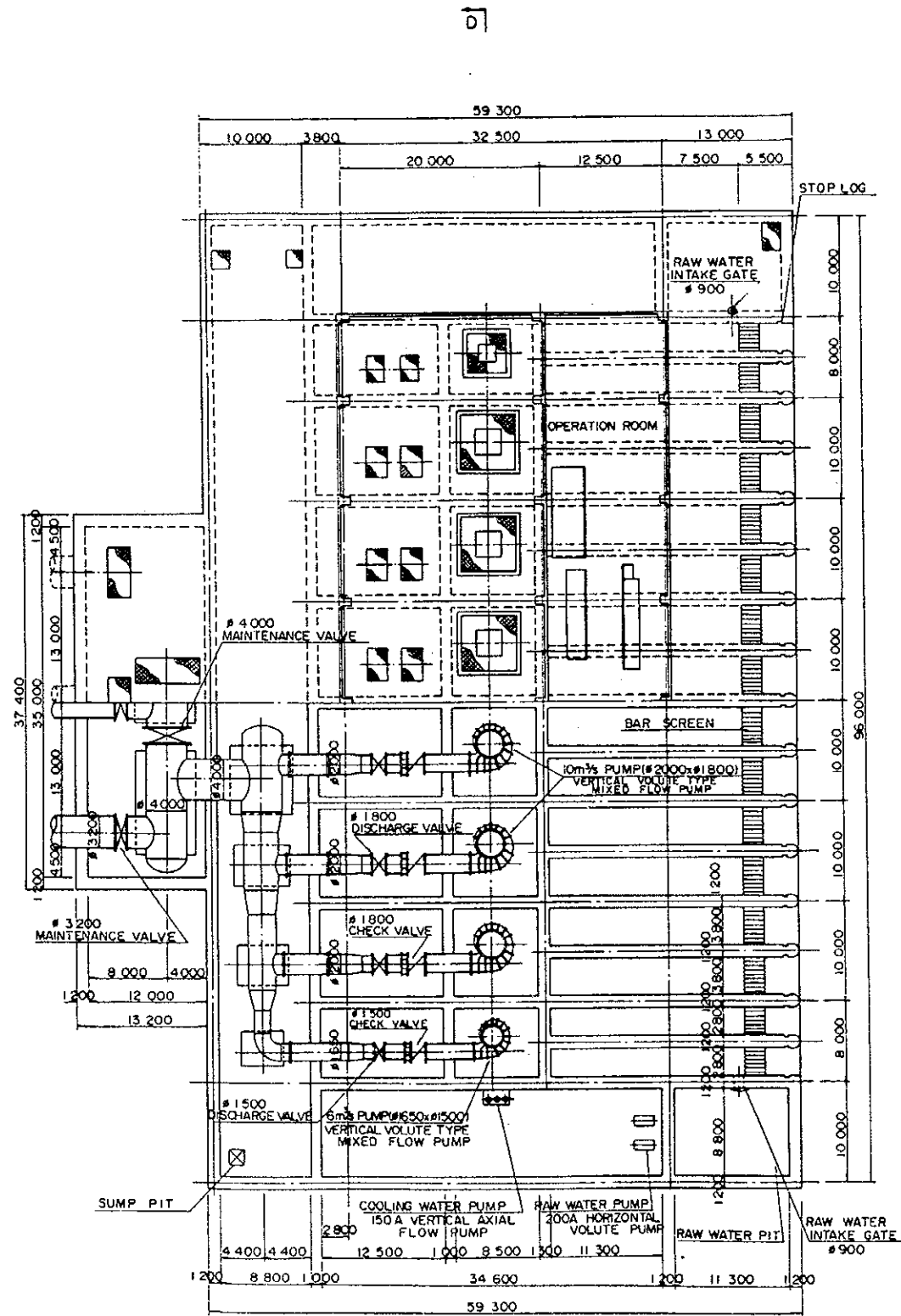
TYPICAL CROSS SECTION OF FEEDER CANAL
SCALE A



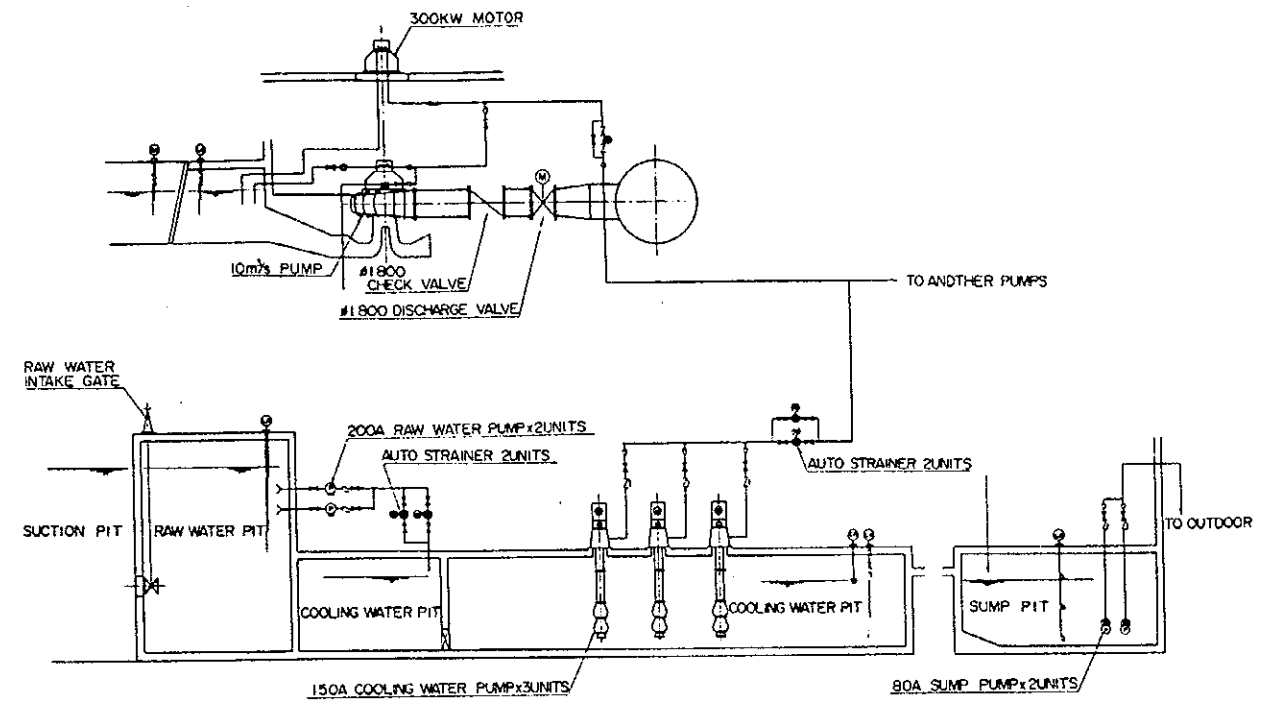
SECTION A-A
SCALE A



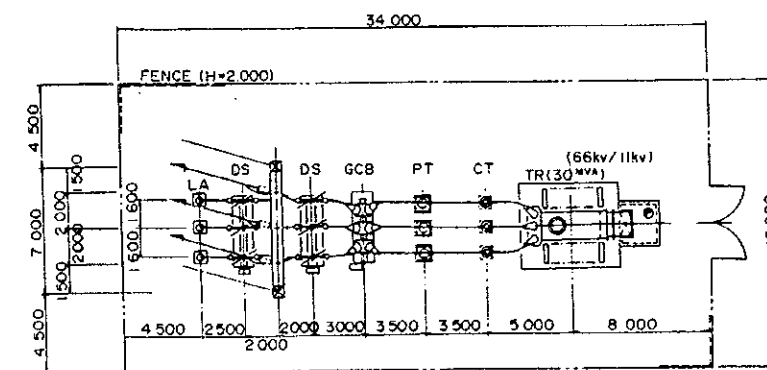
ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF NORTH WEST FRONTIER PROVINCE
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT
TYPICAL CROSS SECTION AND DIKE
CROSSING OF FEEDER CANAL
JAPAN INTERNATIONAL COOPERATION AGENCY D.W. NO.



PLAN OF PUMP HOUSE
S = 1 : 300



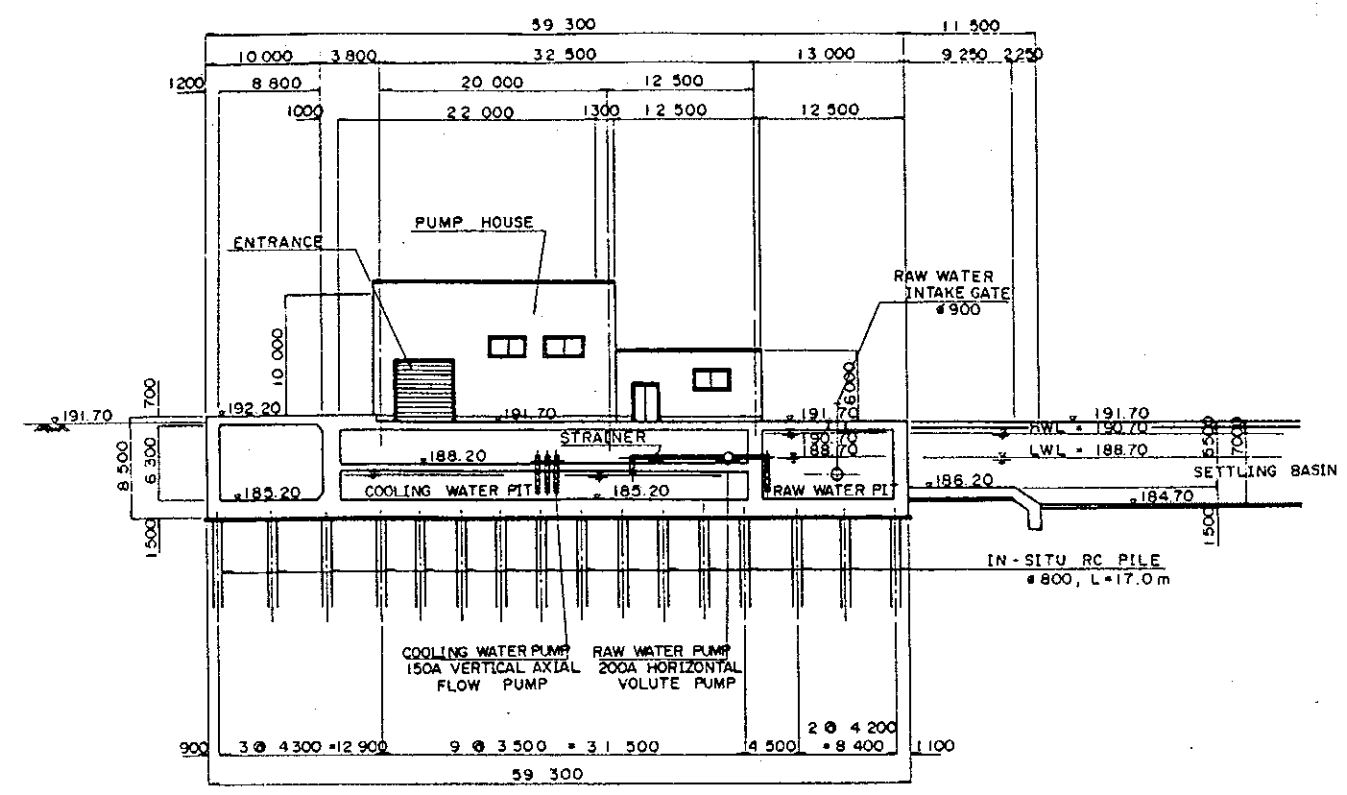
FLOW SHEET OF AUXILIARY EQUIPMENTS



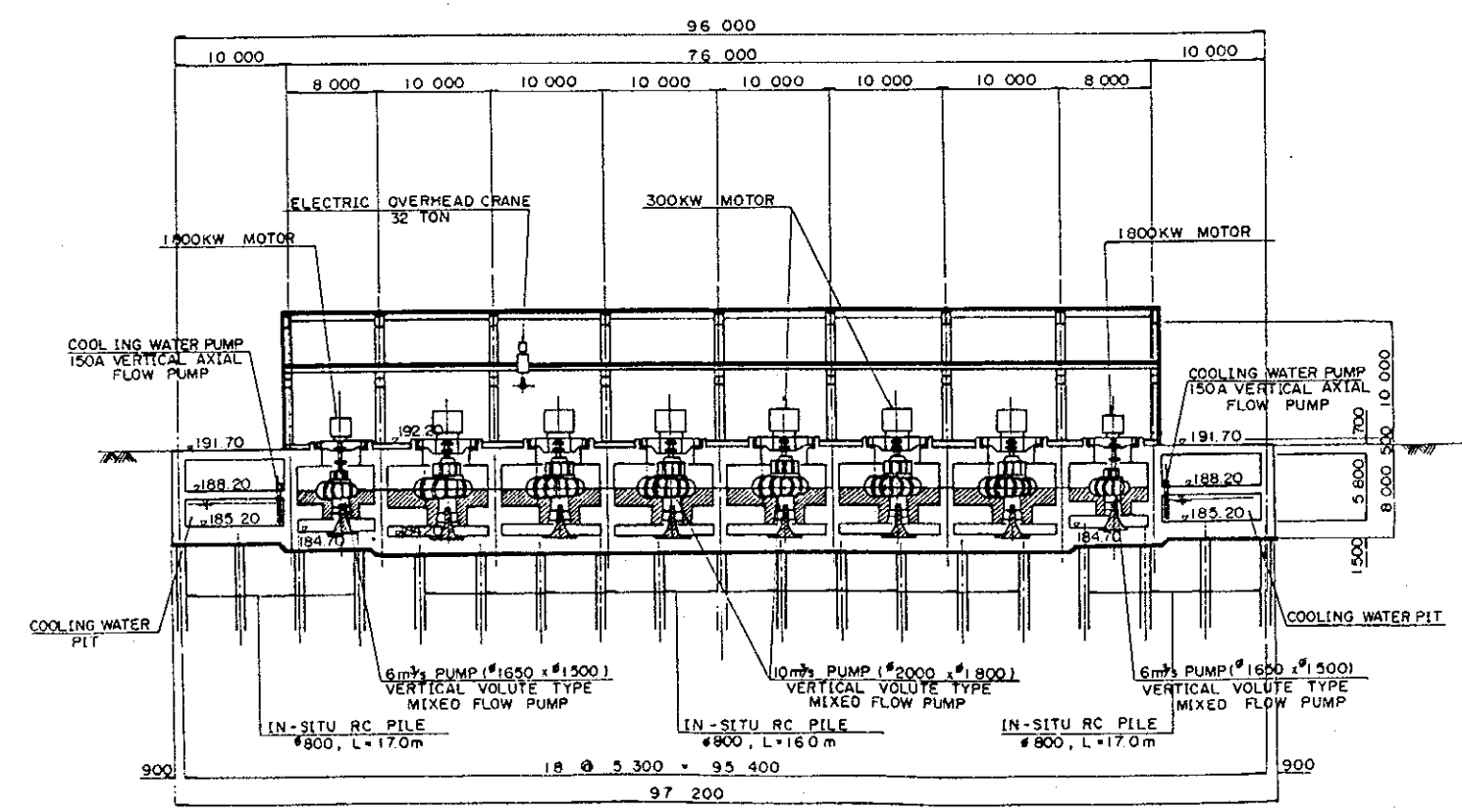
PLAN OF SUBSTATION

S = 1 : 200

ISLAMIC REPUBLIC OF PAKISTAN GOVERNMENT OF NORTH WEST FRONTIER PROVINCE	
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT	
PUMP STATION (2/3)	
JAPAN INTERNATIONAL COOPERATION AGENCY	D.W. NO.

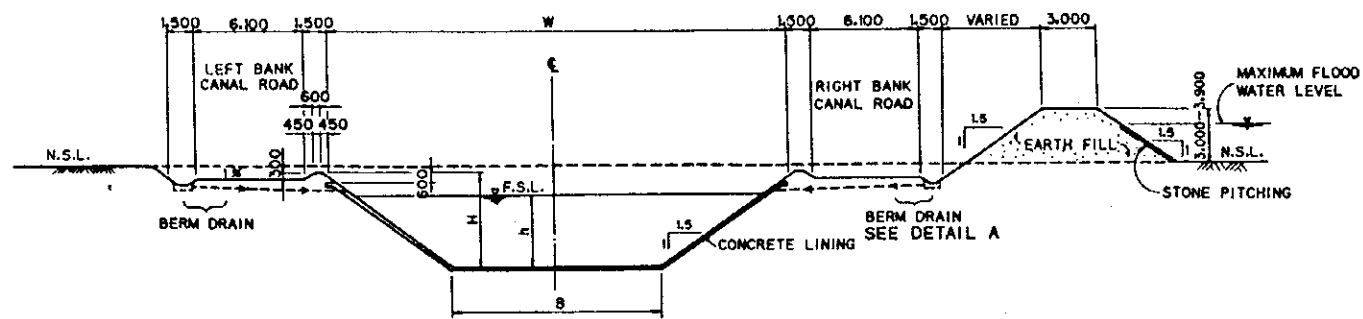


C - C S : 1 : 300

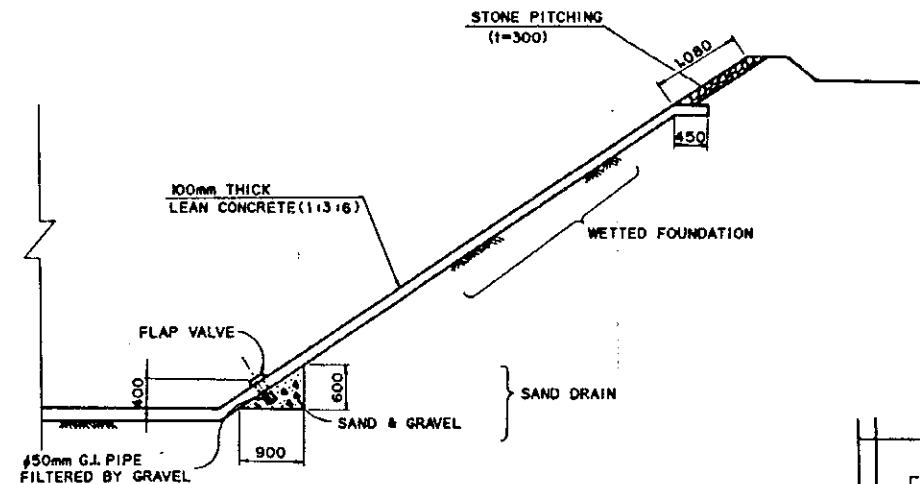


D - D S : 1 : 300

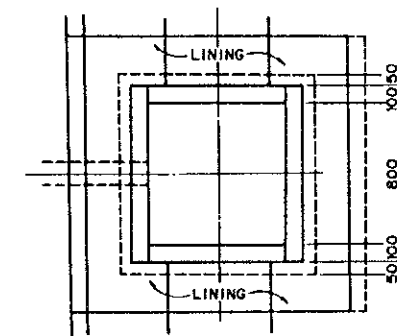
ISLAMIC REPUBLIC OF PAKISTAN
 GOVERNMENT OF NORTH WEST FRONTIER PROVINCE
 CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT
 PUMP STATION (3/3)
 JAPAN INTERNATIONAL COOPERATION AGENCY D.W. NO.



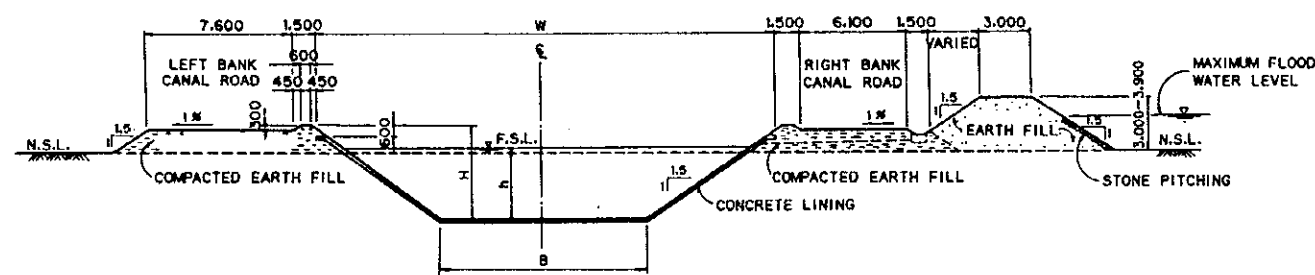
TYPICAL SECTION FULL CUT WITH FLOOD PROTECTION DIKE
SCALE A



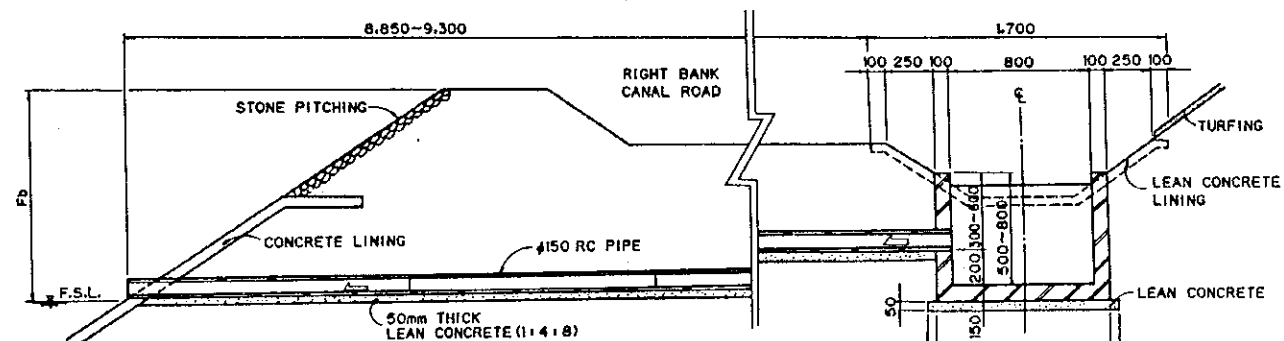
LINING DETAILS
SCALE C



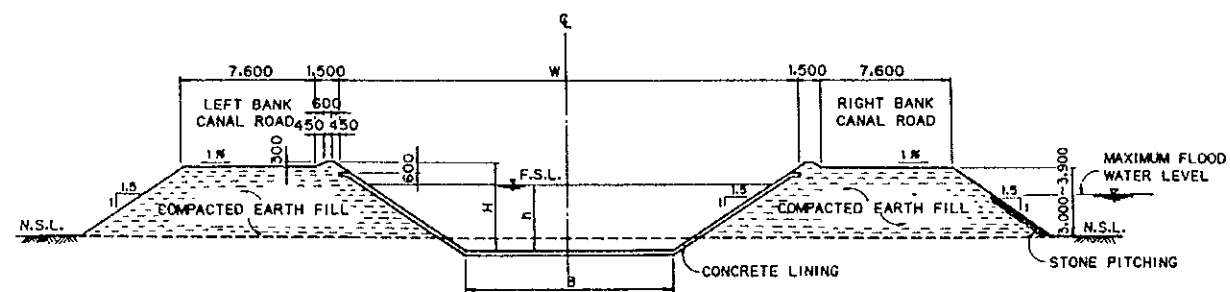
PLAN



TYPICAL SECTION CUT & FILL WITH FLOOD PROTECTION DIKE
SCALE A



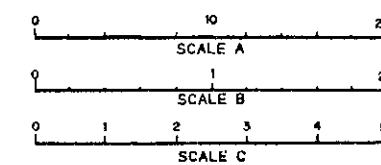
DETAIL-A
SCALE B (BERM DRAIN)



TYPICAL SECTION CUT & FILL OR FULL CUT WITHOUT FLOOD PROTECTION DIKE
SCALE A

DIMENSION TABLE

No. OF SECTION	STATION No. OF BP - EP	DISCHARGE (m ³ /s)	BOTTOM WIDTH (m)	CANAL HEIGHT (m)	WATER DEPTH (m)	FREE BOARD FT (m)	W (m)
1	0+000 - 32+800 (52.80km)	72	12.0	5.15	3.94	1.21	27.45
2	32+800 - 56+550 (23.75km)	53	10.5	4.75	3.53	1.22	24.75
3	56+550 - 75+000 (18.45km)	30	8.0	3.80	2.60	1.20	19.40
4	75+000 - 84+500 (19.50km)	20	6.5	3.20	2.14	1.06	16.10
5	84+500 - 113+250 (18.95km)	10	4.5	2.40	1.49	0.91	11.70



ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF NORTH WEST FRONTIER PROVINCE
CHASHMA RIGHT BANK 1ST LIFT IRRIGATION PROJECT
TYPICAL CROSS SECTION OF MAIN CANAL
JAPAN INTERNATIONAL COOPERATION AGENCY D.W. NO.

