

4.2. Irrigation Canal

The cultivable commanded areas are divided into two areas, the Upstream Area and the Downstream Area of the existing Rawal Dam by topographic conditions. The former is a relatively undulated area with partially eroded land, and the later is almost flat in topography.

In the Upstream Area, the Kurang River, the right side tributary of the Gumreh Kas River and the main flow of the Gumreh Kas River run roughly in parallel with each other in a distance of 10 to 15 km (6 to 9 mi) and in direction from northeast to southwest. Consequently, the area could be divided into five sub-areas as presented below, and the irrigation canals were planned at the elevated location of each sub-area:

Canals in the Upstream Area

<u>Sub-Area</u>		<u>Name of Canal</u>
- Kurang River	: Right Bank Area	Branch Canal No.1
- -do-	: Left Bank Area	Branch Canal No.2
- Gumreh Kas Right Tributary:	Right Bank Area	Main Canal
- -do-	: Left Bank Area	Branch Canal No.4
- Gumreh Kas	: Left Bank Area	Branch Canal No.3

On the other hand, the Downstream Area of the Rawal Dam could be divided into following three sub-areas based on the topography and the irrigation canal networks proposed for the Upstream Area;

Canals in the Downstream Area

<u>Sub-Area</u>	<u>Name of Canal</u>
- Right Bank Area of Kurang River	Branch Canal No.6
- Left Bank Area of Kurang River & Right Bank Area of Gumreh Kas	Main Canal and Branch Canal No.5
- Left Bank Area of Gumreh Kas	Branch Canal No.3

In addition to the above listed main and branch canals, distributary and minor canals are also planned to convey irrigation water to the turnouts commanding the unit irrigation area of approximately 40 - 50 ha each. Total length of the proposed irrigation canals is about 130 km (81 mi). The irrigation water for the upland area situated at the foot of Margalla hill in Bharakao will be supplied through a pump station to be provided at the downstream end of 1st branch canal.

In order to introduce the irrigated agriculture in the upland farming with such crops as vegetable, tree fruits, cereals and fodder, the water conveyance system should meet the following design criteria;

- to supply the irrigation water within 12 hours in the daytime,
- to provide the farm ponds for easy water management,

In order to provide the best available water conveyance system that can fulfill the conditions of the above design criteria, the farm ponds are to be provided at the beginning of the distributary and the minor canals. The storage capacity of each farm pond is planned by 50 percent or more than 50 percent of the maximum daily irrigation water requirements for the irrigation area commanded by the farm pond. The both main and branch irrigation canals in the upstream of the farm pond can convey the required daily irrigation water all the day.

In the Project, the minor canals are planned to be unlined canals because of its small scale, while the other main, branch and distributary canals are planned to be concrete flume.

The general plan of the irrigation canal system is shown in Figure-14 and the salient features are shown in the following table.

LENGTH OF CANAL

<u>Canal</u>	<u>Design Discharge</u> (cu.m)	<u>Length</u> (m)
- Main Canal	4.0 - 1.5	17,710
- Branch Canal		
1st Branch Canal	0.3	3,590
2nd Branch Canal	0.5 - 0.3	4,900
3rd Branch Canal	1.5 - 0.5	17,900
4th Branch Canal	0.3 - 0.5	1,900
5th Branch Canal	1.0 - 0.3	6,000
6th Branch Canal	0.5 - 0.15	7,900
Sub-Total	1.5 - 0.15	42,190
- Distributary Canal		4,830
- Minor Canal		65,320
Total		130,050

NUMBER OF CANAL STRUCTURES

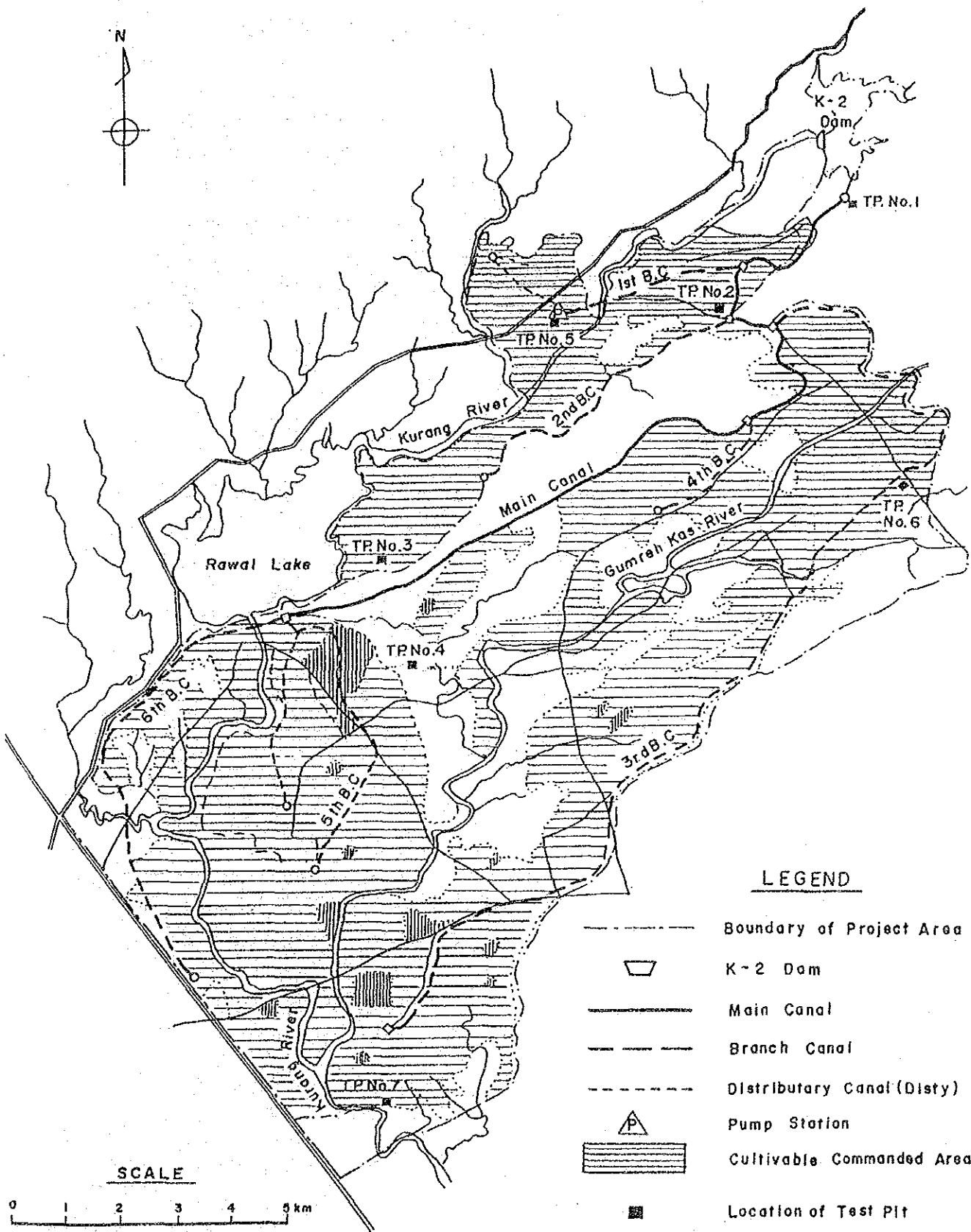
<u>Canal Structure</u>	<u>Main Canal</u>	<u>Branch Canal</u>	<u>Total</u>
Siphon	10	13	23
Cut & cover Conduit	2	15	17
Aqueduct	-	1	1
Drop	43	63	106
Off Take	5	1	6
Turnout	4	24	28
Wasteway	1	3	4
Farm Pond	-	28	28

4.3. On-Farm Facilities

The on-farm facilities are planned according to the following basic principles;

- to provide water course on the higher place in the farm land.
- to provide drainage canal along the lower side of farm.
- to prevent erosion to be caused by rainfall and runoff.
- to provide farm road at a distance of less than 100 m (328 ft) from a longest farm.

FIGURE -14. IRRIGATION CANAL SYSTEM - GENERAL PLAN



- not to be carried out land consolidation and leveling works.

Since the cultivable commanded area in the Project Area can be divided into two, Upstream Area and Downstream Area by topographic conditions, one sample area has been selected for designing the typical on-farm facilities for each area. The construction cost of the on-farm facilities per hectare is estimated at Rs.9,500 (about \$550) for the Upstream Area and at Rs.7,000 (about \$400) for the Downstream Area.

4.4. Marketing Road

In addition to the proposed inspection roads along the irrigation canals, the 18.6 km-long (11.6 mi) marketing roads will be provided including construction works for 13.8 km (8.6 mi) and improvement works for 4.8 km (3.0 mi) so that they can serve for better communication among villages and more efficient transportation of agricultural inputs and products. The marketing roads shall have the total width of 6.1 m (20 ft) including the effective width of 3.05 m (10 ft).

4.5. Project Cost

The project cost was estimated under the following conditions;

- i) The civil works are to be carried out on the contract basis, and the construction machinery and materials required for the civil works should be provided by the Contractors.
- ii) The exchange rate between Pakistani Rupee and US Dollar is fixed as follows;
US\$1.0 = 17.3 Pakistani Rupees

iii) The physical contingency is 10 percent of the total cost.

iv) The price escalation rate is predicted at two percent for the foreign currency portion and eight percent for the local currency portion.

The project cost is estimated at about 1,330 million Rupees as shown in Table-4, of which 667 million Rupees are in the foreign currency and 663 million Rupees in the local currency.

TABLE-4. PROJECT COST

(unit: '000 Rupee)

Item	F/C	L/C	Total
1. Civil Works			
1.1. Pre-Engineering Works	7,300	0.0	7,300
1.2. Dam Works	277,200	128,700	405,900
1.3. Canal Works	82,700	66,300	149,000
1.4. Road Works	5,400	2,500	7,900
1.5. Project Facilities	1,400	4,300	5,700
Sub-Total	<u>374,000</u> (65%)	<u>201,800</u> (35%)	<u>575,800</u> (100%)
2. On-Farm Development	27,100	25,100	52,200
3. Agricultural Supporting Facilities	16,700	3,300	20,000
4. Land Acquisition and Compensation	3,400	110,500	113,900
5. O & M Equipment	12,300	500	12,800
6. Project Administration	4,200	5,300	9,500
7. Consulting Services	60,000	23,800	83,800
8. Total (1 - 7)	<u>497,700</u>	<u>370,300</u>	<u>868,000</u>
9. Contingency (10%)	49,800	37,000	86,800
10. Total (8 + 9)	<u>547,500</u> (57%)	<u>407,300</u> (43%)	<u>954,800</u> (100%)
11. Price Escalation	120,000	255,600	375,600
Grand Total (10 + 11)	<u>667,500</u> (50%)	<u>662,900</u> (50%)	<u>1,330,400</u> (100%)

5. PROJECT IMPLEMENTATION AND OPERATION

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5.1. Project Implementation

The executing agency of the project will be a group of Governmental agencies such as ICTA, WAPDA, SDO, CDA, PHED, NARC and MFAC and the group has sufficient capability and deep experience in carrying out the detailed design, construction of civil works and operation and maintenance of the completed project facilities.

The project Agency executes the detailed design for major project facilities in recruiting a consulting firm, and the construction works in employing competent contractors. The operation and maintenance will be made by the Water Users' Association under the guidance of the O & M Office.

The foreign currency portion of the project cost will be financed by the international financing institute while the local currency portion will be provided by the Pakistani Government.

The detailed design and implementation of the project will take about seven and a half years after completion of the Feasibility Study; three and a half years for loan procedures and detailed design and four years for construction.

The summary of the implementation program and construction schedule are shown in Figure-15 and Figure-16.

5.2. Operation and Maintenance Plan

The irrigation facilities in the Project Area can be largely divided into two categories; one is the major facilities of the K-2 Dam, main and branch canals, distributary and minor canals, and the other is the on-farm facilities in the area of 40 to 50 ha (99 to 124 acres) commanded by outlet.

Operation and maintenance (O/M) works of the major facilities will be carried out by the Upper Kurang River Irrigation Project O/M Office under the jurisdiction of the Project Director of the Upper Kurang River Irrigation Project Office to be newly established in ICTA (see Figure-17).

On the other hand, the operation and maintenance works of the on-farm facilities will be carried out by the Farmers' Group, which will be organized on the basis of turnout level (see Figure-18). The Farmers' Group in the area will be integrated to organize the Water User's Association as shown in Figure-19.

The operation and maintenance cost of the project is estimated at about 4.37 million Rupees per annum.

FIGURE-17. PROPOSED ORGANIZATION CHART OF OPERATION AND MAINTENANCE

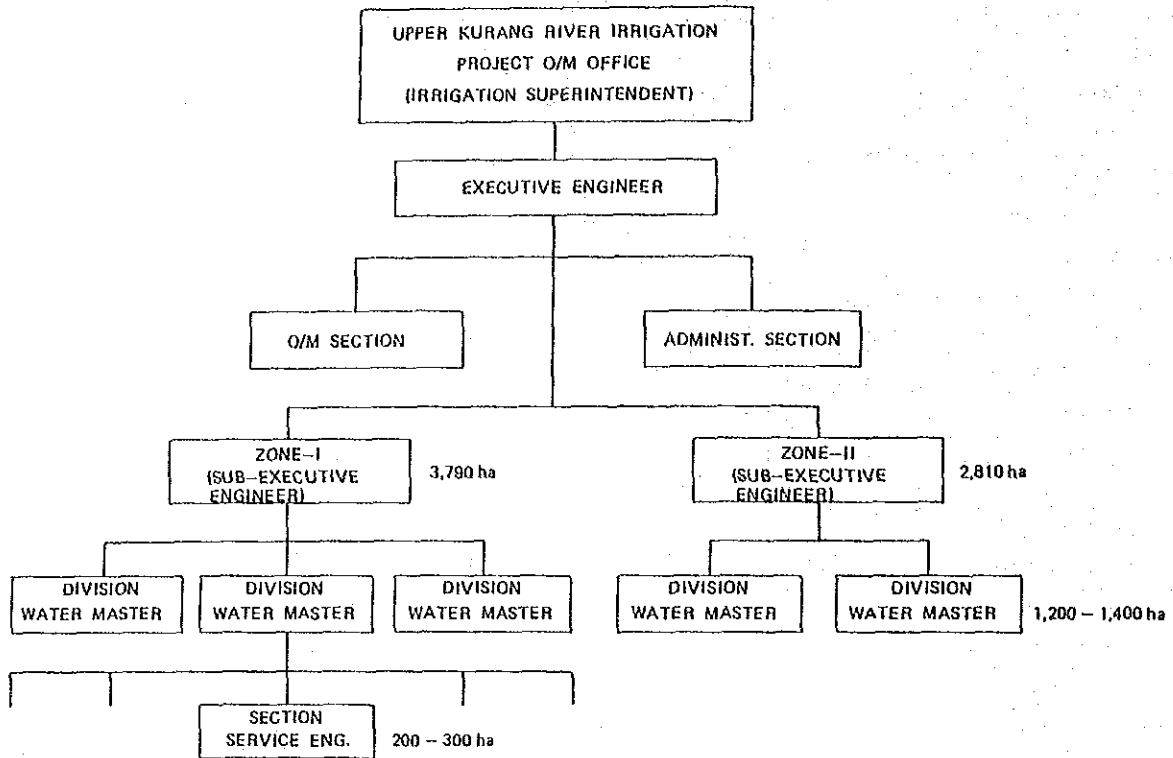


FIGURE-18. PROPOSED ORGANIZATION CHART OF WATER USERS' ASSOCIATION

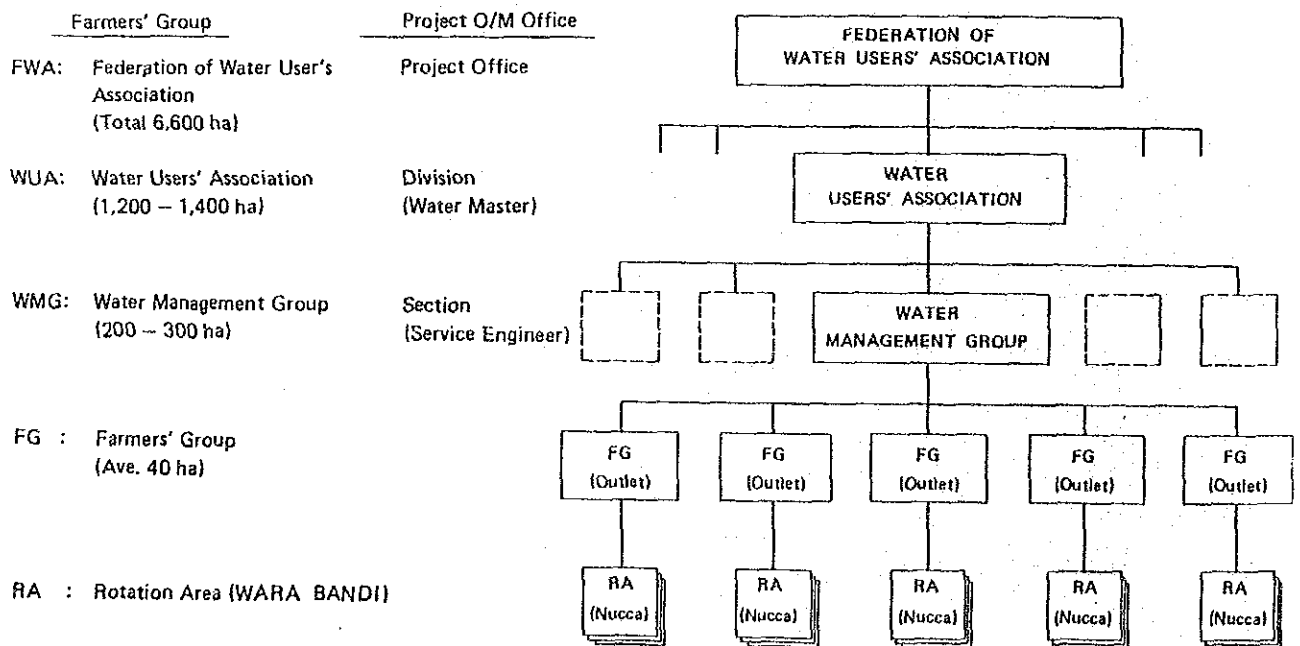
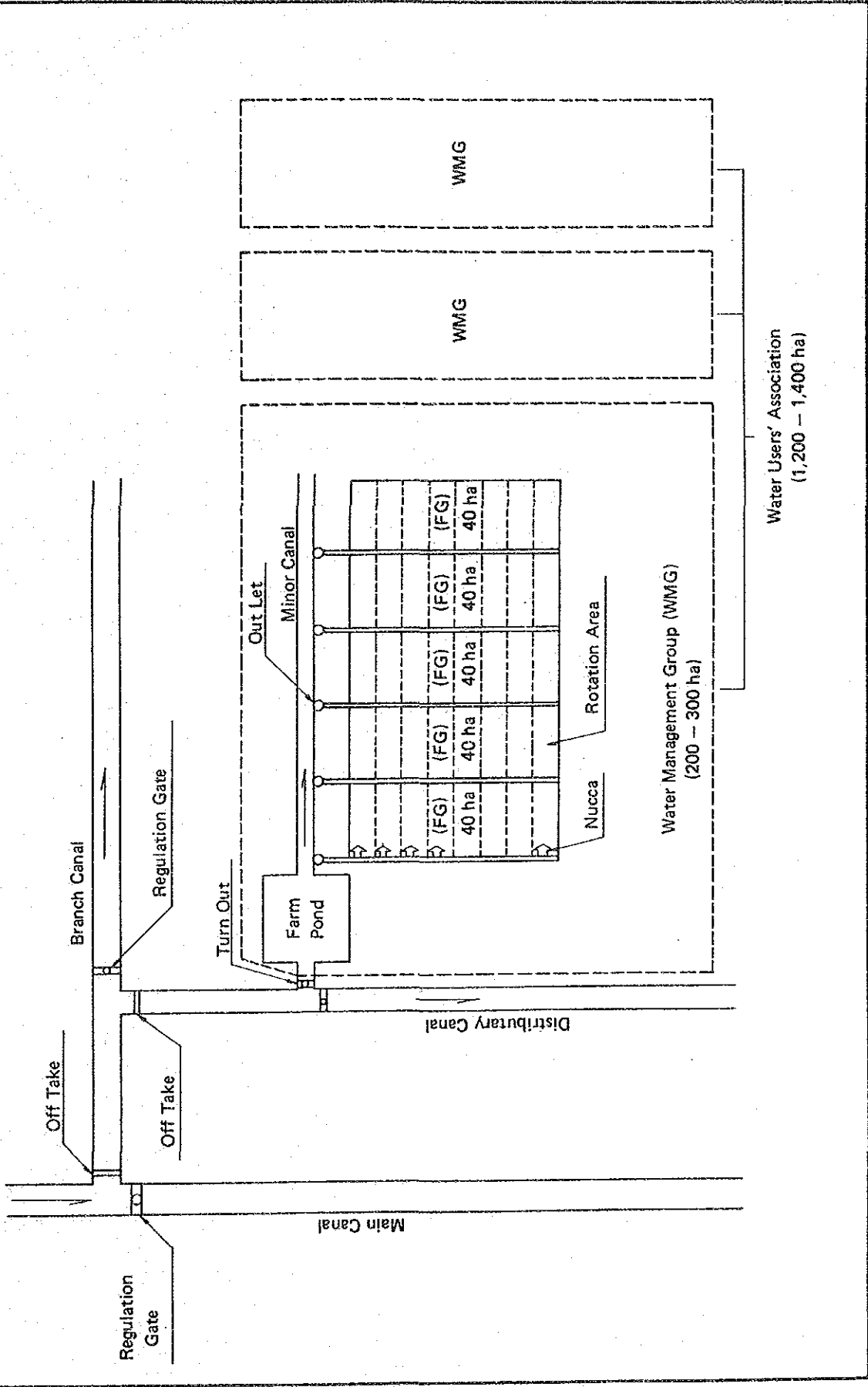


FIGURE -19
ILLUSTRATION FOR ESTABLISHMENT OF WATER USERS' ASSOCIATION
AT IRRIGATION CANAL SYSTEM LEVEL



6. PROJECT EVALUATION

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6.1. Project Cost and Benefit

The Project includes the plan to supply the irrigation water to the experimental fields of NARC. However in considering its characteristics as experimental farm, the estimated benefits and costs of the experimental fields are excluded from the project evaluation, although required water demand is included in the Project.

The project cost and benefits are estimated for 50 years of the project life on the basis of constant price as of 1987.

Project Cost

The total project cost for the proposed commanded area of 6,600 ha (16,300 acres) is estimated at 954.8 million Rupees (144,700 Rs/ha, 58,500 Rs/acres) in financial value, which is equivalent to 799.8 million Rupees (121,200 Rs/ha, 49,000 Rs/acres) in economic value.

The operation and maintenance cost of the project reaches 4.4 million Rupees per year (662 Rs/ha, 268 Rs/acres) on the financial basis and 3.7 million Rupees per year (563 Rs/ha, 228 Rs/acres) on the economic basis.

Cost Allocation

(unit: million Rs.)

Items	Total (6,600 ha)		Service Area (6,100 ha)		NARC Area (500 ha)	
	Financial	Economic	Fi.	Eco.	Fi.	Eco.
1. Project Cost	954.8	799.8	896.8	752.5	58.0	47.3
2. O & M Cost	4.4	3.7	4.1	3.5	0.3	0.2

Project Benefits

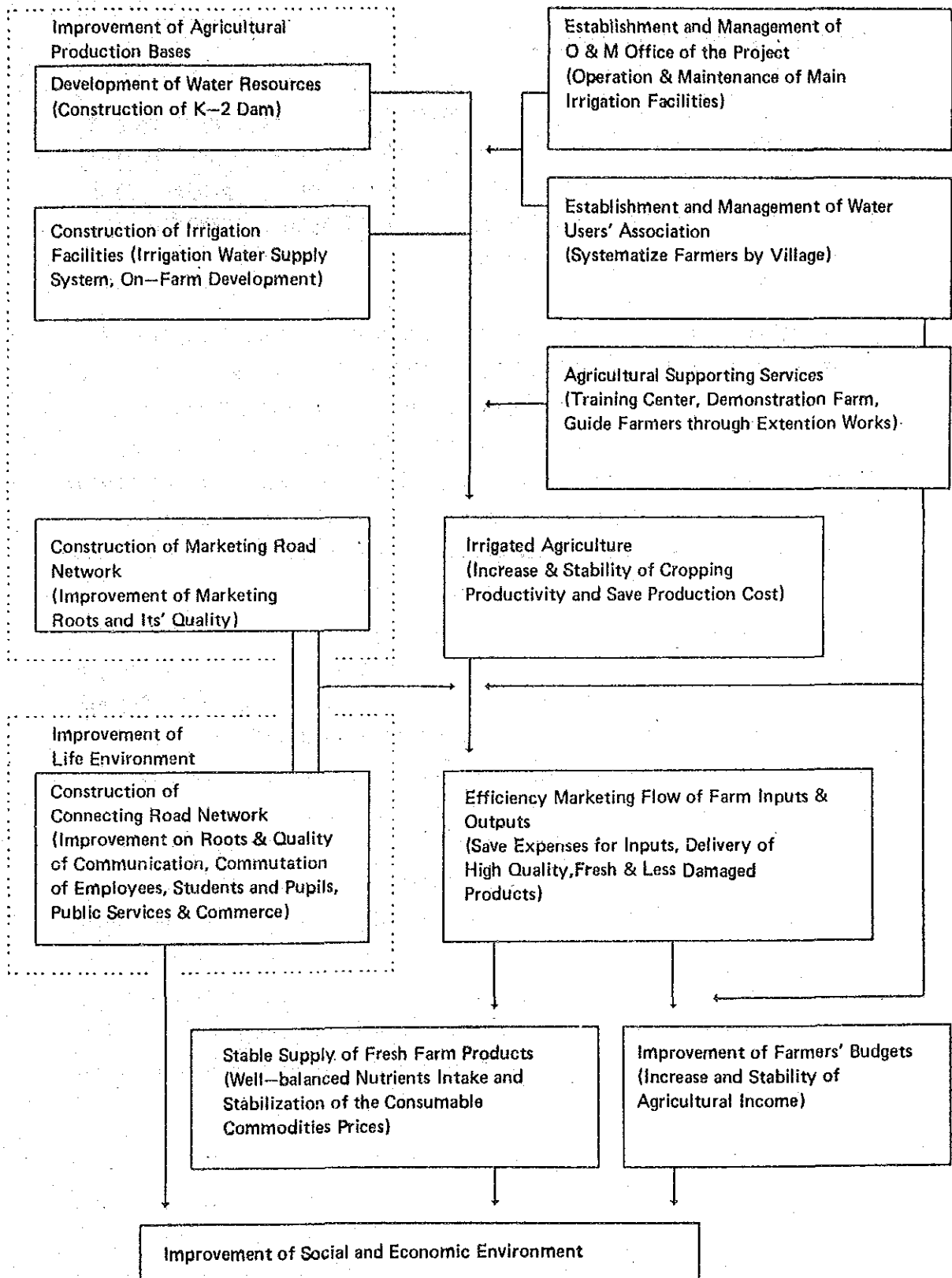
In view of the national economy, implementation of the Project will generate a variety of benefits directly or indirectly (see Figure-20). And the Project benefits can be specified into two, tangible benefits and intangible benefits. The crops production benefits which are tangible and expressive in monetary terms, shall be applied to the comparative study with the project costs.

Crop Benefit (excluded NARC Area)

<u>Items</u>	<u>Without Project</u>		<u>With Project</u>	
1. Commanded Area (ha)	6,930 ^{1/}		6,100	
2. Cropping Area (ha)	7,530		10,180	
3. Cropping Intensity (%)	106		167	
4. Benefit ('000 Rs.)	(Financial)(Economic)		(Financial)(Economic)	
- Net Production	16.0	25.8	213.3	241.2
- Incremental Production (= Benefit)	-	-	197.3	215.4

Note: ^{1/} ... 130 ha of farm land to be submerged by the construction of K-2 Dam is included.

FIGURE -20. IMPACT ON SOCIO - ECONOMIC ENVIRONMENT WITH PROJECT



6.2. Economic Efficiency of the Project

Comparison of Cost and Benefit

The economic analysis of the Project is made by employing the Internal Rate of Return (IRR) method. IRR is the rate that makes the present worth of the cost and the benefit for the project life equal to zero. The Economic Internal Rate of Return (EIRR) of the Project is estimated at 13 percent.

Judging from the fact that the opportunity cost of capital in Pakistan is about 12 percent, EIRR of the Project is not so high as the economic index. However, agriculture is the main industry in the country in spite of low productivity industry, so that, the implementation of the Project will pay the effective availability of resources and an important role in correcting the differences in living standards among the regions in the country.

Farm Budget Analysis

It is revealed that Rs.5,440 of the annual average farm income in the Project Area at present is lower than Rs.21,300 of the average income of Pakistan in the year of 1984 to 1985.

However, the implementation of the Project will make it possible for those farmers to raise their living standard above the average of the rural area of Pakistan and Punjab with the increase in cropping intensity and its yield.

Farm Income With Project

Items	Cultivated Area (ha)	Total Cropping Area (ha)	Farm Household Income ('000 Rs/Year)
1. Future Without Project	1.7	1.8	6.3
2. Future With Project			
- Average	1.6	2.7	64.0
- Vegetable Farm	1.6	3.1	123.8
- Fruit Farm	1.6	1.6	109.1
- Grain Farm	1.6	2.4	10.6

The cost borne by the beneficiaries is the construction cost of the on-farm works and the operation and maintenance cost after completion of the construction works.

The costs of the on-farm facility construction and operation and maintenance of the Project after completion will be burdened by the beneficiary farmers. 20 percent of the total cost of the on-farm facility construction shall be allotted to the farmers in the terms of repayment for seven years after completion, and all the operation and maintenance cost of the Project after completion shall be burdened by the farmers.

According to the result of the analysis, the amount to be allotted to the farmers is 1,184 Rs./ha for seven years after the Project completion and 939 Rs./ha from the eighth years and onward. The burden of the farmers will be rather heavy until the seventh year when the repayment of the cost for the on-farm facility construction is over, although share of the burden in the agricultural income becomes relatively lowered. Therefore, a certain improvement of the repayment condition and subsidy will be needed for seven years after the start of irrigation.

7. RECOMMENDATIONS

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7.1. Recommendations for Project Implementation

The Upper Kurang River Irrigation Project is found technically feasible for construction of the facilities and to have 13 percent of Economic Internal Rate of Return (EIRR); the Project, therefore, can be evaluated technically viable and economically feasible. It is recommended to commence implementation of the Project at the first available opportunity. The early implementation is expected from the following view points.

- Realization of the Project will bring the agricultural production increase, which will allow to raise the living standards of the rural inhabitants of the Islamabad Capital Territory (ICT) and also to correct the income disparity among areas and classes of the people in the Country.
- The Project works include construction of the dam, main/lateral canals, roads, farm pond as well as those terminal facilities at on-farm level etc. The construction of these facilities is expected to increase the acreage of irrigated farm land, which will greatly contribute to development of the agro-economy in ICT and to absorption of the local surplus labor power.
- The Project will enable to have about 220,000 tons of agricultural products annually, which will allow the ICT local economy to be vitalized through development of the facilities in the fields of agri-processing and marketing.
- The water resource development in the Kurang River basin by construction of the K-2 Dam will permit not only the irrigation beneficial areas available by 6,600 ha (16,300 acre), but the water sources stabilized for the Rawal Dam which is supplying domestic water supply to Rawalpindi. In other respect, the K-2 Dam will be greatly helpful to extend a life span of the Rawal reservoir by curbing inflow of sediment into the reservoir.

- The terminal facilities shall be constructed by cooperative works of the Government and the local beneficiary farmers. And the terminal facilities and crop husbandry in the area will enable to prevent soil erosion as a social problems in the Barani area including the Project Area and furthermore to make soil conservation realized. In this view, the Project will be a model of soil conservation to the similar-natured hilly land of the Barani area.

7.2. Recommendations for the Detailed Design and Implementation of the Project

The current Feasibility Study has been carried out based on the topographical map with the scale at 1/21,100 together with various data/information collected during the field works. And the detailed design and implementation of the Project should be carried out with a great care to the following points.

- The executing agency of the Project is an organization to be jointly composed of the governmental agencies such as ICTA, WAPDA, SDO, CDA, PHED, NARC, and MFAC. And it is recommended to establish the organization in the closest cooperation among relevant governmental agencies so as to implement the Project works effectively and smoothly.
- The Project should be implemented with the following basic data/information to be collected and studied.

Preparation of Topographical Maps

- ° Project Area: Topographical map to cover 12,900 ha of the area with scale at 1/5,000.
- ° K-2 Dam Site: Topographical map of cross-section and profile with scale at 1/5,000 and 1/1,000
- ° Canal Route: Topographical map and cross-section

Geological Investigation

- ° K-2 Dam site core-boring and analysis and seismic prospecting

- ° Borrow pit survey
 - ° Embankment material tests
 - ° Geological survey for canal route
- The Feasibility Study has been made on the basis of the topographical map with scale at 1/21,100, as mentioned previously. In particular the study on the present land use and the determination of the Project Area and beneficial area could not but be made based on the said map and some supplemental field survey. Under the situation, the more detailed estimation of the Project Area and the beneficial area should be made according to the topographical map with scale at 1/5,000 which shall be prepared in the course of the detailed design works.
 - A review on the discharge of the Kurang River should be made according to the hydrological and meteorological records observed with the rain gauges and level gauges which were installed by two each in the area by the Study Team during the Feasibility Study. And it is necessary to review the water balance of the Rawal Dam and the K-2 Dam according to the results of the river discharges reviewed.
 - It is quite desirable to carry out the geological investigation and embankment material tests in participation of the geologist, soil expert and dam engineer in the detailed design stage, in taking into consideration the geological conditions of the dam foundation, borrowing of most of the embankment materials from spillway and dam excavation, and the embankment with mixed materials.
 - The canal plan has been made according to the topographical map with the scale of 1/21,100. The re-study for the canal plan should be made on the canal alignment, layout of the related canal structure based on the topographical map with the scale of 1/5,000 to be prepared during the detailed design stage.
 - A thorough study should be made on availability of the pre-cast reinforced concrete flume because this type of flume is easy in quality control and handling.
 - The construction of the K-2 Dam will have to submerge about 300 ha of land (including 130 ha of farm land) and 125 houses. For land acquisition and compensation of properties of the inhabitants in the proposed reservoir area, negotiation and necessary procedures should be followed very carefully in the best understanding of the local people's wishes.

7.3. Recommendations for Raising Project Effects

During and after implementation of the Project, the following conditions should be fulfilled for raising the Project effects smoothly and steadily.

i) Provision of the Terminal Facilities

It is essentially required to provide the on-farm facilities for reaching the target of agricultural production through successful water resources utilization under effective and efficient water management.

The construction works of the proposed on-farm facilities, which should be carried out by beneficiary farmers themselves in principle, shall be implemented under the powerful support and close cooperation of the governmental organizations/agencies for smooth implementation in considerably intricatated topography. Especially, those works shall be completed within the designated construction period by technical and financial assistance of the governmental organizations.

ii) Operation of Rawal Dam and K-2 Dam

The proposed K-2 Dam shall be operated in the link with the existing Rawal Dam in view of the effective utilization of the Kurang River water resource, and the first priority is given to the function as stable source to supplement the water to the Rawal Dam. The operations linked with each other, therefore, shall be practised according to the detailed operation manual to be prepared during the detailed design stage together with full cooperation and close coordination with SDO responsible for the Rawal Dam operation.

iii) Implementation of Irrigated Upland Farming

Efficient irrigated upland farming requires to carry out the following researches, studies, and analysis of the data to be collected.

- To introduce and diffuse the crops and varieties with high suitability to irrigated farming so as to ensure the early achievement of the target of the agricultural production,
- To carry out the measurement of the soil moisture contents by soil types and water requirements by crops in the Project Area and to prepare the irrigation standards covering those items of irrigation water required per one operation and number of the interval days, etc.,
- To develop a furrow irrigation method suitable to the Project Area,
- To encourage deep-plowing and to construct underdrainage in the fruit crop area,
- To formulate fertilization standards by crops,
- To research/study the crop-wise planting patterns, water management by growing stages, seedling method improvement, training method, development of new cropping patterns, plant protection methods, labor saving in farming works, etc., and to prepare the guideline for successful irrigated upland farming, to try to transfer and diffuse these latest developed knowledge and techniques, etc.,
- To establish the reasonable rotational cropping pattern with tree crops and legumes introduced,
- To make a plan for timely distribution of quality seeds, fertilizer, agri-chemicals, and other input materials required, and to organize a system to smoothly distribute these materials,
- To encourage the farmers to make records on their daily farming works, kind/amount of fertilizer and other input materials applied, and also to practise the improvement works for their individual farm management and farming works by their own diagnosis,
- To encourage the local formers to grow vegetables as much as possible and to make a plan for greenhouse farming expected in the future,

- To encourage the local farmers to produce their characteristic farm products on the village basis and to organize cooperative associations for collective works for marketing of such products,
- To give positive guidance for small scale farmers to concentrate their energy to vegetable farming and transfer to greenhouse farming smoothly in the future,

iv) Agri-Supporting System

At present, the agri-supporting services in ICT have been rendered by Technical Transfer Unit (TTU) of NARC. Rainfed farming is dominantly practised in ICT, and consequently, it is necessary to establish the Extension Center of Irrigated Agriculture with TTU as a core for improving and diffusing the irrigated agriculture in the Project Area. And following appropriate measures shall be taken for agricultural production increase in the area and income raise of the local beneficial farmers.

- In the Construction Period:

The construction works of the irrigation facilities including the dam and its related structures are scheduled to be completed for four years after commencement of construction works.

Prior to completion of the construction works, however, the extension workers and the beneficial farmers shall raise consciousness on irrigated agriculture and be trained to learn the related technology of irrigation, since on-farm water management, as a whole, shall be carried out by beneficial farmers themselves.

Under the circumstances, the Extension Center shall be established at the same time as the construction works of the irrigation facilities are commenced so as to render the necessary services for supporting works.

- Period of One to Seven Years after Completion of the Construction Works:

The irrigated agriculture with stable water supply will enable to increase of agricultural production; however, steady production increase for hitting the Project target requires to make application study/research on soil

conditions, suitable crop selection, cropping/ fertilization management, rotational cropping, farm management, so as to realize the planned agricultural production, and the farmers' training for practising applied technology successfully will be necessary for the purpose as well.

- Period of Eight to Fifteen Years after Completion:

The locally best suited cropping and farm management technology shall be firmly established to enable the Project Area to be a prosperous vegetable and fruit production area in the Country.

v) Water Pollution Control and Soil Conservation in the Project Area

According to the physio-chemical analysis and bacteriological analysis of the Kurang River water in the dry season, there have been some coliform bacteria found sometimes in the river water, and only in such case, treatment of water has been taken up as a problem. An agreement, therefore, should be concluded between Pakistani Government and the local inhabitants on water resources development by Project as well as water pollution control in the river. In other respect, excessive felling of the trees to develop new farm land in the Kurang River basin have caused such critical sand wash that ICTA as the executing agency should provide a coordination committee for soil conservation in the Kurang River basin and the like under the close cooperation with the related agencies and organization so as to execute the soil conservation in the area.

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