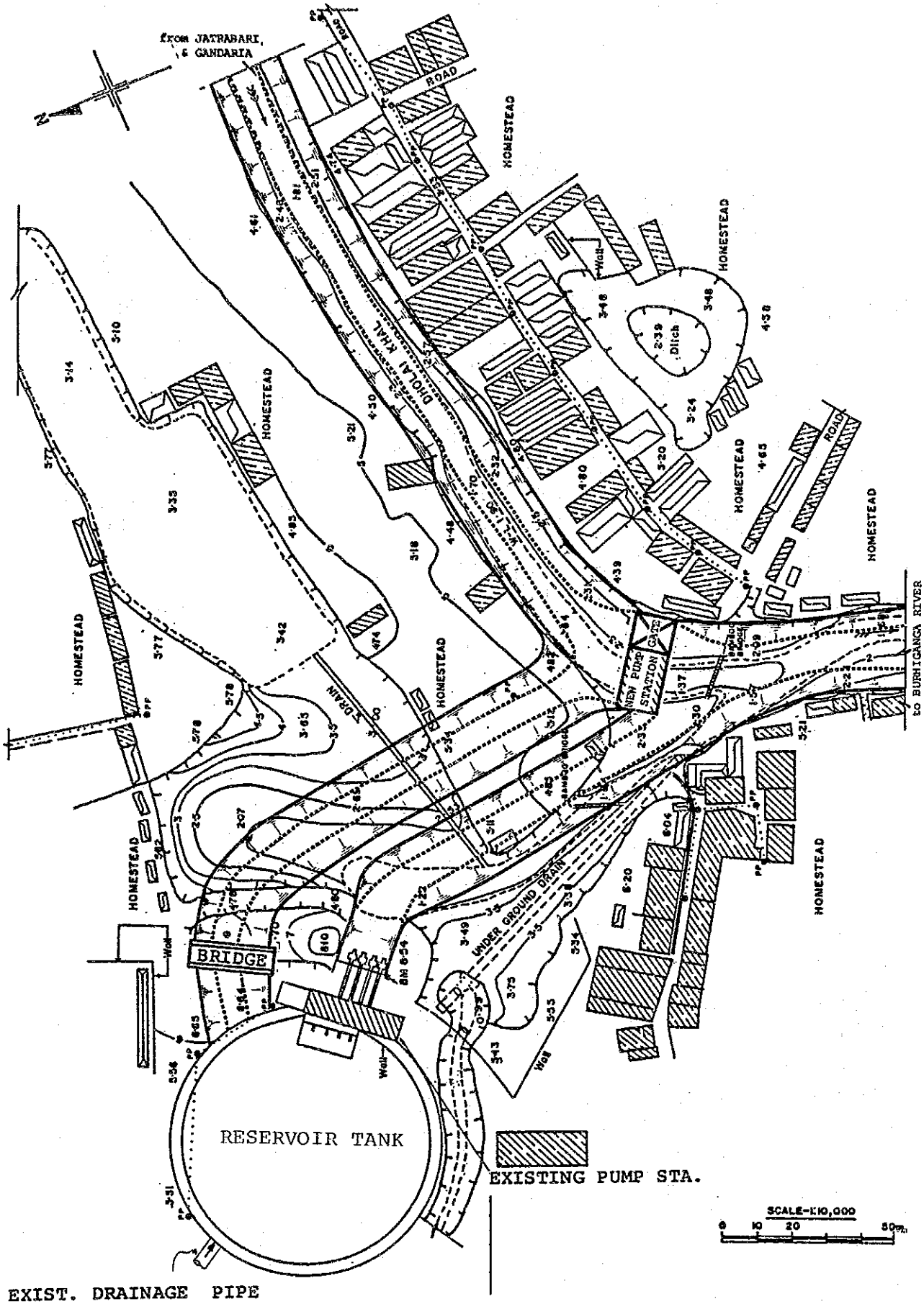

FIG. J.6 LOCATION OF NEW PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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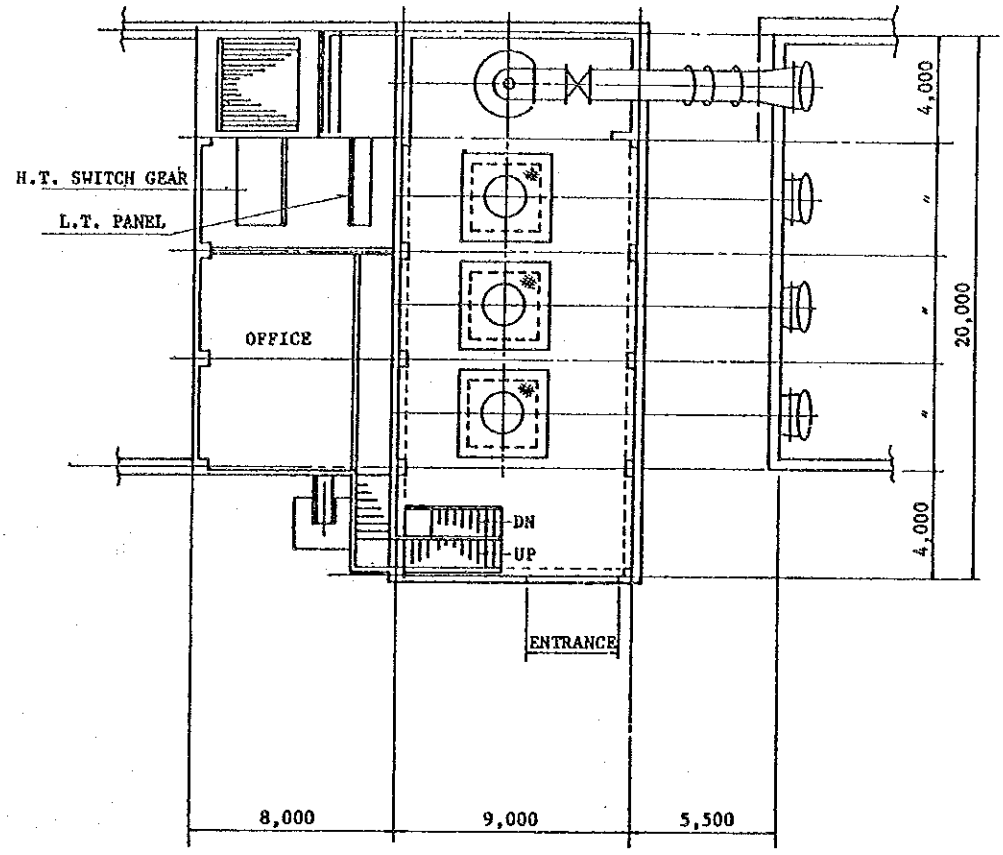
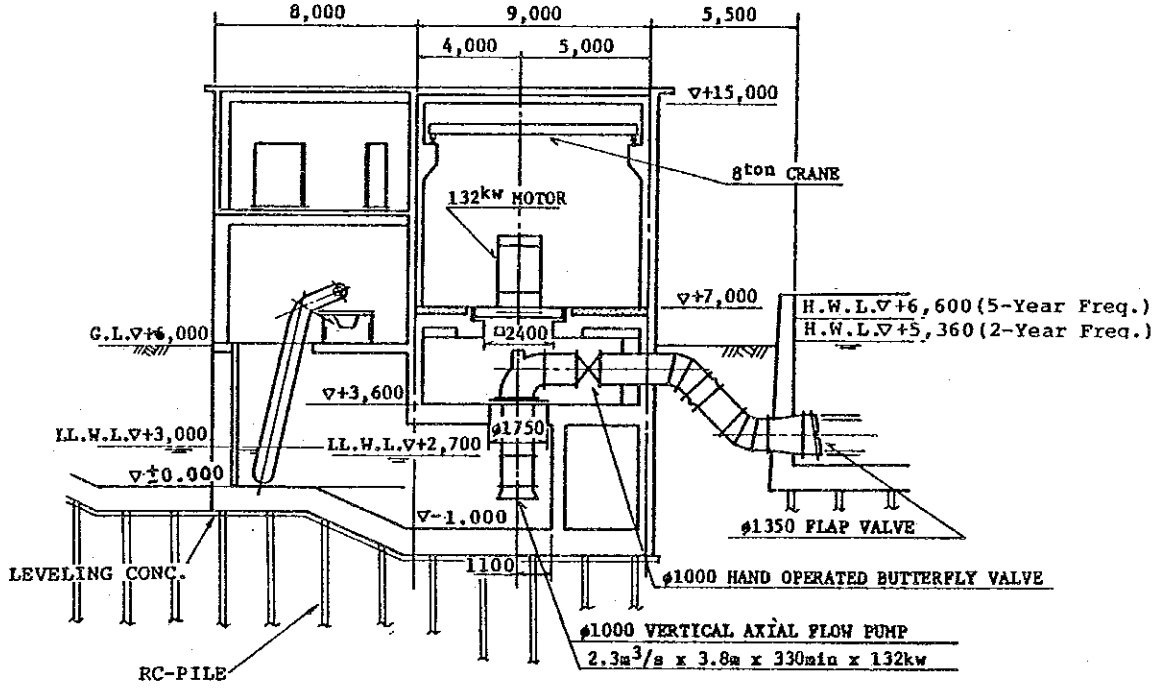
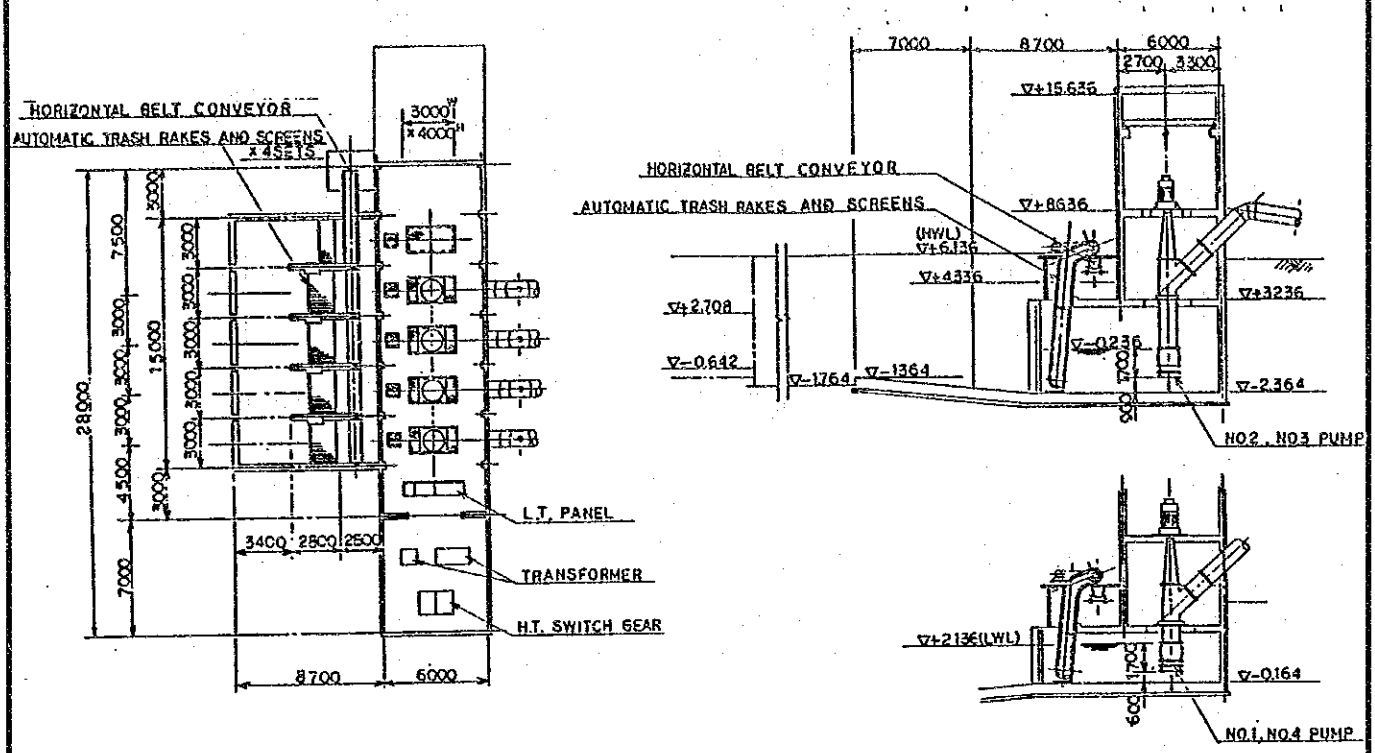




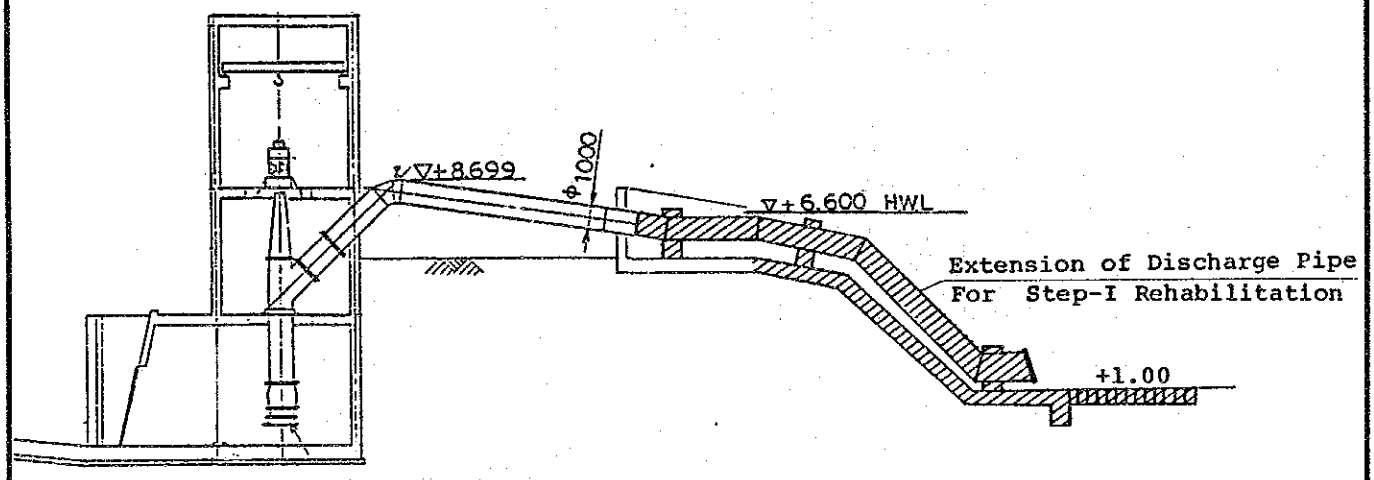
(Unit: mm)

FIG. J.7 TYPICAL DESIGN OF NEW PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH



General Arrangement of Pump Equipment Rehabilitation



Extension Plan of Discharge Pipe

FIG. J.8	REHABILITATION OF EXISTING NARINDA PUMP STATION

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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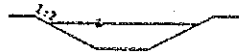
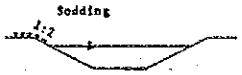
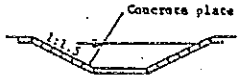
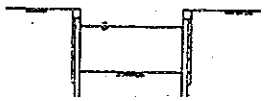
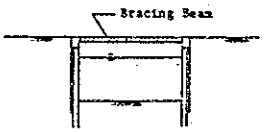
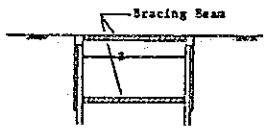
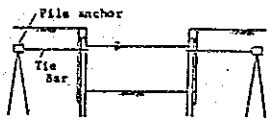
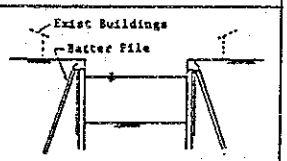
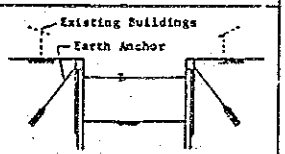
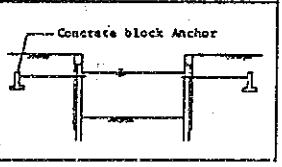
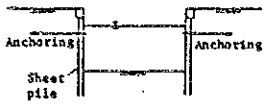
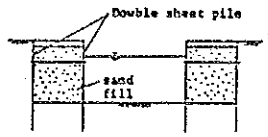
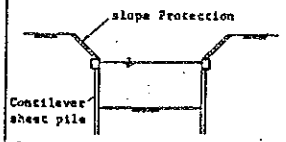
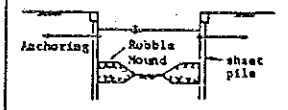
A. Trapezoidal Type

Type		Typical Section
A-1	No Protection Type	
A-2	Sodding Protection Type	
A-3	Concrete Protection Type	

B. Concrete Panel Wall Type

Type		Typical Section
B-1	Cantilever Type	
B-2	Bracing Type	
B-3	Double-Bracing Type	
B-4	Pile anchor Type	
B-5	Batter Pile Type	
B-6	Earth Anchor Type	
B-7	Concrete Block Anchore Type	

C. Sheet Pipe Type

Type		Typical Section
C-1	Anchoring Type	
C-2	Double Sheet Pile Type	
C-3	Cantilever with slope Protection Type	
C-4	Anchoring with Rubble Mound Type	

D. Gravity Type

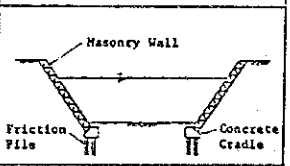
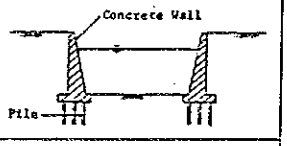
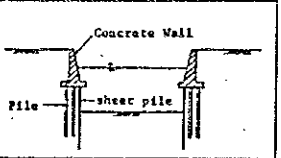
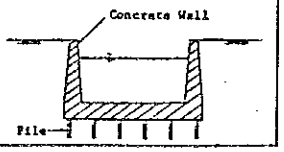
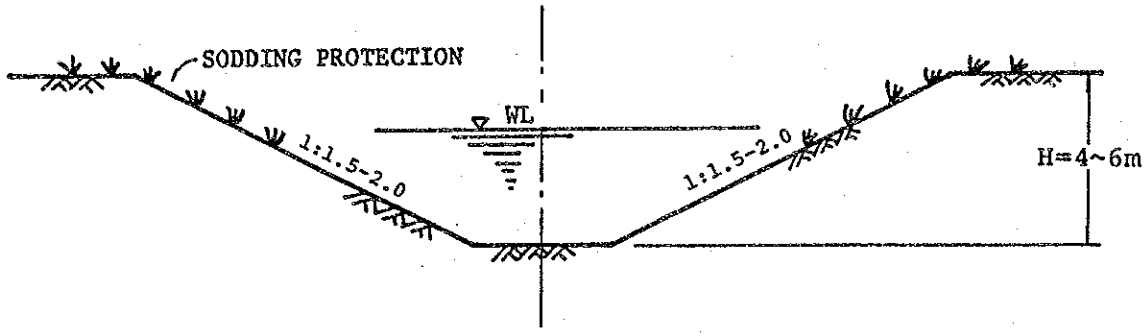
Type		Typical Section
D-1	Masonry Type	
D-2	Concrete Wall Type	
D-3	Concrete Wall with Sheet Pile Type	
D-4	U-Shape Concrete Type	

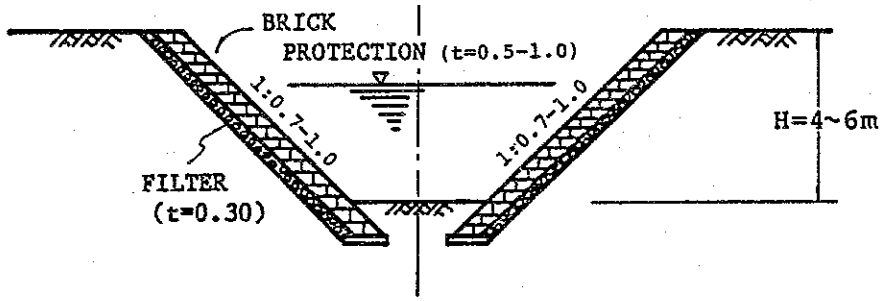
FIG. J.9 TYPICAL SECTION OF RETAINING WALL

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

TYPE - 1 : TRAPEZOIDAL TYPE (1) - SODDING PROTECTION



TYPE - 2 : TRAPEZOIDAL TYPE (2) - BRICK PROTECTION



TYPE - 3 : CONCRETE PANEL WALL TYPE (1) - WITH BRACING BEAM

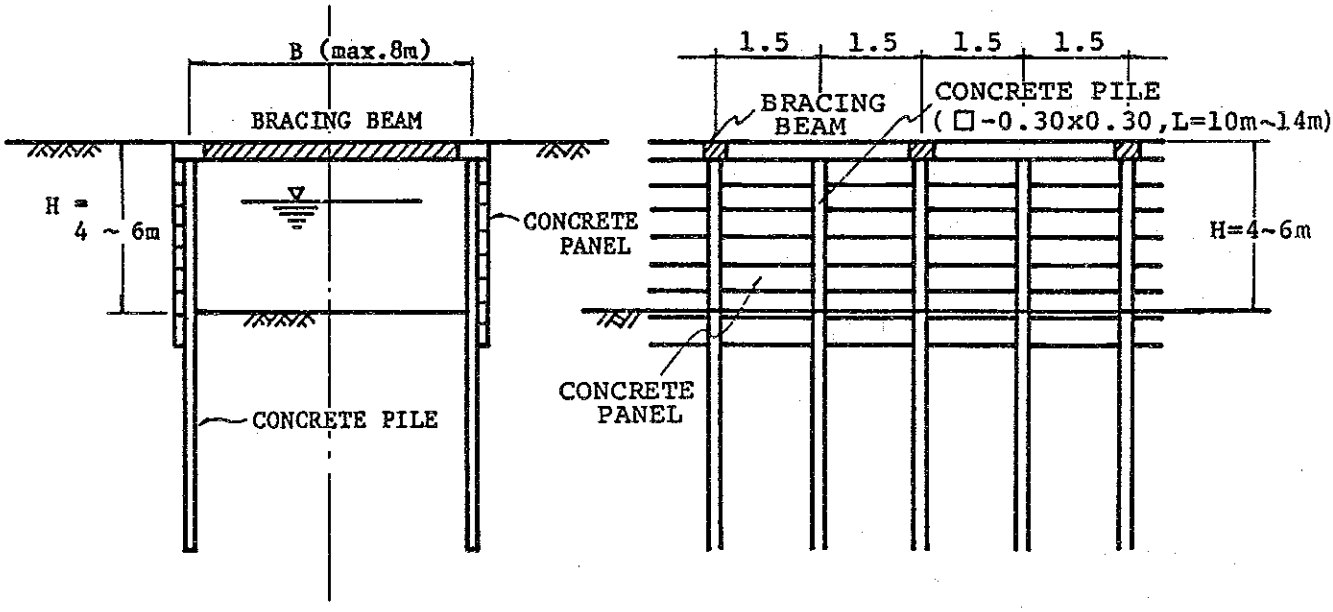
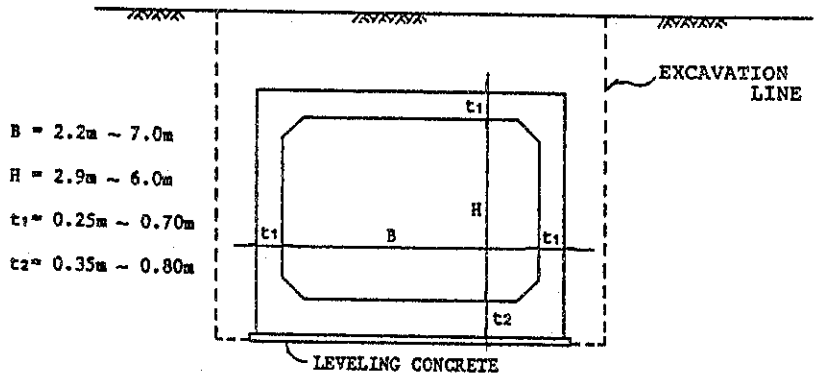
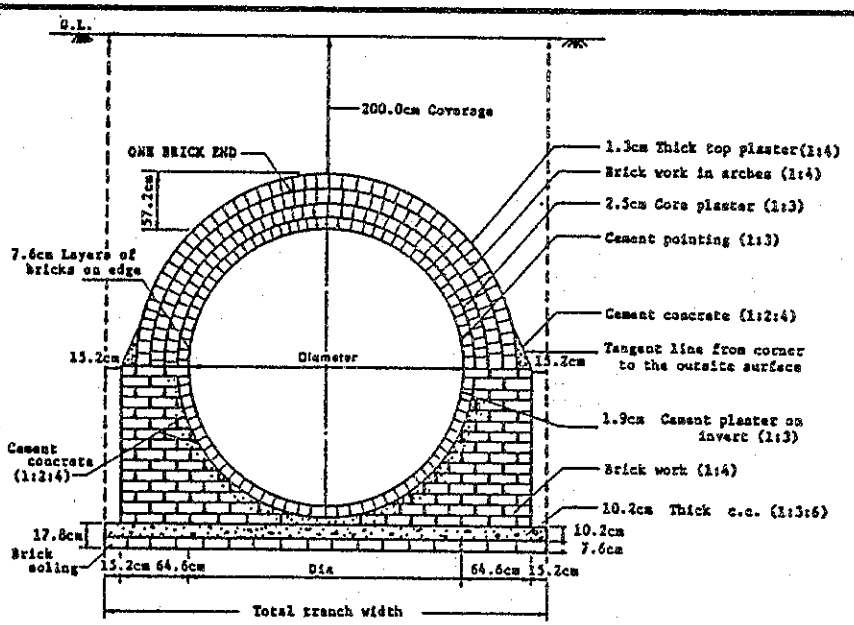


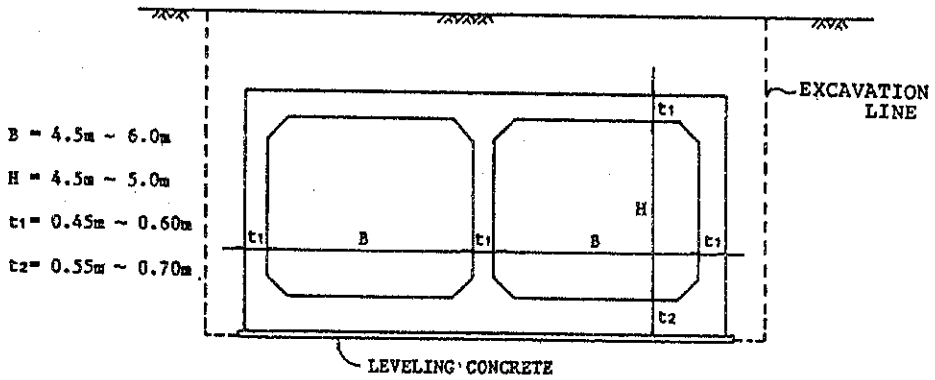
FIG. J.10 TYPICAL DESIGN OF KHAL IMPROVEMENT

TYPE - 1 SINGLE BOX CULVERT





TYPE - 2 DOUBLE BOX CULVERT



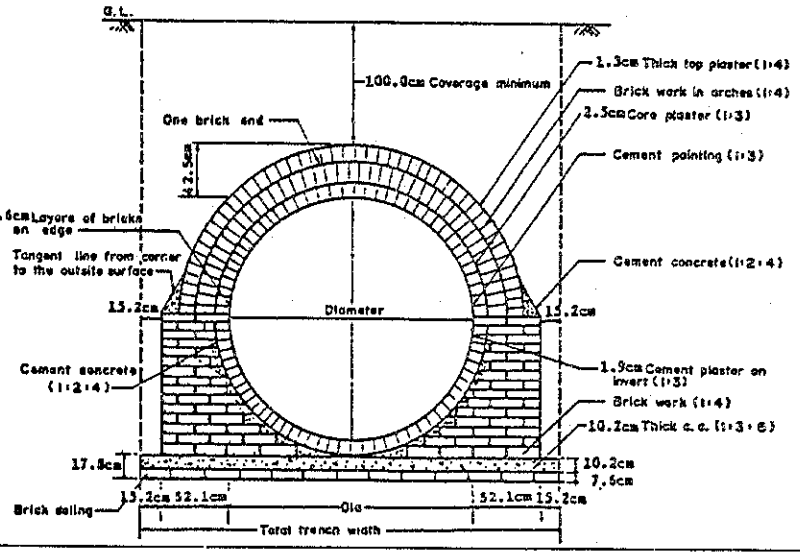


FIG. J.11 TYPICAL DESIGN OF RC-BOX CULVERTS AND BRICK PIPES

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

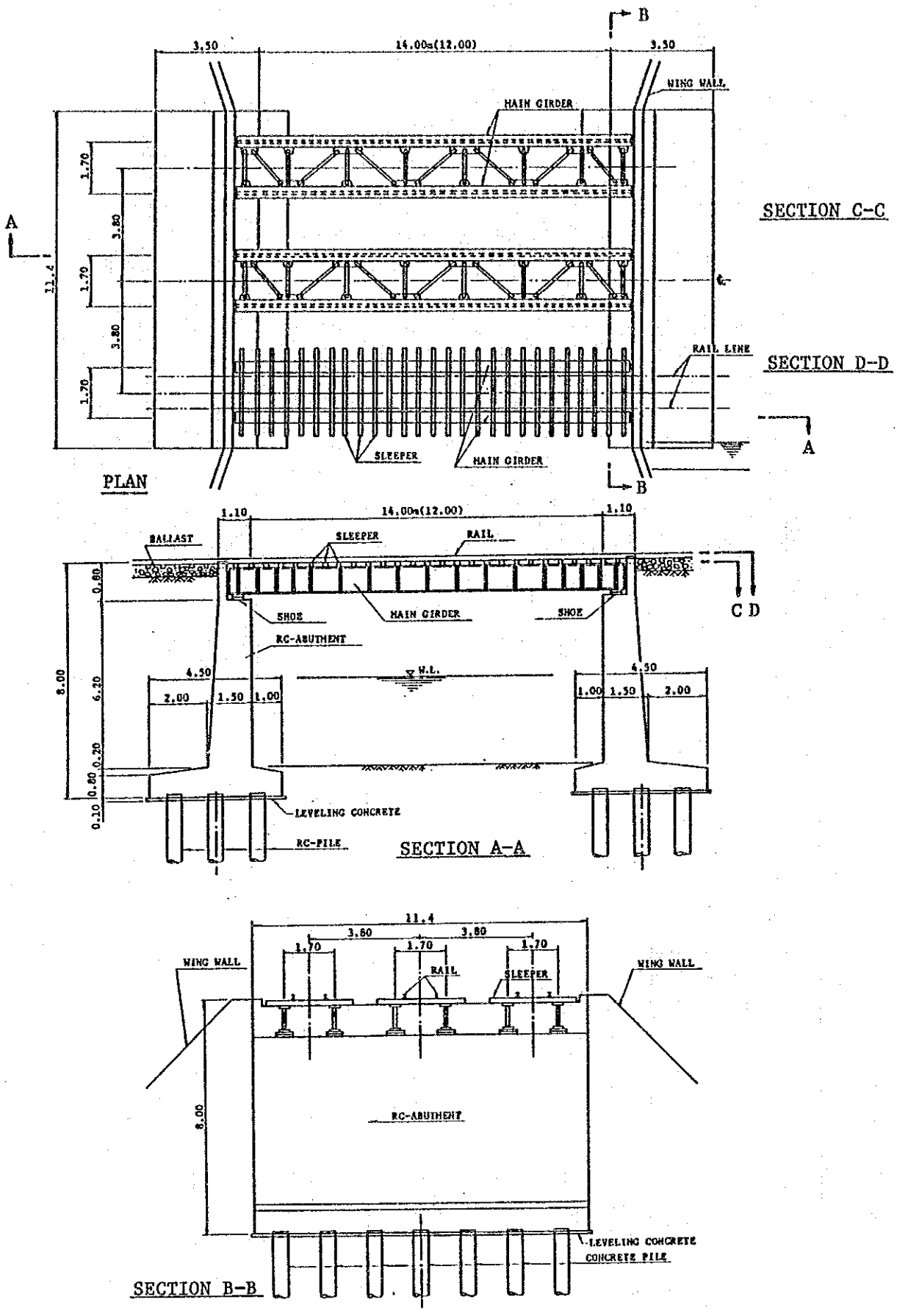


FIG. J.12 TYPICAL DESIGN OF RAILWAY BRIDGE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

SUPPORTING REPORT K

OPERATION / MAINTENANCE, AND ORGANIZATION

SUPPORTING REPORT K OPERATION/MAINTENANCE, AND ORGANIZATION

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SUPPORTING REPORT K

OPERATION/MAINTENANCE, AND ORGANIZATION

1. Required Operation and Maintenance Work

The present major operation and maintenance (O&M) work is limited to:

(1) Cleaning of critical parts of the drainage pipes

(2) Operation and maintenance of the Narinda pump station

The present O&M budget is 2.0 - 2.5 million TK per year on an average. Due to the small budget, the above work is conducted at an unsatisfactory level even when other work is not being done.

To sustain the expected effects of the existing and proposed drainage system of the Project area (B, C and, F zones), the following major O&M work shall be done:

(1) Cleaning of the 91.2 km of drainage pipes (existing: 78.7 km, proposed: 12.5 km),

(2) Dredging of deposits and removal of garbage from the 13.1 km of khals.

(3) Maintenance of the 4.8 km of dikes.

(4) Operation and maintenance of two (2) pump stations.

(5) Operation and maintenance of two (2) control gates.

(6) Land use control, in cooperation with the agencies concerned, to maintain the regulating ponds and khal areas, and to assure the required elevation of new land development.

2. Required Operation and Maintenance Equipment

No special equipment except for four (4) small pump units are provided at present.

Provision of the following equipment is required to satisfactorily implement the above-mentioned O&M work:

(1)	Garbage trolley (mechanically operated)	:	4 ea.
(2)	Trucks for sludge transportation	:	2 ea.
(3)	Cleaning equipment (small, mechanically operated)	:	4 ea.
(4)	Cleaning equipment (truck mounted)	:	2 ea.
(5)	Small pumps for dewatering	:	10 ea.
(6)	Supervision vehicles		
	- Jeeps	:	3 ea.
	- Pickup Trucks	:	4 ea.

3. Operation and Maintenance of Drainage Pipe and Pump Station

3.1 Cleaning of Drainage Pipe

All the drainage pipes will be cleaned once a year in principle.

The cleaning will be made by manual and cleaning machine as illustrated in Fig. K.1.

3.2 Operation Rule of Pump Station

Pump operation period begins when the flood water level of the rivers reaches 3.8 m G.T.S. and ends when it recedes again to 3.8 m G.T.S. The period is usually from early July to mid-October (See Fig. K.2).

During the flood season, the water level of the regulating ponds shall be maintained below 3.2 m G.T.S. to meet the coming storm runoffs.

Estimated yearly operating hours will be 250 on an average.

3.3 Maintenance of Pump Station

Major maintenance work at the pump station is as follows:

(1) Daily maintenance (during pump operation)

- check electric current of motor
- check temperature of motor bearing
- check vibration of pump and motor

(2) Every six (6) months maintenance

- check pump sealing components
- check motor lubrication oil
- check gauge and indicator
- check insulation of motor

(3) Annual maintenance

- check electric panel
- check motor of automatic trash rake

(4) Every three (3) to four (4) years maintenance

- replace gauge and indicator
- replace parts of electric panel
- replace parts of automatic trash rake

4. Land Use Control

The following land use controls are required to sustain the full functioning of the structural drainage improvement plans proposed in Supporting Report I.

4.1 Preservation of Regulating Pond Area

The proposed regulating pond areas (Gandaria area of 47 ha and Jatrabari area of 138 ha) shall be preserved to assure the expected effects of pump drainage.

Adverse effects due to reduction of regulating pond areas are considerable and are assessed below:

(1) Case 1: Gandaria pond area disappears

If the proposed Gandaria regulating pond completely disappears due to urbanization, the high water level of Narinda and Jatrabari regulating ponds will rise by 0.20 - 0.25 m higher than the design high water level (4.50 m G.T.S.).

To maintain the high water level of the regulating ponds below 4.50 m G.T.S. in this situation, the pump capacity shall be increased from the original of 18.3 m^3/S to 38.0 m^3/S.

(2) Case 2: Gandaria pond area disappears and Jatrabari pond area reduced to one half.

If the proposed Jatrabari pond area is reclaimed by 50% in addition to completely filling in the Gandaria pond area for urban development, the high water of Narinda and Jatrabari ponds will rise by 0.90 m higher than the design high water level (4.50 m G.T.S.).

To keep the high water level of the regulating ponds below 4.50 m G.T.S. in these circumstances, the pump capacity shall be incremented from the original one of 18.8 m^3/S to 67.0 m^3/S.

4.2 Preservation of Khal Areas

The existing khal areas are subject to reclamation or by the encroachment of buildings.

The minimum khal sections to be maintained are illustrated in Fig. I.15 - I.18. In addition, inspection road widths shall be maintained on one or both banks of the khal.

4.3 Control of Land Fill Elevation for Urban Development

Pressure of urban development in the low-lying areas of the Gandaria area (B III area) and the Jatrabari area (C II area) will continue to grow after completion of the Project.

Land fill elevation shall be controlled in conformance with the proposed design high water level inside the protection dikes or roads. The lowest land fill elevation for urban development is proposed to be 5.50 m G.T.S. (design high water level 4.50 m plus 1.0 m allowance).

5. Required Organization

5.1 Required Organization for Construction

The required organization for construction of the proposed flood protection and internal drainage works is shown in Fig. K.3.

A total staff of 108 persons will be required to support the organization (the break-down is shown in Table K.1).

5.2 Required Organization for Operation and Maintenance

The required organization for the operation and maintenance of the drainage systems in Dhaka city after completion of the proposed project is shown in Fig. K.3.

A total of 131 persons will be required for the organization (the break-down is shown in Table K.2).

5.3 Job Staff Members

The job of each staff member is described below:

Superintending Engineer:	1) Controlling officer of project 2) Policy planner of project 3) Monitoring 4) Evaluation 5) Overall quantity control & supervision of work
Executive Engineer:	1) Engineer in charge of field 2) Responsible for planning, design, estimating of project 3) Tendering of work 4) Field supervision, controls subordinate field officer & staff 5) Quality control 6) Control of financial matters 7) Progress report
Sub-Divisional Engineer:	1) Preparation of estimates 2) Field supervision of work 3) Control of direct field supervisions 4) Quality control 5) Measurement of work 6) Custody of project materials & tools 7) Progress report
Sub-Divisional Engineer (Electrical):	1) In charge of pump station & equipment 2) Operation of pumps 3) Supervision of maintenance work of pumps & equipment 4) Custody of equipment, tools & plants

Sub-Asst. Engineer:	1) Supervision of work 2) Preparation of estimate & drawing 3) Measurement of work 4) Implementation of work guidelines
Sub-Asst. Engineer (Electrical):	1) Supervision of pump operation 2) Maintenance of pumps 3) Record keeping on pump operations & maintenance
Work-Assistant:	1) Primary supervisor of work 2) Records of field progress & problems
Cleaner:	1) Minor cleaning of drainage pipes 2) Cleaning of catchpits, manholes & attending to problems

Table K.1 Required Staff for Construction

	Superintending Eng.'s Office	Executive Eng.'s Office (2)	Sub-divisional Eng.'s Office (4)	Total
Superintending Eng.	1			1
Executive Eng.		2		2
Sub-divisional Eng.			4	4
Sub-assistant Eng.			8	8
Stenographer	1			1
Head Assistant (UDA)	1	2	4	7
Estimator	1	2		3
Draftsman	1	2		3
Accountant		2		2
Accounting Assistant	1	2	4	7
Cashier		2		2
Work Assistant			16	16
L.D.A.-cum Typist	1	2	4	7
Driver	1	2	4	7
Pump Operator			8	8
Assistant Pump Operator			8	8
M.L.S.S.	2	4	16	22
Total	10	22	76	108

Table K.2 Required Staff for Operation and Maintenance

	Superintending Eng.'s Office	Executive Eng.'s Office (2)	Sub-divisional Eng.'s Office (4)	Total
Superintending Eng.	1			1
Executive Eng.		2		2
Sub-divisional Eng.			4	4
Sub-assistant Eng.			8	8
Stenographer	1			1
Head Assistant (UDA)	1	2	4	7
Estimator	1	2		3
Draftsman	1	2		3
Accountant		2		2
Accounting Assistant	1	2	4	7
Cashier		2		2
Work Assistant			16	16
L.D.A.-cum Typist	1	2	4	7
Driver	1	2	4	7
Pump Operator			8	8
Assistant Pump Operator			8	8
Cleaner			20	20
M.L.S.S.	2	4	16	22
Total	10	22	96	128

BUCKET MACHINE

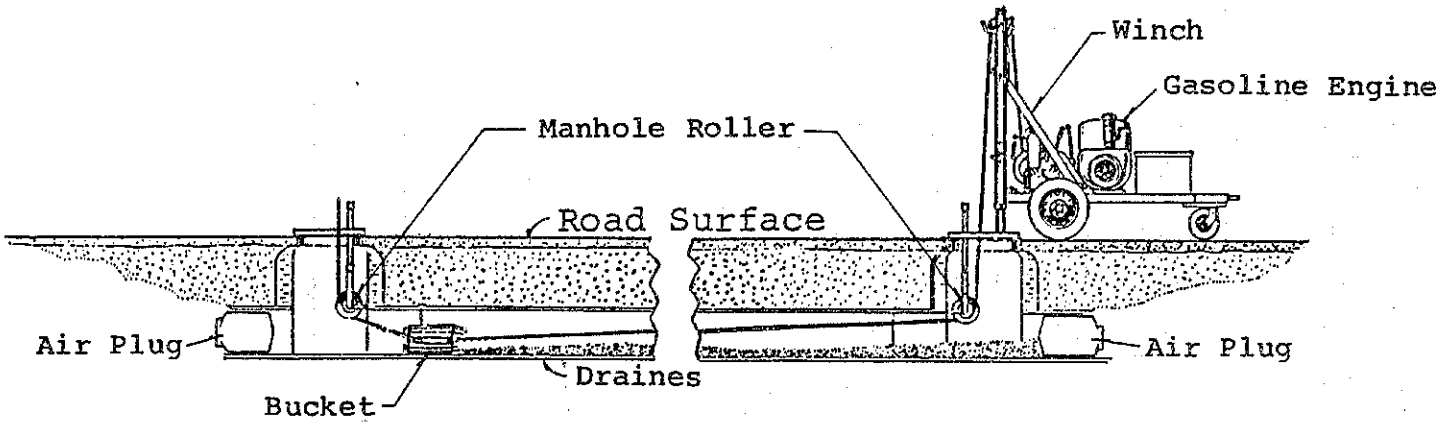
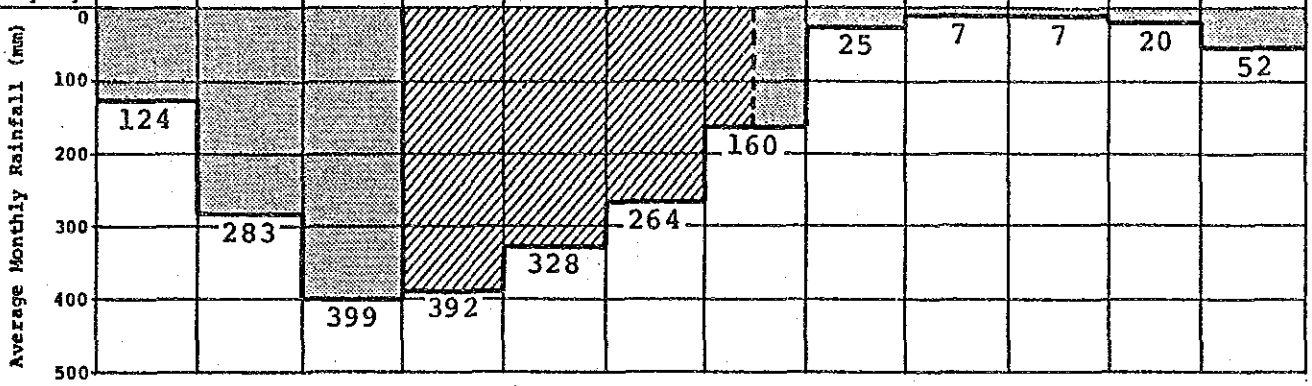


FIG. K.1	DRAINAGE PIPE CLEANING MACHINE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

AVERAGE MONTHLY RAINFALL AND RAINY DAYS

Month	Apr.	May.	Jun.	Jul.	Arg.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Average Rainy Days	8	14	19	22	22	16	19	2	1	1	2	4
Average Monthly Rainfall (mm)	124	283	399	392	328	264	160	25	7	7	20	52



SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AT MILL BARRACK STATION

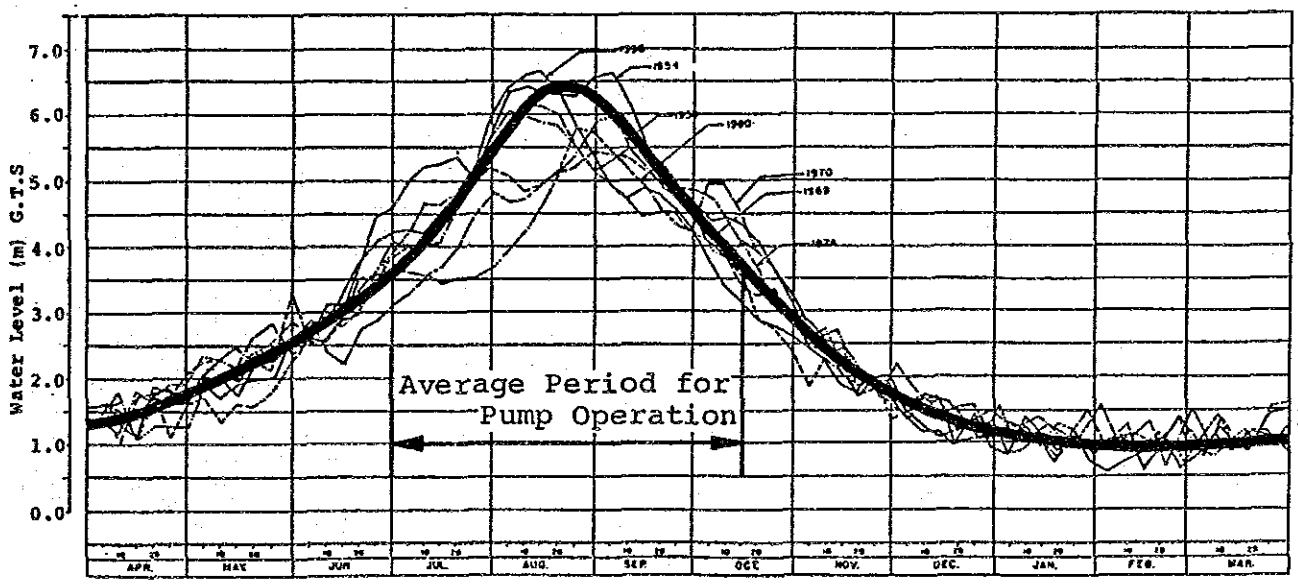


FIG. K.2 SEASONAL VARIATION OF BURIGANGA RIVER WATER LEVEL AND AVERAGE MONTHLY RAINFALL

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

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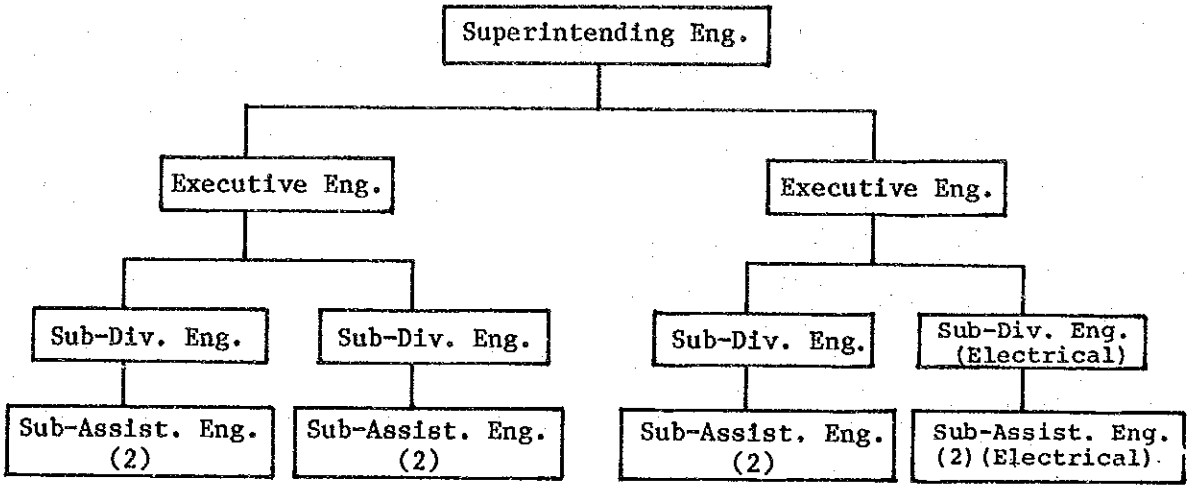
(1) Organization for Construction



(2) Organization for Operation and Maintenance

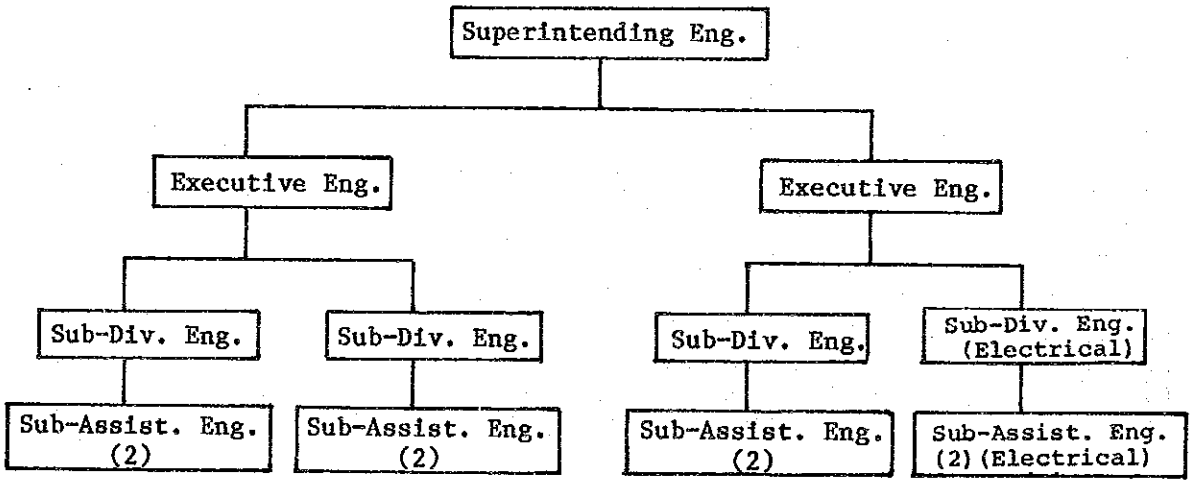


FIG. K.3 ORGANIZATION FOR CONSTRUCTION AND OPERATION/MAINTENANCE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

SUPPORTING REPORT L

PROJECT COST AND IMPLEMENTATION SCHEDULE

SUPPORTING REPORT L PROJECT COST AND IMPLEMENTATION SCHEDULE

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SUPPORTING REPORT L

PROJECT COST AND IMPLEMENTATION SCHEDULE

1. Introduction

The project cost is estimated for the assessment of economic and financial viability, and preparation of a funding schedule for the Government.

The costs are estimated based on the current prices of construction materials, equipment, and labor rates prevailing in Dhaka.

The cost data were obtained from both government agencies and private sectors. The collected data were compared, evaluated, and updated to establish a current cost data base that is applicable to the Project.

2. Basis for Cost Estimates

The estimation of the project cost, consisting of (1) the construction cost of the facilities, (2) engineering service fees, (3) land acquisition and compensation cost, (4) customs duty & sales tax (CDST) and office establishment cost was conducted based on the following conditions:

(1) The estimates are made on the assumption that all construction works will be contracted to general contractors by international tender.

(2) All base costs are expressed under the economic conditions prevailing in December, 1986.

(3) The exchange rates of foreign currencies are considered as follows: US$1.00 = TK30.00 = ¥150. (TK1.00=¥5.0)

(4) The cost is classified into foreign currency and local currency portions, based on the following conditions:

The foreign currency portions include the costs of:
---- Imported equipment, materials, and supplies,
---- Domestic materials of which the country is a net importer,
---- Wages of expatriate personnel, and
---- Overhead and profit of foreign firms.

The local currency portions contain the costs of:
---- Domestic materials and supplies of which the country is a net exporter,
---- Wages of local personnel,
---- Overhead and profit of local firms, and
---- Taxes.

(5) A constant allowance of 20% is added to the direct construction costs for contractor's overhead and profit.

(6) A physical contingency allowance which is an amount added to a "risk-free" base cost is established at 10% of the total construction costs.

(7) Engineering design and supervision fees are assumed to be 10% of the construction cost.

(8) Annual price escalation is considered to be 2% for foreign currency (F/C) and 10% for local currency (L/C). Based on an annual implementation over 6 years as shown in Table L.16, the total price escalations from 1988 to 1994 are estimated to be 13% and 77% higher than 1986 construction costs for F/C and L/C respectively, as shown in Table L.17.

Table L.1 Price Escalation Rate

Year	Escalation (%) F/C	L/C
1988/1989	6	33
1989/1990	8	46
1990/1991	10	61
1991/1992	13	77
1992/1993	15	95
1993/1994	17	114
Average	13 %	77 %

3. Estimation of Unit Costs

The unit costs by work item are calculated from the material cost, labor cost, and equipment cost by analyzing the data on the similar works implemented in recent years as well as taking into consideration the local conditions in Dhaka. The unit costs calculated by work item are as listed in Table L.13. The unit construction costs of each type of facilities are shown in Table L.14.

4. Land Acquisition and Compensation Costs

The price of land varies depending on its location and geographical condition. The unit land costs in Table L.2 are given, in this study for two typical land usages, ie, urbanized area and non-urbanized area. The breakdown of the acquisition costs by each facility are shown in Table L.7.

Table L.2 Unit Land Acquisition Cost

Area	Land Cost	
Lowland in Urbanized Area	400	TK/m^2
Lowland in Non-urbanized Vicinity Area	120	TK/m^2

Source : Planning Commission

The compensation costs for removal of houses from the proposed right-of-way is estimated to be 500,000 TK/family. The breakdown of compensation costs by each facility are also shown in Table L.7.

5. Direct CDST

Most of the construction materials are available locally and can be used for the construction of drainage facilities. However, particular equipment and materials, such as pump and gate with accessories, sheet piles and testing apparatus, must be imported. It is considered that the CDST (customs duty and sales taxes) for this equipment and materials will be borne by the Bangladesh Government and it will be exempted from the contractor's contract as it is being funded by the foreign aid program. The costs for CDST, as of 1987, are estimated on a lump sum basis as shown in Table L.8.

Construction machinery and equipment, which will be temporarily imported for the execution of works and reexported after completion of the works, are assumed to be exempted from CDST, considering that the Bangladesh Gazette No. SRD 542-L/84/886/CUS, issued by the National Board of Revenue (NBR), specifies the CDST exemption of re-exported goods. Other taxes,such as income tax, excise tax, and CDST of raw materials for local industrial products are included in the prices of goods or wages when paid for on the local market.

6. Estimated Project Cost

The total project cost, including construction, engineering, land acquisition, CDST, and contingencies, amounts to 1,790.3 million Taka at 1986 prices as shown in Table L.3. Of this amount, the local currency component is 914.9 million Taka and the foreign currency component is 875.4 million Taka. The breakdown of the estimated project cost are shown in Table L.5 to L.6.

The project cost including escalation contingency for six (6) years is estimated to be 2,609.2 million Taka as shown in the following Table.

Table L.3 Project Cost

Unit: Million Taka

Item	Cost
A. Construction Cost	1,237.3
(1) Dike	(186.2)
(2) Pump Station	(319.9)
(3) Gate	(69.5)
(4) Khal Improvement	(286.7)
(5) Drainage Pipe	(375.0)
B. Physical Contingency	123.7
C. Engineering	136.1
D. Land Acquisition	83.0
E. Office Establishment	25.5
F. Customs Duty & Tax	184.7
Project Cost (1) (at 1986 price)	1,790.3
G. Price Contingency (1988-1994)	818.9
Project Cost (2) (with Price Cont.)	2,609.2

7. Operation and Maintenance Cost

The operation and maintenance costs for the drainage facilities include personnel expense, electricity expense for running the pump and gate, and cleaning and repair expense.

Annual operation and maintenance for the whole Dhaka city area is estimated to be 37.7 million TK of which 25.4 million TK is required for the Project Area (B, C and F drainage zones).

Table L.4 Annual Operation and Maintenance Cost

Item	Cost (Million TK) For Whole Dhaka City Area	Cost (Million TK) For Project Area	Remarks (Million TK)
Pump Station	4.0	(4.0)	
Electricity	2.2	(2.2)	
Maintenance of Pump	0.8	(0.8)	
Maintenance of Pond	1.0	(1.0)	
Cleaning of Drainage Pipe	18.8	(11.3)	0.125x150km(90km)=18.8(11.3)
Maintenance of Khal	5.0	(1.3)	0.1x50km(13km)=5.0(1.3)
Maintenance of Dike	0.5	(0.5)	0.1x5km=0.5
O&M of Vehicle and Other Equipment	2.5	(2.5)	
* Personnel Expense, Office Accommodation, etc.	* 3.5	(3.5)	
SUB-TOTAL	34.3	(23.1)	
Contingency (10%)	3.4	(2.3)	
TOTAL	37.7	(25.4)	

Note: 1) The Project Area includes B, C, and F drainage zones.
2) Breakdown of the personnel expense and office accommodation cost is shown in Table L.15.

8. Implementation Schedule

The proposed facilities will be completed within six (6) years according to the staged construction plan.

(1) Top priority will be given to the construction of the flood protection dikes with gates. This work is not only required to prevent floods from the outer areas, but also a prerequisite for pump drainage of internal storm water.

(2) Construction of the pump station (Narinda) and improvement of main khals, such as Segunbagicha, will be given priority in order to lower the flood water level of the inner areas. Lowering of the inner flood water level will facilitate the internal drainage through the drains.

(3) The remaining sub-khals and sub-drainage pipes will be constructed stage by stage in consideration of the yearly disbursement capacity of finance.

The proposed implementation schedule is shown in Table L.16.

Table L.5 Summary of Construction Cost

Unit : Million TK, 1986 Price

Item	Zone	Description	Construction Cost			Romarks
			F/C	L/C	Total	
A. Dike	C	L = 4,800 m H = 6.0 m	70.7	115.5	186.2	
B. Pump Station						
1. NARINDA (Rehabilitation)	B	Q = 9.6 m3/s	90.5	6.6	97.1	
2. do. (New)	B	Q = 9.2 m3/s	181.5	41.3	222.8	
Subtotal		Q = 18.8 m3/s	272.0	47.9	319.9	
C. Gate						
1. NARINDA	B	6 m x 6 m	27.7	11.8	39.5	
2. GERANI KHAL	C	do.	22.6	7.4	30.0	
Subtotal			50.3	19.2	69.5	
D. Khal Improvement Works						
1. DHOLAI KHAL	B	L = 3,000 m	10.9	11.3	22.2	
2. GANDARIA KHAL	B	L = 1,200 m	5.3	11.0	16.3	
3. GERANI KHAL	C	L = 2,100 m	5.3	4.7	10.0	
4. SEGUNBAGICHA KHAL	C	L = 3,000 m	75.6	66.0	141.6	
5. BEGUNBARI KHAL	F	L = 2,800 m	11.3	13.9	25.2	
6. PARIBAG KHAL	F	L = 1,000 m	33.1	38.3	71.4	
Subtotal		L = 13,100 m	141.5	145.2	286.7	
E. Drainage Pipe						
1. NARINDA	B	L = 4,280 m	90.6	88.2	178.8	
2. SEGUNBAGICHA	C	L = 4,810 m	53.0	72.0	125.0	
3. BEGUNBARI	F	L = 3,410 m	24.9	46.3	71.2	
Subtotal		L = 12,500 m	168.5	206.5	375.0	
SUBTOTAL (A-E)	-	-	**703.0**	**534.3**	**1,237.3**	
F. Physical Contingency (10 %)	-	-	70.3	54.4	123.7	
SUBTOTAL (A-F)	-	-	**773.3**	**587.7**	**1,361.0**	
G. Engineering	-	-	102.1	34.0	136.1	
H. Land Acquisition	-	-	-	33.0	83.0	
I. Office Establishment			-	25.5	25.5	
J. Customs Duty & Tax	-	-	-	184.7	184.7	
TOTAL(A-J)	-	-	**875.4**	**914.9**	**1,790.3**	
K. Price Contingency (1988/1989-1993/1994)			110.0	708.9	818.9	
TOTAL(A-K)			**985.4**	**1,623.8**	**2,609.2**	

Table L.6 (a) Construction Cost of Dike

Unit : 1,000 TK, 1986 Price

Location	Height	Length	Unit Construction Cost			Construction Cost		
	m	m	Total	F/C (%)	L/C (%)	F/C	L/C	Total
SEGUNBAGICHA KHAL ZONE (C ZONE)	6.0	4,800	38.8	38	62	70,770	115,470	186,240

Table L.6 (b) Construction Cost of Gate 6.0 x 6.0 m

Unit : 1,000 TK, 1986 Price

Location	Unit	Unit Construction Cost			Construction Cost		
		Total	F/C (%)	L/C (%)	F/C	L/C	Total
NARINDA G-1	L.S.	39,489	70	30	27,642	11,847	39,489
GERANI KHAL G-2	L.S.	29,989	76	24	22,792	7,197	29,989
	Total		**73**	**27**	**50,434**	**19,044**	**69,478**

Table L.6 (c) Construction Cost of Pump Station

Unit : 1,000 TK, 1986 Price

Location	Existing Capacity	Proposed Capacity	Unit	Unit Construction Cost			Construction Cost		
	m3/s	m3/s		Total	F/C (%)	L/C (%)	F/C	L/C	Total
NARINDA (P-1) Rehabilitation	9.6	9.6	L.S.	106,638	93	7	90,324	6,799	97,123
do. (P-2)	-	9.2	L.S.	222,800	81	19	180,468	42,332	222,800
	Total	**18.8**			**85**	**15**	**270,792**	**49,131**	**319,923**

Table L.6 (d) Construction Cost of Khal Improvement Works (I)

Unit : 1,000 TK, 1986 Price

Khal	Section No.	Length m	Net Length m	Protection Works								Cost For Dredging		
				Type	Length m	Unit Construction Cost			Construction Cost					
						Total	F/C (%)	L/C (%)	F/C	L/C	Total	F/C	L/C	Total
K-1 DHOLAI	1	1000	1000	-								907	605	1,512
	2	500	470	Sodding	470	1.7	0	100	0	799	799	749	499	1,248
	3	200	150	do.	150	1.7	0	100	0	255	255	302	202	504
	4	400	370	do.	370	1.7	0	100	0	629	629	850	566	1,416
	5	200	200	do.	200	1.7	0	100	0	340	340	461	307	768
	6	200	200	do.	200	1.7	0	100	0	340	340	706	470	1,176
	7	500	500	do.	500	1.7	0	100	0	850	850	1,800	1,200	3,000
	SUBTOTAL	3000	2890	(Sodding)	1890				0	3,213	3,213	5,774	3,850	9,624
K-2 GANDARIA		1200	1200	Brick Works A	400	29.3	29	71	3,399	8,321	11,720	1,944	1,296	3,240
				Sodding	800	1.7	0	100	0	1,360	1,360			
	SUBTOTAL	1200	1200	(Brick Works A)	400				3,399	8,321	11,720	1,944	1,296	3,240
				(Sodding)	800				0	1,360	1,360			
							26	74	3,399	9,681	13,080			
K-3 GERANI	1	1400	1400	Sodding	400	1.7	0	100	0	680	680	4,075	2,717	6,792
				-	1000	-								
	2	700	700	Sodding	300	1.7	0	100	0	510	510	1,217	811	2,028
				-	400	-								
	SUBTOTAL	2100	2100	(Sodding)	700		0	100	0	1,190	1,190	5,292	3,528	8,820

Note : Net Length = Section Length - Box Culverts' Length

to be continued

Table L.6 (d) Construction Cost of Khal Improvement Works (2)

Unit : 1,000 TK, 1986 Price

Khal	Section No.	Length m	Net Length m	Protection Works								Cost For Dredging		
				Type	Length m	Unit Construction Cost Total	Unit Construction Cost F/C (%)	Unit Construction Cost L/C (%)	Construction Cost F/C	Construction Cost L/C	Construction Cost Total	F/C	L/C	Total
K-4 SEGUNBAGICHA	1	500	460	-	300	-					-	907	605	1,512
				Sodding	160	1.7	0	100	0	272	272			
	2	600	570	-	300	-					-	857	571	1,428
				Sodding	270	1.7	0	100	0	459	459			
	3	400	380	Brick Works A	380	29.3	29	71	3,229	7,905	11,134	792	528	1,320
	4	200	190	Concrete Panel	90	101	63	37	5,727	3,363	9,090	374	250	624
				Brick Works A	100	29.3	29	71	850	2,080	2,930			
	5	600	540	Concrete Panel	240	101	63	37	15,271	8,969	24,240	1,210	806	2,016
				Brick Works A	300	29.3	29	71	2,549	6,241	8,790			
	6	400	350	Concrete Panel	150	101	63	37	9,545	5,606	15,150	576	384	960
				Brick Works A	200	29.3	29	71	1,699	4,161	5,860			
	7	300	300	Brick Works A	200	29.3	29	71	1,699	4,161	5,860	576	384	960
				Sodding	100	1.7	0	100	0	170	170			
	SUBTOTAL	3000	2790	(Sodding)	530				0	901	901	5,292	3,528	8,820
				(Brick Works A)	1180				10,026	24,548	34,574			
				(Concrete Panal)	480				30,542	17,938	48,480			
							48	52	40,569	43,386	83,955			
K-5 BEGUNBARI	1	1270	1170	Sodding	1170	1.7	0	100	0	1,989	1,989	230	154	384
	2	350	320	do.	320	1.7	0	100	0	544	544	130	86	216
	3	1180	1180	do.	1180	1.7	0	100	0	2,006	2,006	612	408	1,020
	SUBTOTAL	2800	2670	(Sodding)	2670		0	100	0	4,539	4,539	972	648	1,620
K-6 PARIBAGH		1000	980	Concrete Panel	280	101	63	37	17,816	10,464	28,280	1,771	1,181	2,952
				Brick Works B	700	48.9	30	70	10,269	23,961	34,230			
	SUBTOTAL	1000	980	(Concrete Panel)	280				17,816	10,464	28,280	1,771	1,181	2,952
				(Brick Works B)	700				10,269	23,961	34,230			
							45	55	28,085	34,425	62,510			
TOTAL		13100	12630	(Sodding)	6590		0	100	0	11,203	11,203	21,046	14,030	35,076
				(Brick Works)	2280		29	71	23,694	56,830	80,524			
				(Concrete Panel)	760		63	37	48,359	28,401	76,760			
					9630		43	57	72,053	96,434	168,487			

Table L.6 (d) Construction Cost of Khal Improvement Works (3) - Bridge and Box Culverts

Size : Width x Height x Units Unit : 1,000 TK, 1986 Price

Khal	No.	(Type)	Proposed (Size)*	(Length)	Unit Construction Cost			Construction Cost			Remarks
			m x m	m	Total	F/C (%)	L/C (%)	F/C	L/C	Total	
DHOLAI	B-1	Box Culvert	7.5 x 5.0 x 2	25.0	375	55	45	5,156	4,219	9,375	Reconstruction
SEGUNBAGICHA	B-2	Box Culvert	6.0 x 5.0 x 2	17.0	316	55	45	2,955	2,417	5,372	Reconstruction
	B-3	Bridge	12.0 x 5.0	-	LS.	80	20	9,398	2,422	11,820	do. (Railway)
	B-4	Box Culvert	5.0 x 4.5 x 2	15.0	256	55	45	2,112	1,728	3,840	do.
	B-5	do.	5.0 x 4.5 x 2	17.0	256	55	45	2,394	1,958	4,352	do.
	B-6	do.	4.5 x 4.5 x 2	7.0	236	55	45	909	743	1,652	do.
	B-7	do.	4.5 x 4.5 x 2	9.0	236	55	45	1,168	956	2,124	do.
	B-8	do.	7.5 x 4.5	11.0	173	55	45	1,047	856	1,903	do.
	B-9	do.	7.0 x 4.5	37.0	164	55	45	3,337	2,731	6,068	do.
	B-10	do.	7.0 x 4.5	11.0	164	55	45	992	812	1,804	do.
	B-11	do.	7.0 x 4.5	10.0	164	55	45	902	738	1,640	do.
	B-12	do.	6.0 x 4.5	36.0	146	55	45	2,891	2,365	5,256	do.
	B-13	do.	6.0 x 4.0	12.0	134	55	45	884	724	1,608	do.
	B-14	do.	6.0 x 4.0	10.0	134	55	45	737	603	1,340	do.
	Subtotal					61	39	29,725	19,054	48,779	

to be continued

Table L.6 (d) Construction Cost of Khal Improvement Works (4) - Bridge and Box Culverts

Size : Width x Height x Units Unit : 1,000 TK, 1986 Price

Khal	No.	(Type)	Proposed (Size)*	(Length)	Unit Construction Cost			Construction Cost			Remarks
			m x m	m	Total	F/C (%)	L/C (%)	F/C	L/C	Total	
BEGUNBARI	B-15	do.	7.0 x 6.0	25.0	206	55	45	2,833	2,318	5,150	Additional
	B-16	do.	7.0 x 6.0	14.0	206	55	45	1,586	1,298	2,884	do.
	B-17	do.	7.0 x 6.0	30.0	206	55	45	3,399	2,781	6,180	do.
	B-18	Box Culvert	7.0 x 4.5	24.0	164	55	45	2,165	1,771	3,936	Reconstruction
	B-19	Regulation Weir	-	-	LS.	40	60	360	540	900	Additional
	Subtotal					54	46	10,343	8,708	19,050	
PARIBAGH	B-20	Box Culvert	6.0 x 4.0	11.0	134	55	45	811	663	1,474	Reconstruction
	B-21	do.	6.0 x 4.0	13.0	134	55	45	958	784	1,742	do.
	B-22	do.	3.7 x 3.7	30.0	92	55	45	1,518	1,242	2,760	do.
	Subtotal					55	45	3,287	2,689	5,976	
	Total					58	42	**48,511**	**34,669**	**83,180**	

Table L.6 (e) Construction Cost of Drain Pipe (I)

Unit : 1,000 TK, 1986 Price

Route	Section No.	Length m	Proposed Shape	Size m	Unit Construction Cost			Construction Cost			Remarks
					Total	F/C (%)	L/C (%)	F/C	L/C	Total	
D-1 NARINDA(Main)	1	100.0	Square	3.1	73.5	55	45	4,043	3,308	7,350	Additional
	2	650.0	do.	2.9	68.5	55	45	24,489	20,036	44,525	do.
	3	450.0	Circular	2.8	22.3	35	65	3,512	6,523	10,035	do.
	4	350.0	do.	2.6	21.0	35	65	2,573	4,778	7,350	do.
	5	750.0	do.	1.9	16.4	35	65	4,305	7,995	12,300	
(Branch)	6	500.0	do.	2.2	18.3	35	65	3,203	5,948	9,150	
	Subtotal	2800.0				46	54	42,124	48,587	90,710	
D-2 NARINDA(Diversion)	7	1480.0	Rectangular	2.2 x 2.86	59.5	55	45	48,433	39,627	88,060	
	Subtotal	1480.0				55	45	48,433	39,627	88,060	
D-3 Old Railway Rd. & Old Govt. House Rd.	8	700.0	Rectangular	2.6 x 3.0	66.0	55	45	25,410	20,790	46,200	
	9	650.0	Circular	3.0	23.8	35	65	5,415	10,056	15,470	
	10	650.0	do.	2.3	19.0	35	65	4,323	8,028	12,350	
	11	500.0	do.	1.9	16.4	35	65	2,870	5,330	8,200	
	Subtotal	2500.0				46	54	38,017	44,203	82,220	
D-4 Circular Rd.	12	540.0	Circular	1.5	13.9	35	65	2,627	4,879	7,506	Additional
	Subtotal	540.0				35	65	2,627	4,879	7,506	

to be continued

Table L.6 (e) Construction Cost of Drain Pipe (2)

Unit : 1,000 TK, 1986 Price

Route	Section No.	Length m	Proposed Shape	Size m	Unit Construction Cost			Construction Cost			Remarks
					Total	F/C (%)	L/C (%)	F/C	L/C	Total	
D-5 DIT Av.	13	480.0	Circular	2.7	21.6	35	65	3,629	6,739	10,368	
	14	240.0	do.	1.9	16.4	35	65	1,378	2,558	3,936	
	Subtotal	720.0				35	65	5,006	9,298	14,304	
D-6 SANTINAGAR	15	530.0	Circular	2.7	21.6	35	65	4,007	7,441	11,448	Additional
	16	520.0	do.	2.2	18.3	35	65	3,331	6,185	9,516	do.
	Subtotal	1050.0				35	65	7,337	13,627	20,964	
D-7 Downstream side of Railway Begunbari Khal	17	550.0	Circular	2.4	19.8	35	65	3,812	7,079	10,890	Reconstruction
	18	550.0	do.	2.8	22.3	35	65	4,293	7,972	12,265	do.
	Subtotal	1100.0				35	65	8,104	15,051	23,155	
D-8 DHANMAND	19	450.0	Circular	1.8	15.6	35	65	2,457	4,563	7,020	
	Subtotal	450.0				35	65	2,457	4,563	7,020	
D-9 DHAKA Univ. (Main)	20	300.0	Circular	3.7	33.0	35	65	3,465	6,435	9,900	
	21	450.0	do.	2.9	23.0	35	65	3,623	6,728	10,350	
	22	550.0	do.	2.4	19.8	35	65	3,812	7,079	10,890	
(Branch)	23	560.0	do.	2.1	17.7	35	65	3,469	6,443	9,912	
	Subtotal	1860.0				35	65	14,368	26,684	41,052	
TOTAL		12500.0				45	55	168,474	206,517	374,991	

Table L.7 (a) Cost for Land Acquisiton and Compensation

(1986 Price)

Item	Area	Land Acquisition Cost	Compensation for Removal	Total
	ha	million TK	million TK	million TK
A. Dike 80 x 4800 m	38.4	46.1	-	46.1
B. Pump Station	1.0	4.0	1.5	5.5
C. Khal Improvement	12.6	26.9	4.5	31.4
1. Dholai Khal	2.4	2.9	-	2.9
2. Gandaria Khal	1.1	1.3	-	1.3
3. Gerani Khal	2.5	3.0	-	3.0
4. Segunbagicha Khal	1.8	6.5	3.0	9.5
5. Begunbari Khal	4.3	11.3	-	11.3
6. Paribagh Khal	0.5	1.9	1.5	3.4
TOTAL	52.0	77.0	6.0	83.0

Table L.7 (b) Land Acquisition Cost for Khal Improvement Works

(1986 Price)

Khal	Section No.	Land Use Category	Section Length m	Box Culverts Length m	Estimated Length m	Max. Khal Width m	Ave. Exist. Khal Width m	Land Acquisition Width Step I m	Step II m	Step III m	Land Acquisition Area Step I m2	Step II m2	Step III m2	Land Aquisition Cost Step I 1,000 TK	Step II 1,000 TK	Step III 1,000 TK
K-1	1	B	1000	50	950	25.0	-	-	-	-	-	-	-	-	-	-
	2	B	500	30	470	25.0	-	-	-	-	-	-	-	-	-	-
	3	B	200	50	150	23.0	-	-	-	-	-	-	-	-	-	-
	4	B	400	30	370	23.0	10.0	13.0	13.0	19.0	4,810	4,810	7,030	577	577	844
	5	B	200	-	200	27.0	8.0	13.0	19.0	25.0	2,600	3,800	5,000	312	456	600
	6	B	200	-	200	26.0	5.0	15.0	21.0	27.0	3,000	4,200	5,400	360	504	648
	7	B	500	-	500	27.0	5.0	17.0	22.0	28.0	8,500	11,000	14,000	1,020	1,320	1,680
	Subtotal		3000	160	2840	-	-	-	-	-	16,910	23,810	31,430	2,269	2,857	3,772
K-2		B	1200	-	400	12.0	5.0	2.0	7.0	13.0	800	2,800	5,200	96	336	624
		B		-	800	17.0	7.0	8.0	10.0	16.0	6,400	8,000	12,800	768	960	1,536
	Subtotal		1200		1200	-	-	-	-	-	7,200	10,800	18,000	864	1,296	2,160
K-3	1	B	1400	-	1000	25.0	5.0	17.0	20.0	26.0	17,000	20,000	26,000	2,040	2,400	3,120
		B		-	400	-	-	-	-	-	-	-	-	-	-	-
	2	B	700	20	280	24.0	6.0	12.5	18.0	24.0	3,500	5,040	6,720	420	605	806
		B		-	400	-	-	-	-	-	-	-	-	-	-	-
	Subtotal		2100	20	2080	-	-	-	-	-	20,500	25,040	32,720	2,460	3,005	3,926
K-4	1	B	500	40	260	18.0	8.0	10.0	10.0	16.0	2,600	2,600	4,160	312	312	499
		B			200	30.0	-	-	-	-	-	-	-	-	-	-
	2	A	600	30	270	26.0	-	-	-	-	-	-	-	-	-	-
		A			300	15.0	6.5	4.5	8.5	14.5	1,350	2,550	4,350	540	1,020	1,740
	3	A	400	20	380	14.5	6.5	4.0	8.0	14.0	1,520	3,040	5,320	608	1,216	2,128
	4	A	200	10	90	7.5	4.0	3.5	3.5	9.5	315	315	855	126	126	342
		A			100	14.5	5.0	9.5	9.5	15.5	950	950	1,550	380	380	620
	5	A	600	60	240	7.0	4.0	3.0	3.0	9.0	720	720	2,160	288	288	864
		A			300	14.5	5.0	9.5	9.5	15.5	2,850	2,850	4,650	1,140	1,140	1,860
	6	A	400	50	150	6.0	5.0	1.0	1.0	7.0	150	150	1,050	60	60	420
		A			200	14.5	6.0	8.5	8.5	14.5	1,700	1,700	2,900	680	680	1,160
	7	A	300	-	200	14.0	4.0	10.0	10.0	16.0	2,000	2,000	3,200	800	800	1,280
		A			100	19.0	6.0	13.0	13.0	19.0	1,300	1,300	1,900	520	520	760
	Subtotal		3000	210	2790	-	-	-	-	-	15,455	18,175	32,095	5,454	6,542	11,673
K-5	1	B	1270	100	1170	25.5	7.5	2.5	18.0	24.0	2,925	21,060	28,080	351	2,527	3,370
	2	A	350	30	320	24.0	9.0	4.0	15.0	21.0	1,280	4,800	6,720	512	1,920	2,688
	3	A	1180	-	1180	22.0	7.5	3.0	14.5	20.5	3,540	17,110	24,190	1,416	6,844	9,676
	Subtotal		2800	130	2670	-	-	-	-	-	7,745	42,970	58,990	2,279	11,291	15,734
K-6		A	1000	20	280	6.0	5.0	1.0	1.0	7.0	280	280	1,960	112	112	784
		A		-	700	11.5	5.0	6.5	6.5	12.5	4,550	4,550	8,750	1,820	1,820	3,500
	Subtotal		1000	20	980						4,830	4,830	10,710	1,932	1,932	4,284
TOTAL			13100	540	12560	-	-	-	-	-	74,640	125,625	183,945	15,258	26,923	41,549

NOTE:

Step I ; Preset Condition

Step II ; Future Condition

Step III ; Future Condition with Maintenance Road

Table L.8 Customs Duty & Tax for Imported Material & Equipment

Unit : 1,000TK, 1986 Price

Item	Unit	Amount	Unit Price (C.I.F.)	Total Price	Rate (%)			Customs Duty & Tax
					CD	ST	LF	
A. Steel Sheet Pile Foundation for Gates & Pump station	t	470	25	11,750	100	20	5	14,688
B. Gate Leaf & Hoist Machine	L.S.	2	8,780	17,560	50	20	5	13,170
C. Equipment for Pump Station								
1. Rehabilitation	L.S.	1	75,340	75,340				
2. New	do.	1	129,280	129,280				
Subtotal				204,620	50	20	5	153,465
D. Girder for Railway Bridge L=13 m (11 t)	L.S.	3	1,500	4,500	50	20	5	3,375
TOTAL								**184,698**

Note : CD ; Customs Duty
ST ; Sales Tax
LF ; Licence Fee and Surcharge

Table L.9 Labour Wages

Type of Labour	Labour Wage per Day (TK) (1986 Price)
1. Common Labourer	60
2. Mason and Plasterer	180
3. Reinforcement Worker	150
4. Concrete Worker	100
5. Pavement Worker	150
6. Carpenter	180
7. Painter	120
8. Welder	180
9. Foreman	240
10. Chief Forman	360
11. Car Driver and Operator	120
12. Heavy Equipment Operator	210
13. Boat Man	100
14. Boat Captain	150

Table L.10 Rental Fee of Typical Construction Machinery

(1986 Price)

Machinery	Description	Rental Fee in Japan (1,000 TK/day)	Freight* (1,000 TK)	Rental Fee** in Dhaka (1,000 TK/day)
Back Hoe	1.2 m3	12.0	745	14.1
Bulldozer	20 t	10.8	270	11.6
Tyre Roller	8-16 t	1.9	375	2.9
Motor Grader	B = 3.1 m	3.5	290	4.3
Asphalt Finisher	B = 2.4 - 3.6 m	6.0	225	6.6
Hydraulic Crane	15 t	5.0	805	7.2
Crawler Crane	Pile driver	14.0	925	16.6
Batching Plant	54 m3/h	6.0	1,040	8.9
Concrete Pump	65 m3/h	8.0	570	9.6
Trailer	35 t	6.4	735	8.4
Dump Truck	10 t	5.6	430	6.8
Truck	Flat body 6 t	3.0	445	4.2
Agitator Truck	6 m3	6.0	540	7.5
Jeep	4WD	1.6	100	1.9
Generator	100 KVA	1.5	50	1.6
Air Compressor	5.0 m3/min	0.6	40	0.7

Note : * round trip charge between Dhaka and Japan
** use for one year

Table L.11 Unit Prices of Typical Materials

delivery on site

Item	Description	Unit	Price (TK) in 1986	Foregin (%)	Local (%)
Bricks		1000 pcs	1,600	20	80
Mortar (1:2)		m3	2,500	40	60
Ready mixed concrete (1:3:5)	100 kg/cm2	do.	1,700	40	60
do.	160 kg/cm2	do.	1,800	45	55
do. (1:2:4)	210 kg/cm2	do.	2,300	45	55
Cement (50 kg/bag)	Portland	bag	105	60	40
Sand	Use of concrete	m3	350	15	85
do.	Use of filter	do.	290	15	85
do.	Use of backfill	do.	125	15	85
Laterite (Soil)		do.	125	15	85
Riprap (Gravel)	50-150 mm	do.	750	15	85
Brick Chips		do.	950	15	85
Deformed Bar	SD 30	t	17,000	80	20
Steel sheet pile		do.	25,000	100	0
Structural steel		do.	18,000	100	0
Timber	Low Class	m3	11,000	0	100
do.	High Class	do.	53,000	80	20
R. C. Pile	200mm x 200mm x 10m	ec.	2,400	55	45
	do. x 12m	do.	3,000	55	45
	do. x 15m	do.	3,600	55	45
	do. x 20m	do.	4,900	55	45
	300mm x 300mm x 10m	do.	4,900	55	45
	do. x 12m	do.	5,900	55	45
	do. x 15m	do.	7,300	55	45
	do. x 20m	do.	9,800	55	45
	350mm x 350mm x 10m	do.	6,500	55	45
	do. x 12m	do.	7,800	55	45
	do. x 15m	do.	9,700	55	45
	do. x 20m	do.	13,000	55	45
	450mm x 450mm x 10m	do.	10,300	55	45
	do. x 12m	do.	12,300	55	45
	do. x 15m	do.	15,300	55	45
	do. x 20m	do.	20,500	55	45
Gasoline		L	14	90	10
Diesel oil		do.	8	90	10
Light oil		do.	8	90	10

Table L.I2 Freight for Typical Items

Unit : TK/Freight Ton, 1986 Price

Item	Packing	Shipment	Ocean Freight	Land Transport	Total
Deformed Bar	-	600	1,260	1,400	3,260
I - Beam	160	600	1,440	1,400	3,600
Cement	2,600	600	1,560	1,400	6,160
Construction Machinery	200	600	1,800	1,400	4,000
Equipment (waterproofing)	2,400	600	1,800	1,400	6,200
Miscellaneous Goods (dampproofing)	2,600	600	1,800	1,400	6,400

Table L.I3 Unit Construction Cost of General Items

(1986 Price)

Item	Description	Unit	Price (TK)	Foregin (%)	Local (%)
Excavation	Backhoe 0.35 m3	m3	45	60	40
	do. 0.60 m3	do.	45	60	40
	Man power	do.	50	0	100
Dredging	Khal improvement	do.	120	60	40
Back filling	Backhoe 0.35 m3	do.	45	60	40
	do. 0.60 m3	do.	45	60	40
	Man power	do.	50	0	100
Embankment	Well compacted	do.	260	50	50
Concrete work	100 kg/cm2	do.	2,565	40	60
	160 kg/cm2	do.	2,700	45	55
	210 kg/cm2	do.	3,600	45	55
Reinforcement works		t	25,000	70	30
Form works		m2	1,000	50	50
Brick Works		m3	1,870	30	70
Road Pavement		m2	540	40	60
Sodding		do.	85	0	100
Sheet pile driving	L = 6.0 m	piece	16,800	80	20
	L = 8.0 m	do.	22,400	80	20
	L = 10.0 m	do.	28,000	80	20
	L = 12.0 m	do.	33,600	80	20
	L = 15.0 m	do.	42,000	80	20
Concrete pile driving (300mm x 300mm)	L = 10.0 m	do.	9,700	70	30
	L = 11.0 m	do.	10,670	70	30
	L = 12.0 m	do.	11,640	70	30
	L = 13.0 m	do.	12,610	70	30
	L = 14.0 m	do.	13,580	70	30
	L = 15.0 m	do.	14,550	70	30

Table L.I4 (a) Unit Construction Cost of Each Facility

(1986 Price)

Item	Description	Unit	Unit Construction Cost 1,000 TK
A. Dike	H = 6.0 m	TK/m	38.8
B. Gate	6.0 x 6.0 m	TK/place	29,989
C. Pump Station		TK/place	
1. Rehabilitation	Q = 9.6 m3/s		97,123
2. New	Q = 9.2 m3/s		222,800
D. Protection Works		TK/m (for both sides)	
1. Brick Protection	Type A (Slope 1:1)		29.3
2. do.	Type B (Slope 1:0.7)		48.9
3. Sodding			1.7
4. Retaining Wall	Concrete Panel		101.0
E. Railway Bridge	L = 13.0 m x 3	TK/place	11,820
F. Box Culvert	3.0 x 2.0 m	TK/m	59.2
	4.0 x 2.5		73.8
	5.0 x 3.0		98.7
	4.5 x 4.5		117.3
	6.0 x 5.0		158.5
	7.0 x 6.0		206.4
G. Brick Pipe	Ø 1.5 m	TK/m	13.8
	Ø 2.0 m		17.0
	Ø 3.0 m		23.8
	Ø 3.5 m		31.5
	Ø 4.0 m		35.2

Table L.I4 (b) Unit Construction Cost of Dike (for I.0 m length)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
1. Embankment	m3	260	50	50	87.0	11,310	11,310	22,620
2. Sand Filter	do.	290	15	85	18.0	783	4,437	5,220
3. Brick Chips	do.	950	15	85	3.0	428	2,423	2,850
4. Road Pavement	m2	540	40	60	5.0	1,080	1,620	2,700
5. Sodding	do.	85	0	100	28.0	0	2,380	2,380
6. Miscellaneous*	LS.	3000	40	60	1.0	1,200	1,800	3,000
Total			**38**	**62**		**14,801**	**23,970**	**38,770**

* Note: Including Preparation Works and Temporary Works

Table L.I4 (c) Unit Construction Cost of Gate B 6 m x H 6 m (L.S.)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
I. Preparation Works *	LS.	650,000	40	60	1.0	260,000	390,000	650,000
II. Direct Construction Cost								
A. Sheet Pile (Type III)								
1. L = 20.0 m	piece	56,000	80	20	50.0	2,240,000	560,000	2,800,000
2. L = 13.0 m	do.	36,400	80	20	105.0	3,057,600	764,400	3,822,000
3. L = 6 m	do.	16,800	80	20	27.0	362,880	90,720	453,600
Subtotal			80	20		5,660,480	1,415,120	7,075,600
B. R.C. Pile (0.4 x 0.4 m)								
1. L = 15.0 m	piece	26,000	70	30	30.0	546,000	234,000	780,000
Subtotal			70	30		546,000	234,000	780,000
C. Foundation and Gate Pier								
1. Excavation	m3	45	60	40	194.0	5,238	3,492	8,730
2. Levelling Concrete	do.	2,565	40	60	13.0	13,338	20,007	33,345
3. Concrete	do.	3,600	45	55	510.0	826,200	1,009,800	1,836,000
4. Re - Bar	t	25,000	70	30	71.0	1,242,500	532,500	1,775,000
5. Form	m2	1,000	50	50	590.0	295,000	295,000	590,000
Subtotal			56	44		2,382,276	1,860,799	4,243,075
D. Apron and Wing Wall								
1. Excavation	m3	45	60	40	36.0	972	648	1,620
2. Levelling Concrete	do.	2,565	40	60	3.7	3,796	5,694	9,491
3. Concrete	do.	3,600	45	55	100.0	162,000	198,000	360,000
4. Re - Bar	t	25,000	70	30	12.0	210,000	90,000	300,000
5. Form	m2	1,000	50	50	290.0	145,000	145,000	290,000
Subtotal			54	46		521,768	439,342	961,111
E. Brick Protection								
1. Excavation	m3	45	60	40	103.0	2,781	1,854	4,635
2. Brick Works	do.	1,870	30	70	103.0	57,783	134,827	192,610
Subtotal			31	69		60,564	136,681	197,245
F. Bridge								
1. Concrete	m3	3,600	45	55	19.0	30,780	37,620	68,400
2. Re - Bar	t	25,000	70	30	2.9	50,750	21,750	72,500
3. Form	m2	1,000	50	50	40.0	20,000	20,000	40,000
Subtotal			56	44		101,530	79,370	180,900
G. Miscellaneous Works	LS.	400,000	55	45	1.0	220,000	180,000	400,000
Total			69	31		9,382,618	4,255,313	13,637,931
III. Temporary Works **	LS.	3,800,000	40	60	1.0	1,520,000	2,280,000	3,800,000
Total			62	38		11,162,618	6,925,313	18,087,931
IV. Gate Leaf and Equipment								
1. Gate Leaf and Sheet	LS.	5,800,000	100	0	1.0	5,800,000	0	5,800,000
2. Hoist Machine	do.	1,900,000	100	0	1.0	1,900,000	0	1,900,000
3. Electrical Facilities	do.	600,000	80	20	1.0	480,000	120,000	600,000
4. Freight	do.	600,000	100	0	1.0	600,000	0	600,000
5. Installation	do.	3,000,000	90	10	1.0	2,700,000	300,000	3,000,000
Subtotal			96	4		11,480,000	420,000	11,900,000
Total			76	24		22,642,618	7,345,313	29,987,931

Note: * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)
** Temporary works (Cofferdam, de-watering, staging, etc.)

Diversion Chanel for NARINDA Gate								
1. Dredging	m3	120	60	40	22500.0	1,620,000	1,080,000	2,700,000
2. Bridge (L=25m)	LS.	4,500,000	60	40	1.0	2,700,000	1,800,000	4,500,000
Subtotal			60	40		4,320,000	2,880,000	7,200,000
Preparation Works & Temporary Works	LS.	2,300,000	30	60	1.0	690,000	1,610,000	2,300,000
Total			53	47		5,010,000	4,490,000	9,500,000

Table L.I4 (d) Unit Construction Cost of Pump Station (1) Rehabilitation Q=9.6 m3/s (L.S.)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
[Step 1]								
I. Preparation Works *	LS.	163,000	40	60	1.0	65,200	97,800	163,000
II. Direct Construction Cost								
A. Civil Works								
1. Concrete	m3	3,600	45	55	200.0	324,000	396,000	720,000
2. Re - Bar	t	25,000	70	30	24.0	420,000	180,000	600,000
3. Form	m2	1,000	50	50	600.0	300,000	300,000	600,000
4. Excavation	m3	45	60	40	750.0	20,250	13,500	33,750
5. Miscellaneous Works	do.	90,000	55	45	1.0	49,500	40,500	90,000
Subtotal			55	45		1,114,000	930,000	2,044,000
III. Temporary Works **	LS.	572,000	40	60	1.0	228,800	343,200	572,000
Total			51	49		1,408,000	1,371,000	2,779,000
IV. Equiptment								
1. Pipe Ø 1000	LS.	1,080,000	100	0	1.0	1,080,000	0	1,080,000
2. Trash Rake	do.	13,600,000	100	0	1.0	13,600,000	0	13,600,000
2. Installation	do.	3,000,000	85	15	1.0	2,550,000	450,000	3,000,000
3. Freight	do.	1,080,000	100	0	1.0	1,080,000	0	1,080,000
Subtotal			98	2		18,310,000	450,000	18,760,000
Total			**92**	**8**		**19,718,000**	**1,821,000**	**21,539,000**
[Step 2]								
I. Preparation Works *	LS.	350,000	40	60	1.0	140,000	210,000	350,000
II. Direct Construction Cost								
A. Civil Works								
1. Concrete	m3	3,600	45	55	400.0	648,000	792,000	1,440,000
2. Re - Bar	t	25,000	70	30	48.0	840,000	360,000	1,200,000
3. Form	m2	1,000	50	50	1600.0	800,000	800,000	1,600,000
4. Excavation	m3	45	60	40	750.0	20,250	13,500	33,750
5. Sheet Pile (L=8 m) Type III	piece	22,400	80	20	50.0	896,000	224,000	1,120,000
6. R.C. Pile (L = 15 m) 0.5 x 0.5 m	do.	38,250	70	30	40.0	1,071,000	459,000	1,530,000
7. Miscellaneous Works	LS.	90,000	50	50	1.0	45,000	45,000	90,000
Subtotal			62	38		4,320,500	2,693,500	7,014,000
III. Temporary Works **	LS.	1,960,000	40	60	1.0	784,000	1,176,000	1,960,000
Total			56	44		5,244,500	4,079,500	9,324,000
IV. Equiptment								
1. Main Pump L=4.7m	piece	8,800,000	100	0	2.0	17,600,000	0	17,600,000
2. Main Pump L=2.8m	do.	8,140,000	100	0	2.0	16,280,000	0	16,280,000
3. Main Motor	do.	4,400,000	100	0	4.0	17,600,000	0	17,600,000
4. Pipe & Valve	LS.	5,680,000	100	0	1.0	5,680,000	0	5,680,000
5. Spare Parts	do.	1,200,000	100	0	1.0	1,200,000	0	1,200,000
6. Installation	do.	6,680,000	90	10	1.0	6,012,000	668,000	6,680,000
7. Freight	do.	1,220,000	100	0	1.0	1,220,000	0	1,220,000
Subtotal			99	1		65,592,000	668,000	66,260,000
Total			**94**	**6**		**70,836,500**	**4,747,500**	**75,584,000**
Total (Step 1 & 2)			**93**	**7**		**90,554,500**	**6,568,500**	**97,123,000**

Note : * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)
** Temporary works (Cifferdam, de-watering, staging, etc.)

Table L.14 (e) Unit Construction Cost of Pump Station (2) New Q=9.2 m3/s (L.S.)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
I. Preparation Works *	LS.	2,700,000	40	60	1.0	1,080,000	1,620,000	2,700,000
II. Direct Construction Cost								
A. Civil Works								
1. Concrete	m3	3,600	45	55	3000.0	4,860,000	5,940,000	10,800,000
2. Re - Bar	t	25,000	70	30	360.0	6,300,000	2,700,000	9,000,000
3. Form	m2	1,000	50	50	12000.0	6,000,000	6,000,000	12,000,000
4. Excavation	m3	45	60	40	2500.0	67,500	45,000	112,500
5. Sheet Pile (L=8 m) Type III	piece	22,400	80	20	250.0	4,480,000	1,120,000	5,600,000
6. R.C. Pile (L = 15 m) 0.5 x 0.5 m	do.	38,250	70	30	150.0	4,016,250	1,721,250	5,737,500
7. Building	LS.	10,000,000	40	60	1.0	4,000,000	6,000,000	10,000,000
8. Miscellaneous Works	LS.	450,000	55	45	1.0	247,500	202,500	450,000
Subtotal			56	44		29,971,250	23,728,750	53,700,000
III. Temporary Works **	LS.	15,000,000	40	60	1.0	6,000,000	9,000,000	15,000,000
Total			52	48		37,051,250	34,348,750	71,400,000
IV. Mechanical & Electrical Facilities								
1. Ø1000 Pump	piece	8,650,000	100	0	4.0	34,600,000	0	34,600,000
2. 132kw Main Motor	do.	4,200,000	100	0	4.0	16,800,000	0	16,800,000
3. Trash Rake	LS.	13,600,000	100	0	1.0	13,600,000	0	13,600,000
4. Pipe And Valve	do.	7,300,000	100	0	1.0	7,300,000	0	7,300,000
5. Electrical Facilities	do.	30,600,000	80	20	1.0	24,480,000	6,120,000	30,600,000
6.Crane and Spare Parts	do.	2,500,000	100	0	1.0	2,500,000	0	2,500,000
7. Installation	do.	16,000,000	95	5	1.0	15,200,000	800,000	16,000,000
8. Freight	do.	30,000,000	100	0	1.0	30,000,000	0	30,000,000
Subtotal			95	5		144,480,000	6,920,000	151,400,000
Total			**81**	**19**		**181,531,250**	**41,268,750**	**222,800,000**

Note : * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)

** Temporary works (Cfferdam, de-watering, staging, etc.)

Table L.l4 (f) Unit Construction Cost of Protection Works (for l.0 m length of both sides)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
I. Brick Protection								
A. Type A : Slope 1:1								
1. Excavation	m3	45	60	40	18.0	486	324	810
2. Brick Works	do.	1870	30	70	9.8	5,498	12,828	18,326
3. Brick Chips	do.	950	15	85	5.9	841	4,764	5,605
4. Levelling Concrete	do.	2565	40	60	0.8	821	1,231	2,052
5. Backfill	do.	45	60	40	6.0	162	108	270
6. Weep Hole	piece	45	40	60	6.0	108	162	270
7. Miscellaneous *	LS.	2000	25	75	1.0	500	1,500	2,000
Total			**29**	**71**		**8,415**	**20,918**	**29,333**
B. Type B : Slope 1:0.7								
1. Excavation	m3	45	60	40	28.0	756	504	1,260
2. Brick Works	do.	1870	30	70	18.9	10,603	24,740	35,343
3. Brick Chips	do.	950	15	85	5.9	841	4,764	5,605
4. Levelling Concrete	do.	2565	40	60	1.6	1,642	2,462	4,104
5. Backfill	do.	45	60	40	6.0	162	108	270
6. Weep Hole	piece	45	40	60	6.0	108	162	270
7. Miscellaneous *	LS.	2000	25	75	1.0	500	1,500	2,000
Total			**30**	**70**		**14,611**	**34,241**	**48,852**
II. Sodding Protection								
Sodding *	m2	85	0	100	20.0	0	1,700	1,700
Total			**0**	**100**		**0**	**1,700**	**1,700**

Note: * Including Preparation works and Temporary works

Table L.I4 (g) Unit Construction Cost of Retaining Wall (for 6.0 m length of both sides)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
A. Cap Beam (0.7 x 0.7 m) 6.0 m x 2								
1. Concrete	m3	3600	45	55	5.9	9,558	11,682	21,240
2. Re - Bar	kg	25	70	30	880.0	15,400	6,600	22,000
3. Form	m2	1000	50	50	25.2	12,600	12,600	25,200
Subtotal			55	45		37,558	30,882	68,440
B. Bracing Beam (0.5 x 0.5 m) 8.0 m x 2								
1. Concrete	m3	3600	45	55	4.0	6,480	7,920	14,400
2. Re - Bar	kg	25	70	30	600.0	10,500	4,500	15,000
3. Form	m2	1000	50	50	24.0	12,000	12,000	24,000
4. Miscellaneous *	LS.	4000	75	25	1.0	3,000	1,000	4,000
Subtotal			56	44		31,980	25,420	57,400
C. Concrete Panel (t= 0.10 m) 84.0 m2								
1. Concrete	m3	3600	45	55	8.4	13,608	16,632	30,240
2. Re - Bar	kg	25	70	30	1260.0	22,050	9,450	31,500
3. Form	m2	1000	50	50	84.0	42,000	42,000	84,000
4. Miscellaneous *	LS.	8000	75	25	1.0	6,000	2,000	8,000
Subtotal			54	46		83,658	70,082	153,740
D. King Pile (0.5 x 0.5 m)								
L = 16.0 m	piece	40800	70	30	8.0	228,480	97,920	326,400
Subtotal			70	30		228,480	97,920	326,400
Total			63	37		381,676	224,304	605,980
							(for 1.0 m)	101,000

Note: * Including Preparation works and Temporary works

Table L.I4 (h) Unit Construction Cost of Railway Bridge (L.S.)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
I. Preparation Works *	L.S.	210000	40	60	1.0	84,000	126,000	210,000
II. Direct Construction Cost								
A. Foundation (R.C. Pile)								
0.4 x 0.4 x 15 m	Piece	26000	70	30	42.0	764,400	327,600	1,092,000
Subtotal			70	30		764,400	327,600	1,092,000
B. Abutment								
1. Excavation	m3	45	60	40	2640.0	71,280	47,520	118,800
2. Backfill	do.	45	60	40	1860.0	50,220	33,480	83,700
3. Levelling Concrete	do.	2565	40	60	10.9	11,183	16,775	27,959
4. Concrete	do.	3600	45	55	300.0	486,000	594,000	1,080,000
5. Re - Bar	t	25000	70	30	30.0	525,000	225,000	750,000
6. Form	m2	1000	50	50	418.0	209,000	209,000	418,000
Subtotal			55	45		1,352,683	1,125,776	2,478,459
C. Wing Wall (t= 0.50 m)								
1. Concrete	m3	3600	45	55	65.0	105,300	128,700	234,000
2. Re - Bar	t	25000	70	30	7.8	136,500	58,500	195,000
3. Form	m2	1000	50	50	260.0	130,000	130,000	260,000
Subtotal			54	46		371,800	317,200	689,000
Total						2,489,000	1,771,000	4,260,000
III. Temporary Works **	L.S.	1,200,000	70	30	1.0	840,000	360,000	1,200,000
Total			60	40		3,413,000	2,257,000	5,670,000
IV. Prefabricated Steel Structure Main Girder (13 m) x 3								
1. Girder	t	100000	100	0	33.0	3,300,000	0	3,300,000
2. Freight	L.S.	1200000	100	0	1.0	1,200,000	0	1,200,000
3. Installation	do.	1650000	90	10	1.0	1,485,000	165,000	1,650,000
Subotal			97	3		5,985,000	165,000	6,150,000
Total			**80**	**20**		**9,398,000**	**2,422,000**	**11,820,000**

Note: * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)

** Temporary works (Cofferdam, de-watering, staging, etc.)

Table L.I4 (i) Unit Construction Cost of Box Culvert (for I m length) (I)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
A. 3.0 m x 2.0 m (A = 6.0 m2)								
1. Excavation	m3	45	60	40	29.1	786	524	1,310
2. Levelling Concrete	m3	2,565	40	60	1.2	1,231	1,847	3,078
3. Concrete	m3	3,600	45	55	4.5	7,290	8,910	16,200
4. Form	m2	1,000	50	50	12.8	6,400	6,400	12,800
5. Re - Bar	kg	25	70	30	675.0	11,813	5,063	16,875
6. Backfill	m3	45	60	40	18.1	489	326	815
7. Road Pavement	m2	540	40	60	5.7	1,231	1,847	3,078
8. Miscellaneous *	LS.	5,000	55	45	1.0	2,750	2,250	5,000
Total			54	46		31,989	27,166	59,155
B. 4.0 m x 2.5 m (A = 10.0 m2)								
1. Excavation	m3	45	60	40	37.5	1,013	675	1,688
2. Levelling Concrete	m3	2,565	40	60	1.5	1,539	2,309	3,848
3. Concrete	m3	3,600	45	55	5.7	9,234	11,286	20,520
4. Form	m2	1,000	50	50	15.8	7,900	7,900	15,800
5. Re - Bar	kg	25	70	30	855.0	14,963	6,413	21,375
6. Backfill	m3	45	60	40	20.5	554	369	923
7. Road Pavement	m2	540	40	60	6.7	1,447	2,171	3,618
8. Miscellaneous *	LS.	6,000	55	45	1.0	3,300	2,700	6,000
Total			54	46		39,949	33,822	73,771

Note: * including Preparation works and Temporary works

Table L.l4 (j) Unit Construction Cost of Box Culvert (for I m length) (2)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
C. 5.0 m x 3.0 m (A = 15.0 m2)								
1. Excavation	m3	45	60	40	49.0	1,323	882	2,205
2. Levelling Concrete	m3	2,565	40	60	1.9	1,949	2,924	4,874
3. Concrete	m3	3,600	45	55	8.2	13,284	16,236	29,520
4. Form	m2	1,000	50	50	19.0	9,500	9,500	19,000
5. Re - Bar	kg	25	70	30	1230.0	21,525	9,225	30,750
6. Backfill	m3	45	60	40	24.1	651	434	1,085
7. Road Pavement	m2	540	40	60	7.9	1,706	2,560	4,266
8. Miscellaneous *	LS	7,000	55	45	1.0	3,850	3,150	7,000
Total			54	46		53,789	44,911	98,699
D. 4.5 m x 4.5 m (A = 20.2 m2)								
1. Excavation	m3	45	60	40	58.5	1,580	1,053	2,633
2. Levelling Concrete	m3	2,565	40	60	1.7	1,785	2,678	4,463
3. Concrete	m3	3,600	45	55	10.0	16,200	19,800	36,000
4. Form	m2	1,000	50	50	24.5	12,250	12,250	24,500
5. Re - Bar	kg	25	70	30	1500.0	26,250	11,250	37,500
6. Backfill	m3	45	60	40	26.5	716	477	1,193
7. Road Pavement	m2	540	40	60	7.5	1,620	2,430	4,050
8. Miscellaneous *	LS	7,000	55	45	1.0	3,850	3,150	7,000
Total			55	45		64,251	53,088	117,339

Note: * including Preparation works and Temporary works

Table L.14 (k) Unit Construction Cost of Box Culvert (for 1 m length)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
E. 6.0 m x 5.0 m (A = 30.0 m2)								
1. Excavation	m3	45	60	40	78.2	2,111	1,408	3,519
2. Levelling Concrete	m3	2,565	40	60	2.3	2,309	3,463	5,771
3. Concrete	m3	3,600	45	55	14.6	23,717	28,987	52,704
4. Form	m2	1,000	50	50	28.4	14,200	14,200	28,400
5. Re - Bar	kg	25	70	30	2190.0	38,325	16,425	54,750
6. Backfill	m3	45	60	40	31.3	845	564	1,409
7. Road Pavement	m2	540	40	60	9.2	1,987	2,981	4,968
8. Miscellaneous *	LS.	7,000	55	45	1.0	3,850	3,150	7,000
Total			55	45		87,344	71,177	158,521
F. 7.0 m x 6.0 m (A = 42.0 m2)								
1. Excavation	m3	45	60	40	100.9	2,724	1,816	4,540
2. Levelling Concrete	m3	2,565	40	60	2.5	2,586	3,878	6,464
3. Concrete	m3	3,600	45	55	20.2	32,659	39,917	72,576
4. Form	m2	1,000	50	50	33.8	16,900	16,900	33,800
5. Re - Bar	kg	25	70	30	3030.0	53,025	22,725	75,750
6. Backfill	m3	45	60	40	13.5	365	243	608
7. Road Pavement	m2	540	40	60	10.4	2,246	3,370	5,616
8. Miscellaneous *	LS.	7,000	55	45	1.0	3,850	3,150	7,000
Total			55	45		114,355	91,999	206,354

Note: * Including Preparation works and Temporary works

CONSTRUCTION COST FOR BOX CULVERT

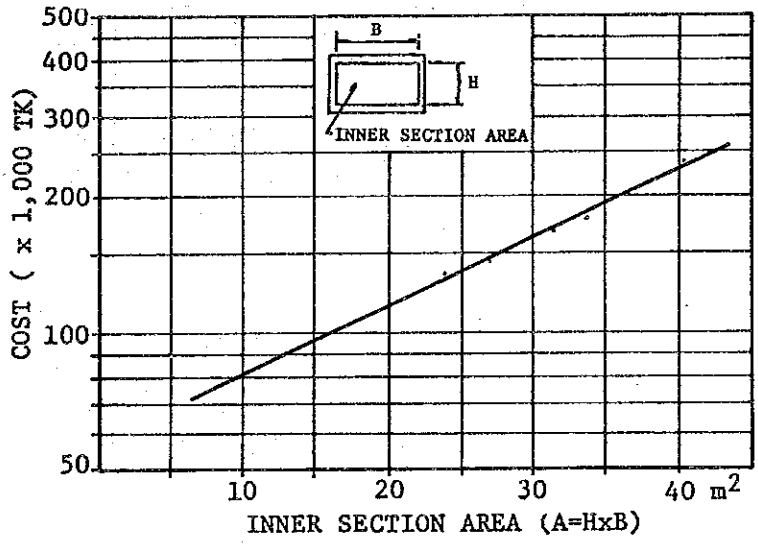

Table L.14 (I) Unit Construction Cost of Brick Pipe (for 1 m length) (1)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
3 Layers Type								
A. Ø1.5 m								
1. Excavation	m3	45	60	40	14.8	400	266	666
2. Levelling Concrete	m3	2,565	40	60	0.6	616	923	1,539
3. Shutter	m2	130	20	80	4.7	122	489	611
4. Brick Works	m3	1,870	30	70	3.1	1,739	4,058	5,797
5. Backfill	m3	45	60	40	9.9	267	178	446
6. Road Pavement	m2	540	40	60	3.3	702	1,053	1,755
7. Miscellaneous *	LS.	3,000	35	65	1.0	1,050	1,950	3,000
Total			35	65		4,896	8,918	13,814
B. Ø2.0 m								
1. Excavation	m3	45	60	40	18.9	510	340	851
2. Levelling Concrete	m3	2,565	40	60	0.7	718	1,077	1,796
3. Shutter	m2	130	20	80	6.3	164	655	819
4. Brick Works	m3	1,870	30	70	4.0	2,244	5,236	7,480
5. Backfill	m3	45	60	40	11.8	319	212	531
6. Road Pavement	m2	540	40	60	3.8	821	1,231	2,052
7. Miscellaneous *	LS.	3,500	35	65	1.0	1,225	2,275	3,500
Total			35	65		6,001	11,027	17,028
C. Ø3.0 m								
1. Excavation	m3	45	60	40	28.7	775	517	1,292
2. Levelling Concrete	m3	2,565	40	60	0.9	923	1,385	2,309
3. Shutter	m2	130	20	80	9.4	245	980	1,225
4. Brick Works	m3	1,870	30	70	6.0	3,366	7,854	11,220
5. Backfill	m3	45	60	40	15.6	421	281	702
6. Road Pavement	m2	540	40	60	4.8	1,037	1,555	2,592
7. Miscellaneous *	LS.	4,500	35	65	1.0	1,575	2,925	4,500
Total			35	65		8,342	15,497	23,839

Note: * Including Preparation works and Temporary works

Table L.14 (m) Unit Construction Cost of Brick Pipe (for 1 m length) (2)

(1986 Price)

Item	Unit	Unit Cost (TK)			Quantity	Construction Cost (TK)		
		Total	F/C (%)	L/C (%)		F/C	L/C	Total
4 Layers Type								
A. Ø3.5 m								
1. Excavation	m3	45	60	40	37.4	1,010	673	1,683
2. Levelling Concrete	m3	2,565	40	60	1.0	1,047	1,570	2,616
3. Shutter	m2	130	20	80	11.0	286	1,144	1,430
4. Brick Works	m3	1,870	30	70	9.1	5,105	11,912	17,017
5. Backfill	m3	45	60	40	17.1	462	308	770
6. Road Pavement	m2	540	40	60	5.5	1,188	1,782	2,970
7. Miscellaneous *	LS.	5,000	35	65	1.0	1,750	3,250	5,000
Total			34	66		10,847	20,639	31,486
B. Ø4.0 m								
1. Excavation	m3	45	60	40	43.8	1,183	788	1,971
2. Levelling Concrete	m3	2,565	40	60	1.1	1,149	1,724	2,873
3. Shutter	m2	130	20	80	12.6	328	1,310	1,638
4. Brick Works	m3	1,870	30	70	10.5	5,891	13,745	19,635
5. Backfill	m3	45	60	40	19.1	516	344	860
6. Road Pavement	m2	540	40	60	6.0	1,296	1,944	3,240
7. Miscellaneous *	LS.	5,000	35	65	1.0	1,750	3,250	5,000
Total			34	66		12,113	23,103	35,216

Note: * Including Preparation works and Temporary works

CONSTRUCTION COST FOR BRICK DRAINAGE PIPE

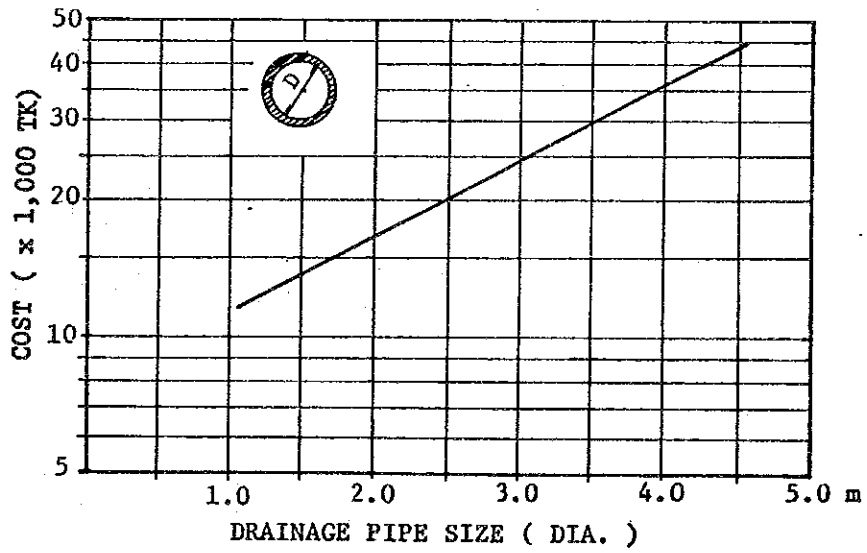

TABLE L-15 (1) OFFICE ESTABLISHMENTCOST (1)
(ANNUAL EXPENSES OF DPHE'S PERSONNEL/OFFICE ACCOMODATION FOR CONSTRUCTION SUPERVITION)
(1986 Price)

POSITION	UNIT RATE	1 - SUPERINTENDING ENGR'S OFFICE		2 - EXECUTIVE ENGR'S OFFICE		4 - SUB-DIVISIONAL ENGR'S OFFICE		TOTAL	
		STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT
	(TK/MON/PER)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)
PERSONNEL EXPENSE									
(1) SUPERINTEDING ENG.	6,500	1	78,000	-		-	-	1	78,000
(2) EXECUTIVE ENG.	4,500	-	-	2	108,000	-	-	2	108,000
(3) SUB-DIVISIONAL ENG.	3,500	-	-	-	-	4	168,000	4	168,000
(4) SUB-ASSISTANT ENG.	2,500	-	-	-	-	8	240,000	8	240,000
(5) STENOGRAPHER	2,000	1	24,000	-	-	-	-	1	24,000
(6) HEAD ASSISTASNT(UDA)	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(7) ESTIMATER	2,200	1	26,400	2	52,800	-	-	3	79,200
(8) DRAFTSMAN	2,200	1	26,400	2	52,800	-	-	3	79,200
(9) ACCOUNTANT	2,000	-	-	2	48,000	-	-	2	48,000
(10) ACCOUNT ASSISTANT	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(11) CASHIER	1,500	-	-	2	36,000	-	-	2	36,000
(12) WORK ASSISTANT	1,500	-	-	-	-	16	288,000	16	288,000
(13) L.D.A.-CUM TYPIST	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(14) DRIVER	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(15) PUMP OPERATER	1,500	-	-	-	-	8	144,000	8	144,000
(16) ASSIST. PUMP OPERATER	1,300	-	-	-	-	8	124,800	8	124,800
(17) M.L.S.S.	1,200	2	28,800	4	57,600	16	230,400	22	316,800
SUS-TOTAL (1)	-	10	261,600	22	511,200	76	1,507,200	108	2,280,000
OFFICE ACCOMODATION ETC.									
(1)OFFICE ACCOMODATION	L.S.		120,000		240,000		240,000		600,000
(2)T.A.D.A/OTHER ALLOWANCE	L.S.		48,000		48,000		96,000		192,000
(3)STATIONARY	L.S.		36,000		72,000		48,000		156,000
(4)CONTINGENCY	L.S.		12,000		24,000		24,000		60,000
SUB-TOTAL (2)	-		216,000		384,000		408,000		1,008,000
TOTAL	-		477,600		895,200		1,915,200		3,288,000

TABLE L-15 (2) OFFICE ESTABLISHMENT COST (2)
(PROCUREMENT COST OF VEHICLE AND MOTER CYCLE FOR DPHE'S CONSTRUCTION SUPERVITION)
UNIT: THOUSAND TK, 1986 PRICE

VEHICLE/MOTOR CYCLE	NO.	UNIT PRICE			TOTAL PRICE
		C.I.F.	COST	TOTAL	
(1) 1300 cc CAR	1	250	440	690	690
(2) J EEP	2	450	340	790	1,580
(3) PICKUP CAR	4	300	230	530	2,120
(4) 90 cc MOTOR CYCLE	8	40	120	160	1,280
TOTAL	15	-	-	-	5,670

TABLE L-15 (3) ANNUAL EXPENSES OF DPHE'S PERSONNEL/OFFICE ACCOMODATION FOR OPERATION AND MAINTENANCE
(AT 1986 PRICE)

Unit : TK, 1986 Price

POSITION	UNIT RATE	1 - SUPERINTENDING ENGR'S OFFICE		2 - EXECUTIVE ENGR'S OFFICE		4 - SUB-DIVISIONAL ENGR'S OFFICE		TOTAL	
		STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT	STAFF	PAYMENT
	(TK/MON/PER)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)	(PERSON)	(TK/YEAR)
PERSONNEL EXPENSES									
(1) SUPERINTEDING ENG.	6,500	1	78,000	-		-	-	1	78,000
(2) EXECUTIVE ENG.	4,500	-	-	2	108,000	-	-	2	108,000
(3) SUB-DIVISIONAL ENG.	3,500	-	-	-	-	4	168,000	4	168,000
(4) SUB-ASSISTANT ENG.	2,500	-	-	-	-	8	240,000	8	240,000
(5) STENOGRAPHER	2,000	1	24,000	-	-	-	-	1	24,000
(6) HEAD ASSISTASNT(UDA)	2,000	1	24,000	2	48,000	4	96,000	7	168,000
(7) ESTIMATER	2,200	1	26,400	2	52,800	-	-	3	79,200
(8) DRAFTSMAN	2,200	1	26,400	2	52,800	-	-	3	79,200
(9) ACCOUNTANT	2,000	-	-	2	48,000	-	-	2	48,000
(10) ACCOUNT ASSISTANT	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(11) CASHIER	1,500	-	-	2	36,000	-	-	2	36,000
(12) WORK ASSISTANT	1,500	-	-	-	-	16	288,000	16	288,000
(13) L.D.A.-CUM TYPIST	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(14) DRIVER	1,500	1	18,000	2	36,000	4	72,000	7	126,000
(15) PUMP OPERATER	1,500	-	-	-	-	8	144,000	8	144,000
(16) ASSIST. PUMP OPERATER	1,300	-	-	-	-	8	124,800	8	124,800
(17) CLEANER	1,200	-	-	-	-	20	288,000	20	288,000
(18) M.L.S.S.	1,200	2	28,800	4	57,600	16	230,400	22	316,800
SUS-TOTAL (1)	-	10	261,600	22	511,200	96	1,795,200	128	2,568,000
OFFICE ACCOMODATION ETC.									
(1)OFFICE ACCOMODATION	L.S.		120,000		240,000		240,000		600,000
(2)T.A.D.A./OTHER ALLOWANCE	L.S.		48,000		48,000		96,000		192,000
(3)STATIONERY	L.S.		36,000		72,000		48,000		156,000
(4)CONTINGENCY	L.S.		12,000		24,000		24,000		60,000
SUB-TOTAL (2)	-		216,000		384,000		408,000		1,008,000
TOTAL	-		477,600		895,200		2,203,200		3,576,000

Table L.16 Implementation Schedule

Unit : Million Tk , 1986 Price

ZONE	WORK ITEM	QUANTITY	CONSTRUC-TION COST	DESIGN STAGE	CONSTRUCTION STAGE				
				FIRST YEAR 1988/ '89	SECOND YEAR 1989/ '90	THIRD YEAR 1990/ '91	FOURTH YEAR 1991/ '92	FIFTH YEAR 1992/ '93	SIXTH YEAR 1993/ '94
B	(1) PUMP STATION (REHABIL.)	9.6 m3/s	97.1		31.6 Step I				75.5 Step II
	(2) GATE (NARINDA)	1 place	39.5		39.5 1 place				
	(3) KHAL IMPROVEMENT								
	1.DHOLAI KHAL (K-1)	3.0 km	22.2			22.2 3.0 km			
	2.GANDARIA KHAL (K-2)	1.2 km	16.3					16.3 1.2 km	
	(4) DRAINS								
	1. D-1	2.80 km	90.7		51.9 0.75 km [Main	29.7 1.55 km Drainage pipe]			9.1 0.5 km [Branch
	2. D-2	1.48 km	88.1					59.5 1.0 km	28.6 0.48 km
	(5) LAND ACQUISITION	4.50 ha	[9.7]	[8.4] 3.4 ha		[1.3] 1.1 ha			
C	(1) DIKE	4.80 km	186.2			93.1 2.4 km	93.1 2.4 km		
	(2) GATE	1 place	30.0				30.0 1 place		
	(3) PUMP STATION (ADDITION)	9.2 m3/S	222.8		73.5 Whole Civil + Mech.	73.6 (4.6 m3/s)		75.7 Mech.(4.6m3/s)	
	(4) KHAL IMPROVEMENT								
	1. GERANI KHAL (K-3)	2.10 km	10.0					10.0 2.10km	
	2. SEGUNBAGICHA KHAL (K-4)	3.00 km	141.6			25.9 Box Cul 9 places	92.8 3.0 km	22.9 Box Cul 4 places(No.2,3,5, 4)	
	(5) DRAINS								
	1. D-3	2.50 km	82.2				61.7 1.4 km	20.5 1.1 km	
	2. D-4	0.54 km	7.5						7.5 0.54 km
	3. D-5	0.72 km	14.3					14.3 0.72km	
	4. D-6	1.05 km	21.0						21.0 1.05 km
	(6) LAND ACQUISITION	42.70 ha	[58.6]		[55.6] 40.2 ha	[3.0] 23.5 ha			
F	(1) KHAL IMPROVEMENT								
	1. BEGUNBARI (K-5)	2.80 km	25.2						25.2 2.8 km
	2. PARIBAGH (K-6)	1.00 km	71.4					35.7 0.5 km	35.7 0.5 km
	(2) DRAINS								
	1. D-7	1.10 km	23.2						23.2 1.10 km
	2. D-8	0.45 km	7.0						7.0 0.45 km
	3. D-9	1.85 km	41.0					20.5 0.93 km	20.5 0.93 km
	(3) LAND ACQUISITION	4.80 ha	[14.7]			[1.7] 0.3 ha	[13.0] 4.5 ha		
	(1) SUB TOTAL		1237.3		186.5	244.5	277.6	275.4	253.3
	(2) CONTINGENCY		123.7		18.6	24.5	27.8	27.5	25.3
	TOTAL OF (1)+(2)		1361.0		205.1	269.0	305.4	302.9	278.6
	(3) ENGINEERING		136.1	46.1 (D/D)	18.0	18.0	18.0	18.0	18.0
	TOTAL OF (1)+(2)+(3)		1497.1	46.1	223.1	287.0	323.4	320.9	296.6
	LAND ACQUISITION (4)		[83.0]	8.4	55.6	6.0	13.0	0	0
	OFFICE ESTABLISH. (5)		[25.5]	9.0	3.3	3.3	3.3	3.3	3.3
	CUSTOMS DUTY/TAX(6)		[184.7]	0.0	27.8	48.5	11.9	51.8	44.7
	TOTAL OF (4)+(5)+(6)		[293.2]	17.4	86.7	57.8	28.2	55.1	48.0
	TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)		1,790.3	63.5	309.8	344.8	351.6	376.0	344.6
	(7) PRICE CONTENGENCY		818.9	11.6	82.9	133.1	167.2	199.5	224.6
	TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)+(7)		2,609.2	75.1	392.7	477.9	518.8	575.5	569.2

Table L.17 Escalation Contingency (1988/1989-1993/1994)

Unit : Million Tk. 1986 Price

ZONE	WORK ITEM	CONSTRUCTION COST			DESIGN STAGE		CONSTRUCTION STAGE									
					FIRST YEAR 1988/ '89		SECOND YEAR 1989/ '90		THIRD YEAR 1990/ '91		FOURTH YEAR 1991/ '92		FIFTH YEAR 1992/ '93		SIXTH YEAR 1993/ '94	
			F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
	ESCALATION RATE (%)		6.0	33.0	6.0	33.0	8.0	46.0	10.0	61.0	13.0	77.0	15.0	95.0	17.0	114.0
B	(1) PUMP STATION (REHABILI.)	97.1	90.5	6.6			19.7	1.9							70.8	4.7
	(2) GATE (NARINDA)	39.5	27.7	11.8			27.7	11.8								
	(3) KHAL IMPROVEMENT															
	1.DHOLAI KHAL (K-1)	22.2	10.9	11.3					10.9	11.3						
	2.GANDARIA KHAL (K-2)	16.3	5.3	11.0									5.3	11.0		
	(4) DRAINS															
	1. D-1	90.7	42.1	48.6			28.5	23.4	10.4	19.3					3.2	5.9
	2. D-2	88.1	48.4	39.7									32.7	26.8	15.7	12.9
	(5) LAND ACQUISITION	[9.7]	0.0	9.7		8.4				1.3						
C	(1) DIKE	186.2	70.7	115.5					35.3	57.8	35.4	57.7				
	(2) GATE	30.0	22.6	7.4							22.6	7.4				
	(3) PUMP STATION (ADDITIONAL)	222.8	181.5	41.3			54.6	18.9	54.7	18.9			72.2	3.5		
	(4) KHAL IMPROVEMENT															
	1. GERANI KHAL (K-3)	10.0	5.3	4.7									5.3	4.7		
	2. SEGUNBAGICHA KHAL (K-4)	141.6	75.6	66.0					14.2	11.7	45.9	46.9	15.5	7.4		
	(5) DRAINS															
	1. D-3	82.2	38.0	44.2							30.8	30.9	7.2	13.3		
	2. D-4	7.5	2.6	4.9											2.6	4.9
	3. D-5	14.3	5.0	9.3									5.0	9.3		
	4. D-6	21.0	7.4	13.6											7.4	13.6
	(6) LAND ACQUISITION	[58.6]	0.0	58.6				55.6		3.0						
F	(1) KHAL IMPROVEMENT															
	1. BEGUNBARI (K-5)	25.2	11.3	13.9											11.3	13.9
	2. PARIBAGH (K-6)	71.4	33.1	38.3									16.5	19.2	16.6	19.1
	(2) DRAINS															
	1. D-7	23.2	8.1	15.1											8.1	15.1
	2. D-8	7.0	2.5	4.5											2.5	4.5
	3. D-9	41.0	14.4	26.6									7.2	13.3	7.2	13.3
	(3) LAND ACQUISITION	[14.7]	0.0	14.7						1.7		13.0				
	(1)SUB TOTAL	1,237.3	703.0	534.3	0.0	0.0	130.5	56.0	125.5	119.0	134.7	142.9	166.9	108.5	145.4	107.9
	(2)CONTINGENCY	123.7	70.3	53.4	0.0	0.0	13.0	5.6	12.6	11.9	13.5	14.3	16.7	10.8	14.5	10.8
	(3)ENGINEERING	136.1	102.1	34.0	34.6	11.5	13.5	4.5	13.5	4.5	13.3	4.5	13.5	4.5	13.5	4.5
	TOTAL OF (1)+(2)+(3)=(4)	1,497.1	875.4	621.7	34.6	11.5	157.0	66.1	151.6	135.4	161.7	161.7	197.1	123.8	173.4	123.2
	(5) LAND ACQUISITION	83.0	0.0	0.0	0.0	8.4	0.0	55.6	0.0	6.0	0.0	13.0	0.0	0.0	0.0	0.0
	(6)OFFICE ESTABLISHMENT	25.5	0.0	0.0	0.0	9.0	0.0	3.3	0.0	3.3	0.0	3.3	0.0	3.3	0.0	3.3
	(7)CUSTOMS DUTY/SALES TAX	184.7	0.0	0.0	0.0	0.0	0.0	27.8	0.0	48.5	0.0	11.9	0.0	51.8	0.0	44.7
	TOTAL OF (5)+(6)+(7)=(8)	293.2	0.0	0.0	0.0	17.4	0.0	86.7	0.0	57.8	0.0	28.2	0.0	55.1	0.0	48.0
	(9)PRICE CONTIN. OF (4)	609.3	110.0	499.3	2.1	3.8	12.6	30.4	15.2	82.6	21.0	124.5	29.6	117.6	29.5	140.4
	(10)PRICE CONTIN. OF (8)	209.6	0.0	209.6	0.0	5.7	0.0	39.9	0.0	35.3	0.0	21.7	0.0	52.3	0.0	54.7
	TOTAL OF (9)+(10)=(11)	818.9	110.0	708.9	2.1	9.5	12.6	70.3	15.2	117.9	21.0	146.2	29.6	169.9	29.5	195.1
TOTAL OF (4)+(8)+(11)		2,609.2	985.4	1,623.8	36.7	38.4	169.6	223.1	166.8	311.1	182.7	336.1	226.7	348.8	202.9	366.3

SUPPORTING REPORT M

PROJECT EVALUATION

SUPPORTING REPORT M

PROJECT EVALUATION

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SUPPORTING REPORT M

PROJECT EVALUATION

1. Introduction

1.1 Framework

The technical aspects of flood protection and drainage works have been discussed in the previous papers. Practical method of mitigating storm water damage have been examined and the technically best policy prepared.

It is therefore necessary to conduct an economic evaluation to examine investment efficiency of the technically best alternative and then to allow for variation in cost and benefit assumptions by use of sensitivity analysis.

For that purpose, impact of the proposed improvement plan is measured in terms of damage reduction job creation and consequently acceleration of economic and social activities.

Task components are shown in Fig. M.1. Whole the evaluation work consists of three (3) major components, which are;

1. Estimation of flood/inundation damage potential,
2. Estimation of economic costs for the project, and
3. Economic analysis

In this series of supporting reports, work 1 is contained in Supporting Report F. This report covers works 2 and 3 only.

1.2 Analytical Assumptions

(1) Area under the examination are limited to the drainage zones B, C and F since, first in all, these are listed at the top of the priority sequence of the drainage zone, and secondly investment period for these zones (6 years in total) falls in the suitable time horizon to keep an accuracy of the cost and benefit estimations for the feasibility study.

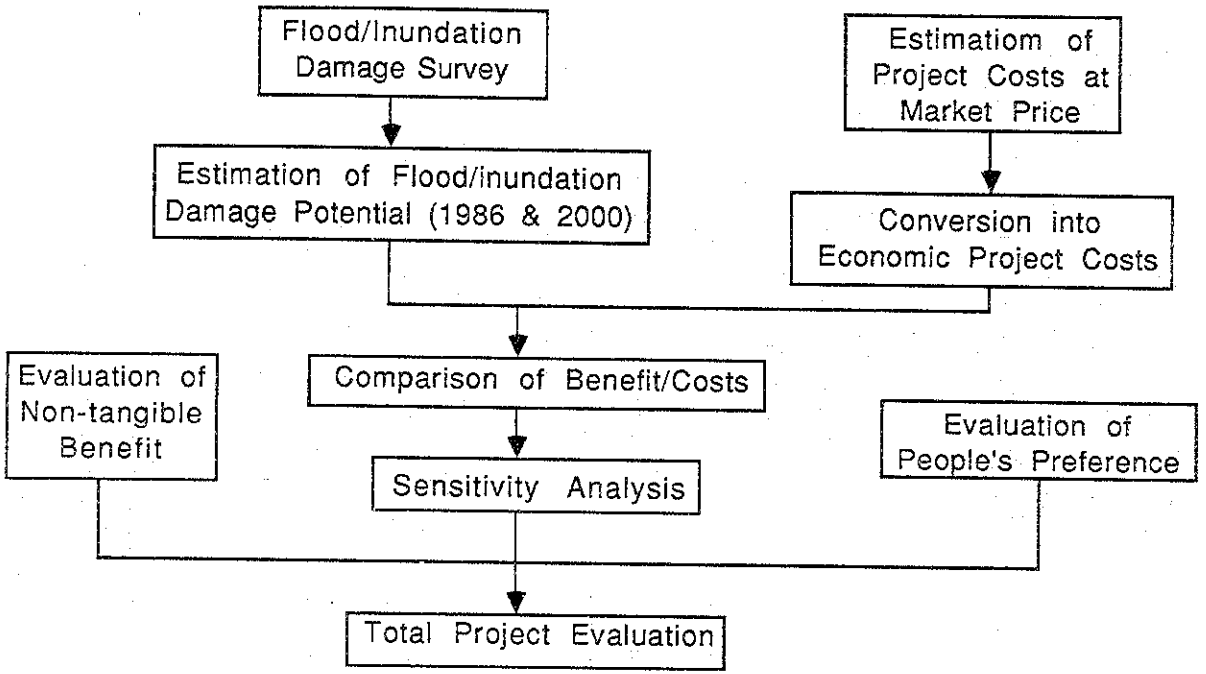

FIG. M.1 TASK COMPONENTS AND PROCEDURE

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

(2) All the data necessary for this project evaluation are collected in these zones and compiled. therefore, figures of the data might be slightly different from those of the Dhaka and/or national data. the difference is rather the very nature of the things attributable to the differences in characters of the sampling areas.

(3) Investment schedule is set in the implementation programme. It schedules all the anti-flood projects in these zones for the Phase I period (1989 thru 1993).

2. Project Benefits

2.1 Definition of Benefits

Benefit of this drainage system improvement project is defined as an incremental difference of flood/inundation damage potential between the cases of "with the project" and "without the project". This is equivalent to the magnitude of reduction in flood/inundation damage.

At present, no practical counter-measures are planned by the planning authorities concerned for the same time horizon as this study. It is therefore assumed in this case of "without the project" that new additional facilities are not built up in this project life.

Progress of urban expansion into the low flood-prone area is assumed to be non-sensitive to an implementation of the project because of its extreme pressure of population increase.

2.2 Identification of Benefits

Six items of the project benefit are taken into consideration. Each benefit item here narrows down its subject to the tangible and quantitatively measurable benefit. They are;

- Reduction of general property damage
- Reduction of public property damage
- Reduction of income/sales loss
- Reduction of vehicles' running costs
- Creation of employment opportunity

Multiplier effects of each benefit are not taken into consideration. thus total benefit of the project measured in the report is the minimum level of the actual benefit. And the final evaluation indicators are to be properly interpreted.

2.3 Estimation of Project Benefits

There are two steps in the estimation process; annual damage reduction by flood frequency, and average annual damage reduction.

First, annual damage reduction is measured. In Suporting Report F, value in annual damage reduction is calculated for the flood of annual and 10-year frequency, and are presented with explanation on estimation method of each benefit.

In this section, other two cases are added for the flood with 5- and 30-year frequency. Results are shown in Table M.1. Value in annual damage reduction in case of 5- and 30- year frequency is assumed to have a semi-logarithmic relationship with flood frequency.

It is noteworthy that reduction of general property damage in case of 1986 accounts for 52.9% of the whole benefit of the project, followed by the reduction of public property damage, especially road damage reduction, of 14.3%. In sum, about 67.2% of all project benefits attributes to these two kinds of benefits. In case of the year 2000, these two kinds of damage reduction occupies more than 59% of the whole benefit of the project.

In general, a paralysis of transportation, break-out of epidemic and income/sales loss is believed to be the most apparent defects of the flood/inundation. However, this rather causes inconvenience in the daily life and are not measured in depth because of its nature. Small share of these benefit items lies in this facts.

Table M.1 Summary of Project Benefits

(Unit : million TK. in 1986 Price)

Items	1986				2000			
	1 / 1	1 / 5	1 / 10	1 / 30	1 / 1	1 / 5	1 / 10	1 / 30
A. General Property								
(1) Houses	99.1	176.6	210.0	262.9	138.0	231.8	272.4	336.5
(2)Household Articles	1.3	8.8	12.1	17.4	2.7	18.5	25.3	36.1
(3) Commercial Buildings (depreciating assets & stocks)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	100.4	185.4	222.1	280.3	140.7	250.3	297.7	372.6
B. Public Property								
(1) Electric Facilities	1.0	2.0	2.5	3.2	2.1	4.3	5.3	6.8
(2) Telecommunication Facilities	17.7	36.3	44.3	57.0	37.0	75.8	92.5	119.0
(3) Public Facilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(4) Roads	26.8	55.9	66.9	139.7	55.9	114.5	139.7	179.7
(5) Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	45.5	94.2	113.7	199.9	95.0	194.6	237.5	305.5
C. Agricultural Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. Income/Sales Loss Potential								
(1) Labour	4.4	5.0	5.2	5.6	15.2	17.2	18.1	19.5
(2) Shop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(3) Electricity Sales	2.9	6.0	7.3	9.4	6.1	12.5	15.2	19.5
(4) Transport Charges								
Bus	17.7	31.1	36.9	46.1	44.2	77.8	92.3	115.2
Rickshaw	1.7	3.0	3.5	4.4	4.2	7.4	8.8	11.0
Subtotal	26.7	45.1	52.9	65.5	69.7	114.9	134.4	165.2
E. Vehicle's Running Costs								
(1) Operating Costs	0.8	0.8	0.8	0.8	1.6	1.6	1.6	1.6
(2) Time Costs Vehicles	5.4	5.4	5.4	5.4	10.9	10.9	10.9	10.9
Passengers	8.6	8.6	8.6	8.6	17.5	17.5	17.5	17.5
Subtotal	14.8	14.8	14.8	14.8	30.0	30.0	30.0	30.0
Grand Total	187.4	339.5	403.5	560.5	335.4	589.8	699.6	873.3

Secondly, average annual damage reduction is calculated. Annual damage reduction in the years 1986 and 2000 by flood probability is weighted by frequency of flood and their aggregation makes the average annual damage reduction of each year. Calculation function is given as follows;

$$D = E [(N_{m-1} - N_m) \times (L_{m-1} + L_m)/2]$$

Where, D = average annual damage reduction
N = probability of flood
L = damage potential corresponding to probability of flood
m = ordinal number

Figures in Table M.1 are applied to the function above. In estimating the average annual damage, (1) 30-year frequency for the external flood and (2) 5-year frequency for the internal flood are adopted as an maximum frequency up to which annual damage reduction is accumulated because those are corresponding to the design flood frequency of each flood protection works. Actual benefit area is diagrammatically shown in Fig. M.2, and calculation is done as follows;

$$\begin{aligned} D_{1986} = & (1 - 1/5) \times (166.9 + 192.9)/2 \\ & + [(1 - 1/5) \times (20.2 + 145.5)/2 \\ & + (1/5 - 1/10) \times (145.5 + 204.1)/2 \\ & + (1/10 - 1/30) \times (204.1 + 284.8)/2] \\ = & 243.5 \end{aligned}$$

$$\begin{aligned} D_{2000} = & (1 - 1/5) \times (293.5 + 348.9)/2 \\ & + [(1 - 1/5) \times (41.8 + 241.1)/2 \\ & + (1/5 - 1/10) \times (241.1 + 326.9)/2 \\ & + (1/10 - 1/30) \times (326.9 + 463.0)/2] \\ = & 424.9 \end{aligned}$$

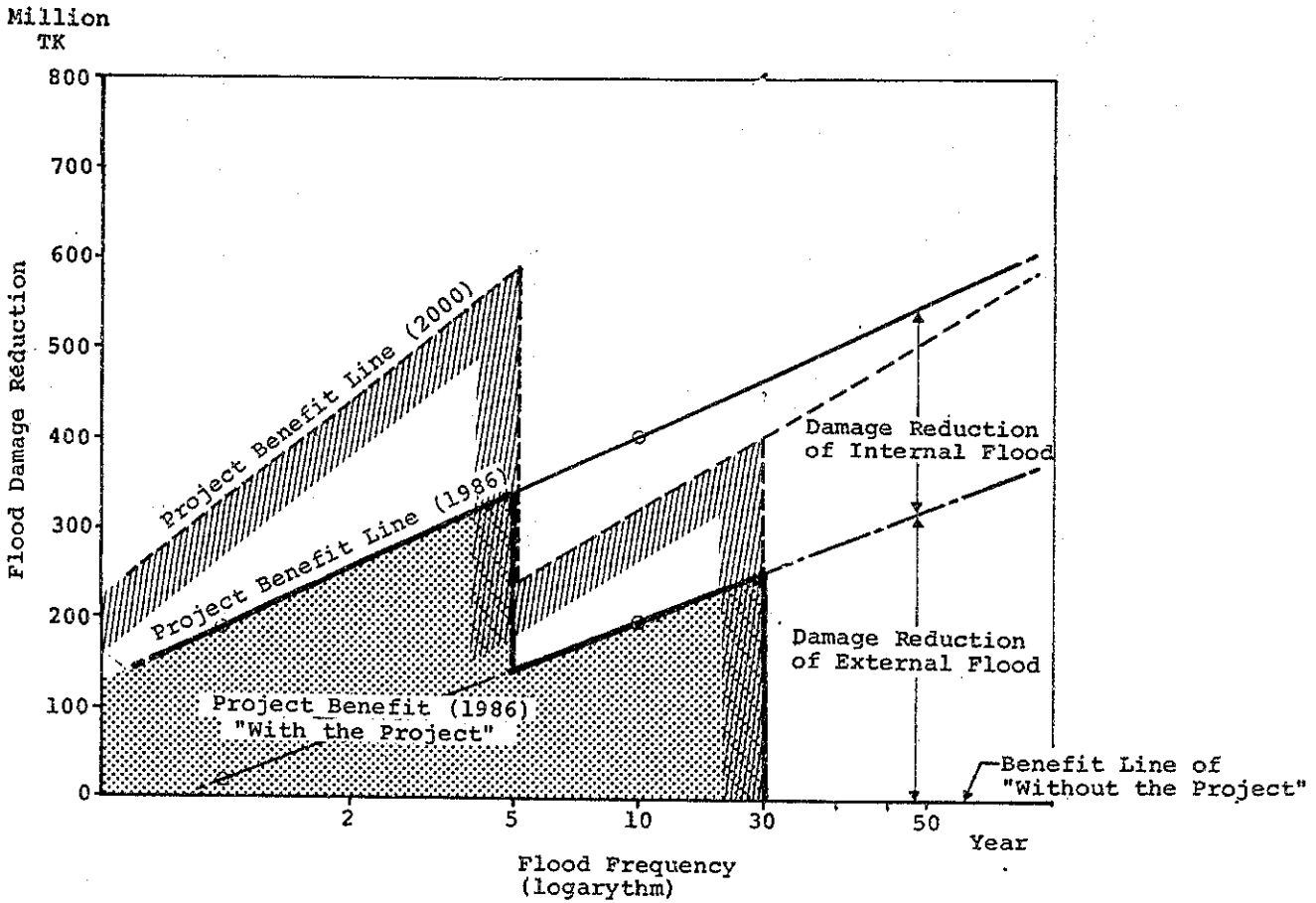

FIG. M.2 Relation between the Flood Frequency and the Flood Damage Reduction

STORM WATER DRAINAGE SYSTEM IMPROVEMENT PROJECT IN DHAKA CITY, THE PEOPLE'S REPUBLIC OF BANGLADESH

Benefit of the project is assumed to increase linearly between the years 1986 and 2000, and keep constant after the year 2000. For land use plan assumes that all the land in the Study Area will be developed up to the year 2000 and that urbanization will be directed toward north of the present Dhaka town afterwards where are free from any water stagnating problems.

Flow of the average annual damage reduction at the major milestone years are as follows;

(Unit: million TK in 1986 prices)

Items	1986	1990	1995	2000
Average Annual Damage Potential	243.5	295.5	360.5	424.9
Internal Flood	143.9	176.3	216.8	257.0
External Flood	99.6	119.2	143.7	167.9

3. Estimation of Economic Costs

Project costs at 1986 market prices are shown in Supporting Report F. In the economic evaluation, all the costs of inputs are prices at the real marginal productivity of each input which will be withdrawn from the other production fields because of this project.

The nominal cost is processed into the economic costs by using the following processes;

(1) Conversion factors of every work items are calculated by weighting the specific conversion factor of each material with the composition share in terms of value. They are;

Work Item	General Conversion Factor
Dike	0.888
Pump Station (rehabilitation)	0.994
- ditto - (new)	0.954
Gate	0.928
Khal Improvement	0.819
Land Acquisition	1.000

Calculation details are shown in Tables M.2, M.3, M.4 and M.5. Original conversion factors are adopted from "Overview of Industrial Project Appraisal, 1986."

(2) Construction costs at the market price distributed according to the implementation schedule, are multiplied by the conversion factors estimated in the previous step. And the economic costs are gained. Distribution flow of economic costs is shown in Table M.6 in the same format as the implementation schedule.

As for the maintenance costs, enrollment is expected at the first year after the installation or completion of construction works. Each component is presented in Table M.7 with its flow up to the year 1995, and assumed constant in the consequent years. And all the machines and parts are assumed to be replaced by new one at the same price as the present one every 15 years. total replacement cost of the pump is equivalent to 151.4 million TK and gate equivalent to 11.9 million TK.

4. Economic Evaluation

Economic cost and benefits are compared in this section and the results show enough investment efficiency of the investment. The high feasibility of this project is proven with various evaluation indicators.

In this section, first, some assumptions are explained and then the results are shown with some interpretations.

Table M.2 Economic Unit Construction Cost of Dike (for 1.0 m length)

(in 1986 prices)

Item	Construction Cost (TK)			Conversion Factor of L/C	Economic Construction Cost (TK)		
	F/C	L/C	Total		F/C	L/C	Total
1. Embankment	11,310	11,310	22,620	0.819	11,310	9,263	20,573
2. Sand Filter	783	4,437	5,220	0.819	783	3,634	4,417
3. Brick Chips	428	2,423	2,850	0.819	428	1,984	2,412
4. Road Pavement	1,080	1,620	2,700	0.819	1,080	1,327	2,407
5. Sodding	0	2,380	2,380	0.819	0	1,949	1,949
6. Miscellaneous*	1,200	1,800	3,000	0.819	1,200	1,474	2,674
Total	**14,801**	**23,970**	**38,770**		**14,801**	**19,631**	**34,432**

* Note: including Preparation Works and Temporary Works

Dike conversion factor

= 34,432 / 38770

= 0.888

Table M.3 Economic Unit Construction Cost of Gate B 6 m x H 6 m (L.S.)

(in 1986 prices)

Item	Construction Cost (TK)			Conversion Factor of L/C	Economic Construction Cost (TK)		
	F/C	L/C	Total		F/C	L/C	Total
I. Preparation Works *	260,000	390,000	650,000	0.751	260,000	292,890	552,890
II. Direct Construction Cost							
A. Sheet Pile (Type III)							
1. L = 20.0 m	2,240,000	560,000	2,800,000	0.613	2,240,000	343,280	2,583,280
2. L = 13.0 m	3,057,600	764,400	3,822,000	0.613	3,057,600	468,577	3,526,177
3. L = 6 m	362,880	90,720	453,600	0.613	362,880	55,611	418,491
Subtotal	5,660,480	1,415,120	7,075,600		5,660,480	867,469	6,527,949
B. R.C. Pile (0.4 x 0.4 m)							
1. L = 15.0 m	546,000	234,000	780,000	0.613	546,000	143,442	689,442
Subtotal	546,000	234,000	780,000		546,000	143,442	689,442
C. Foundation and Gate Pier							
1. Excavation	5,238	3,492	8,730	0.819	5,238	2,860	8,098
2. Levelling Concrete	13,338	20,007	33,345	0.754	13,338	15,085	28,423
3. Concrete	826,200	1,009,800	1,836,000	0.754	826,200	761,389	1,587,589
4. Re - Bar	1,242,500	532,500	1,775,000	0.613	1,242,500	326,423	1,568,923
5. Form	295,000	295,000	590,000	0.819	295,000	241,605	536,605
Subtotal	2,382,276	1,860,799	4,243,075		2,382,276	1,347,362	3,729,638
D. Apron and Wing Wall							
1. Excavation	972	648	1,620	0.819	972	531	1,503
2. Levelling Concrete	3,796	5,694	9,491	0.754	3,796	4,294	8,090
3. Concrete	162,000	198,000	360,000	0.754	162,000	149,292	311,292
4. Re - Bar	210,000	90,000	300,000	0.613	210,000	55,170	265,170
5. Form	145,000	145,000	290,000	0.819	145,000	118,755	263,755
Subtotal	521,768	439,342	961,111		521,768	328,041	849,809
E. Brick Protection							
1. Excavation	2,781	1,854	4,635	0.819	2,781	1,518	4,299
2. Brick Works	57,783	134,827	192,610	0.751	57,783	101,255	159,038
Subtotal	60,564	136,681	197,245		60,564	102,774	163,338
F. Bridge						0	0
1. Concrete	30,780	37,620	68,400	0.754	30,780	28,365	59,145
2. Re - Bar	50,750	21,750	72,500	0.613	50,750	13,333	64,083
3. Form	20,000	20,000	40,000	0.819	20,000	16,380	36,380
Subtotal	101,530	79,370	180,900		101,530	58,078	159,608
G. Miscellaneous Works	220,000	180,000	400,000	0.819	220,000	147,420	367,420
Total	9,382,618	4,255,313	13,637,931		9,382,618	2,847,165	12,229,784
III. Temporary Works **	1,520,000	2,280,000	3,800,000	0.751	1,520,000	1,712,280	3,232,280
Total	11,162,618	6,925,313	18,087,931		11,162,618	4,852,335	16,014,954
IV. Gate Leaf and Equipment							
1. Gate Leaf and Sheet	5,800,000	0	5,800,000	0.819	5,800,000	0	5,800,000
2. Hoist Machine	1,900,000	0	1,900,000	0.796	1,900,000	0	1,900,000
3. Electrical Facilities	480,000	120,000	600,000	0.819	480,000	98,280	578,280
4. Freight	600,000	0	600,000	0.759	600,000	0	600,000
5. Installation	2,700,000	300,000	3,000,000	0.751	2,700,000	225,300	2,925,300
Subtotal	11,480,000	420,000	11,900,000		11,480,000	323,580	11,803,580
Total	**22,642,618**	**7,345,313**	**29,987,931**		**22,642,618**	**5,175,915**	**27,818,534**

Note: * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)
** Temporary works (Cofferdam, de-watering, staging, etc.)

Diversion Chanel for NARINDA Gate							
1. Dredging	1,620,000	1,080,000	2,700,000	0.819	1,620,000	884,520	2,504,520
2. Bridge (L=25m)	2,700,000	1,800,000	4,500,000	0.819	2,700,000	1,474,200	4,174,200
Subtotal	4,320,000	2,880,000	7,200,000		4,320,000	2,358,720	6,678,720
Preparation Works & Temporary Works	690,000	1,610,000	2,300,000	0.751 0.751	690,000	1,209,110	1,899,110
Total	5,010,000	4,490,000	9,500,000		5,010,000	3,567,830	8,577,830

Gate conversion factor = 27,818,534 / 29987930.5
= 0.928

Table M.4 Economic Unit Construction Cost of Pump Station (1) Rehabilitation Q=9.6 m3/s (L.S.)

(in 1986 prices)

Item	Construction Cost (TK)			Conversion Factor of L/C	Economic Construction Costs (Tk)		
	F/C	L/C	Total		F/C	L/C	Total
[Step 1]							
I. Preparation Works *	65,200	97,800	163,000	0.819	65,200	80,098	145,298
II. Direct Construction Cost							
A. Civil Works							
1. Concrete	324,000	396,000	720,000	0.754	324,000	298,584	622,584
2. Re - Bar	420,000	180,000	600,000	0.613	420,000	110,340	530,340
3. Form	300,000	300,000	600,000	0.819	300,000	245,700	545,700
4. Excavation	20,250	13,500	33,750	0.819	20,250	11,057	31,307
5. Miscellaneous Works	49,500	40,500	90,000	0.819	49,500	33,170	82,670
Subtotal	1,114,000	930,000	2,044,000		1,114,000	698,850	1,812,850
III. Temporary Works **	228,800	343,200	572,000	0.751	228,800	257,743	486,543
Total	1,408,000	1,371,000	2,779,000		1,408,000	1,036,691	2,444,691
IV. Equipment							
1. Pipe Ø 1000	1,080,000	0	1,080,000	0.613	1,080,000	0	1,080,000
2. Trash Rake	13,600,000	0	13,600,000	0.613	13,600,000	0	13,600,000
2. Installation	2,550,000	450,000	3,000,000	0.819	2,550,000	368,550	2,918,550
3. Freight	1,080,000	0	1,080,000	0.759	1,080,000	0	1,080,000
Subtotal	18,310,000	450,000	18,760,000		18,310,000	368,550	18,678,550
Total of Step 1	**19,718,000**	**1,821,000**	**21,539,000**		**19,718,000**	**1,405,241**	**21,123,241**
[Step 2]							
I. Preparation Works *	140,000	210,000	350,000	0.751	140,000	157,710	297,710
II. Direct Construction Cost							
A. Civil Works							
1. Concrete	648,000	792,000	1,440,000	0.754	648,000	597,168	1,245,168
2. Re - Bar	840,000	360,000	1,200,000	0.613	840,000	220,680	1,060,680
3. Form	800,000	800,000	1,600,000	0.819	800,000	655,200	1,455,200
4. Excavation	20,250	13,500	33,750	0.819	20,250	11,057	31,307
5. Sheet Pile (L=8 m)	896,000	224,000	1,120,000	0.613	896,000	137,312	1,033,312
6. R.C. Pile (L = 15 m)	1,071,000	459,000	1,530,000	0.613	1,071,000	281,367	1,352,367
7. Miscellaneous Works	45,000	45,000	90,000	0.819	45,000	36,855	81,855
Subtotal	4,320,500	2,693,500	7,014,000		4,320,500	1,939,639	6,260,139
III. Temporary Works **	784,000	1,176,000	1,960,000	0.751	784,000	883,176	1,667,176
Total	5,244,500	4,079,500	9,324,000		5,244,500	2,980,525	8,225,025
IV. Equipment							
1. Main Pump L=4.7m	17,600,000	0	17,600,000	0.796	17,600,000	0	17,600,000
2. Main Pump L=2.8m	16,280,000	0	16,280,000	0.796	16,280,000	0	16,280,000
3. Main Motor	17,600,000	0	17,600,000	0.796	17,600,000	0	17,600,000
4. Pipe & Valve	5,680,000	0	5,680,000	0.613	5,680,000	0	5,680,000
5. Spar Parts	1,200,000	0	1,200,000	0.613	1,200,000	0	1,200,000
6. Installation	6,012,000	668,000	6,680,000	0.819	6,012,000	547,092	6,559,092
7. Freight	1,220,000	0	1,220,000	0.759	1,220,000	0	1,220,000
Subtotal	65,592,000	668,000	66,260,000		65,592,000	547,092	65,592,000
Total of Step 2	**70,836,500**	**4,747,500**	**75,584,000**		**70,836,500**	**547,092**	**71,383,592**
Grand Total (Step 1 & Step 2)	**90,554,500**	**6,568,500**	**97,123,000**		**90,554,500**	**5,969,549**	**96,524,049**

Note : * Preparation work Note :

** Temporary works (Cfferdam, de-watering, staging, etc.)

Pump conversion factor = 96,524,049 / 97123000

(rehabilitation) = 0.994

Table M.5 Economic Unit Construction Cost of Pump Station (2) New Q=9.2 m3/s (L.S.)

(In 1986 price)

Item	Construction Cost (TK)			Conversion Factor of L/C	Economic Construction Cost (Tk)		
	F/C	L/C	Total		F/C	L/C	Total
I. Preparation Works *	1,080,000	1,620,000	2,700,000	0.751	1,080,000	1,216,620	2,296,620
II. Direct Construction Cost							
A. Civil Works							
1. Concrete	4,860,000	5,940,000	10,800,000	0.754	4,860,000	4,478,760	9,338,760
2. Re - Bar	6,300,000	2,700,000	9,000,000	0.613	6,300,000	1,655,100	7,955,100
3. Form	6,000,000	6,000,000	12,000,000	0.819	6,000,000	4,914,000	10,914,000
4. Excavation	67,500	45,000	112,500	0.819	67,500	36,855	104,355
5. Sheet Pile (L=8 m) Type III	4,480,000	1,120,000	5,600,000	0.613	4,480,000	686,560	5,166,560
6. R.C. Pile (L = 15 m) 0.5 x 0.5 m	4,016,250	1,721,250	5,737,500	0.613	4,016,250	1,055,126	5,071,376
7. Building	4,000,000	6,000,000	10,000,000	0.751	4,000,000	4,506,000	8,506,000
8. Miscellaneous Works	247,500	202,500	450,000	0.819	247,500	165,848	413,348
Subtotal	29,971,250	23,728,750	53,700,000		29,971,250	17,498,249	47,469,499
III. Temporary Works **	6,000,000	9,000,000	15,000,000	0.751	6,000,000	6,759,000	12,759,000
Total	37,051,250	34,348,750	71,400,000		37,051,250	25,473,869	62,525,119
IV. Mechanical & Electrical Facilities							
1. Ø1000 Pump	34,600,000	0	34,600,000	0.796	34,600,000	0	34,600,000
2. 132kw Main Motor	16,800,000	0	16,800,000	0.796	16,800,000	0	16,800,000
3. Trash Rake	13,600,000	0	13,600,000	0.613	13,600,000	0	13,600,000
4. Pipe And Valve	7,300,000	0	7,300,000	0.613	7,300,000	0	7,300,000
5. Electrical Facilities	24,480,000	6,120,000	30,600,000	0.819	24,480,000	5,012,280	29,492,280
6.Crane and Spare Parts	2,500,000	0	2,500,000	0.796	2,500,000	0	2,500,000
7. Installation	15,200,000	800,000	16,000,000	0.751	15,200,000	600,800	15,800,800
8. Freight	30,000,000	0	30,000,000	0.759	30,000,000	0	30,000,000
			0				
Subtotal	144,480,000	6,920,000	151,400,000		144,480,000	5,613,080	150,093,080
			0				
Total	**181,531,250**	**41,268,750**	**222,800,000**		**181,531,250**	**31,086,949**	**212,618,199**

Note : * Preparation works (site clearing, site office, motor pool, survey works, soil boring, safety control, etc.)

** Temporary works (Cffordam, de-watering, staging, etc.)

Pump conversion factor = 212,618,199 / 222800000
(new) = 0.954

TABLE M.7 FLOW OF ECONOMIC COSTS

(Unit : Million Tk)

ZONE	WORK ITEM	QUANTITY	CONSTRUC-TION COSTS	YEAR FIRST [1] 1988/ 89	SECOND [2] 1989/ 90	THIRD [3] 1990/ 91	FOURTH [4] 1991/ 92	FIFTH [5] 1992/ 93	SIXTH [6] 1993/ 94
B	(1) PUMP STATION	9.6 m3/s	95.5		21.5 Step I				75.0 Step II
	(2) GATE (NARINDA)	1 place	36.7		36.7 1 place				
	(3) KHAL IMPROVEMENT								
	1.DHOLAI KHAL (K-1)	3.0 km	18.2			18.2 3.0 km			
	2.GANDARIA KHAL (K-	1.2 km	13.3					13.3 1.2 km	
	(4) DRAINS								
	1. D-1	2.80 km	74.3		42.5 0.75km (Main Drainage Pipe)	24.3 1.55km			7.5 0.5 km [Branch]
	2. D-2	1.48 km	72.1					48.7 1.0km	23.4 0.48km
	(5) LAND ACQUISITION	4.20 ha	(9.7)	(8.4) 3.4 ha		(1.3) 1.1 ha			
C	(1) DIKE	4.80 km	165.4			82.7 2.4 km	82.7 2.4 km		
	(2) GATE	1 place	27.8				27.8 1 place		
	(3) PUMP STATION	9.2 m3/S	212.5		70.1 Whole Civil + (4.6m3/s)	70.2		72.2 Mech.(4.6m3/s)	
	(4) KHAL IMPROVEMENT								
	1. GERANI KHAL (K-3)	2.10 km	8.2					8.2 2.10 km	
	2. SEGUNBAGICHA KHA (K-4)	3.00 km	116.0			21.2 Box Cul 9 places	76.0 3.0km	18.8 Box Cul 4 places	
	(5) DRAINS								
	1. D-3	2.50 km	67.3				50.5 1.4 km	16.8 1.1 km	
	2. D-4	0.54 km	6.1						6.1 0.54 km
	3. D-5	0.72 km	11.7					11.7 0.72 km	
	4. D-6	1.05 km	17.2						17.2 1.05 km
	(6) LAND ACQUISITION	42.70 ha	(58.6)		(55.6) 40.2ha	(3.0) 23.5ha			
F	(1) KHAL IMPROVEMENT								
	1. BEGUNBARI (K-5)	2.60 km	20.5						20.5 2.6km
	2. PARIBAGH (K-6)	1.00 km	58.4					29.2 0.5km	29.2 0.5km
	(2) DRAINS								
	1. D-7	1.10 km	19.0						19.0 1.10 km
	2. D-8	0.45 km	5.7						5.7 0.45 km
	3. D-9	1.66 km	33.5					16.8 0.93 km	16.8 0.93 km
	(3) LAND ACQUISITION	4.70 ha	(14.7)			(1.7) 0.3ha	(13.0) 4.5ha		
	(1) SUB-TOTAL		1,080.6	0.0	170.8	216.6	237.0	235.7	220.5
	(2) CONTINGENCY		108.2	0.0	17.1	21.7	23.7	23.6	22.1
	(3) CONSTRUCTION COST, (1)+(2)		1,188.8	0.0	187.8	238.3	260.7	259.3	242.6
	(4)ENGINEERING		136.1	46.1	18.0	18.0	18.0	18.0	18.0
	(5) TOTAL OF (3)+(4)= (5)		1,324.9	46.1	205.9	256.3	278.7	277.3	260.6
	(6) LAND ACQUISITION		(83.0)	(8.4)	(55.6)	(6.0)	(13.0)	(0.0)	(0.0)
	(7) OFFICE ESTABLISH-MENT COSTS		20.9	7.4	2.7	2.7	2.7	2.7	2.7
	TOTAL OF (5)+(6)+(7)		1,428.8	61.9	264.2	265.0	294.4	280.0	263.3

Table M.6 Accumulated Flows of O/M Costs and Miscellaneous Costs

(unit ; million TK. in 1986 prices)

Items	O / M Costs (a)	O/M of Vehicle and Other Equipment (b)	Office Maintenance (c)	Subtotal	Contingency for (a), (b) and (c)	Total Maintenance Costs
1989	0.0	2.5	3.5	6.0	0.6	6.6
1990	0.0	2.5	3.5	6.0	0.6	6.6
1991	0.3	2.5	3.5	6.3	0.6	6.9
1992	4.6	2.5	3.5	10.6	1.1	11.7
1993	5.1	2.5	3.5	11.1	1.1	12.2
1994	9.0	2.5	3.5	15.0	1.5	16.5
1995	17.1	2.5	3.5	23.1	2.3	25.4

4.1 Assumptions

The assumptions used in this evaluation are;

(i) First year of the project life starts at the year 1987 while the base year of project benefit estimation is set at the year 1986.

(ii) The benefit flow period is 20 years after the completion of the construction works, while cost flow period begins at 1989.

(iii) The average flood damage reduction increases linearly between 1986 to 2000. Beyond the year 2000, it is assumed constant.

(iv) The residual value of the equipment are not reckoned in this evaluation because of scarce opportunity of substitutional usage.

(v) Opportunity cost of capital is set at 14.2%.
(Source; Overview of Industrial Project Appraisal, 1986)

4.2 Results of Economic Evaluation

Total flow of economic costs and benefits are summarized in Table 8. Results of the economic evaluation is shown in Table M.9.

Three major indicators prove the high validity of the project in terms of investment efficiency.

Economic internal rate of return is 17.11%, enough high compared with the opportunity cost of capital of Bangladesh in 1986 (=14.2%). B/C (=1.24) shows simple comparison of size of benefit and cost, and shows sufficient level to adjust the project. Magnitude of net present value of the project reaches 188.9 million TK, accounting for 24.4% of the present value of total economic costs (=774.1 million TK). This shows enough amount of net return. This drainage system improvement project shows the higher investment efficiency compared with other similar projects, which IRR ranges from 5 to 10 in general. This proves the superiority of this project.

TABLE M.8 Flows of Economic Costs and Benefits

YEAR	CONSTRUCTION					CONTIN-GENCY & ENGINEER-ING COSTS	LAND ACQUI-SITION COST	OFFICE ESTAB-LISHMENT COST	TOTAL ECONOMIC CONSTRUCTION COSTS	TOTAL MAINTE-NANCE COSTS	FACILITY REPLACEMENT COSTS		TOTAL ECONOMIC COSTS	TOTAL ECONOMIC BENEFITS	NET BALANCE
	DIKE	GATE	PUMP	KHAL	DRAIN						GATE	PUMP STATION			
1987										0			0.0	0.0	0.0
1988										0			0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	46.1	8.4	7.4	61.9	6.6			68.5	0.0	-68.5
1990	0.0	36.7	91.6	0.0	42.5	35.1	55.6	2.7	264.2	6.6			270.8	0.0	-270.8
1991	82.7	0.0	70.2	39.4	24.3	39.7	6.0	2.7	265.0	6.9			271.9	0.0	-271.9
1992	82.7	27.8	0.0	76.0	50.5	41.7	13.0	2.7	294.4	11.7			306.1	0.0	-306.1
1993	0.0	0.0	72.2	69.5	94.0	41.6	0.0	2.7	280.0	12.2			292.2	0.0	-292.2
1994	0.0	0.0	75.0	49.8	95.7	40.1	0.0	2.7	263.3	16.5			279.8	0.0	-279.8
1995										25.4			25.4	360.5	335.1
1996										25.4			25.4	373.5	348.1
1997										25.4			25.4	386.5	361.1
1998										25.4			25.4	399.5	374.1
1999										25.4			25.4	412.5	387.1
2000										25.4			25.4	424.9	399.5
2001										25.4			25.4	424.9	399.5
2002										25.4			25.4	424.9	399.5
2003										25.4			25.4	424.9	399.5
2004										25.4			25.4	424.9	399.5
2005										25.4	11.9		37.3	424.9	387.6
2006										25.4			25.4	424.9	399.5
2007										25.4	11.9		37.3	424.9	387.6
2008										25.4		151.4	176.8	424.9	248.1
2009										25.4		151.4	176.8	424.9	248.1
2010										25.4			25.4	424.9	399.5
2011										25.4			25.4	424.9	399.5
2012										25.4			25.4	424.9	399.5
2013										25.4			25.4	424.9	399.5
2014										25.4			25.4	424.9	399.5
2015										25.4			25.4	424.9	399.5
2016										25.4			25.4	424.9	399.5
2017										25.4			25.4	424.9	399.5
2018										25.4			25.4	424.9	399.5
2019										25.4			25.4	424.9	399.5
2020										25.4	11.9		37.3	424.9	387.6
2021										25.4			25.4	424.9	399.5
2022										25.4	11.9		37.3	424.9	387.6
2023										25.4		151.4	176.8	424.9	248.1
TOTAL	163.4	64.5	309.0	234.7	307.0	244.3	83.0	20.9	1,428.8	797.1	47.6	454.2	2,727.7	12,130.1	9,402.4
												P. V. =	774.1	963.0	188.9
												NPV =			188.9
												IRR =			17.11%
												B/C =			1.24

Table M.9 Investment Efficiency

Total Economic Costs	Total Economic Benefit	EIRR (%)	B/C	Net Present Value	Present Value of Total Economic Costs	Present value of Total Economic Costs
(mil. TK) (not discounted)	(mil. TK)			(mil. TK) (Discount rate = 14.2%)	(mil. TK)	(mil. TK)
2727.7	12,130.1	17.11	1.24	188.9	774.1	963.0

Remarks: B/C is calculated by the following setting;

Present value of total economic cost is 963.0 million TK, while present value of total economic cost is 774.1 million TK. Therefore B/C is calculated by the function below;

NVP = 963.0/774.1 (million TK)
= 1.24

NVP is arrived by reducing present value of total economic costs from present value of total economic benefits;

NVP = 963.0 - 774.1
= 188.9 (million)

Other evaluation indicators of the project are shown in Table M.10. Population which will be free from the stagnating water reaches 660 thousands, equivalent to 21% of the whole population of the Dhaka in 2000.

Construction works will contribute to the new job creations. Its magnitude is 7,884 thousand man-day and total amount of wage is 387.4 million TK. Considering the massive unemployment at present, it is sure that new job positions will be filled with present unemployment or underemployment persons. This is other channel of the project to contribute to the lifting-up of the national welfare.

Table M.10 Other Indicators of Economic Evaluation

Area Affected (Maximum case in 2000) (km^2)	Population Affected (Maximum case in 2000) (x 1000)	Employment Opportunity Created (x 1000)	Total Expenditure of Wage (Million TK)
1,220	660	7,884	387.4

Remarks: Wage share is assumed to be 15% of the whole cost and labours' wage is set at 60 TK/day. Conversion factor is set at 0.819.

5. Sensitivity Analysis

Estimation works always face an uncertainty and economic analysis involve invalidity attributable to the degree of accuracy in estimating economic prices and various benefits. Sensitivity analysis is, therefore, carried out to determine the effect of variations caused by influential factors on the evaluation. And the most influential factors are also identified and asked to pay attentions whenever policy implemented.

For this purpose, the EIRR is examined by using the various assumptions to costs and benefits. First, gross costs and benefits are set at different level by 10% from +30% to -30%. Secondly magnitude of change in one component of costs is examined.

Results are summarized in Table M.11. The EIRR ranges from 12.47 to 22.41, proving in any cases enough investment efficiency in comparison with the opportunity cost of capital (=14.2%).

Table M.11 Summary of Sensitivity Analysis

Fluctuating Factors	Degree of Change					
	+30%	+20%	+10%	-10%	-20%	-30%
Gross Costs	13.64	14.66	15.81	18.60	20.35	22.41
Cost of Dike	17.57	17.41	17.26	16.97	16.82	16.68
Cost of Gate	17.31	17.25	17.18	17.05	16.98	16.92
Cost of Pump	18.01	17.70	17.40	16.83	16.56	16.29
Cost of Khal	17.66	17.48	17.29	16.94	16.76	16.59
Cost of Drain	17.84	17.60	17.35	16.88	16.65	16.63
Cost of Land	17.39	17.29	17.20	17.02	16.93	16.85
Gross Benefits	20.95	19.73	18.46	15.68	14.14	12.47

Remarks: Change in costs of construction item is attributable to one of or combination of factors such as estimation of unit costs, total quantity of material, price conversion factors and progress of urbanization.

Change of gross costs is attributable to one of or combination of factors such as house value, damage ratio of house, unit cost of vehicle running cost, progress of urbanization, and so on.

Changing rate of EIRR corresponding to the fluctuation in some factors shows the degree which all the policy planners and executors have to pay attention to price disturbance factors since minor changes of this factor cause a drastic decrease of investment efficiency.

Elasticity of EIRR is shown in Table M.12.

Table M.12 Elasticity of EIRR

Items	Increase (0 to 30%)	Decrease (0 to -30%)
Gross Costs	0.6760	1.0325
Gross Benefits	0.7481	0.9040

Elasticity of EIRR in this Study shows a risk avoiding character in its fluctuation behavior in general. For, when costs increase (= most risky case), its elasticity records least sensitive movement (elasticity = 0.6760). When costs decrease, it shows the most sensitive shift which results in favourable effect. And for the sensitivity to benefit changes, case of decrease shows less figures (elasticity = 0.9040), but the absolute level of the EIRR (= 12.47) is kept slightly less than the oppertunity cost of capital in Bangladesh in 1986 (= 14.20%).

It is suggested that price fluctuation of cost and benefit factors should be always monitored by the policy planners/executors. And in the most extreme case, some modification of the project should be suggested without any delay. Those factors are;

1. Cost of pump station
2. Cost of drain improvement
3. Cost of khal improvement

Finally, the most appropriate year of the project starting was analyzed by changing the starting year. Results show that the sooner the project starts, the more the level of EIRR are improved. In case that project commences in 1989, EIRR is equal to 17.11 and the delay of commencement by one year causes a decrease of EIRR by 0.1. Thus all the efforts should be taken by all the authorities concerned to minimize the preparation period for this project, and start the necessary construction as soon as possible.

6. Conclusion

In this economic evaluation of the project, the following are suggested;

1. The project proves high investment efficiency, far higher than the opportunity cost of capital, and its implementation is strongly suggested.

2. The project keeps the validity of its project feasibility even in the most risky case attributable to the fluctuation of the factor price.

3. The sooner the project is commenced, the more the level of EIRR is improved. Consequently the effort should be made to minimize the preparation period for this project.

SUPPORTING REPORT N

SUPPLEMENTARY STUDY

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SUPPORTING REPORT N
SUPPLEMENTARY STUDY

1. Khal Improvement by Using Box Culverts

1.1 General

As the results of the comparative studies of both "Open channel" and "box culvert" schemes for the khal improvement described in the Supporting Report I, the open channel scheme is adopted in this project considering the technical and financial view points of the flood protection and drainage system in Dhaka.

In the course of the Study, however, DPHE has requested to include, also in this report, the khal improvement based on the box culvert scheme for further reference to discuss the effective and esthetic land use.

In response to DPHE's request, although the scheme is not adopted in the project, this paragraph discusses the supplementary study of khal improvement of the box culvert scheme ie, required box culvert section, construction cost and implementation schedule.

The objective khals and its sections to be improved with the box culvert type, which locate in the urbanized area, are listed by DPHE as follows:

Khal		Section	
(1) Segunbagicha	:	Circular Road to DPHE Store Circle, (K-4-3 to K-4-5)	2.1 km
(2) Begunbari	:	Airport Road to Dhanmondi Lake, (K-6)	1.8 km
(3) Paribagh	:	Begunbari Khal Junction to New Elephant Road, (K-5-2 to K-5-3)	1.0 km

Total Length = 4.9 km

1.2 Box Culvert Section

The basic hydrological and hydraulic conditions to establish the khal improvement plan for the open channel scheme, such as flood protection and drainage system, drainage area and design discharge as mentioned in Supporting Report I, are also applied to study the khal improvement plan for the box culvert scheme. Fig. N.1 shows the concept of proposed system applied to the box culvert scheme.

(1) Design discharge

The design discharge to determine the box culvert sections are listed below. Fig. N.2 shows the distribution of the design discharges.

. Segunbagicha khal	(1) K-4-3	:	37.8 m3/s
	(2) K-4-4	:	35.7 m3/s
	(3) k-4-5	:	26.1 m3/s
. Begunbari khal	(1) K-5-2	:	30.8 m3/s
	(2) K-5-3	:	28.6 m3/s
. Paribagh khal	(1) K-6	:	25.1 m3/s

(2) Required box culvert section

Based on the design discharge, the required box culvert sections are determined by uniform flow method as shown in Table N.2. which longitudinal sections are applied the same as one of the open channel scheme.

			(Width)	x	(Height)
. Segunbagicha					
	(1) K-4-3	:	5.5 m	x	4.1 m
	(2) K-4-4	:	5.0	x	4.1
	(3) K-4-5	:	4.0	x	4.1
. Begunbari	(1) K-5-2	:	5.0 m	x	4.6 m
	(2) K-5-3	:	4.5	x	4.6
. Paripagh	(1) K-6	:	4.0	x	4.3

1.3 Project Cost

The khal improvement cost of the box culvert type including the dredging, slope protection and box culvert construction costs amounts to 706.3 million TK, as shown in Table N.3. The project cost, therefore, amounts to 2,251.9 million TK, as shown in Table N.1, out of which the local currency component is 1,108.1 million Taka and the foreign currency component is 1,143.8 million Taka. The breakdown of the estimated project costs are shown in Table N.4.

The project cost including price contingency for six (6) years is estimated to be 3,273.7 million TK as shown in the following Table.

Table N.1 Project Cost

Item	Cost (1986 price)
A. Construction Cost	1,656.9
(1) Dike	(186.2)
(2) Pump Station	(319.9)
(3) Gate	(69.5)
(4) Khal Improvement	(706.3)
(5) Drainage Pipe	(375.0)
B. Physical Contingency	165.7
C. Engineering	136.1
Sub Total	1,958.7
D. Land Acquisition	83.0
E. Office Establishment	25.5
F. Custom Duty & Tax	184.7
Project Cost (1) (at 1986 Price)	2,251.9
G. Price Contingency (1988/1993-1993/1994)	1,021.8
Project Cost (2) (with Price Contingency)	3,273.7

1.4 Implementation Schedule

The proposed works is executed according to the staged construction plan considering the implementation priority in six (6) year completion described in Supporting Report L. Table N.5 shows the proposed implementation schedule considering the khal improvement of the box culvert scheme.

Table N.2 Discharge Capacity of Box Culvert Section

Section No.	Drainage Area (Km3)	Design Discharge (m3/s)	Length (Km)	Hydraulic Gradient (I)	Roughness Coefficient (n)	Box Culvert Section (Bo x Ho)	H (m)	A (m3)	P (m)	R (-)	R^2/3 (-)	V (m/s)	Q (m3/s)	Remarks
Segunbagicha Khal														
1	4.45	37.8	0.5	1/2000	0.015	5.5 x 4.1	3.8	20.9	13.1	1.595	1.365	2.04	42.5	
2	3.99	35.7	0.8	1/2000	0.015	5.0 x 4.1	3.8	19.0	12.6	1.508	1.315	1.96	37.2	
3	2.95	26.1	0.8	1/2000	0.015	4.0 x 4.1	3.8	15.2	11.6	1.310	1.197	1.79	27.1	
Begunbari Khal														
1	3.31	30.8	0.8	1/3000	0.015	5.0 x 4.6	4.3	21.5	13.6	1.581	1.357	1.65	35.5	
2	2.71	28.6	1.0	1/3000	0.015	4.5 x 4.6	4.3	19.4	13.1	1.477	1.297	1.58	30.5	
Paribagh Khal														
1	2.99	25.1	1.0	1/2000	0.015	4.0 x 4.3	4.0	16.0	12.0	1.333	1.211	1.81	28.9	

Table N.3 Construction Cost of Khal Improvement Works **(Covered Channel Type)**

Unit : x 1,000 TK,1998 Price

Khal	Section No.	Section Length m	Protection Works: Type	Length m	Unit Construction Cost: Total	Unit Construction Cost: F/C (%)	Unit Construction Cost: L/C (%)	Construction Cost: F/C	Construction Cost: L/C	Construction Cost: Total	Dredging Works	Total
K-1 ONDUAI	K-1-1	1,000	(-)	1,000	-	-	-	-	-	-		
	K-1-2	500	Sodding	470	1.7	0	100	0	799	799		
			Box Culvert (Utilize Exist)	30	-	-	-	-	-	-		
	K-1-3	200	Sodding	150	1.7	0	100	0	255	255		
			Box Culvert (Utilize Exist)	50	-	-	-	-	-	-		
	K-1-4	400	Sodding	375	1.7	0	100	0	638	638		
			Box Culvert (B-1) 7.5x5.0x2	25	375.0	55	45	5,156	4,218	9,375		
	K-1-5	200	Sodding	200	1.7	0	100	0	340	340		
	K-1-6	200	do.	200	1.7	0	100	0	340	340	F/C=5,774	
	K-1-7	500	do.	500	1.7	0	100	0	850	850	L/C=3,850	
	SUBTOTAL	3,800		3,000	-	-	-	5,156	7,441	12,597	9,624	22,221
			(-)	1,000	-	-	-	-	-	-		
			(Sodding)	1,895	-	-	-	0	3,222	3,222		
			(Box Culvert)	25	-	-	-	5,156	4,218	9,375		
			(Box Culvert : Exist)	80	-	-	-	-	-	-		
K-2 GANDARA	K-2-1	1,200	Brick Works A	400	29.3	29	71	3,399	8,321	11,720	F/C=1,884	
			Sodding	800	1.7	0	100	0	1,380	1,380	L/C=1,296	
	SUBTOTAL	1,200		1,200	-	-	-	3,399	9,681	13,080	3,240	16,320
			(Brick Works A)	400	-	-	-	3,399	8,321	11,720		
			(Sodding)	800	-	-	-	0	1,380	1,380		
K-3 OSMANI	K-3-1	1,400	Sodding	400	1.7	0	100	0	680	680		
			(-)	1,000	-	-	-	-	-	-		
	K-3-2	700	Sodding	300	1.7	0	100	0	510	510	F/C=5,282	
			(-)	400	-	-	-	-	-	-	L/C=3,528	
	SUBTOTAL	2,100		2,100	-	-	-	0	1,190	1,190	8,810	10,010
			(-)	1,400	-	-	-	-	-	-		
			(Sodding)	700	-	-	-	0	1,190	1,190		
K-4 SEGUNBAGICHA	K-4-1	500	(-)	300	-	-	-	-	-	-		
			Sodding	184	1.7	0	100	0	278	278		
			Box Culvert (B-2) 6.0x5.0x2	17	316.0	55	45	2,855	2,417	5,272		
			Railway Bridge (B-3) 12.0x5.0	19	L.S.	80	20	9,398	2,422	11,820		
	K-4-2	400	Sodding	385	1.7	0	100	0	655	655		
			Box Culvert (B-4) 5.0x4.5x2	15	258.0	55	45	2,112	1,728	3,840		
	K-4-3	500	Box Culvert 5.5x4.1	500	139.0	55	45	38,225	31,275	69,500		
	K-4-4	800	Box Culvert 5.0x4.1	800	130.0	55	45	57,200	46,800	104,000	F/C=5,282	
	K-4-5	800	Box Culvert 4.0x4.1	800	112.0	55	45	49,280	40,320	89,600	L/C=3,528	
	SUBTOTAL	3,200		3,000	-	-	-	159,170	125,888	285,058	8,810	293,868
			(-)	300	-	-	-	-	-	-		
			(Sodding)	549	-	-	-	0	934	934		
			(Box Culvert / Railway Bridge)	2,151	-	-	-	159,170	124,882	284,132		
K-5 BEGUNBARI	K-5-1	1,000	Sodding	961	1.7	0	100	0	1,634	1,634		
			Box Culvert (B-15) 7.0x8.0	25	206.0	55	45	2,833	2,317	5,150		
			Box Culvert (B-16) 7.0x8.0	14	206.0	55	45	1,586	1,298	2,884		
	K-5-2	800	Box Culvert 5.0x4.0	800	142.0	55	45	62,480	51,120	113,600	F/C=872	
	K-5-3	1,000	Box Culvert 4.0x4.0	1,000	120.0	55	45	66,000	54,000	120,000	L/C=648	
	SUBTOTAL	2,869		2,800	-	-	-	132,899	110,389	243,288	1,520	244,808
			(Sodding)	961	-	-	-	0	1,634	1,634		
			(Box Culvert)	1,833	-	-	-	132,899	109,735	241,634		
K-6 PARBAGH	K-6-1	1,000	Box Culvert 4.0x4.0	1,000	118.0	55	45	65,800	52,200	118,000	F/C=1,771 L/C=1,161	
	SUBTOTAL	1,000	(Box Culvert)	1,000	-	-	-	65,800	52,200	118,000	2,932	118,932
	TOTAL	13,100		13100	-	-	-	364,424	308,777	671,201	35,876	706,277
			(Sodding)	4,905	-	-	-	0	8,340	8,340	F/C=21,048	
			(Brick Works)	400	-	-	-	3,399	8,321	11,720	L/C=14,828	
			(Box Culvert / Railway Bridge)	8,815	-	-	-	361,025	290,118	651,141		

Table N.4 Summary of Construction Cost (Covered Channel Type)

Unit : Million TK ,1986 Price

Item	Zone	Description	Construction Cost			Remarks
			F/C	L/C	Total	
A. Dike	C	L = 4,800 m H = 6.0 m	70.7	115.5	186.2	
B. Pump Station						
1. NARINDA (Rehabilitation)	B	Q = 9.6 m3/s	90.5	6.6	97.1	
2. do. (New)	B	Q = 9.2 m3/s	181.5	41.3	222.8	
Subtotal		Q = 18.8 m3/s	272.0	47.9	319.9	
C. Gate						
1. NARINDA	B	6 m x 6 m	27.7	11.8	39.5	
2. GERANI KHAL	C	do.	22.6	7.4	30.0	
Subtotal			50.3	19.2	69.5	
D. Khal Improvement Works						
1. DHOLAI KHAL	B	L = 3,000 m	10.9	11.3	22.2	
2. GANDARIA KHAL	B	L = 1,200 m	5.3	11.0	16.3	
3. GERANI KHAL	C	L = 2,100 m	5.3	4.7	10.0	
4. SEGUNBAGICHA KHAL	C	L = 3,000 m	164.5	129.4	293.9	
5. BEGUNBARI KHAL	F	L = 2,800 m	133.9	111.0	244.9	
6. PARIBAG KHAL	F	L = 1,000 m	65.6	53.4	119.0	
Subtotal		L = 13,100 m	385.5	320.8	706.3	
E. Drainage Pipe						
1. NARINDA	B	L = 4,280 m	90.6	88.2	178.8	
2. SEGUNBAGICHA	C	L = 4,810 m	53.0	72.0	125.0	
3. BEGUNBARI	F	L = 3,410 m	24.9	46.3	71.2	
Subtotal		L = 12,500 m	168.5	206.5	375.0	
SUBTOTAL (A-E)	-	-	**947.0**	**709.9**	**1,656.9**	
F. Phisical Contingency (10 %)	-	-	94.7	71.0	165.7	
SUBTOTAL (A-F)	-	-	**1,041.7**	**780.9**	**1,822.6**	
G. Engineering	-	-	102.1	34.0	136.1	
SUBTOTAL(A-G)			**1,143.8**	**814.9**	**1,958.7**	
H. Land Acquisition	-	-	0.0	83.0	83.0	
I. Office Establishment			0.0	25.5	25.5	
J. Customs Duty & Tax	-	-	0.0	184.7	184.7	
SUBTOTAL(A-J)	-	-	**1,143.8**	**1,108.1**	**2,251.9**	
K. Price Contingency (1988/'89-1993/'94)			146.5	875.3	1,021.8	
TOTAL (A - K)			1,290.3	1,983.4	3,273.7	

Table N.5 Implementation Schedule (Covered Channel Type)

Unit : Million Tk , 1986 Price

ZONE	WORK ITEM	QUANTITY	CONSTRUCTION COST	DESIGN STAGE	CONSTRUCTION STAGE				
				FIRST YEAR 1988/ '89	SECOND YEAR 1989/ '90	THIRD YEAR 1990/ '91	FOURTH YEAR 1991/ '92	FIFTH YEAR 1992/ '93	SIXTH YEAR 1993/ '94
B	(1) PUMP STATION (REHABILI.)	9.6 m3/s	97.1		21.6 Step I				75.5 Step II
	(2) GATE (NARINDA)	1 place	39.5		39.5 1 place				
	(3) KHAL IMPROVEMENT								
	1.DHOLAI KHAL (K-1)	3.0 km	22.2			22.2 3.0 km			
	2.GANDARIA KHAL (K-2)	1.2 km	16.3					16.3 1.2 km	
	(4) DRAINS								
	1. D-1	2.80 km	90.7		51.9 0.75 km	29.7 1.55 km			9.1 0.5 km
	2. D-2	1.48 km	88.1		[Main	Drainage pipe]		59.5 1.0 km	[Branch] 28.6 0.48 km
	(5) LAND ACQUISITION	4.50 ha	[9.7]	[8.4] 3.4 ha		[1.3] 1.1 ha			
C	(1) DIKE	4.80 km	186.2			93.1 2.4 km	93.1 2.4 km		
	(2) GATE	1 place	30.0				30.0 1 place		
	(3) PUMP STATION (ADDITIONAL)	9.2 m3/S	222.8		73.5	73.6		75.7	
	(4) KHAL IMPROVEMENT				Whole Civil + Mech.	(4.6 m3/s)		Mech.(4.6m3/s)	
	1. GERANI KHAL (K-3)	2.10 km	10.0					10.0 2.10km	
	2. SEGUNBAGICHA KHAL (K-4)	3.00 km	293.9		73.5	73.5	73.5	73.4	
	(5) DRAINS								
	1. D-3	2.50 km	82.2				61.7 1.4 km	20.5 1.1 km	
	2. D-4	0.54 km	7.5						7.5 0.54 km
	3. D-5	0.72 km	14.3					14.3 0.72km	
	4. D-6	1.05 km	21.0						21.0 1.05 km
	(6) LAND ACQUISITION	42.70 ha	[58.6]		[55.6] 40.2 ha	[3.0] 23.5 ha			
F	(1) KHAL IMPROVEMENT								
	1. BEGUNBARI (K-5)	2.80 km	244.9				80.0	80.0	84.9
	2. PARIBAGH (K-6)	1.00 km	119.0						119.0
	(2) DRAINS								
	1. D-7	1.10 km	23.2						23.2 1.10 km
	2. D-8	0.45 km	7.0						7.0 0.45 km
	3. D-9	1.86 km	41.0					20.5 0.93 km	20.5 0.93 km
	(3) LAND ACQUISITION	4.80 ha	[14.7]			[1.7] 0.3 ha	[13.0] 4.5 ha		
	(1) SUB TOTAL		1656.9		260.0	292.1	338.3	370.2	396.3
	(2) CONTINGENCY		165.7		26.0	29.2	33.8	37.0	39.7
	TOTAL OF (1)+(2)		1822.6		286.0	321.3	372.1	407.2	436.0
	(3) ENGINEERING		136.1	46.1 (D/D)	18.0	18.0	18.0	18.0	18.0
	TOTAL OF (1)+(2)+(3)		1958.7	46.1	304.0	339.3	390.1	425.2	454.0
	LAND ACQUISITION (4)		[83.0]	8.4	55.6	6.0	13.0	0	0
	OFFICE ESTABLISH. (5)		[25.5]	9.0	3.3	3.3	3.3	3.3	3.3
	CUSTOMS DUTY/ TAX(6)		[184.7]	0.0	27.8	48.5	11.9	51.8	44.7
	TOTAL OF (4)+(5)+(6)		[293.2]	17.4	86.7	57.8	28.2	55.1	48.0
TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)			2,251.9	63.5	390.7	397.1	418.3	480.3	502.0
	(7)PRICE CONTENGENCY (1988/89 - 1993/94)		1,021.8	11.6	102.8	149.9	191.3	252.1	314.1
TOTAL OF (1)+(2)+(3)+(4)+(5)+(6)+(7)			3,273.7	75.1	493.5	547.0	609.6	732.4	816.1

Table N.6 Price Contingency (1988/1989-1993/1994)

Unit : Million Tk , 1986 Price

ZONE	WORK ITEM	CONSTRUCTION COST			DESIGN STAGE		CONSTRUCTION STAGE									
					FIRST YEAR 1988/ '89		SECOND YEAR 1989/ '90		THIRD YEAR 1990/ '91		FOURTH YEAR 1991/ '92		FIFTH YEAR 1992/ '93		SEXTH YEAR 1993/ '94	
		TOTAL	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
	ESCALATION RATE (%)	-	-	-	6.0	33.0	8.0	46.0	10.0	61.0	13.0	77.0	15.0	95.0	17.0	114.0
B	(1) PUMP STATION (RHABILI	97.1	90.5	6.6			19.7	1.9							70.8	4.7
	(2) GATE (NARINDA)	39.5	27.7	11.8			27.7	11.8								
	(3) KHAL IMPROVEMENT															
	1.DHOLAI KHAL (K-1)	22.2	10.9	11.3					10.9	11.3						
	2.GANDARIA KHAL (K-2)	16.3	5.3	11.0									5.3	11.0		
	(4) DRAINS															
	1. D-1	90.7	42.1	48.6			28.5	23.4	10.4	19.3					3.2	5.9
	2. D-2	88.1	48.4	39.7									32.7	26.8	15.7	12.9
	(5) LAND ACQUISITION	[9.7]	0.0	9.7		8.4				1.3						
C	(1) DIKE	186.2	70.7	115.5					35.3	57.8	35.4	57.7				
	(2) GATE	30.0	22.6	7.4							22.6	7.4				
	(3) PUMP STATION (ADDITION	222.8	181.5	41.3			54.6	18.9	54.7	18.9			72.2	3.5		
	(4) KHAL IMPROVEMENT															
	1. GERANI KHAL (K-3)	10.0	5.3	4.7									5.3	4.7		
	2. SEGUNBAGICHA KHAL (K-4)	293.9	164.5	129.4			41.2	32.3	41.1	32.4	41.1	32.4	41.1	32.3		
	(5) DRAINS															
	1. D-3	82.2	38.0	44.2							30.8	30.9	7.2	13.3		
	2. D-4	7.5	2.6	4.9											2.6	4.9
	3. D-5	14.3	5.0	9.3									5.0	9.3		
	4. D-6	21.0	7.4	13.6											7.4	13.6
	(6) LAND ACQUISITION	[58.6]	0.0	58.6				55.6		3.0						
F	(1) KHAL IMPROVEMENT															
	1. BEGUNBARI (K-5)	244.9	133.9	111.0							43.7	36.3	43.7	36.3	46.5	38.4
	2. PARIBAGH (K-6)	119.0	65.6	53.4											65.6	53.4
	(2) DRAINS															
	1. D-7	23.2	8.1	15.1											8.1	15.1
	2. D-8	7.0	2.5	4.5											2.5	4.5
	3. D-9	41.0	14.4	26.6									7.2	13.3	7.2	13.3
	(3) LAND ACQUISITION	[14.7]	0.0	14.7						1.7		13.0				
	(1)SUB TOTAL	1,656.9	947.0	709.9	0.0	0.0	171.7	88.3	152.4	139.7	173.6	164.7	219.7	150.5	229.6	166.7
	(2)CONTINGENCY	165.7	94.7	70.9	0.0	0.0	17.2	8.8	15.2	14.0	17.3	16.5	22.0	15.0	23.0	16.7
	(3)ENGINEERING	136.1	102.1	34.0	34.6	11.5	13.5	4.5	13.5	4.5	13.5	4.5	13.5	4.5	13.5	4.5
	TOTAL OF (1)+(2)+(3)=(4)	1,958.7	1,143.8	814.9	34.6	11.5	202.4	101.6	181.1	158.2	204.4	185.7	255.2	170.0	266.1	187.9
	(5) LAND ACQUISITION	83.0	0.0	83.0	0.0	8.4	0.0	55.6	0.0	6.0	0.0	13.0	0.0	0.0	0.0	0.0
	(6)OFFICE ESTABLISHMEN	25.5	0.0	25.5	0.0	9.0	0.0	3.3	0.0	3.3	0.0	3.3	0.0	3.3	0.0	3.3
	(7)CUSTOMS DUTY/SALES T	184.7	0.0	184.7	0.0	0.0	0.0	27.8	0.0	48.5	0.0	11.9	0.0	51.8	0.0	44.7
	TOTAL OF (5)+(6)+(7)=(8)	293.2	0.0	293.2	0.0	17.4	0.0	86.7	0.0	57.8	0.0	28.2	0.0	55.1	0.0	48.0
	(9)PRICE CONTIN. OF (4)	812.2	146.5	665.7	2.1	3.8	16.2	46.7	18.1	96.5	26.6	143.0	38.3	161.5	45.2	214.2
	(10)PRICE CONTIN. OF (8)	209.6	0.0	209.6	0.0	5.7	0.0	39.9	0.0	35.3	0.0	21.7	0.0	52.3	0.0	54.7
	TOTAL OF (9)+(10)=(11)	1,021.8	146.5	875.3	2.1	9.5	16.2	86.6	18.1	131.8	26.6	164.7	38.3	213.8	45.2	268.9
	TOTAL OF (4)+(8)+(11)	3,273.7	1,290.3	1,983.4	36.7	38.4	218.6	274.9	199.2	347.8	231.0	378.6	293.5	438.9	311.3	504.8

2. Drainage Improvement Plan of Drainage Zones D and H

2.1 General

In the Preparation of Phased Program described in Supporting Report H, a part of drainage zone D and drainage zone H were selected as a second priority area.

The present urbanization rates of both zones are 59% and 62% respectively. However, since their land value for the residential area are very high, it is forecasted that both zones will be rapidly urbanized in the near future. The rate of their future urbanization are estimated in 71% and 91%, respectively.

The objectives of this study are to prepare a drainage improvement plan of trunk facilities in both Zones D and H, in order to suggest a detailed guide-line for future urban developments.

2.2 Planning Policy and Design Criteria

Planning policy and design criteria are, in principle, same as given in the priority areas, B, C and F zones. (Refer to Supporting Report I)

(1) Target year of plan: year 2000

(2) Design flood water level

- The flood water level with a 30-year frequency (6.60 m G.T.S. for D Zone, 7.30 m G.T.S. for H Zone) applied for the design of flood protection works.

- 2-year frequency flood water level (5.36 m G.T.S. for D Zone, 5.96 m G.T.S. for H Zone) is employed as the design out-let water level for internal drainage works.

(3) Design Rainfall

- The rainfall intensity with a 5-year frequency is employed for the design of drainage pipes and khal improvements.

$$i = 9005/(t + 50)$$

where, i = rainfall intensity (mm/hr)
t = duration time (min.)

The applied rainfall intensity-duration curve is illustrated in Fig. I.1 in Supporting Report I.

For the design of pump stations, the two days consecutive rainfall with a 5-year frequency is proposed.

The rainfall depth and hourly distribution of the design two days consecutive rainfall are illustrated in Fig. I.2 in Supporting Report I.

(4) Runoff calculation method

Design discharge for the drainage pipes and khal improvements is calculated by the Rational Formula described below:

$$Q = CiA/360$$

where, Q: Peak discharge (m^3/s)
C: Runoff coefficient
i: Rainfall intensity during time of concentration (mm/hr)
A: Drainage area (ha).

(5) Runoff coefficient and runoff ratio

The following runoff coefficients are used for the calculation of flood runoff peak by the Rational Formula.

Runoff Coefficient

Land Use	Runoff Coefficient
Commercial Area	0.65
Industrial Area	0.55
High Class Residential Area	0.30
Middle & Low Class Residential Area	0.5
Green Zone and Others	0.2

The runoff ratio (total runoff/total rainfall) of 0.8 is employed in the estimate of flood runoff volume required for the calculation of pump capacity.

(6) Manning's roughness coefficient

Manning's roughness coefficient applied for hydraulic calculation of drainage pipes, culverts and khal improvements are as follows:

Drainage pipe (brick):	0.015
Concrete Box Culvert:	0.015
Khal Improvement (smooth section):	0.025
" " (rough section):	0.035

(8) Drainage pipes are designed under the surcharge condition of storm water where the ground elevation is not high enough compared to the design outlet water level.

2.3 Review of Drainage Zones

2.3.1 Revision of Drainage Zone Boundaries

The boundary of the drainage zone D divided in the Phased Program stage are revised as illustrated in Fig. N.7, based on the detailed studies on the topographic conditions, existing drainage system, on-going drainage program and proposed drainage system.

(1) No. 1 revised area (Kamulapur area): 0.95 km^2

The alignment of flood protection dike for the drainage zone D, which is one of the first priority zones, were revised to prevent the Kamulapur area from the intrusion of flood.

(2) No. 2 revised area (Rajarbogh area): 0.16 km^2

This area is converted to C Zone from D Zone in order to be easily benefited by the C Zone project, which is one of the first priority projects.

(3) No. 3 revised area (east side area of DIT road): 0.25 km^2

This area is transferred to D from F, based on the detailed collation of the existing drainage system.

The boundary of the drainage zone H remains as it is divided in the Phased Program stage. However, since Kallyanpur and Sher-e-Bangla Nagar areas are very difficult from topographic and land use conditions, the drainage Zone H is divided into two areas, I and II as illustrated in Fig. N.7.

The revised zone areas of D and H are presented in Table N.7.

Table N.7 Revised Drainage Zone Area

Drainage Zone	Original Area (km^2)	Revised Area (km^2)
D: Bashabo Zone	8.32	7.46
H: Kallyanpur Zone	12.78	12.78
(H-I area)	(9.40)	(9.40)
(H-II area)	(3.38)	(3.38)
Total	21.10	20.24

2.3.2 Demarcation of Gravity and Pump Drainage Areas

Ground elevation and area curves were made for the following drainage areas to demarcate gravity and pump drainage areas.

D Zone: (Bashabo zone: 7.46 km^2)

H Zone: H-I (Kallyanpur area: 9.40 km^2)
H-II (Shar-e-Bangla Nagar area: 3.38 km^2)

Ground elevation and area curves of the above drainage areas are shown in Fig. N.8.

Flood and drainage conditions corresponding to ground elevation are as follows:

- For D Zone

(1) The area above 6.60 m G.T.S. is free from the river floods.

(2) The area between 6.40 m G.T.S. and 6.60 m G.T.S. is flood prone but can drain storm waters by gravity, assuming that

- outlet water level of drainage pipes is a frequent flood water level (2-year return period) of 5.36 m G.T.S.
- head difference required for gravity drain of a 5-year frequency discharge through drainage pipes is approximately 1.0 m.

(3) The area below 6.40 m G.T.S. can not drain by gravity.

- For H Zone

(1) The area above 7.30 m G.T.S. is free from the river floods.

(2) The area between 7.00 m G.T.S. and 7.30 m G.T.S. is flood prone but can drain storm waters by gravity, assuming that

- outlet water level of drainage pipes is a frequent flood water level (2-year return period) of 5.96 m G.T.S.
- head difference required for gravity drain of a 5-year frequency discharge through drainage pipes is approximately 1.0 m.

(3) The area below 7.00 m G.T.S. can not drain by gravity.

In consideration of the above conditions, the following conclusions are reached for flood protection and drainage of each area.

(1) D Zone

Ninety percent (90%) of the area is below 6.60 m G.T.S. Eighty (80)% is below 6.40 m G.T.S. Flood protection works and pump drainage are required.

(2) H-I areas

Eighty-five percent (85%) of the area is below 7.20 m G.T.S. Eighty percent (80%) is below 7.00 m G.T.S. Flood protection works and pump drainage are required.

(3) H-II areas

Almost all areas are higher than 7.20 m G.T.S. No flood protection work are required and gravity drainage is available.

Table N.8 shows a land area above different ground levels of each drainage area.

Table N.8 Land Areas above Different Ground Levels

G.L. (m)	Drainage Area (km^2)			
	D Zone	H-I	H-II	H Zone
1.0	0.50	-	-	-
2.0	1.35	-	-	-
3.0	2.64	0.75	-	0.75
4.0	3.24	1.73	-	1.73
5.0	3.70	4.00	-	4.00
6.0	5.13	5.76	-	5.76
7.0	7.46	7.90	-	7.90
8.0	-	8.13	2.74	10.87
9.0	-	8.36	3.38	11.74
13.5	-	9.40	3.38	12.78

2.4 Proposed Drainage Improvement Plan

2.4.1 Flood Protection Plan

(1) Bashabo Zone (D Zone)

C Zone covers 6.49 km^2 of low-lying land below the design flood level of 6.60 m G.T.S. out of the total area of 7.46 km^2. At present, Rajarbagh and Shajahanpur areas are protected from the flood water by the existing railway. However, Khilgaon and Bashabo areas being lower than 6.60 m G.T.S. are not free from the design flood.

Construction of dike is proposed to prevent the floods from the Balu River. The alignment of the proposed dike (Total length L = 5.0 km) was determined, based on the following considerations;

- Existing and future land use
- Existing khal networks
- Required regulation pond area for pump drainage
- Multipurpose use of dike for transportation
- Existing community boundary

The main features of the proposed dike are;

- Total length: L = 5.0 km
- Design high water level: H = 6.60 m G.T.S.
- Free board: h = 1.0 m
- Crown elevation: E = 7.60 m G.T.S.

The proposed dikes are provided with a control gates of 6x6 m in size to drain flash floods in the off-season of pump drainage together with a control gate of same size attached to the proposed pump station.

Location of the proposed flood protection works is illustrated in Fig. N.9.

(2) Kallyanpur area (H-I area)

H-I area covers 7.97 km^2 of low-lying below the design flood level of 7.30 m G.T.S. out of the total area of 9.40 km^2. The existing Dhaka-Aricha Rd. protects the Kallyampur area from the flood water of the Buriganga River. However, its top elevation (6.2 to 7.6 m G.T.S.) between near the Mirapur bridge and the Shyamali Cinema Hall is not enough for the design flood level.

Rising construction of the Dhaka-Aricha Rd. (Total length L = 3.0 km) is proposed to prevent the floods from the Buriganga River. The main features of the proposed level rising construction are;

- Total length: L = 3.0 km
- Design high water level: H = 7.3 m G.T.S.
- Free board: h = 1.0 m
- Top elevation of the road rising: E = 8.3 m G.T.S.

Two central gates of 2x2 m in size located near the crossing point of the Old Mirapur and Dhaka-Aricha Rd are proposed to drain flash floods in the off-season of pump drainage together with a control gate of 6x6 m in size attached to the proposed pump station.

Location of the proposed flood protection works is illustrated in Fig. N.10.

2.4.2 Pump Drainage Plan

As concluded in 3.3.2, Bashabo Zone (D Zone) and Kallyanpur area (H-I area) are required to adopt the pump drainage system. In this section, the proposed pump drainage system is explained.

(1) Required Pump and Regulation Capacities

The required pump and regulation pond capacities are calculated by the mass curve method under the same conditions as described in Supporting Report I.

According to the calculation results shown in Fig. N.11, the required pump and regulating pond capacities are shown in Table N.9.

Table N.9. Required Pump and Regulation Pond Capacities

Required Capacity	D Zone	H-I area
Pump (m^3/sec)	8.5	10.7
Regulation Pond (m^3)	862,000	1,212,700

(2) High Water Level of Regulating Pond

The design high water levels of the regulating ponds in D Zone and H-I area are proposed to be 4.5 and 5.0 m G.T.S. respectively through the following consideration:

- The lowest elevation of the existing developed land in the fringe area of D Zone and H-I area are approx. 5.5 and 6.0 m G.T.S.
- It is recommended that future land development be made in conformity with the elevation of the neighbouring built-up land.
- A hydraulic head difference of approx. 1.0 m will be required for satisfactory drainage of the above mentioned low-lying developed land.

(3) Low Water Level of Regulating Pond

The L.W.L. of the regulating pond is related with the H.W.L. and the required storage volume of the regulating pond. Accordingly, the storage volume between H.W.L. and L.W.L. is to be the same as the required regulating volume. The design L.W.L. is, however, desirable to be more than 3.0 m G.T.S. in D Zone and 3.6 m G.T.S. in H-I area, due to the following considerations:

- Ground elevation of the proposed regulating ponds.
- River flood hydrograph and required period of pump operation.

(4) Proposed Regulating Pond

The proposed regulation ponds provided with a required storage capacity between H.W.L. and L.W.L. as shown in Fig. N.12 and N.13, taking into account of anticipated future land development.

The regulation pond in D Zone (hereinafter called Khilgaon Pond) is proposed at the lowland area along the proposed dike, of which area (0.75 km^2) is approx. 22% of the existing lowland area (3.49 km^2).

On the other hand, the proposed location of the pond in H-I area (hereinafter called Kallyanpur Pond) is in a lowland area along the existing main khal in Kallyanpur. The proposed pond area (1.15 km^2) is approx. 29% of the existing lowland area (4.00 km^2) in H-I area.

The provided surface area and storage capacity of the regulating ponds are;

- Khilgaon Pond:	surface area:	$A = 0.75\ km^2$
	effective storage capacity:	$V = 975{,}000\ m^3$
- Kallyanpur Pond:	surface area:	$A = 1.15\ km^2$
	effective storage capacity:	$V = 1{,}263.000\ m^3$

These ponds are effective for reduction of the required pump capacity.

A variation of water level of both ponds under the design rainstorm are estimated by storage basin model and H-V curve of both ponds.

According to the calculation results, the water level at occurrence of peak runoff (H peak) and high water level (H.W.L.) of both ponds are as follows:

- Khilgaon Pond: H peak = 4.00 m G.T.S.
  H.W.L. = 4.50 m G.T.S.

- Kallyanpur Pond: H peak = 4.60 m G.T.S.
  H.W.L. = 5.00 m G.T.S.

The variation curves of the water level of both ponds are illustrated in Fig. N.14.

(5) Proposed Pump Station

The required pump capacities of D Zone and H-I area are 8.5 and 10.7 m^3/s, respectively.

Location of D Zone pump station (hereinafter called Khilgaon pump station) is proposed at the north-east side of Meradia as shown in Fig. N.18, due to the following viewpoints:

- The site to have favourable conditions for pump drainage system, construction and maintenance

- A neighbourhood of the proposed site is not to be developed in the future to operate together with the proposed regulating pond.

Location of H-I area pump station (hereinafter called Kallyanpur pump station) is proposed at the cross point of the Dhaka-Aricha Rd. and the existing main khal as shown in Fig. N.19.