CHAPTER 1 INTRODUCTION

In 1986, the People's Republic of Bangladesh (hereinafter referred to as "the Government of Bangladesh") requested the Government of Japan to undertake a study on model rural development in the Comilla and Tangail Districts. In response to this request, the Japan International Cooperation Agency (hereinafter referred to as "JICA") conducted a study on the Model Rural Development Project Plan for the Homna and Daudkandi upazilas in the Comilla District from 1988 to 1989 and submitted a report which proposed an integrated rural development master plan composed of the construction of rural infrastructures, encouragement of irrigated agriculture, strengthening of farmers' organizations, etc., with the aim of alleviating poverty and increasing employment opportunities.

In July, 1990, in response to the request made by the Government of Bangladesh to the Government of Japan for grant aid on the priority components and contents selected from the master plan, JICA dispatched a preliminary study team, which confirmed the requested items through a field survey and discussions with officials concerned of the Government of Bangladesh.

As a result, the Government of Japan decided to conduct a basic design study on a model rural development project for the Homna and Daudkandi upazilas. In accordance with this decision, JICA dispatched a basic design study team to Bangladesh from November 17th, 1990 to February 28th, 1991 (From December 8th, 1990 to January 18th, 1991, field work was suspended due to the social unrest in Bangladesh.) for a field survey, data collection and discussions with officials concerned in Bangladesh in terms of the basic design.

Based on the field work results, further studies were conducted in Japan. From July 1st to 12th in 1991, JICA dispatched a study team to Bangladesh for explanation and discussions on a draft report. Finally, this report has been compiled to present the project background and the basic design for the project's facilities and equipment.

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Background of the Project

Bangladesh has 144,000 km^2 of land, of which most is composed of deltas formed by big international rivers including the Brahmaputra, the Ganges and the Meghna. Approximately two thirds of the land area is submerged by floods every monsoon season. 112 million people inhabit this severe land with a high population density of 780 persons/km^2 (1990) and a high population growth rate of 2.3%. Under these severe natural and social conditions, the people of Bangladesh have been facing poverty problems. Agriculture contributes 37% of the GDP, employs two thirds of the labor force and produces 90% of the export goods. 85% of the population live in rural areas (1981). The number of farm households is 10 million, of which 70% are small scale of 0.2 to 1.0 ha. Approximately 45% of the total households in rural areas are landless. Under these circumstances, rural areas especially are suffered from serious poverty problems. Therefore, rural development to alleviate poverty has been one of the most important issues in this country from a social and economical viewpoint since independence.

As for the component programmes of rural development, the Third Five Year Plan (from 1985 to 1990) set up the following:

- Physical infrastructural development; feeder roads, markets and electrification.
- Irrigated agricultural development, drainage and minor flood control; the most important item is irrigated agricultural development composed of minor irrigation schemes, provision of production inputs such as fertilizer and seeds and provision of credit to farmers.
- Production and employment programme for the rural poor; compulsory marketing components, training and other input supplies.

In the draft of the Fourth Five Year Plan, which has yet to be decided officially, the same components as in the Third Five Year Plan are given.

During the Third Five Year Plan period (from 1985 to 1990), rural development was implemented through Rural Develoment Project-2, 3, 4, 5, 6, 7, 8, 9, 12, 13, South-West Rural Development Project, North-West Rural Development Project, Noakhali Rural Development Project-2, Deep Tubewell Project-2, Bhola Irrigation Project, Second Tubewell Project, Integrated Development of Rural Women and Children and Small Farmers and Landless Labourers. The achievement in the period consisted of 435 km of Type B feeder roads, 1195 m of bridges and

culverts, 72 growth centers, 10700 shallow tubewells, irrigation management improvement covering 6488 deep tubewells and 2786 shallow tubewells, formation of 5400 KSSs with 127000 members, formation of 16090 BSS/MBSS/informal groups with 376000 members, etc..

There are two core institutional organizations in the forefront for rural development, which were formed based on past experiences in Bangladesh. One is a two tier system of cooperative societies composed of village level cooperatives (KSS) and their upazila level association (UCCA). A village is a naturally formed community with an existing solidarity within its inhabitants. Therefore, a cooperative formed on the basis of a village can work well in group activities. The upazila level association supports village level cooperatives for the administration and the monitoring of credit, training, etc., which are difficult for a small scale village level cooperative to manage. This system has been fostered to encourage rural people's self-reliant efforts to better their own lives. The Bangladesh Rural Development Board (BRDB) is responsible for the administration of this cooperative system.

The other is a local government called upazila parishad, which is composed of a chairman directly elected by the upazila people, chairmen of union parishads (administrative units under control of the upazila parishad), a chairman of the UCCA, officers representing related agencies to rural development and local administration and other four designated members. This upazila parishad system was established in 1982 as a result of a power decentralization policy for effective and efficient rural development with a combination of the rural people's self-governing and the coordinated activities of officers from agencies concerned of the National Government. As for upazila level public works for roads, markets, canals, school houses, etc., the Local Government Engineering Bureau (LGEB) gives administrative and technical guidance to upazila parishads.

Both the BRDB and the LGEB belong to the Ministry of Local Government, Rural Development and Cooperatives.

2-2 Outline of the Request

The requested items which were confirmed between the JICA preliminary study team and agencies concerned in Bangladesh (the BRDB and the LGEB) are as follows.

(1) The improvement of feeder and rural roads.

(2) The re-excavation of irrigation and drainage cannals and the installation of buried pipelines.

(3) The procurement of floating pumps and low-lift pumps together with the erection of storage houses for low-lift pumps.

(4) The improvement of growth centers and hut markets.

(5) The improvement of school houses.

(6) The construction of godowns (one for foodgrain and one for fertilizer in each upazila).

(7) The construction of training rooms for Upazila Central Cooperative Associations (UCCA).

2-3 Outline of the Project Area

The project area, the Homna and the Daudkandi upazilas in the Comilla District, is located 50 km east of Dhaka. It is composed of 554 km^2 of flat lowlands extending along the Meghna river and its tributaries, which suffer from annual floods. The population is approximately 730 thousand with a density of 1,330 persons/km^2, which is 1.8 times higher than the national average. The major industry is agriculture with some cottage manufacturing industries such as rice mills and jute mills related to agriculture and tertiary industry. Among the crops grown in the 43,000 ha cultivated area of the Project area, rice is dominant and the other important crops are wheat, potato, jute and vegetables. Annual floods and the lack of irrigation facilities mainly constrain agricultural development in the Project area, although the acreage irrigated by such measures as low-lift pumps, tube-well pumps and other facilities has reached 29% of the cultivated area as well as improved agricultural technology such as the application of high yield varieties and fertilizer has been introduced to some extent. In a few words, the project area is a typical Bangladeshi example of a rural area which suffers severe poverty problems.

CHAPTER 3 PROJECT OUTLINE

3-1 Objective

The objective of the Project is to develop rural infrastructures, agriculture, employment and income opportunities which will contribute towards poverty alleviation.

3-2 Study and Examination on the Request

This Project is to implement integrated rural development, composed of roads, irrigation and drainage facilities such as canals, minor-discharge pumps and pipelines, school houses and UCCA facilities including training facilities and storage houses, in the Daudkandi and the Homna upazilas in the Comilla District.

As mentioned in section 2-1, Chapter 2, in Bangladesh, rural areas not only play an important role in terms of social and economical aspects but also they especially are suffered from serious poverty problems. Therefore, it is a very significant move to encourage rural development aimed at poverty alleviation in accordance with a most important Bangladeshi governmental policy.

The Government of Bangladesh has promoted rural development since its independence through the execution of its own policy as well as projects assisted by international organizations and donor countries. The basic strategy for rural development has been as follows:

(1) To efficiently and properly execute with the participation of rural people the development of rural infrastructure including roads and markets, irrigation facilities etc. as well as local administration through upazila parishads, which were established as core local governments with the function to combine the activities of central government agencies with the self-governing of rural people.

(2) To motivate rural people to make self-reliant efforts to better their living through the fostering organization of two-tier cooperative systems as well as through the encouragement of its activities including the extension of improved farming techniques, provision of agricultural credit and input, vocational training, and promotion of family welfare.

In rural areas where infrastructures are mostly undeveloped and the people are uneducated and in serious poverty, development projects tend to be less effective unless there is the development of major infrastructure components and the encouragement of rural people's efforts towards better production and living standards to be executed in an integrated and balanced manner. Thus the concept of integrated rural development has been formed. In Bangladesh, integrated rural development has been introduced and implemented.

This Model Rural Development Project is aimed at the realization of a more remarkable and comprehensive impacts by intensively investing into integrated development in a relatively small project area, while most of the rural development projects in Bangladesh have usually been implemented rather extensively in wide project areas. Besides, the Project area is a typical Bangladesh rural area, which suffers from floods every monsoon season, and is located in the Comilla District, to which a leading role has been given in the progress of rural development in this country. Accordingly, this Project is expected to present an appropriate model for rural development in Bangladesh.

Among the requested components of rural infrastructural development is the improvement of roads which are important and basic measures to secure traffic, communication and transportation needed for agricultural and other industrial productions, the extension service of improved agricultural technology and other activities regarding people's daily lives and local administration. Since roads in the Project area remain in serious condition with a lot of gaps, eroded embankments and damaged bridges, it is vital to improve selected important routes as to secure traffic even in the rainy season. The feeder A road, the second most important trunk route following the national highway (running across the Project area from west to east) in the Project area, connecting the Homna Upazila headquarters with the national highway, should be upgraded by replacing the existing brick pavement with a more solid pavement structure. With regards to the improvement of feeder B roads, most of them, which have suffered erosion due to floods or have not been shaped in standard cross sectional sizes, need additional embankments for their rehabilitation. However, this earth work may require troublesome land acquisitions, which is difficult for a grant aid project with a short construction period. It is considered more apporopriate for the Project to concentrate on the construction of pavement and bridges, which is relatively difficult for the LGEB to implement. Results from discussion between the JICA Study Team and the LGEB concluded that the necessary embankments would beforehand be constructed by the LGEB's initiative through the growth center connecting road program under the World Food Program (WFP) and pavement would be laid on the completed embankment by the Project.

The improvement of markets, growth centers and hut markets, which play a key role for rural people to sell their products, to purchase commodities needed for their daily lives and to obtain employment opportunities, is considered to be a great deal more effective when planned to be connected with access road improvements.

Irrigation and drainage, which has always been a key component in rural development projects in Bangladesh, is also an indispensable component to increase agricultural production in this Project area, where cropping areas and the introduction of improved seeds and technology are restricted in the rainy season due to the impact of annual floods. Such measures for irrigation as re-excavation of canals and the installation of pumps will be able to a great deal enlarge cropping areas to increase agricultural production in the dry season, when improved technology can effectively be applied

without inundation problems. The increased production will raise farmers' incomes and thus bring about positive impacts to the regional economy. Excavation of canals will be conducted by means of manual labor, which will provide employment opportunities during the construction period.

Floating pumps are set to lift water for canals whose beds are too high to excavate so that they can intake water by gravity. Floating pumps require an investment cost per unit water discharge with the same head which is more than 10 times that of low-lift pumps. In addition to floating pumps, low-lift pumps are needed to lift water from canals to fields. Therefore, an irrigation system using floating pumps needs about a twofold fuel cost compared to a system intaking water by gravity. Accordingly, floating pumps are given less priority from their economical and operational disadvantages.

An upazila central cooperative association (UCCA) is a key organization to encourage cooperative activities in an upazila. One of its major activities is the training of members and employees of the UCCA and primary cooperative societies on cooperative activities, improved farming techniques, family welfare, vocational skills, etc. Training facilities are essential for this Project to promot training activities. Storage houses for management of low-lift pumps for rental to cooperative members as well as godowns for food grain storage and fertilizer supply are planned. The construction of these facilities will significantly be instrumental but not sufficient to encourage the activities of and to strengthen the organization of the UCCA-KSS system. In parallel, raising funds for the expansion of activities and the strengthening management capabilities will be necessary, which is beyond the scope of a grant aid project. However, income from the rental of pumps to be procured by the Project will be able to be utilized for funds. Furthermore, technical cooperation through the dispatch of experts and overseas cooperation volunteers (JOCV) from Japan would be remarkably effective to support the activities and management of the UCCA.

The rehabilitation of school houses has not been included as a component in rural development projects so far implemented in this country. This Project has planned to incorporate schools as to contribute to the national key policy to promote compulsory primary education as well as for the attached function of community centers. It is said that upgrading the educational level of rural people through the extension of primary education will bring about significant productivity increases in the long run, which will also encourage rural development.

3-3 Project Description

3-3-1 Executing Agencies and Operational Structure

It was confirmed between Bangladeshi and Japanese sides that the responsible agency for this Project would be the Ministry of Local Government, Rural Development and Cooperatives (MLGRDC) and the executing agencies would be the Local Government Engineering Bureau (LGEB) and the Bangladesh Rural Development Board (BRDB).

These two executing agencies are to be in charge of the following components respectively. And operation in the Project area will be carried out by upazila parishads and the UCCAs under the respective control of the LGEB and the BRDB.

LGEB-upazila parishads: Roads, growth centers, canals, pipelines and primary schools. As for the feeder A road, the LGEB is responsible only for construction, and maintenance is to be executed by the Road and Highway Department (RHD).

BRDB-UCCA: Low-lift pumps and UCCA facilities.

During the implementation stage of the Project, the LGEB plans to set up an organization and to post the required personnel shown in Fig. 3-1 and Table 3-1.

All components for which the LGEB is responsible are the improvement of existing facilities. Accordingly, the future operation and maintenance of the facilities to be improved shall appropriately be executed by the existing organization of each upazila parishad in collaboration with existing beneficiary associations for deep tube-well schemes for which pipelines are to be installed and the school management committees of the relevant primary schools.

During the implementation and operation stages of the Project, the BRDB plans to post the required personnel shown in Fig. 3-2 and Table 3-2.

Each UCCA will install an assistant rural development officer who is responsible for training. Each assistant rural development officer will prepare and coordinate the execution of training programs in consultation with the upazila rural development officer under the supervision and support of the BRDB Headquarters and the Deputy Project Director, BRDB, Comilla.

The training materials will be prepared and provided by the Training Material Production Section (TMPS) in the BRDB headquarters, which has produced them for some rural development projects.

Most of the trainers are upazila level officers of cooperative, agriculture, health and family planning, the BADC and other government agencies.

Table 3-1 Required Personnel for LGEB Portion

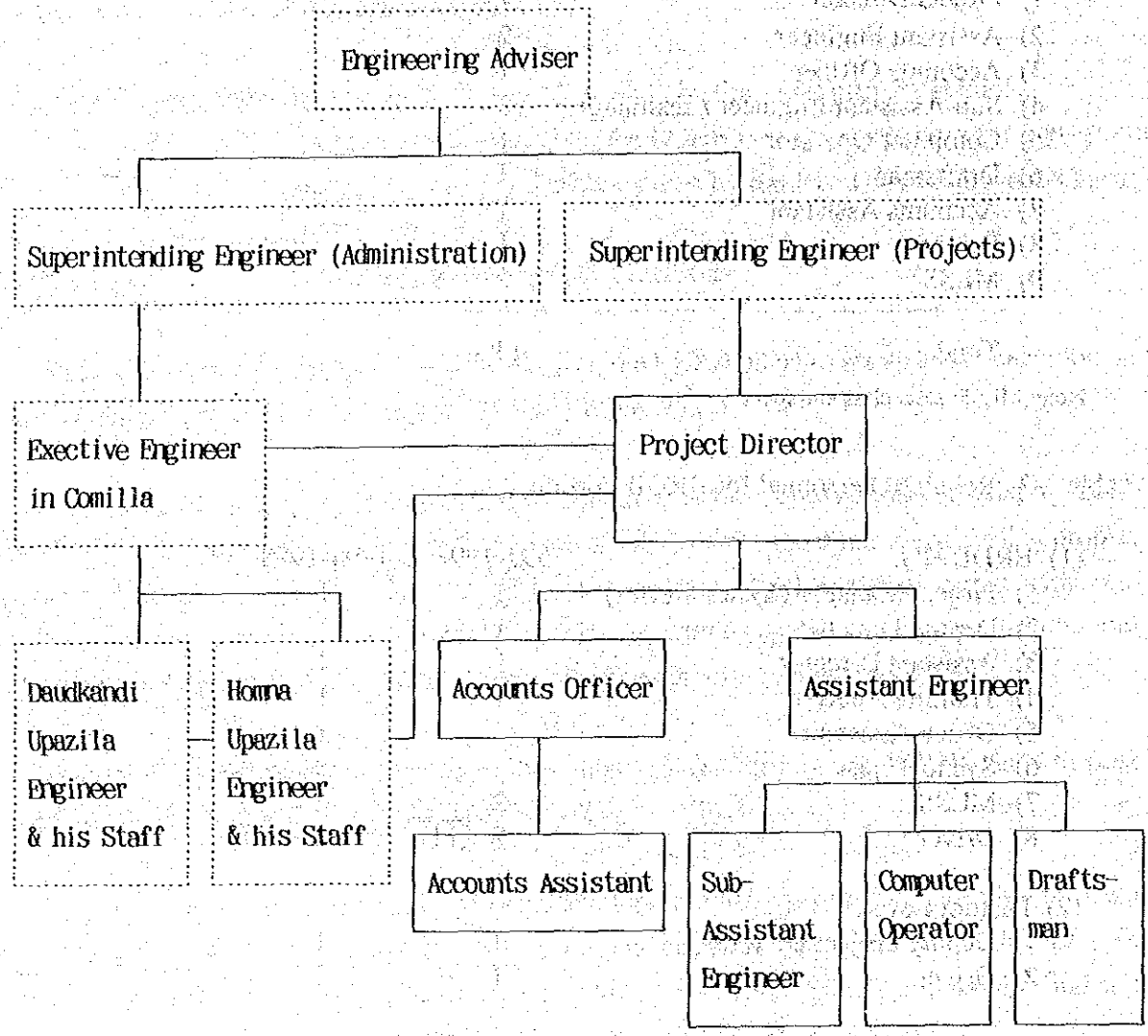
1) Project Director	1
2) Assistant Engineer	2
3) Accounts Officer	1
4) Sub-Assistant Engineer / Estimator	3
5) Computer Operator	1
6) Draftsman	1
7) Accounts Assistant	1
8) Driver	1
9) MLSS	2
Total	13

Note: MLSS; Low class employee

Table 3-2 Required Personnel for BRDB Portion

	1991-1993		1994-1998	
(1) BRDB HQ.				
1) Project Manager (Joint Director)	1		1	
2) Deputy Director	1		1	
3) Assistant Director	1		1	
4) Training Analyst	1		1	
5) Office Assistant	1		1	
6) Syeno Typist	2		2	
7) MLSS	2		2	
8) Driver	2	(11)	2	(11)
(2) District Level				
1) Deputy Project Director	1		1	
2) Driver	1		1	
(3) Upazila Level				
1) ARDO (C/P of Senior JOCV)	2		2	
2) Organizer (C/P of JOCV) (Quilified person in each field)	10	(12)	10	(12)
(4) Grassroots Level				
1) Manager	2		2	
2) Godown Keeper	2		2	
3) Training Attendant	2		2	
4) Driver	2		2	
5) Mechanics	7		7	
6) Cook	2		2	
7) MLSS	4		4	
8) Guard	6	(27)	6	(27)
Total	52		52	

Note: ARDO; Assistant Rural Development Officer



Existing Posts

New Posts for the Project

Fig. 3-1 LGEB Organization Chart

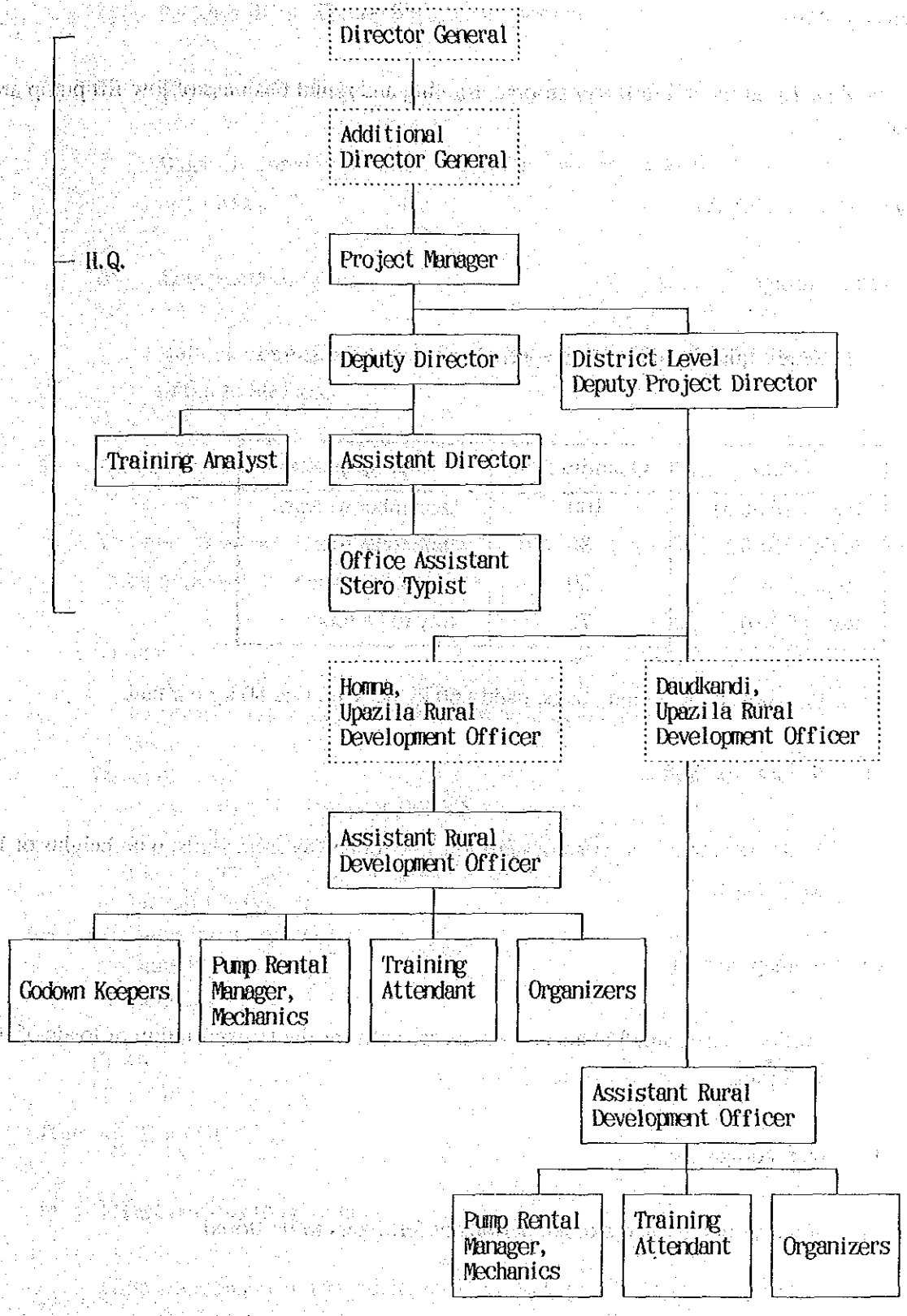


Fig. 3-2 BRDB Organization Chart

3-3-2 Activity plans

Activity plans for grain and fertilizer storage, training and rental business of low-lift pump are given as follows.

(1) Storage (Homna UCCA)

1) Grain storage

a) Kinds, quantity and storage periods of grain to be stored

Grain	Quantity (ton)	Storage period
Paddy (Aman)	100	December to April
Paddy (Boro)	80	June to October
Rice (Aman)	80	January to April
Rice (Boro)	70	July to October

b) Packing shape: Gunny bags, paddy 60 kg per bag, rice 80 kg per bag.

c) Storage method

Bags are stored in a crisscross fashion, one foot away from walls, with heights of 10 to 15 bags.

d) Transportation

Bullock carts, small boats and trucks are used for the transportation of loads of 0.6 to 5 tons.

2) Fertilizer storage

a) Kinds, quantity and storage periods of fertilizers to be stored

Fertilizer	Quantity (ton)	Storage period
Urea	600	Two seasons
TSP	150	Two seasons
MOP	50	January to March
Zinc Sulfate	2	July to October

b) Packing shape: Gunny bags, 50 kg per bag.

c) Storage method

Bags are stored in a crisscross fashion, one foot away from walls, with heights of 10 to 15 bags.

d) Transportation

Bullock carts, small boats, trucks and barges are used for transportation with loads of 0.5 to 300 tons.

3) Annual Income and Expenditures

The annual income and expenditures for marketing business run by the Homna UCCA using godowns are estimated as follows.

Income			
Grain	: Sale 1,600,000 TK - Purchase 1,200,000 TK	=	400,000 TK
Fertilizer	: Sale 4,000,000 TK - Purchase 3,300,000 TK	=	700,000
Total		=	1,100,000
Expenditures			
Pay for store keepers	: 24,000 TK x 2 persons	=	48,000
Pay for Truck drivers	: 21,000 TK x 2 persons	=	42,000
Pay for guards	: 16,500 TK x 2 persons	=	33,000
Fuel & Carrying	:	=	80,000
Bags, labor cost, etc.	:	=	16,000
Bank interest		=	421,000
Total		=	640,000
Profit		=	460,000 TK

(2) Training (Both UCCAs)

1) Target persons to be trained

Target persons to be trained are leaders and general members of village level cooperative societies. There are 484 primary societies with 17,700 members in Daudkandi and 289 primary societies with 16,433 members in Homna. Each cooperative has a manager, a chairman and a model farmer. It is planned to train newly elected managers, chairmen and model farmers every year. The annual number of trainees will be a half the number of the

total since they are elected for two year assignments. The planned training units are as follows.

- Managers 4 units / day x 47 days (weekly) = 188 units
- Chairmen 4 units / day x 12 days (monthly) = 48 units
- Model farmers 4 units / day x 14 days (2 sessions) = 56 units

Accordingly, the annual training man-days will be given as follows.

- Daudkandi: (47 + 12 + 14) days x 484 men x 1/2 x 0.9 = 15,899 man-days
- Homna: (47 + 12 + 14) days x 289 men x 1/2 x 0.9 = 9,494 man-days

Where the attendance rate is given as 0.90.

2) Major training items

Major training items for managers, chairmen and model farmers will be as follows.

	Manager	Chairman	Model farmer
- Increasing awareness of cooperative movements and general knowledge on cooperative ordinances and rules.	x	x	x
- Management of cooperative societies.	x	x	
- Organizing group activities through cooperative capital formation, credit utilization.	x	x	x
- Cooperative marketing.	x	x	x
- Management of irrigation facilities.	x		x
- Increasing production through improved farming practices.	x		x
- Family welfare (Health, nutrition, family planning)	x	x	x
- Animal husbandry, poultry raising, fish farming.	x		x
- Income generating activities for the rural poor.	x		

Attention should be paid to the training for women, who remain at lower social status compared with men. The above-mentioned cooperative societies include 31 MBSSes (assetless women's cooperative societies) in the Daudkandi UCCA and 13 MBSSes in the Homna UCCA. Women from these MBSSes will be trained as well as men from KSSes and BSSes. In addition, the training programs on sewing and dyeing for women to increase income opportunities will be prepared.

3) Annual Expenditures for Training

The annual expenditures for training are estimated as follows.

Pay for assistant rural development officers :		
66,000 TK x 2 persons	=	132,000 TK
Pay for a training analyst (BRDB HQ) : 62,400 x 1	=	62,400
Pay for cooks : 36,000 x 2	=	72,000
Other employees : 30,000 x 4	=	120,000
Allowances for trainees :	=	507,860
Daudkandi 20 TK/man·day x15,899 man·days	=	317,980
Homna 20 x 9,494	=	189,880
Honorariums for trainers :	=	73,000
Daudkandi : 50 TK/man·dayx4 persons/day x 219	=	43,800
Homna : 50 TK/man·dayx4 persons/day x 146	=	29,200
Training material & others	=	132,740
Total	=	1,100,000

(3) Rental Business of Low-lift Pumps

1) Contract specifications for pump rental

The contract specifications for pump rentals will be studied based on the standard contract form which has been prepared and used by the Bangladesh Agricultural Development Corporation (BADC) for pump rental. Pumps will be leased to cooperatives or groups comprised of cooperative members under each UCCA. The rental fee and security deposit are planned as follows.

- Rental fee: 3,600 TK for pump rental for a season.
- Deposit: 6,000 TK for pump rental for a season.

2) Employment

An irrigation overseer (Sub-assistant engineer) for each UCCA and a Mechanic for each 20 pumps will be employed for the pump rental business.

3) Estimated annual income and expenditures

Homna UCCA

Income		
Rental fee : 3,600 TK/pump x 38 pumps	=	136,800 TK
Interest on deposit : 6,000 TK x 38 x 0.05 (rate)	=	11,400
Total	=	148,200

Expenditures

Pay for a overseer : 56,000 TK x 1 person	= 56,000
Pay for mechanics : 28,000 TK x 2 persons	= 56,000
Repair & maintenance :	= 19,000
Total	= 131,000
Profit	= 17,200

Daudkandi UCCA

Income	
Rental fee : 3,600 TK/pump x 104 pumps	= 374,400 TK
Interest on deposit : 6,000 TK x 104 x 0.05 (rate)	= 31,200
Total	= 405,600
Expenditures	
Pay for a overseer : 56,000 TK x 1 person	= 56,000
Pay for mechanics : 28,000 TK x 5 persons	= 140,000
Repair & maintenance :	= 52,000
Total	= 248,000
Profit	= 157,600 TK

(4) Annual Income and Expenditures for the planned UCCA activities

The annual income and expenditures for storage, training and pump rental are summarized as follows.

-Expenditures for training :	1,100,000 TK
-Profit from storage :	460,000
-Profit from pump rental : Homna 17,000, Daudkande 157,000	174,000
Net expenditures	466,000

3-3-3 Outline of Facilities and Equipment

Considering the appropriate scale of the Project in cooperation with the grant aid program, the installation of floating pumps, which is not a priority as mentioned in Section 3-2, has been excluded from the Project's components. The contents of each component have been planned as follows, taking balanced composition of the Project into consideration.

(1) Roads

For the feeder A road connecting the Homna headquarters with the national highway, the second most important trunk route in the Project area following the national highway, pavement of the RHD standard is to be constructed. For the selected sections of feeder B road routes, D-3, D-5 and D-8 in Daudkandi and H-2 and H-4 in Homna, which are important to connect growth centers or neighboring upazilas with the national highway or the feeder A road, pavement of the LGEB standard and bridges are to be constructed. The planned pavement for the feeder B roads will be laid on the embankment, which will have been executed in advance by the Bangladeshi side's initiative through the "Growth Center Connecting Road Program" etc.

(2) Growth Centers

Two growth centers, the Dulalpur Bazar and the Goalmari Bazar, were selected to be improved in the Project, since the improvement of the two markets are considered to be the most urgent and effective, being that they are directly connected with the improvement of their access roads, routes H-2 and D-8. These two markets, located apart from the national highway or the feeder A road, at present mostly depend on boat transportation due to the poor conditions of access roads. The improvement of road networks to be implemented in the Project will provide both the markets with land transportation routes to the national highway, which will enhance the importance of and bring about business expansion of the markets. The market improvement is to include the construction of public market sheds and the improvement of pathways, drainage and sanitation.

(3) Irrigation and drainage Facilities

Canals to be excavated have been selected taking into consideration the Bangladeshi priorities as well as technical and economical advantages. Those which technically need to be expanded beyond the existing canal widths for necessary depth of excavation have been excluded due to their economical and technical disadvantages. Excavation is planned to be conducted by manual labor so as to contribute to the increase of employment opportunities. The labor force is to be mobilized and organized in cooperation with the relevant upazila and union parishads in the same way as earth work for the "Food for Work" program is executed.
Low-lift pumps have been planned to lift irrigation water from the canals to be excavated.

Buried pipelines will be installed at two deep tube-well irrigation schemes, suitable to demonstrate a method to efficiently use water.

(4) UCCA facilities

A training center for each UCCA is to be constructed, which will play a significant role for the promotion of training to improve farming and irrigation management in connection with canals to be excavated and pumps to be installed, to foster cooperative activities and to upgrade family welfare. The training center is planned to furnish lodging accommodations for instructors.

A storage house with a work shop used for the introduced pumps is planned for each UCCA. The work shop will also be able to be used for training on the operation and maintenance of pumps.

As for godowns, only one for 200 tons of grain and one for 400 tons of fertilizer for the Homna UCCA are planned. No godown is planned for the Daudkandi UCCA, considering that there is no urgent need for additional storage capacity around the Daudkandi headquarters, where godowns of the total capacity of 2,000 tons for grain and 4,000 tons for fertilizer exist. On the other hand, there is only 1,000 tons of storage capacity for grain godowns and no fertilizer godown around the Homna headquarters. Therefore, the planned capacity of godowns is expected to be fully utilized.

(5) Primary schools

Four schools have been selected for construction to replace the existing superannuated school houses with less capacity than expected, considering the Bangladeshi priorities, urgencies and construction access. School capacities have been determined based on the criterion that a section be of less than 50 pupils and classes be divided into two parts a day.

Table-3-3 shows the outline of facilities and equipment.

Table 3-3 Project Outline

Project Components	Quantity			Remarks	Executing Agencies
	Total	Daudkandi	Homna		
Road:					
Feeder Road A, Pavement	16.93 km			Gouripur–Homna	LGEB
Feeder Road B, Pavement	31.99 km	21.71 km	10.28 km	D-3, D-5, D-8, H-2 & H-4.	LGEB
Bridge	4 sites	3 sites	1 site	D-5 (L=25.8 m, 12.9 m, RC), D-3 (L=5.3 m, RC) H-2 (L=62 m, Sub. RC, Super. Steel).	
Growth centers	2 sites	1 site	1 site	Market sheds, pathways, drainage	LGEB
Irrigation Facilities:					
Canal Re-excavation	13 canals 63.6 km	9 canals 55.2 km	4 canals 8.4 km	Planned Irrigated Area: Daudkandi 4428 ha, Homna 1080 ha, Total 5508 ha.	LGEB
Buried Pipeline	2 sites 5.23 km	2 sites 5.23 km	– –	Connected with existing DTW schemes. Pipes (PVC, Bore 200 mm).	LGEB
Low-lift Pump (Irrigated Area)	142 sets (2272ha)	104 sets (1664ha)	38 sets (608ha)	Discharge3.4m³/min, Bore 150 mm, Engine 10.5 HP.	BRDB
UCCA Facilities:					
Training Center	2 sites	1 site	1 site	A center has 4 training rooms, lodging accommodations, water supply, sanitation etc.	BRDB
Grain Godown	1 site	–	1 site	200 t	BRDB
Fertilizer Godown	1 site	–	1 site	400 t	BRDB
Pump Storage House	2 sites	1 site	1 site	For planned low-lift pumps, furnished with a workshop.	BRDB
Primary School House (No. of class rooms)	4 schools (25 rooms)	3 schools (13 rooms)	1 school (12 rooms)	Rooms for classes, teachers & storage, water supply & sanitation.	LGEB
Equipment:					
For Primary Schools	1 set	1 set	1 set		LGEB
For UCCAS	1 set	1 set	1 set		BRDB

3-3-4 Operation and Maintenance Plan

(1) Roads

1) Road Pavement

With regard to road structures, this Project is only to execute pavement. However, maintenance of the completed roads should be conducted as to preserve as a whole the function of road structures, which consist of pavement and other work to be implemented by the Bangladeshi side such as embankments, side slope protection and plantation work. Especially careful attention should be paid to periodical inspection during and after the rainy season and quick repairment of the damaged portions of embankment, shoulder and slope, and pavement structures.

2) Bridges

Less requirement of maintenance is adopted as the conception on bridge design, but still routine inspection and maintenance works shall be required especially in the rainy season. The most sensitive portion will be embankment behind both abuttments.

(2) Irrigation Facilities

1) Canals

Excavated canals are to be maintained by dredging sedimented soil on canal beds approximately once in three or four years. This maintenance work will be done by upazila parishads (Upazila Engineers are in charge.) with cooperation of beneficial farmers.

2) Low-lift Pumps

UCCAs will own, maintain and rent to cooperative members low-lift pumps. In principle, pumps are to be rent to and used by groups or cooperatives, whose members will benefit from the lifted water. Pumps are to be collected, examined and repaired at pump storage houses in the rainy season.

To keep impartiality between beneficiaries and non-beneficiaries, an appropriate rental fee is planned to be collected from beneficiaries. Each UCCA will be able to appropriate for its activities the resource, which will be obtained from the collected rents excluding direct expenditures necessary for the pump leasing management. In addition, the UCCA is to collect deposits from beneficiaries on lending pumps. Pump running costs including fuel,

operator and repair costs are also planned to be taken care of by the beneficiaries.

3) Buried pipelines

Pipelines, which are to be installed for demonstration purposes of a method of efficient water use, will be administered by the Daudkandi Upazila Parishad. The actual operation and maintenance work is to be conducted by each cooperative or association of deep tube well schemes to be provided with a pipeline system, under the supervision of the upazila. The operation and maintenance cost is planned to be taken care of by the beneficiaries. The appropriate amount of rent for the pipeline may be paid to the upazila parishad from each beneficiary group.

(3) Buildings

The buildings have been planned to be constructed with reinforced concrete pillars, beams, slabs and roofs, brick walls, cement mortar and sprayed paint for exterior and interior finishing, which require only simple and easy maintenance. Ordinary maintenance work including the replacement of fixtures such as electric lights and the removal of sludge from waste water treatment tanks is required to be conducted.

The electric capacities and annual electric costs for electrical fixtures such as lights and water supply pumps are roughly estimated as shown in Table 3-4.

Table 3-4 Estimated Electric Capacities and Charges

Facilities	Electric Capacity	Annual Charge
Primary Schools	KW	x 1,000 TK
Homna (12 classrooms)	40	44
Itakhola (3 classrooms)	12	11
Jamlkandi (5 classrooms)	18	19
Ichapur (5 classrooms)	18	19
Daudkandi UCCA		
Training Center	33	43
Pump storage house	34	43
Total	67	86
Homna UCCA		
Training Center	30	37
Pump Storage House	31.5	39
Godown for grain	4	3
Godown for fertilizer	6.5	5
Total	72	84

3-4 Technical Cooperation

It is very important for rural development to strengthen and support the activities of the cooperative system, which has been fostered to motivate rural people to make self-reliant efforts to better their own lives. Therefore, the construction of training facilities and storage houses and the provision of low-lift pumps to rent for cooperative members are planned for both the UCCAs. These facilities and equipment should fully be utilized to promote improved irrigated agriculture, training for better production, family welfare and employment, etc. In connection with this, technical cooperation through the dispatch of experts and overseas cooperation volunteers (JOCV) from Japan would be remarkably effective for supporting activities and management of the UCCA. The following plan for technical cooperation is recommended.

(1) Dispatch of a JICA Expert to the BRDB Headquarters

– An expert on rural development, whose counterpart personnel is to be Director, Planning of the BRDB.

– Major duties: To plan rural development strategy, to monitor ongoing rural development projects, to evaluate rural development projects, to advise the Director General on rural development policy.

(2) Dispatch of JOCVs to Daudkandi and Homna UCCAs

– Fields of members to be dispatched: Handycraft, cooperative society, agricultural machinery, public health, etc.

CHAPTER 4 BASIC DESIGN

4-1 Roads

4-1-1 General

Considering the purpose and characteristics of the Project, the following ideas and conditions are taken into consideration in the Basic Design.

1) To consider the use of materials and construction equipment available in Bangladesh, as much as possible.

2) To adopt Bangladesh traditional construction methods as much as possible.

3) To adopt the Design Standards and the Standard Design and Drawings adopted by the RHD and the LGEB with some revisions, if necessary.

4) To adopt local technical standards effect in Bangladesh.

5) Heavy vehicles, cargo trucks etc., to pass on the specified roads and bridges after completion of the Project.

4-1-2 Pavement Design

(1) General

Feeder Road-A is under the control of the Road and Highway Department (RHD) and Feeder Road-B is under the control of the Local Government Engineering Bureau (LGEB). The evaluation of suitable types and cross sections for the pavement structures were conducted through meetings and discussions with the LGEB and the RHD in Bangladesh, and the related organizations in Japan.

The conclusions on the types and cross sections are as follows.

1) Studying several types of pavement, the Bitumineous Seal Coat types, which were proposed by the LGEB and the RHD respectively, were adopted as the most optimal for the Project.

2) Considering the availability of materials and the adaptability of construction methods, both typical cross sections, which were proposed by the LGEB and the RHD, are the most

appropriate ones for the Project.

3) The surface of the bridges to be constructed in the Project, are not covered by bituminous seal coats. The surface of deck slabs for the RCC Bridge is cement concrete and the deck slab of the Steel Truss Bridge is made of steel.

4) The width of Bitumineous Sealed Pavement is 12 feet (3.66 meters).

(2) Design Criteria

The following criteria were established through discussions and studies as to get the best results suitable for the Design.

1) Geometrical design criteria

Crest width 24 feet (7.33 meters)
Pavement width 12 feet (3.66 meters)

2) Live load

H 20 - 44 (AASHTO) --- Two axle truck of 20 tons

3) Typical cross sections

For Feeder Road-A: Shown in Attached Drawings
For Feeder Road-B: Shown in Attached Drawings

(3) Design Standards and Technical Specifications

1) Design Standards

(Feeder Road-A)

"A GUIDE TO THE DESIGN AND CONSTRUCTION OF BITUMINEN SURFACED ROADS IN BANGLADESH – 1987 – RHD"

(Feeder Road-B)

"EARTH WORK MANUAL - 1981 – LGEB"
"A GUIDE TO THE DESIGN AND CONSTRUCTION OF BITUMINEN SURFACED ROADS IN BANGLADESH – 1987 – RHD"

2) Technical Specifications

(Feeder Road-A)

"STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE WORKS – 1990 – RHD"

(Feeder Road-B)

"STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE WORKS – 1990 – RHD"

(4) The Layout of Pavement Improvement for Each Specified Route/Section

The purpose of the road portion of this Project, is to improve road networks in the Project area. As to acquire fruitful results from the project both governments will jointly share the actual working items of the Project as follows.

1) The work items, done or to be done by the Government of Bangladesh

① Improvement or repairs of the damaged road embankment including the soft pavement of road surfaces and slope protection structures.

② Necessary measures to make the contractor, who will conduct the specified pavement improvement work and bridge construction work in the Project, free from the matter of land acquisition.

2) The work items expected to be done by the Government of Japan

① Improvement of pavement along Feeder Road-A between Gouripur and Homna

From a not smooth surfaced brick (HBB) pavement to a bitumen sealed pavement.

② Improvement of pavement along the specified routes and sections of Feeder Road-B

From soft base or damaged brick (HBB) pavement to bitumen sealed pavement, which is more durable.

The Government of Bangladesh will conduct the necessary improvements or repairs of the specified feeder roads prior to the implementation of the work items expected to be covered by grant aid from the Government of Japan.

The location map is shown in Fig. 4-1-1 and the specified remarks for Feeder Road-B routes/ locations, for which bitumen sealed pavement is planned by the Project, are given as follows.

1) ROUTE (D - 3), DAUDKANDI UPAZILA

The present conditions of this road are as follows.

- The road width is 12 to 24 feet and the height of road embankments are around 5 meters above sea level or more.
- In some portions, poor road alignments remain, such as sharp curvatures, etc.
- In most portions, road surfaces are not smooth and have many dents.

The Government of Bangladesh will conduct an improvement program of road embankments along this route, to expand road widths to 24 feet and to embank road elevations to sufficient heights against flooding prior to the improvement of pavement.

2) ROUTE (D - 5), DAUDKANDI UPAZILA

The road conditions of both north and south portions are as follows.

(North portion)

From Feeder Road-A to the 1st gap which has a very narrow and poor wooden bridge crossing canal, the road width is not enough for cargo vehicle traffic.

(South portion)

From the National Highway, Dhaka-Chittagong Highway, to the 1st gap, the road width is 12 to 24 feet and the surface condition is not smooth even in the dry season.

Road alignment is rather good compared to other Feeder Road-B routes in the Project area.

The Government of Bangladesh will conduct the improvement programme of road embankments along this route, to expand the road's width to 24 feet and to embank the road elevation to sufficient heights against flooding prior to the improvement of pavement.

3) ROUTE (D - 8), DAUDKANDI UPAZILA

During these 3 years, 1988/1989 to 1990/1991, the road embankments have been improved by the GCCR Programme, Growth Center Connecting Road Program, and it is planned to be completed within the next fiscal year, 1991/1992. The planned crest width of the road is 24 feet and the elevation will be sufficient against flooding.

4) ROUTE (H - 4), HOMNA UPAZILA

The road embankment improvements on the specified portion, from Homna to the east end of the Homna Union, is under construction by the Food for Work program under the control of the Upazila and it is planned to be completed within the 1991/1992 fiscal year. The planned crest width of the road is 24 feet and the elevation will be sufficient against flooding.

5) ROUTE (H - 2), HOMNA UPAZILA

The present conditions of this road are as follows.

- Road embankments, side slopes and road surfaces have been seriously damaged by flooding especially in 1988.
- There are two big gaps in this route and the construction plan of a new bridge for the 1st gap was established and financed in 1990/1991, and the announcement was done late in 1990. It is expected that the construction work will be started soon.
- It is planned to construct a new bridge at the 2nd gap in the Project.
- The improvement of road embankments has been under going since 1988 by the GCCR Program and it is planned to be completed within the 1991/1992 fiscal year.

The planned crest width of road is 24 feet and the elevation will be sufficient against flooding.

(5) Specified Work in the Project

The specified work in the Project is to improve the existing road surface (pavement) on the specified routes and locations along Feeder Road-A and -B.

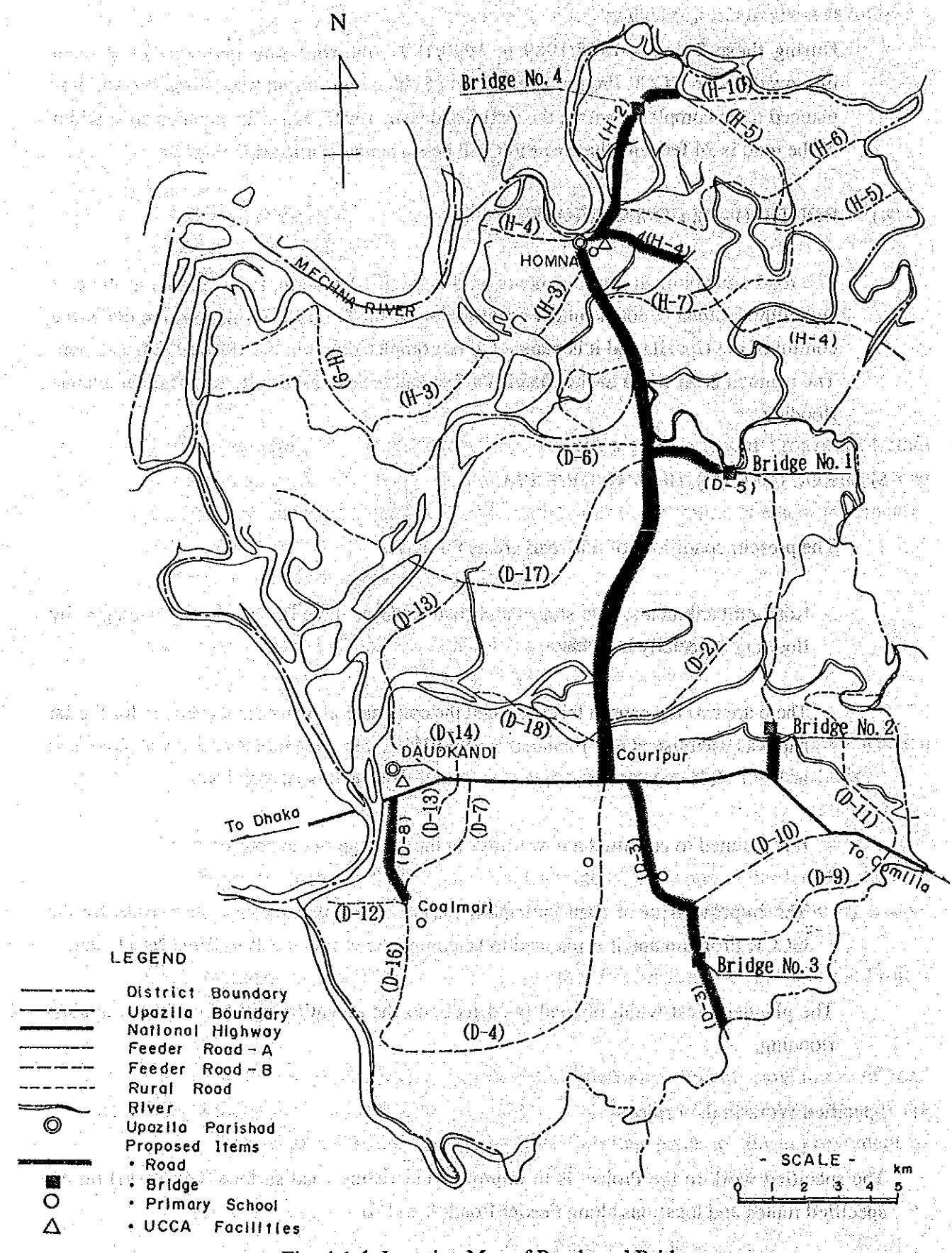


Fig. 4-1-1 Location Map of Roads and Bridges

1) Box cutting of obstacles and unsuitable materials for pavement

2) Construction of the pavement structure with bituminous seal coat

According to the Minutes of the Meeting on January 28, 1991 in Dhaka, it was agreed upon between both Governments that road body (embankment, shoulder etc.) and other related road facilities should be constructed or repaired by the related organizations of the Government of Bangladesh.

(6) Drawings

The drawings are attached.

4-1-3 Bridge Design

(1) General

Through the study and survey in Bangladesh, several characteristic conditions related to the construction of bridges are recognized as follows.

1) Availability of construction materials

① Materials for concrete

– Cement:

Domestic cement products are not sufficient to the market requirement in volume and some 10% of the cement is imported from Indonesia and other countries. Cement is generally packed in bags and only Type-1 cement (ASTM) is available in local markets.

– Reinforcing bar:

Mild steel round bar, dia. 10 to 25 mm, are generally used for bridge structures and deformed bars of medium diameter were mentioned at the construction site of a building in Dhaka.

– Aggregates:

(Fine aggregate)

The sand which is available in the project area, is reported to be too fine for concrete and so it must be mixed with hill sand.

(Coarse aggregate)

Brick chips have conventionally been used for coarse aggregate in concrete in the past but recently brick chips are replaced with stronger coarse aggregates, like crushed stone or boulders, because of the poor strength and durability of brickchip concrete.

② Steel

Thick steel plates of high strength are to be used for steel bridges, they are not produced in Bangladesh and are not available in the markets.

2) Construction Equipment

The present situation of construction equipment for bridge construction works including transportation vehicles is as follows.

① Piling equipment

A drop Hammer is generally used for driving of piles but it is not so popular because of the following reasons.

- Precast concrete piles are not popular due to the lack of production in factories, transportation vehicles and poor concrete strength.

- Lack of towers for pile driving in number and capacity.

On the other hand, Cast in Situ Concrete Piling Equipment is available and used on the National Highway Expansion Project in the Daudkandi Upazila and other many projects.

The availability of the equipment in Bangladesh, more than 10 sets belonging to some firms, was confirmed.

② Crane (Fixed crane & Movable crane)

It is considered to be difficult to prepare the crane(s) in local markets suitable for bridge construction work in the Project due to the lack of numbers and capacity. Very limited local firms can provide cranes of suitable capacity.

③ Concrete Mixer

Several modernized mixing plants are used in large-scale projects, but in most cases small size mixers with engines are used. The control of mixing is generally done in volume.

④ Scaffolding and supporting

Timber is generally used for this purpose.

3) Basic Strategy for Layout of Bridges

Through studies and discussions, the layout of the bridges was decided based on the following ideas.

- RCC (Reinforced Cement Concrete) structure is basically adopted for super structure and sub-structure.
- A steel super structure is adopted only for Bridge No. 4, which has rather long bridge length of 62 meters, because it is not feasible to complete this bridge within the limited construction period of one physical year in case of RCC super structure.
- Pile foundation is adopted due to its durability against river bed scoring.

4) Selected Bridges

The bridges, which were finally adopted, are as follows.

BRIDGE No. 1:

Route & Location: The 1st gap from Feeder Road-A along Feeder Road-B (D-5)

Present Condion: A poor and narrow wooden bridge with timber colums and abuttments

New Bridge:

Width: 24 feet (7.33 meters)

Length: 25.80 meters

BRIDGE No. 2:

Route & Location: The 1st gap from the National Highway (Dhaka to Chittagong) along Feeder Road-B (D-5)

Present Condition: The existing RCC bridge with spread brick abutments completely collapsed due to flooding

New Bridge:

Width: 24 feet (7.33 meters)

Length: 12.90 meters

BRIDGE No. 3:

Route & Location: The 12th bridge from the National Highway (Dhaka to Chittagong) along Feeder Road (D-3)

Present Condition: The existing RCC Slab Bridge with a big hole of 2 meters diameter on the deck slab, which causes seriously harmful effects to vehicle traffic

New Bridge:

Width: 24 feet (7.33 meters)

Length: 5.30 meters (Clear span 4.50 meters)

BRIDGE No. 4:

Route & Location: The 2nd gap from Homna along the Feeder Road-B (H-2)

Present Condition: The existing bridge completely collapsed and lost away, and only several ruined columns remain. Public boat service is available.

New Bridge:

Width: 14.85 feet (4.50 meters)

Length: 62 meters

(2) Design Criteria

The following criteria were established through discussions and studies as to get the most suitable design results.

1) Geometric design criteria

Effective Bridge width: 24 feet (7.33 meters) except Bridge No. 4
In the case of Bridge No. 4, 4 meter effective width is adopted from an economical view point.

2) Loads

① Live Load
H 20 - 44 --- Two axle truck of 20 tons

② Dead Load
- Plain concrete 2.3 ton per cubic meter (t/c.m)
- Concrete (RCC) 2.5 t/c.m
- Steel 7.85 t/c.m

③ Seismic Load
The seismic load is considered in the design through the following formula. (by Equivalent Static Force Method, 3.21.1–AASHTO–1983–)

$$EQ = C \times F \times W$$

where: EQ = equivalent static horizontal force applied at the center of gravity of the structure,
C = combined response coefficient (0.05),
F = framing factor (1.0 for structures where single columns or piers resist the horizontal forces,
W = total dead weight of the structure.

(3) Design Standards and Technical Specifications

1) Design Standards

"Road Structure manual (Part-A & -B)–1989–LGEB"
----- Design conceptions and standard drawings

"Standard Specifications for Highway Bridges–1983–AASHTO"
----- Design standards

Through discussions and studies, the above standards are adopted as the most suitable ones for the Project, agreeable to local conditions and international standards, and both are already adopted by the related organizations in Bangladesh, such as the LGEB and the RHD.

2) Technical Specifications

"Road Structure manual (Part-B)–1989–LGEB"
"Standard Specifications for Road and Bridge Works–1990–RHD"

"The Manual of LGEB" should preferentially be applied for the bridge construction work of Feeder Road-B which is under the control of the LGEB/Upazila, but it does not have detailed specifications compared to the Specifications of the RHD".

Therefore it is recommended to jointly use both specifications.

(4) The Layout of Bridges to be Constructed

Through mutual discussions and collection/collation of data in Bangladesh and Japan, a study has been carefully conducted and the major process and results of the study are described below.

1) Super Structure

The layout of super structure for each bridge is given as follows.

BRIDGE NO. 1

Considering the replacement of the existing bridge by a permanent bridge which is a very poor wooden bridge of about 2.00 meters in width and an insufficient loading capacity for vehicle traffic, the layout of the new bridge is decided as follows.

Type of Super Structure:	Two Span Simply Supported Reinforced Cement Concrete (RCC) Girder Bridge
Length:	(0.45 + 12.00 + 0.45) x 2 = 25.80 m
Width (Effective):	24 feet (7.33 m)

The details of the above structure are based on the standard drawings, the Design Number GB 12 of "ROAD STRUCTURES MANUAL", which are established by the LGEB.

BRIDGE NO. 2

Considering the present situation of the existing bridge which has completely collapsed mainly by the scoring of the river bed below the abutments of the spread foundations, the layout of the new bridge was decided as follows.

Type of Super Structure:	One Span Simply Supported Reinforced Cement Concrete (RCC) Girder Bridge
Length:	0.45 + 12.00 + 0.45 = 12.90 m
Width (Effective):	24 feet (7.33 m)

The details of the above structure are based on standard drawings which are established by the LGEB, the Design Number GB 12 of "ROAD STRUCTURES MANUAL".

BRIDGE NO. 3

Considering the present situation of the existing bridge which has a big hole in the deck slab and some damages on the brick abutments and wing walls with spread foundations, the layout of the new bridge is decided as follows.

Type of Super Structure:	One Span Simply Supported Reinforced Cement Concrete (RCC) Slab Bridge
Length:	0.40 + 4.50 + 0.40 = 5.30 m
Width (Effective):	24 feet (7.33 m)

The details of the above structure are based on standard drawings which are established by the LGEB, the Design Number SC 8 of "ROAD STRUCTURES MANUAL".

BRIDGE NO. 4

Considering the present situation of the existing bridge which completely collapsed and was lost due to flooding, and the length of the collapsed bridge is supposed at about 60 meters, the layout of the new bridge is decided as follows.

Type of Super Structure:	Simply Supported Through Type Steel Truss Bridge of two(2) spans
Length:	(0.50 + 30.00 + 0.50) x 2 = 62.00 m
Width (Effective):	4.50 m (width of steel deck plate is 4.00 m)

The details of the above structure are based on the engineering data and informations

about portable steel truss bridge. In case of Bridge No. 4, economical feasibility was strongly considered in the decision of the width because of the length of 62 m, about 5 times of other bridges, and the present situation of width of similar steel truss bridges along Feeder Road-A, between Gouripur and Homna, which is about 4 meters.

2) Sub-structure

① Abutment

The most important requirements of the sub-structure for the bridges are as follows.

- Sufficient durability for river bed scoring in the vicinity of abutments
- Sufficient durability against erosion of road embankment due to flooding around abutment

As to satisfy the above conditions, a study on the following items was conducted and suitable layouts were adopted as follows.

- RCC material:
  Considering durability of members and covering strengths of concrete to reinforcing bars, Reinforced Cement Concrete with crushed stone is adopted.

- Shape of Breast Wall:
  Cantilevered walls based on footings are adopted as the most tough shape for protection of road embankments behind abutment against erosion due to water stream in canal.

- Slope protection on both sides of the abutment:
  During the flood season, water streams square serious effects to the stability of road embankments especially around abutments. Through the study of these situations, the RCC wing wall on the footing is adopted beside the abutment that is a very tough structure against erosion due to the water stream.

The details of abutment are based on the standard drawing of ATC 30 of "ROAD STRUCTURE MANUAL".

② Pier

As to protect the sub-structure against harmful effects due to the water stream, such as the scoring of the river bed around foundations etc., circular shaped multi column type piers with top beams, cross beams, pile caps and pile foundation are adopted for the bridges No. 1 and No. 4, and are based on the standard drawings, the Design Number PIER-4, of "ROAD STRUCTURE MANUAL".

③ Foundation

Several conditions were considered when studying for a suitable layout of foundation structures for the bridge.

The result from the study of foundations are briefly described as follows.

- Precast concrete piles have no advantages over cast in situ concrete piles because of poor production, and lack of transportation facilities and piling equipment.
- On the other hand, cast in situ concrete piles has expanded its market in recent years due to advantage of adjustability of pile length, arrangement of pile reinforcements to various soil conditions and other unexpected happenings at the site.

Taking into consideration these results, concrete pile foundations are adopted an cast in situ concrete piles are recognized to have advantages over precast concrete.

(5) Specified Work in the Project

The specified work to be designed in the Project, are described as follows.

1) Construction of new bridges at the specified locations

2) Removal of existing collapsed bridges, if any

3) Adjusting of elevations and widths on approach roads including embankments of road bodies and soft bases, if necessary

More detailed descriptions on the specified work item of 2) and 3) are as follows.

(Bridge No. 1) Removal of the existing collapsed bridge and adjusting road elevations and widths on the eastern side approach road will be necessary. On the western side, road embankments are to be constructed by the Bangladesh side and pavement improvements will be covered by the Pavement Work portion.

(Bridge No. 2) Removal of the existing collapsed bridges and adjustments of road elevations and widths on the northern side approach road will be necessary. On the southern side, road embankments are to be constructed by the Bangladesh side and pavement improvements will be covered by the Pavement Work portion.

(Bridge No. 3) Removal of the existing collapsed bridge is only required, but no other supplemental work will be necessary on road portions. Because the embankments of both approach roads are to be constructed by Bangladesh side according to the Minutes of the Meeting signed on January, 1991 between both governments prior to the Project, and pavement improvements on this portion will be covered by the Pavement Work portion.

(Bridge No. 4) Removal of the remaining columns, which will be obstacles for the new bridge, will be necessary.

(6) Drawings

In the Basic Design, the Design Manual, the Standard Drawings and the related documents which have been adopted for design and construction of bridges in Bangladesh, by the LGEB and the RHD, are taken into consideration. Most of the drawings are based on those standard drawings and some minor revisions are done mainly for layout of foundation structures.

The drawings are annexed.

4-2 Irrigation Facilities

4-2-1 Design Strategy

The Project area is adjacent to the Meghna river in the west and about 80 percent of the area is below 4 meters (PWD). Canals in the area, which are considered to have been excavated for drainage purposes originally, are used for irrigation as well and are connected to rivers such as Meghna, Gumti, and Titas. Existing conditions of those canals are generally poor for irrigation purposes in the dry season due to the silt sedimentation caused by floods occurring every year. Re-excavations will be conducted in this project to lower such canals' beds to intake irrigation water by gravity from rivers. This will consequently lead to the intensification of irrigated agriculture in the dry season. These canals are also used for drainage purposes and for boat transportation, therefore these purposes should be taken into consideration in the canal re-excavation design.

Low lift pumps, which are portable engine pumps, are to be distributed to lift water from re-excavated canals to fields or earthen ditches.

Buried pipeline systems which are new irrigation systems in this area are introduced for demonstration purposes towards future more sophisticated irrigated agriculture.

(1) Irrigation Canal Re-excavation

1) Canals to be re-excavated

Canals to be re-excavated are selected from the canals listed in the Master Plan Study Report considering the Bangladeshi priorities, field study results, and survey results.

Canal re-excavation is determined so as not to extend existing canal width in order to avoid new land acquisition.

The canal priority list given by the Bangladeshi side is as follows.

Priority	Name	Length
Daudkandi		km
1	KHIRAI	23.0
2	ASMANIA	9.7
3	DARAGKHOLA	12.0
4	NOORPUR	6.0
5	SATANI-KRISHNAPUR	5.8
6	AMTALI	5.0
7	MAZIBARI	8.0
8	LALPUR-SUNDULPUR	9.7
9	RAMPUR	8.0
Homna		
1	LATIA	2.4
2	MATHABANGA	3.2
3	RAGNATHPUR	3.2
4	OMRABAD	1.6
5	BHASANIA	2.4
6	CHANDERCHAR	4.8
	Total	104.8

2) Design Strategy

In the design of the canal re-excavation the following should be taken into account.

a) A designed canal cross section must have enough capacity for irrigation water discharge required for the command area.

b) The re-excavated canal will have a double cross section to avoid side slope sliding.

c) In case the designed canal bed has to be excavated extremely deeper than the existing level to get water to flow by gravity and the existing canal width has to be accordingly increased to maintain side slopes, then the re-excavation of the canal will be suspended.

d) The longitudinal plan will be level to allow the reverse flow for drainage in the rainy season.

e) The planned elevation of the canal bed will be 50 cm lower than the average low water level of Meghna river in February, which is 1.0 m (PWD).

f) The planned width of the canal bed will be at least 2.0 m considering the workability of the excavation work.

g) Re-excavation and soil removal will be conducted by manual labor so that employment opportunities increase.

(2) Low Lift Pump

There is an elevation difference of 2-3 m between the command area fields and the water level of irrigation canal in the dry season. This situation will not be improved after canal re-excavation because the Meghna river's average low water level in February is 1.0 m while the ground level of the project area is 3.5 m in average and 2.0 m (PWD) at the lowest. Therefore low lift pumps are required to lift water from canals to the fields to be irrigated.

1) The number of pumps required

Low lift pumps are currently used in the project area.

The number of existing LLPs in both Upazilas is as follows:

Upazila	Nos of Existing LLPs
Daudkandi	665
Homna	211
Total	876

Source: Upazila Information 1990

The maximum number of LLPs that can be introduced in this Project area will be obtained by subtracting the number of existing LLPs from the number of LLPs required for the command area of excavated canals. And the number to be procured by the Project will be determined to be 60% of the maximum usable number, considering the acceptabiliy of farmers.

2) Pump Selection

Currently used LLPs (Q=2 cusec) are mostly Chinese made because of lower prices and availability. According to the field investigation, however, Japanese made pumps are strongly requested due to their reliability and easy maintenance. Pump selection will be determined taking this request from the farmers into consideration.

3) Management

Low lift pumps are to be managed by the UCCA on a rental basis. At the end of the irrigation season pumps are collected in a storage house built by the project which includes a workshop. A deposit may be required to ensure the secure return of the pumps. It may be better to lend the pump to a group such as the KSS considering the availability of money for the deposit. Tools and equipment are to be facilitated in the work shop as to repair damaged pumps.

4) Pump transportation equipment

In present conditions, rikishaws or boats may be used for the transportation of pumps in most of the Project area. After the completion of this project, more jeeps and trucks will be used for transportation. For less accessible areas however, power tillers pulling trailers which can run on the farm land will be introduced in this project for pump transportation.

The number of power tillers to be introduced for the transportation of low lift pumps is determined according to the access routes from irrigation canals to the upazila headquarters where a pump store house is constructed or to the main road from which the pumps can be transported by means of truks or other vehicles. From the topographical condition of the project area, the irrigation canals are divided into 10 groups as shown below. A power tiller will be introduced in each group, therefore 10 power tillers will be introduced in the project area, 7 for Daudkandi and 3 for Homna respectively.

1) Daudkandi

1. The southeast of National High Way including D-1(Khirai) northern part and D-3 (Daragkhloa)
2. The southwest of N.H.W. including D-1(Khirai) southern part and D-6(Amtali)
3. The southern part of Gumti river including D-4(Noorpur)
4. The northern part of Gumti river and the east side of Feeder A including D-2(Asmania) and D-7(Mazibari) eastern part
5. The northern part of Gumti river and the west side of Feeder A including D-7(Mazibari) western part and D-8(Lalpur-Sundulpur)

6. The northern part of Daudkandi including D-5(Satani-Krishnapur)
7. The western part of Daudkandi including D-9(Rampur)

2) Homna

1. The northeastern Homna including H-6(Chanderchar)
2. The eastern Homna including H-5(Bhasania)
3. The middle part of Homna including H-1(Latia), H-2(Asmania), and H-4(Omrabad)

(3) Buried Pipeline

1) Design Strategy

There is no existing buried pipeline system in the Project area. However, expectations on the introduction of this irrigation system are rather high. This may be due to the good results of pipeline systems in the Tangail project which was conducted by Germany.

Generally, a buried pipeline system involves the following advantages:

a) Less conveyance loss leading to high irrigation efficiency which contributes to an increased irrigable area.
b) Water can be conveyed up slope.
c) The shortest route can be taken to the farm.
d) Higher leveled water management systems can be introduced compared to that in open channel flow.

Disadvantages include that it requires higher construction cost as well as higher management skills.

The biggest buried pipeline project in Bangladesh is included in the Tangail Project where existing deep tube wells are used as water sources and lifting equipment. The system is an open type pipeline system where the water head in the pipeline is less than 4 m. Pipes used are non-reinforced concrete pipes made in the project site using aggregates produced in the area. This leads to significantly cheaper construction costs, which have raised great interest in the people and lead to the expectations on the introduction of pipeline systems.

Success in the Tangail Project is, however, a result of several years of trial and error involving training local masons for making pipeline systems without leaks. It is therefore difficult for this Project to introduce the locally made concrete pipe system in Daudkandi

and Homna within a limited construction period. After the completion of the pipeline system, it is also necessary to introduce technical training on water management and maintenance of the pipeline system.

From the above, two sites are selected for the buried pipeline system as demonstration farms toward the future high leveled irrigation system. Crops to be irrigated are supposed to be winter vegetables and boro rice whose water requirement are used for the design. The system is planned to be an open type pipeline using an existing deep tube well. PVC pipes are to be used considering the construction period.

2) Site Selection

For the buried pipeline system the site must be 1) on a higher ground level so that the flooded period is shorter, 2) close to a main road for demonstration purposes, and 3) on a farm which has a deep tube well without brick water ways, because percolation loss can effectively be decreased with the installation of the pipes in this case. Transportation of pipe materials must also be taken into account for site selection.

In a priority list given from Upazilas, the following five sites were selected and surveyed for the study.

Priority	Name of Site
Daudkandi	
1	Karikandi
2	Kasirkona
3	Srychil Mohammedpur
4	Horipur
Homna	
1	Kashinpur

(4) The Study on Necessity of Floating Pumps

Floating pumps may be introduced as part of an irrigation system when it is forecasted that an irrigation canal can not provide water by gravity after re-excavation has been implemented.

A floating pump is a pumping system that is installed on a floating pontoon which lifts water onto land through floating pipes. The pump's advantages are 1)the installation cost is relatively lower than the construction of a fixed pumping station since an inlet structure and a shelter are not necessary, 2)land acquisition is not required for the pumping station, 3)suction heads are not affected by river water levels and 4)the pumping site is movable. A typical specification for floating pumps currently used in Bangladesh is as follows: