People's Republic of Bangladesh
Ministry of Irrigation, Water Development and Flood Control

Flood Plan Coordination Organisation

Southwest Area Water Resources Management Project

United Nations Development Programme
(BGD/88/038)

Asian Development Bank
(TA No 1498-BAN)

FAP 4

FINAL REPORT

Volume 13

Pre - Feasibility Study of Selected Projects

August 1993

Sir William Halcrow & Partners Ltd.

in association with
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SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT (FAP-4)

PRE-FEASIBILITY STUDY OF SELECTED PROJECTS

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AEZ	Agro-Ecological Zones
Aman	Main Monsoon Paddy
AST	Agricultural Sector Team
Aus	Late dry season/early monsoon Paddy
BADC	Bangladesh Agriculture Development Corporation
B.Aman	Broadcast Aman
Baor	Ox-bow lake
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Forest Research Institute
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BIWTMAS	Bangladesh Inland Water Transport Master Plan
BKB	Bangladesh Krishi Bank
BLRI	Bangladesh Livestock Research Institute
BMD	Bangladesh Meteorological Department
Boro	Winter (dry) season Paddy
BRAC	Bangladesh Rural Advancement Committee (NGO)
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BSS	Bhumiheen Samabay Samity (Landless Cooperative Society)
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere (NGO)
CEP	Coastal Embankment Project
CERP II	Second Coastal Embankment Rehabilitation Project
CH	Chainage (1 Chain = 100 feet)
CIDA	Canadian International Development Agency
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DHI	Danish Hydraulic Institute
DOF	Department of Fisheries
DPHE	Directorate of Public Health Engineering
DSSTW	Deep Set Shallow Tube Well
DTW	Deep Tube Well
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organisation of the United Nations
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control, Drainage and Irrigation
FFYP	Fourth Five Year Plan
FPCO	Flood Plan Coordination Organisation
GB	Grameen Bank
GIS	Geographical Information System
G-K	Ganges - Kobadak
GOB	Government of Bangladesh
HYV	High Yielding Variety
IDA	International Development Agency (World Bank)
IECO	International Engineering Company Inc

IFAD	International Fund for Agricultural Development
Khariff	Summer, monsoon cropping season
KSS	Krishi Samabya Samity (Farmers' Cooperative Society)
LAD	Least Available Depth
LLP	Low Lift Pump
LGEB	Local Government Engineering Bureau (Now LGED)
MBR	Madaripur Beel Route
MLGRDC	Ministry of Local Government, Rural Development and Cooperatives
MP	Muriate of Potash
MPO	Master Plan Organisation
MS	Ministry of Shipping
MSY	Maximum Sustainable Yield
NAM	Rainfall Runoff Model
NFC	National Flood Council
NFMP	New Fisheries Management Policy
NGO	Non - Government Organisation
NWC	National Water Council
O & M	Operation and Maintenance
ODA	Overseas Development Administration (U.K)
PDB	Power Development Board
PDEU	Population Development and Evaluation Unit
PEP	Production Employment Programme
PET	Potential Evapotranspiration
PU	Planning Unit
PWD	Public Works Department
Rabi	Winter (dry) season crop
RAOM	Resource Allocation and Optimisation Model
RB	Right Bank
R & H	Roads and Highways
SC	South Central
SCR	South Central Region
SCRM	South Central Regional Model
STW	Shallow Tube Well
SW	South West
SWA	South West Area
SWAM	South West Area Model
SWRM	South West Regional Model
SWMC	Surface Water Modelling Centre
SWR	South West Region
T. Aman	Transplanted Aman
TOR	Terms of Reference
TSP	Triple Super Phosphate
UCCA	Upazila Central Cooperative Association
UNDP	United Nations Development Programme
UNO	Upazila Nirbahi Officer
Upazila (Now Thana)	Administrative Unit above Union and below Zila
WFP	World Food Programme
WARPO	Water Resources Planning Organisation
WSS	Women's Cooperative Society

1 INTRODUCTION

1.1 Prefeasibility Studies

In the Second Interim Report (November 1992), 19 Schemes were identified as near term projects and were subjected to an initial screening process. Out of which 7 were selected for pre-feasibility studies. In this report, the results reported in the Second Interim Report were revised with additional data. During the review meeting of the Second Interim Report it was agreed to study the Chenchuri Beel Rehabilitation Project in more detail, but still at pre-feasibility level, with additional data collection. This report covers the revised pre-feasibility studies of the following seven schemes:

		Ref. No.
(a)	Chenchuri Beel Rehabilitation Project	W 20
(b)	Padma - Kumar Scheme	W 11
(c)	Narail FCDI Scheme	W 19
(d)	Arial Khan - Bisarkandi Scheme	C 3
(e)	Swarupkati FCDI Scheme	C 6
(f)	Barisal Irrigation Rehabilitation Scheme	C 7
(g)	Bishkhali FCDI Scheme	C 10

The location of the schemes are shown in Figure 1.1.

In the Second Interim Report stage, the Coastal Studies have not advanced far enough to recommend any projects at that stage and that is the reason that no projects in the Coastal Embankment Project area has been included in the original list. In the final plan, however, three pilot projects have been included in the CEP area (Volume 1).

1.2 Summary of Economic Analysis

Summaries of the economic analysis for the seven schemes are presented in Tables 1.1, 1.2 and 1.3. It should be noted that the economic assessment for the Chenchuri Beel Rehabilitation follows a relatively stringent approach on the basis that:

- development costs have been estimated after extended field study and using large scale topographic/contour maps, but as per the FPCO guidelines relating to prefeasibility study an additional 25% cost has also been included to cover for any unforeseen quantities or items of works.

- incremental benefits relate to a maximum LLP intake of 66% of the potential irrigable area.

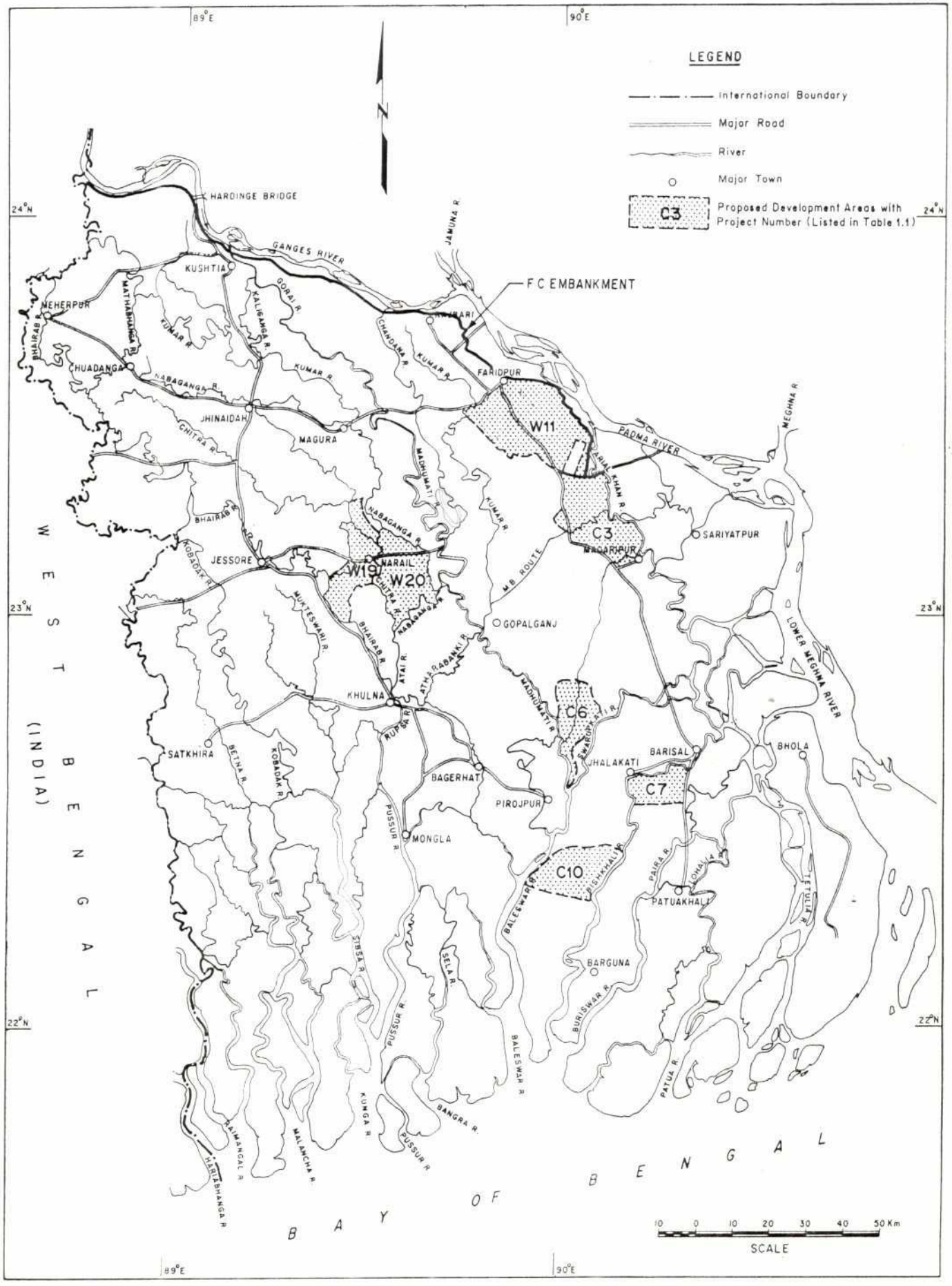
Inspite of that, the Chenchuri Beel Rehabilitation Project appears economically robust.

1.3 Selection of Schemes for Feasibility Study

The Benefit Cost Ratio (B/C) is generally accepted as a good measure to rank independent projects and to determine the order in which they should be taken up for implementation. However, taking into consideration that the Chenchuri Beel Rehabilitation Project has been subjected to a relatively stringent economic assessment and still comes at the top, it is being recommended to be taken up first. In addition, on the basis of the EIRR ranking of the other schemes given below, and taking note of the comparative impact assessment presented in Table 1.4, it is recommended that Padma-Kumar and Arial Khan Bisarkandi schemes are also taken up in the near term.

Scheme	Rank
Chenchuri	1
Arial Khan	2
Padma-Kumar	3
Bishkhali	4
Swarupkati	5
Barisal	6
Narail	7

Figure 1.1



Prefeasibility Studies : Location of Schemes

TABLE 1.1

Summary of Selected SWA Development Projects (1991 Economic Values)

	Projects						
	C3	W11	C7	C6	C10	W19	W20
	Arial Khan	Padma	Barisal	Swarupkati	Bishkhali	Narail	Chenchuri
Unit							
Gross Area km²	936	510	208	169	273	351	256
NCA	720	390	160	130	210	270	179
FCD only	250	80	-	30	-	80	43
FCD/I	470	310	160	100	210	190	136
Financial Costs M Tk							
Capital	1587	955	311	407	469	649	334
Recurrent (pa)	238	126	57	57	94	122	75
Tk/ha NCA							
Capital	22000	24500	19440	31000	22335	24000	18680
Recurrent (pa)	3300	3230	3535	4380	4480	4505	3150
Foreign exchange Capital M Tk	131	119	3	12	20	28	
Economic Costs M Tk							
Capital	1039	611	199	361	294	399	202
Recurrent (pa)	221	118	76	46	82	107	29
Tk/ha NCA							
Capital	14400	15600	12420	27800	14010	14780	11300
Recurrent (pa)	3065	3000	4765	3540	3900	3970	3780
Economic Incremental Benefit Tk/ha NCA	12500	16300	10105	10300	9940	10200	16300
Fisheries Losses (Tk/ha NCA) (economic value)	660	2600	-	684	-	746	200

Source: Consultant's estimates.

TABLE 1.2

Summary of SWA Selected Projects Economic Analyses (1991 Economic values)

Project	Base Case		
	EIRR %	NPV 12% M Tk	B/C ratio
Chenchuri	30.7	352	2.01
Arial Khan	33.7	2122	1.87
Padma Kumar	32.5	1340	1.73
Barisal Irrigation	24.6	251	1.37
Swarupkati	29.6	275	1.40
Bishkhali	30.0	466	1.58
Narail	21.0	359	1.29

Source : Consultant's estimates.

TABLE 1.3

Summary of Economic Sensitivity Analyses (1991 economic values)

	Arial Khan	Padma-Kumar	Barisal Irrigation	Swarup khati	Bishkhali	Narail	Chenchuri
Costs x 1.2 capital							
EIRR %	29.7	29.0	21.5	21.9	26.1	18.9	
NPV Mtk	1952	1231	214.2	212	412.7	287	
B/C ratio	1.74	1.63	1.3	1.28	1.49	1.22	
Costs x 1.2 recurrent							
EIRR %	31.1	30.1	19.7	24.4	26.11	18.3	
NPV Mtk	1866	1202	152.3	214	359.1	219	
B/C ratio	1.69	1.61	1.2	1.29	1.40	1.16	
Costs x 1.2 total							
EIRR %	26.9	25.1	17.2	18.9	22.5	15.6	25.3
NPV Mtk	1632	971	115.5	138	306.2	116	282
B/C ratio	1.55	1.44	1.14	1.17	1.32	1.08	1.68
Benefits x 0.8							
EIRR %	25.2	23.9	15.6	17.6	20.9	14.9	24.1
NPV Mtk	1207	703	65.34	83	213.1	44	212
B/C ratio	1.49	1.38	1.1	1.12	1.27	1.04	1.61
Benefits delayed x 2 years							
EIRR %	20.1	19.4	13.8	15.4	17.0	12.8	20.7
NPV Mtk	1144	659	53.62	72	193.58	24	213
B/C ratio	1.47	1.36	1.08	1.11	1.24	1.02	1.62
Costs x 1.2 and Benefits x 0.8							
EIRR %	22.4	21.1	7.6	13.4	14.0	11.7	19.2
NPV Mtk	1037	595	-77.7	20	53.7	-28	142
B/C ratio	1.40	1.30	0.91	1.03	1.06	0.98	1.34

Source : Consultant's estimates

TABLE 1.4
Comparative Impact Assessment

Scheme Ref.		Arialkhan (C3)	Padma (W11)	Barisal (C7)	Swarupkati (C6)	Bishkhali (C10)	Narail (W19)	Chenchuri (W20)
1 TYPE OF DEVELOPMENT	Units							
Surface Irrigation	ha	25,000	7,000	16,000	10,000	21,000	12,000	7,660
Ground water	ha	22,000	24,000	-	-	-	7,000	-
Total Irrigation area	ha	47,000	31,000	16,000	10,000	21,000	19,000	7,660
2 QUANTITATIVE ANALYSIS								
Increase in crop production	M Tk	902	635	162	134	209	275	125
Reduction in capture fishery	M Tk	48	102	-	9	-	19	2
3 QUALITATIVE CRITERIA								
Physical/Chemical								
- River erosion protection		+2	+2	0	+1	+1	+1	0
- River Channel works		0	0	0	0	0	0	+1
- Containment of river floods		+1	0	0	+1	+1	+1	0
- Intervention land losses		-1	-1	0	-1	-1	-1	-1
- Reduction in salinity		0	0	0	0	0	0	0
- Changes in water quality		-1	-2	0	-1	-1	-1	-1
Biological / Ecological								
- Floodplain fish migration		-1	-3	0	-3	-2	-3	-1
- Spawn/shrimp larvae capture		-1	0	0	0	0	0	0
- River & esturarine fisheires		0	-2	0	-2	-2	-2	-1
- Shrimp & fish culture		0	-2	0	-1	-1	-2	0
- Social forestry/village groves		-1	-3	0	-1	-2	-1	-1
- Plantation forests		0	0	0	0	0	0	0
- Sundarbans forest		0	0	0	0	0	0	0
- Bio-diversity conservation		0	0	0	0	0	0	0
Sociological / Culture								
- Security of homesteads		+1	+2	0	+1	+1	+1	+2
- Agricultural livelihoods		+3	+2	+1	+2	0	+2	+2
- Fishing livelihoods		0	-2	0	-1	-1	0	0
- Artisanal transport		+2	0	0	-2	+2	-1	+1
- Commercial transport		0	0	0	0	0	0	0
- Nutrition		+2	+2	+1	+2	+1	+2	+2
- Potable water supplies		-1	-3	0	0	-1	0	0
- Water related disease		0	0	-1	-1	-1	-1	+1
- Social/cultural sites		0	+1	0	0	0	0	0
Economic / Operational								
- Distribution of income		+2	+2	0	+1	0	+1	+1
- Rate of benefit generation		+2	+2	+3	+2	+2	+2	+2
- Oparational complexity		-1	-2	-2	-2	-2	+2	+2
4 FINANCIAL								
- Capital cost		1,587	955	311	407	469	649	334
- O&M Cost (annual)		238	126	57	57	94	122	24

vp\chen-tab\tab1-4

2 CHENCHURI BEEL REHABILITATION PROJECT

2.1 Project Setting

2.1.1 Project Description

A mainly flood control and drainage (FCD) scheme, referred to as the Chenchuri Beel FCD Project, was implemented about 10 years ago to provide security against large scale inundation to a gross area of about 25, 560 ha (net area of about 17,900 ha) with the objective to increase agricultural production by increasing the cropping intensity from 135% to 152%. But according to available data, this objective has not yet been achieved. A FAO/World Bank Report (1989) as identified the need for further improvement in drainage, substantial increase in irrigation and the introduction of an appropriate O & M. The proposed Chenchuri Beel Rehabilitation Project is aimed at meeting these needs.

The strategy of the proposed improvement for this scheme is to introduce an integrated development by enhancing water utilisation for agriculture, fisheries (in beels), etc., that would allow the beneficiaries to have controlled flooding/drainage in the wet season and a formal irrigation that will promote extensive rabi/boro (dry season) cultivation. In particular, the development would encourage beneficiary and private sector participation (mobilisation of local resources) to give the required thrust towards achieving the targeted objective.

2.1.2 Project Location

The existing scheme is located in thanas Narail, Lohagora and Kalia of Narail District. It covers the planning units (PU) SW10 and SW5 (Figures 1.1 and 2.1). The area is adjacent to other similar existing FCD projects: Bamankhali-Barnali FC Sub-project to the north, Singia Nebugati Beel Drainage Scheme and the Barnal-Salimpur Kolabashukhali Project to the southwest and southeast, respectively and the Madhumati-Nabaganga Project to the north east. The project area is surrounded by the rivers Chitra and Nabaganga.

The corner of the project area nearest to Jessore is about 33 km to the southwest, and a metalled road in reasonable condition leads to this point. However, the need to use a ferry to cross the Chitra to reach the project makes the area comparatively remote.

2.1.3 Previous Studies

The World Bank's Hardcore Programme Report of February 1973 recommended certain criteria for selection of flood control projects which would contribute to a rapid increase in food production, be self contained and would eliminate the problems of salinity, flooding and drainage congestion.

On the basis of this, the original project was identified by FAO/World Bank, appraised by a mission in 1978 and implemented in 1982/83.

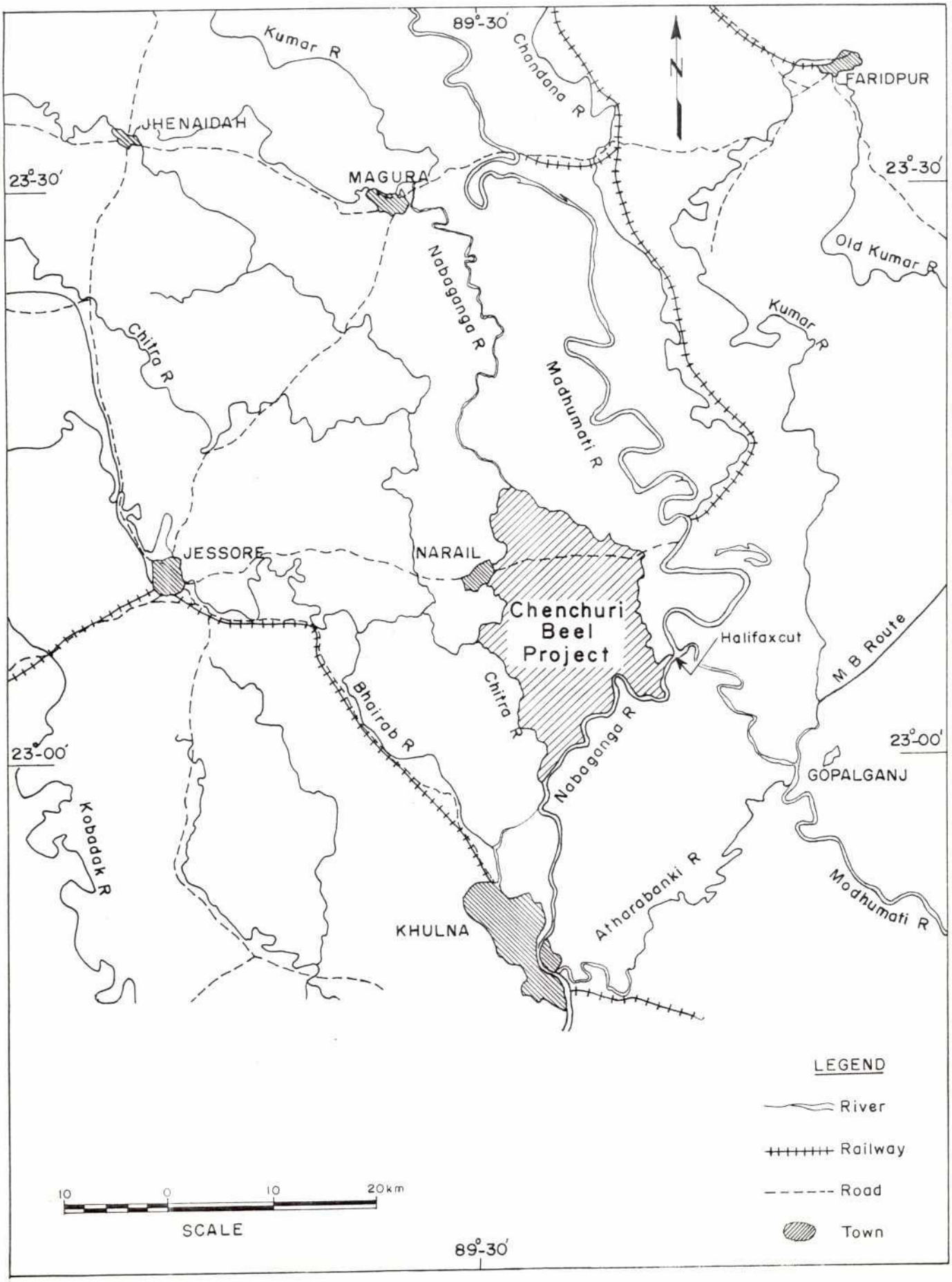
A project completion report relating to this scheme was prepared by FAO/World Bank in 1987 (revised 1989) after a field assessment and records review.

2.2 Issues and Needs

2.2.1 General

A field assessment and project review carried out by an FAO/World Bank team in October 1987 has indicated the need for further improvement in drainage, substantial increase in irrigated agriculture and the introduction of an appropriate O&M. The team has also

Figure 2.1



Location Map

identified possible conflict in needs between certain land owners : some farmers breaching embankments to relieve localised drainage accumulation.

During the current enhanced prefeasibility study, a team of the Consultant, comprising a sociologist, an agroeconomist, a hydrologist and an irrigation/drainage engineer, carried out field interviews and collected relevant information in the project area. The team during its three weeks stay in the area interviewed farmers and other inhabitants in 33 villages. The villages are listed below and their locations shown in Figure 2.2.

Thana	Village
Narail :	Dhearia, Phedi, Kammalpratap, Palaidanga, Mohishkhola, Auria, Shibanandapur, Bhadrabila, Komadanga, Dottapara, Basupati, Hogladanga, Chanchari.
Lohagora :	Hamarol, Sarutia, Amada, Chandar Char, Tabra, Noagram.
Kalia :	Suktagram, Kanchanpur, Kadamtala, Jusala, Maulicha, Babra, Krishnapur, Moheskhola, Dariaghata, Keshtapur, Pateswari, Hachla, Dhumdi, Nowagram.

The issues and needs that were highlighted by the villagers at various interviews are given in Sections 2.2.2 and 2.2.3. The details of the RRA and the analysis is given in Volume 9 - Impact Studies.

2.2.2 Issues

Flood Control

Repeated breaching of a reach (1.1 km) of the flood control embankment along the lower Nabaganga (near Noagram). This reach has been retired four times during the 10 years since the project was implemented.

Drainage Control

Water logging in certain low lying areas due to drainage congestion resulting from high river stage levels;

Lack of effective operation of those outfall regulators which do not have flapgates in working condition;

Siltation of khals and at the outfall regulators, and also unauthorised cultivation in khals resulting in retarded drainage flow;

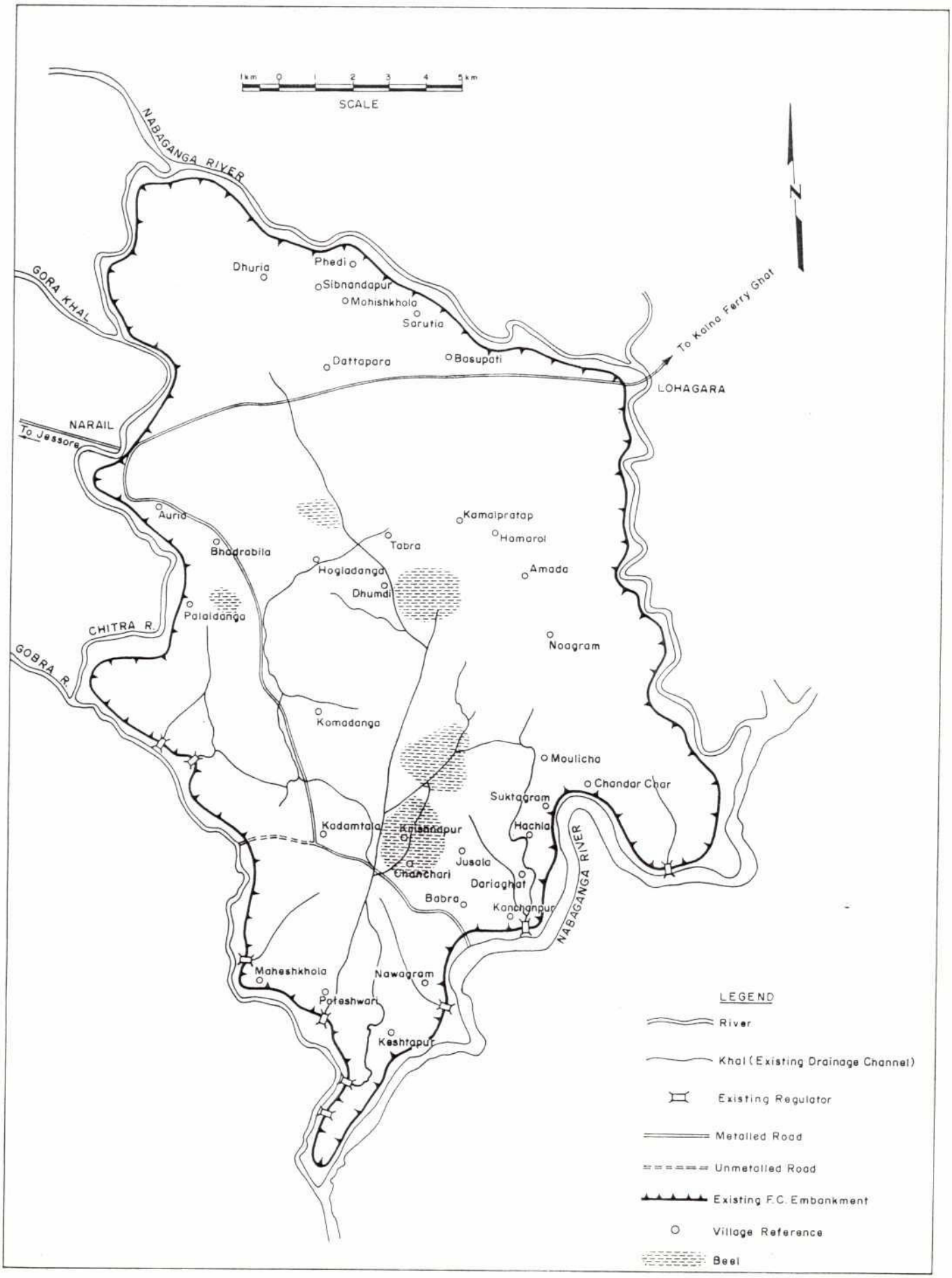
Conflict in needs between farmers in upstream and downstream areas relating to depth and period of inundation.

Irrigation/Agriculture

Limitation in water abstraction (gravity) from rivers for irrigation during the dry season due to low flows in the Chitra and inadequate intakes on the lower Nabaganga;

Higher salinity levels for a period of four to six weeks during April-May in the downstream reaches of the lower Nabaganga and the Chitra (at the southern corner of the project area);

Figure 2.2



Location of Interviews with Villagers

High cost of irrigation, particularly for the small-holder farmers and share-croppers (generally poor farmers leasing small areas from land owners) who have to depend on entrepreneur irrigators;

Net benefit particularly to a share-cropper is too small, after paying the shares in crop yield to the land owner and the irrigator (each taking 25% - 33%), to cover his risk factor and/or the opportunity cost of his labour input;

Most entrepreneur irrigators rarely meet crop irrigation demands (short irrigation duration and lengthy interval), consequently yields are lower than expected.

Related Social Aspects

Lack of adequate storage ponds for domestic and livestock use (bathing, consumption, etc);

Low employment potential particularly in the dry season (some men go to other areas where boro cropping is carried out, while women do not take such alternative employment because of long distance travel requirement);

Other income generating activities for the women are very poor;

No formalised water bodies and fisheries programmes for the artisan fishermen.

Subdued enthusiasm from share-croppers to participate in non-paid work relating to project implementation and maintenance due to the lack of suitable contractual provisions for their land leasing (which makes the leasing arrangement very temporary);

Lack of adequate credit facilities from formal institutions for the small-holder farmers and share-croppers;

Other Issues

Farmers and fishermen were generally sceptical about any support from the relevant government agencies to mitigate their problems or to improve the production, and many of them cited that visits by junior field staff were seldom and by senior staff were rare;

Low prices for produce when bumper harvests were obtained and lack of produce storage facilities.

2.2.3 Needs

The interviewed farmers overwhelmingly requested for facilities to enable them irrigate during the dry season and to improve and control the drainage disposal. They also wanted credit facilities from formal institutions to pay for the expensive crop production inputs.

They expect the government to organise improved maintenance programmes, but most were prepared to participate in them.

2.3 Existing Situation

2.3.1 Land Resources

Topography

The overall topographic feature of the Chenchuri Beel Project is complicated due to the presence of a number of low lying areas inter connected by a network of natural water courses and drainage channels. These low lying areas (beels) are individually named : Chenchuri, Pateswari, Nala and Mauli, etc; most of which dry up in the dry season but remain under water in the monsoon. The general topography of the scheme area slopes from North to South from 4.8 m PWD to 1.0 m PWD. The topographic and other features of the existing Scheme are discussed in Section 2.5.3.

Agro-ecological Regions

The Project area falls under the Higher Ganges River Floodplain (HGRF), the Low Ganges River Floodplain (LGRF) and the Peat Basin (PB) agro-ecological regions. The HGRF area is mainly medium lowlands with moderate permeability. The LGRF area has a typical meander landscape of broad ridges and basins. Soils of this area are relatively heavier and less permeable. Soils of the Peat Basin margins are acidic; heavy clay overlie peat or muck at 25-100 cm. Soft peat and muck occupy perennially wet basin centres. Calcareous loams to clays occupy a generally narrow strip on river basins. The agro-ecological regions are given in Figure 2.3.

Soil and Land Capability

Soil Associations

The soils of the area are developed as alluvium of the Young and Old Ganges Meander Floodplain. In the centre of the area is a depression running north-south in which peat or mucks layers have developed in the highly decomposed aquatic grasses and reeds buried by Ganges clays of variable thickness.

The area of the different soil associations and their characteristics are given in Table 2.1 and their locations are shown in Figure 2.4.

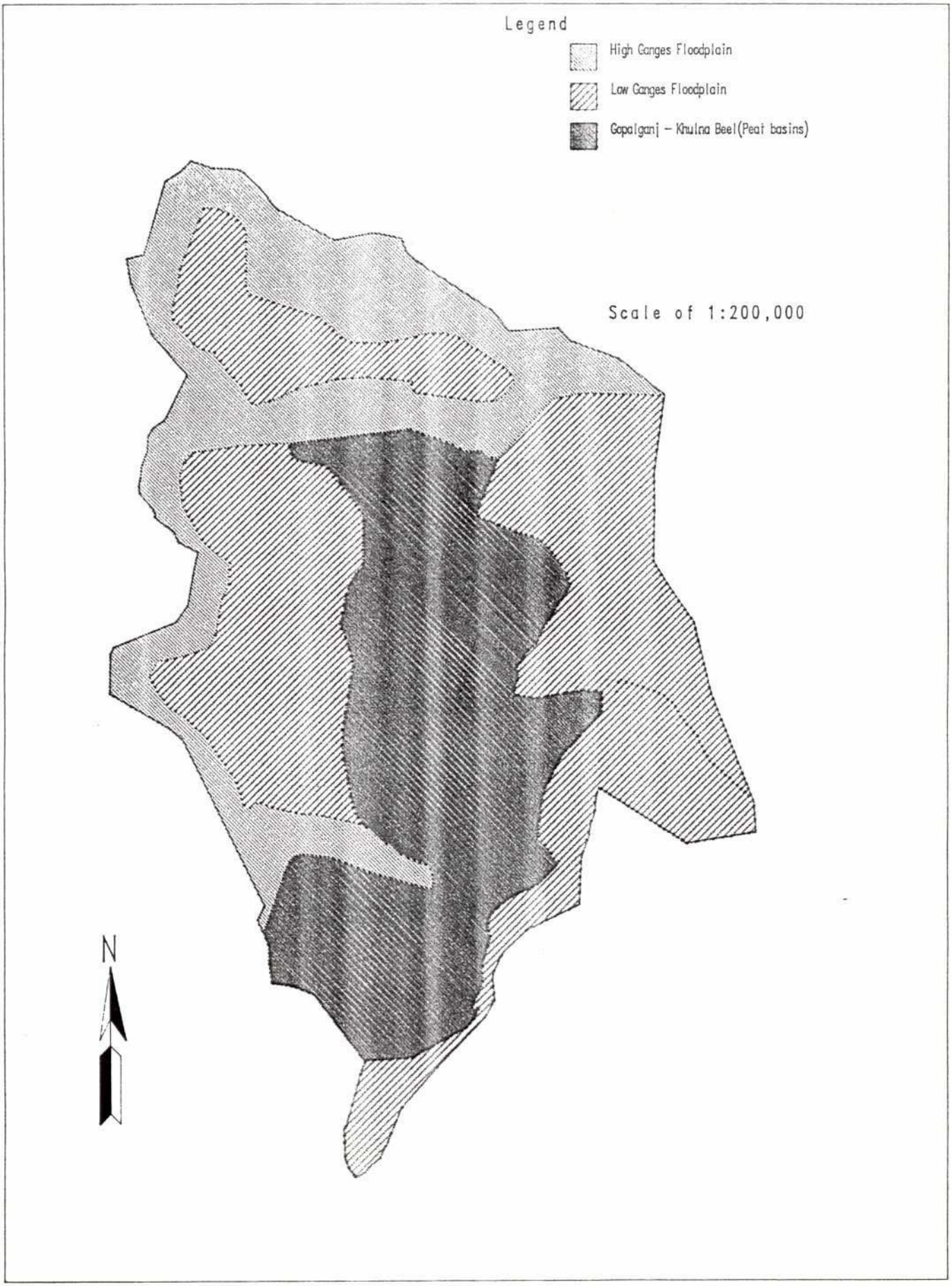
Description of Soil Associations

Ishurdi-Sara-Gopalpur Association occurs at the eastern part of the beel. (The other soil series not included in this soil association are : Pakuria and garuri). The soils are calcareous silt loam, silty clay loam and clay. Silty loam and silty clay loam occur on the medium highlands and clay on the medium lowlands.

Garuri-Pakuria Association is found in the western part of the beel. (The other soil series not included in this soil association are : Ishuri, Gangni, Ghior, Batra, Baliakandi and Kumarkhali). The soils are silty clay and clay where the area of clay soils predominate. Top soils are mostly non-calcareous. Subsoils of some soils are calcareous and some are non-calcareous.

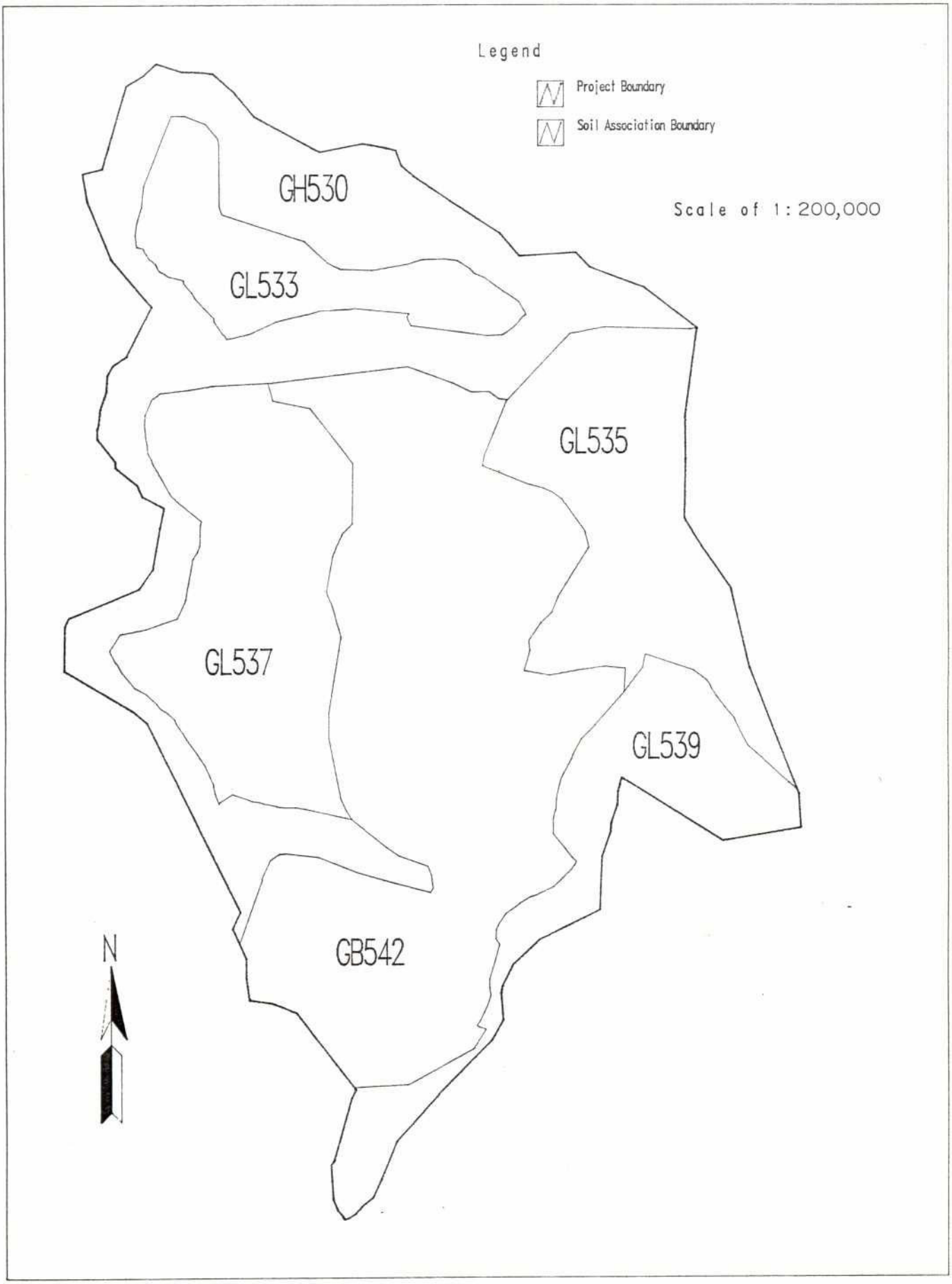
Ghior-Batra Association occurs in a linear strip at the south-eastern part of the beel along the Nabaganga river. (The other soil series not included in this soil association are : Ishurdi,

Figure 2.3



Agro Ecological Regions

Figure 2.4



Soil Associations

Pakuria, Gangni, Garuri, Kashiani, Batra and Baliakandi). The soils are silty clay and clay where the clay soils occupy more than two-thirds of the area. Most of the soils are calcareous throughout the profile.

TABLE 2.1

Soil Associations

Soil Assoc No.	AEZ No.	Soil Association Name	Area (ha)	Dominant Texture	Percent (Approx)
3	GI 535	Ishurdi-Sara-Gopalpur	3600	Silt loam Silty clay loam Clay	20 55 25
11	GI 537	Garuri-Pakuria, Medium Lowland Phase	3600	Silty clay Clay	30 70
14	GI 539	Ghior - Batra	3000	Silty clay Clay	30 70
15	GL 533	Ghior - Ramdia	2400	Silty clay Clay	5 95
18	GH 530	Sara-Ishurdi-Garuri	5310	Silty loam Silty clay loam Silty clay Clay	30 25 25 30
23	GB 542	Narail - Harta	7650	Clay Clay (Peat 20-50 cm below surface) Peat (at surface or within 10-25 cm below)	30 35 35

Source : Reconnaissance Soil Survey, Jessore District (SRDI, 1970) and Consultant's estimation.

Ghior-Ramdia Association is found in the northern part of the beel slightly away from the ridges of the river Nbaganga. (The other soil series not included in this soil association are: Ishurdi, Gangni, Pakuria and Rajoir). The Rajoir soil series has less than 20 to 30cm thick mineral soils overlying peaty or mucky layer. An insignificant area is occupied by this soil within the association unit. All other soils are clayey. Top soil is non-calcareous but sub-soil at a depth of about a meter is calcareous.

Narail-Harta Association occurs at the centre of the beel. The association is characterised by a layer of clay between 25-50cm in thickness over peat layer or peaty muck layer which occupy about half of the area. On about one third of the area organic soils are either at the surface or 10-25cm below the surface. The rest of the area has deep calcareous silty clay and clay soils. The soil series include: Ishurdi, Garuri, Kashiani, Ghior and Batra.

Land Capability Association

Land capability associations are groups of land capability classes and sub -classes. Because of scale limitations, each land capability class and sub-class are grouped together as in the case of soil associations. Implicit in the land capability classification the potential of the land for improvement over the present agricultural land use.

The area, name of the land capability association and major characteristics of their sub-groups are given in Table 2.2.

TABLE 2.2

Land Capability Associations

Land Cap. Assoc No.	Land Capability Association Name	Area (Ha)	Sub-group No.	Major Characteristics
1	Predominantly good agricultural land	100	1c	Mainly imperfectly drained, draughty broad, highland ridges with some medium highland
4	Mainly moderate with some good agricultural land	11,900	4c	Mainly medium highland ridges with some medium lowland
			4d	Mainly medium lowland and broad low land basins, locally with flash flood and slow drainage
5	Predominantly moderate agricultural land	500	5a	Predominantly medium lowland
6	Mainly moderate with some poor agricultural land	13,000	6b	Mainly medium lowland with slow draining in dry season and locally perennially wet
			6c	Mainly medium lowland broad basin with slow draining in dry season and flood hazard; part with perennially wet peat and part peat at shallow depth

Source: Reconnaissance Soil Survey, Jessore District (SRDI, 1970) and Consultant's estimate

Major Physical Constraints to Agricultural Development

Prior to FCD intervention in 1982 most of the beel area used to be moderately deeply to deeply flooded. After the intervention about half of the area is at present moderately deeply flooded, about one-third of the area is shallowly flooded and the remaining area is either shallowly or non-flooded.

About half of the area at the center have peat soils. Peat or muck occurs in few places at the surface but in most places at a shallow depth below mineral soils. These soils have low bearing capacity when wet. Due to this special soil condition, farmers need to put in more labour and time for transplantation of rice seedlings.

The remaining areas have no underlying peat or muck but the soils are silty clay or clay which become quickly draughty after the end of the dry season. This makes the land difficult to till for growing rainfed rabi crops.

Moderately deeply and deeply flooding restrict the growing of transplanted HYV aman crop during monsoon season. During the rabi crop season, the lack of surface irrigation is the

major limitation for not growing boro extensively although during recent years cultivation of some boro by shallow tubewells is being practised.

An additional limitation to the basin low areas is that in years of early monsoon flash flood from rainfall runoff from adjoining higher areas damages crops even at mature stage.

2.3.2 Existing Flood Control, Drainage and Irrigation Facilities

The composite gross area that has been protected by the existing Chenchuri Beel FCD Project is about 25,560 ha. An area covering about 1100 ha in the northwest corner has a formalised irrigation system of BWDB, incorporating two pump stations and networks of lined canals, which was recently commissioned (April 1993) and it is presently being operated by BWDB. In addition, individual and groups of farmers operate their own separate LLPs and STWs which cover a total net area of about 2580 ha. The existing project features are shown in Figure 2.5. A summarised description of the present condition of the existing FCD/I facilities based on the recent field visits and interviews is given hereunder.

Flood Control Embankment

The project area is entirely bounded by the Chitra and the Nabaganga rivers and this boundary runs a total distance of about 85 km. Flood control embankment covers a total length of about 62 km, while an existing road on embankment provides protection to a 10 km long reach. Another reach in the northeast (high ground) covering about 12 km has dwarf embankments at isolated low lying sections. A small reach along the lower Nabaganga has no formalised protection due to disagreement between local farmers.

These embankments in general are in reasonable condition. However, a small reach close to Noagram (Ch. 64 km - 65 km) has been breached on four occasions, even though this reach gets set back further inland (retired) after each breach. Relevant details of these embankments are given in Table 2.3. a typical cross-section of the flood control embankment is shown in Figure 2.6.

Drainage Network

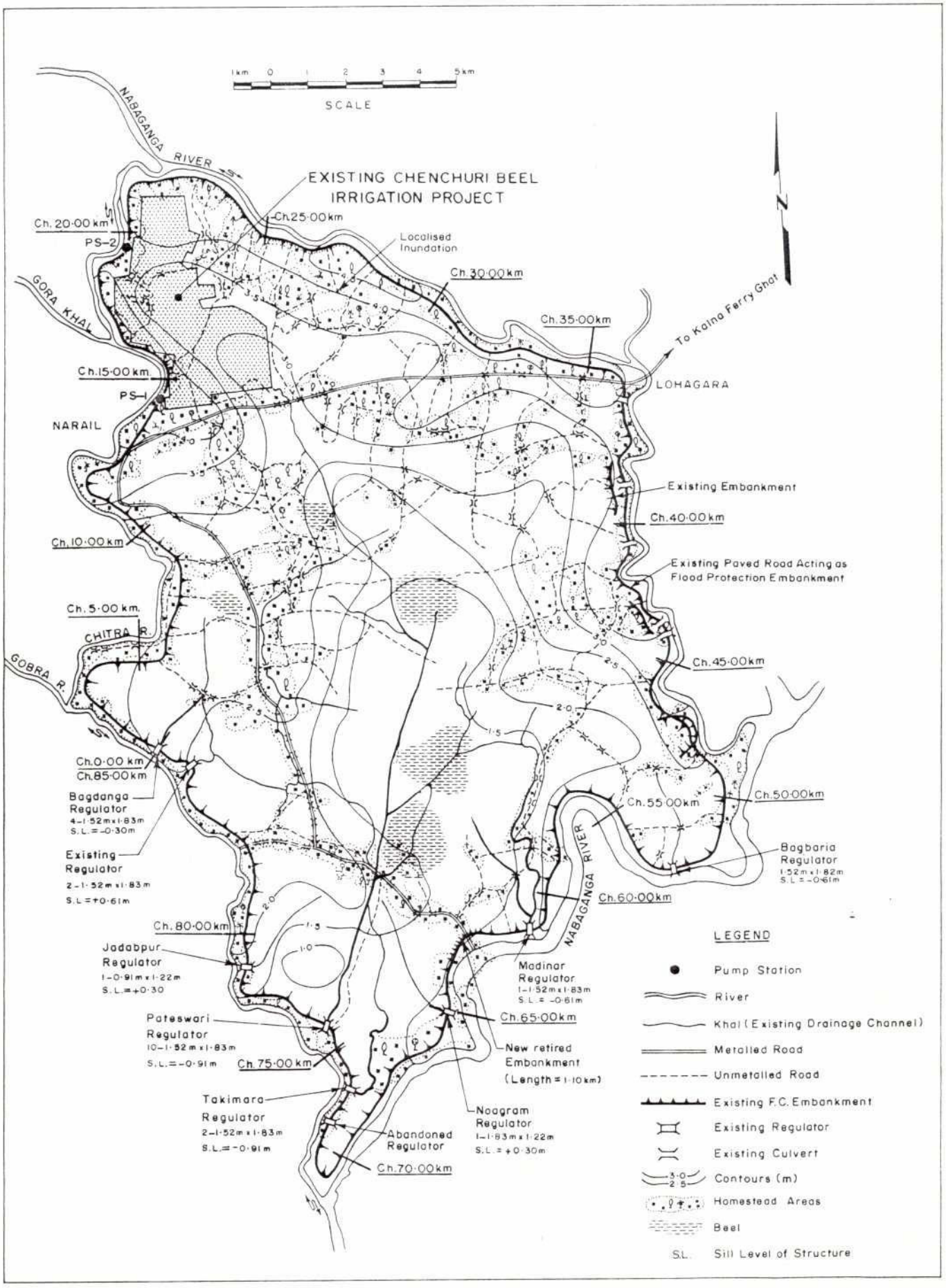
There are about 15 km of main and secondary khals/drains. Most of the lengths have been recently desilted. The drains associated with the Jadabpur regulator is yet to be desilted. These khals and drains are located generally in the southern low lying areas and are connected individually to separate outfall regulators.

There are eight regulators (Figure 2.5) excluding the already abandoned one at Takimara. they are all located along the southern reaches of the Chitra and Nabaganga rivers. The features of these regulators are given in Table 2.4.

Irrigation

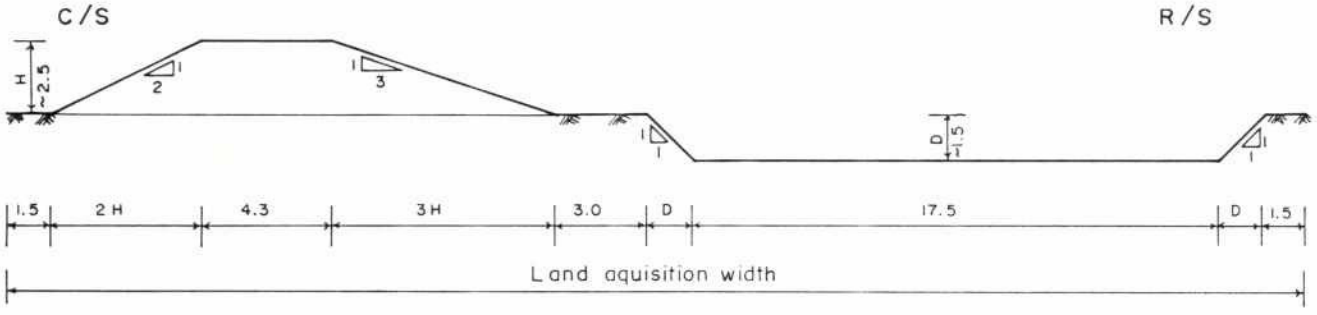
The above regulators can also allow river inflow during the period May to December to support LLP irrigation of very limited areas within the project that lie close to the regulators. However, since the regulators are located at the lower reaches of the two rivers and for a short period (about 5 weeks in April/May) the river salinity levels are relatively high, the farmers are reluctant to make use of this facility. This affects the aus (Kharif-I) crop production.

Figure 2.5

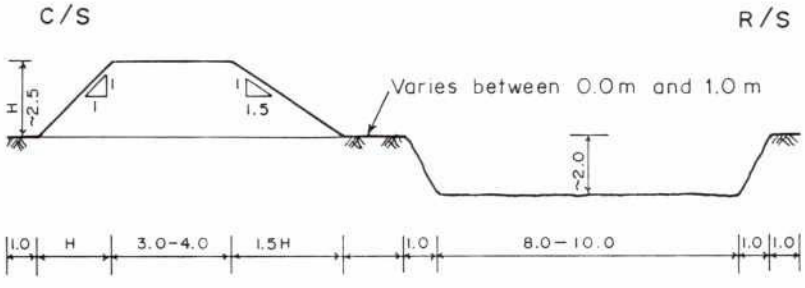


Existing Features

Figure 2.6



BWDB PROPOSED TYPICAL CROSS SECTION



EXISTING TYPICAL CROSS SECTION

Note: All dimensions are in metre

Typical Cross Sections of FC Embankment

TABLE 2.3

Existing Embankment Details

Embankment Reach (Km)	Representative G.L Elevation (m PWD)	Embankment			Remarks
		Crest Level (m PWD)	Cross-section (m) : Height (H), Crest width (b) and Base width (B)	Set back Distance (m)	
00-05	2.4-2.5	4.7-4.9	H = 2.3, b = 4.0 B = 11	200-300	
05-10	2.5-3.1	4.9-5.2	H = 2.3, b = 4.0 B = 11	100-300	
10-15	3.1-3.5	5.2-5.3	H = 2.3, b = 4.0 B = 11	100-300	
15-20	3.5-4.4	5.3-5.4	H = 2.0, b = 3.0 B = 9	100-400	
20-25	4.4-4.1	5.4-5.0	H = 1.08 b = 3.5 B = 9	200-300	
25-30	4.1-4.4	5.0-5.1	H = 1.0, b = 3.0 B = 6	50-200	Localised inundation
30-35	4.4-4.6	-	-	200-300	
35-40	4.6-4.7	-	-	100-200	Paved Road is acting as FC embankment
40-45	4.7-4.1	-	-	50-200	
45-50	4.1-2.7	5.0-5.4	H = 1.2, b = 4.0 B = 8	100-300	
50-55	2.7-3.1	5.4-5.3	H = 1.8 , b = 4.0 B = 9	100-300	
55-60	3.1-1.8	5.3-5.2	H = 3.0, b = 3.5 B = 13	100-300	
60-65	1.8-2.3	5.2-5.1	H = 3.3, b = 3.0 B = 13	100-300	Embankment retired for the 4th time
65-70	2.3-1.7	5.1-5.0	H = 3.0, b = 3.0 B = 12	100-300	-
70-75	1.7-1.0	5.0-4.7	H = 3.6, b = 3.5 B = 14	100-250	
75-80	1.0-2.3	4.7	H = 3.6, b = 3.5 B = 14	100-300	
80-85	2.3-1.5	4.7	H = 2.6, b = 3.5 B = 11	100-250	

Note : Embankment side slopes (average): country side - 1.1 to 1:1.5; river side - 1:1.5 to 1:2

Table 2.4

Information on Existing Regulators

Name of Structure	Location (Embankment reach km)	Name of outfall River	No. of vent with Vent size (mxm)	Invert Level (m PWD).	Operating Deck slab level in m PWD	Gates
Bagbaria Regulator	Islampur 53.0	Nabaganga	1 - 1.52x1.83	(-) 0.61	5.49	Drainage & flushing 1 No flap gate
Modiner Khal Regulator	Kanchanpur 61.0	-do-	1 - 1.52x1.83	(-) 0.61	5.49	Drainage & flushing 1 No. flap gate
Noagram Flushing Sluice	Noagram 65.0	-do-	1 - 1.83x1.22	(+) 0.30	4.57	Flushing 1 No. slide gate
Takimara Regulator	Takimara 73.5	Chitra	2 - 1.52x1.83	(-) 0.91	5.18	Drainage & flushing 2 Nos. flap & slide gate
Pateswari Regulator	Pateswari 76.0	-do-	10 - 1.52x1.83	(-) 0.91	5.18	Drainage & flushing 10 Nos. flap & slide gate
Jadabpur Flushing Structure	Jadabpur 79.0	-do-	1 - 0.91x1.22	(+) 0.30	3.84	1 No slide gate flushing
Bagdanga Regulator	Bagdanga 0.0	-do-	4 - 1.52x1.83	(+) 0.61	5.79	Drainage & flushing 4 Nos. flap & slide gate
Bagdanga Regulator	Bagdanga 0.3	-do-	2 - 1.52x1.83	(-) 0.30	4.88	Drainage & flushing 2 Nos flap & slide gate

Description of the general condition of the regulators:

Bagdanga Regulators

There are two regulators at Bagdanga, one having 2 vents and the other having 4 vents at a distance of about 300 m from each other. The 2 vents regulator was constructed during the implementation of the scheme to drain areas in Aterhati, Damuda, Koya, Azugar beel and Bhadra Billa etc. Its capacity was apparently found inadequate and second regulator was constructed later. Both of these regulators are providing drainage as well as flushing facilities. The tidal fluctuation at these locations is about 0.90m as reported by the local people. No significant amount of crop damage due to drainage congestion was reported by the local people, possibly because the farmers are mostly practicing local variety B and T Aman. The drainage khals of the regulators were found in good condition upto a length of about 1 km.

Jadabpur Regulator

This is a single vent regulator located at Jadabpur village. This regulator receives runoff from the area Jadabpur, Chandpur, Raghunathpur, Purulia, Chandrapur, Fuldaha, Amtala, Bishnapur, Satbaria and Pateswari beel. The drainage channel connecting the regulator was found silted up. This causes drainage congestion in the low lying areas, delaying the start of rabi cultivation.

Pateswari Regulator

This is the biggest regulator of the scheme and it receives water from the upland northern

areas through the Howai khal. The drainage khal has recently been re-excavated for a length of about 4 km. Significant crop damage due to drainage congestion was reported by the farmers. The tidal fluctuation in the months of February to May is reported to vary between 1.52 and 1.83 m. Salinity concentration of the Chitra river is reported to rise beyond generally accepted levels for rice during Kharif-I crop. This situation has been observed in the last 3 to 4 years. The structure is in good working condition but two flap gates were found missing. The local people demanded immediate reinstallation of these two gates.

Takimara Regulator

This regulator is located at Takimara. It drains partly the surface runoff coming from the upland northern areas as it is also connected to main Howai khal. The drainage khal was found partly in good condition. The structure is also in good working condition but one flap gate was found missing. It needs to be installed as significant amount of crop damage was reported by the farmers.

Noagram Regulator

This regulator is located at Noagram. It receives water from the upland areas of Babra, Baze Babra and Purulia etc villages. The drainage khal is silted up partly and it needs to be resectioned to accelerate drainage. The structure is in good working condition. Crop damage occurs due to inadequate drainage capacity of the gate.

Madinar Regulator

This regulator is located at Madinar khal. It receives drainage water from Chenchuri beel, Suktagram, Moulicha and Kumri villages and also from the upland. The tidal fluctuation of the outfall river is reported to vary between 0.91 to 1.22 m in the months of March-May. Crop damage is reported to occur in the year 1989 due to inadequate drainage capacity of the structure. The local people propose another 2 vent regulator to augment the drainage capacity. The drainage khal has been resectioned for about 2 km length. The remaining portion needs resectioning.

Bagbaria Regulator

This regulator is located at Bagbaria. This structure has only flap gate. It receives water from Mauli, Tapsidanga, Kalagachi and Malgram villages. The drainage khal is about 3 km in length and has been partly silted up. The tidal fluctuation at this location is reported to vary between 0.30 to 0.60 m in the months of March-May. The salinity level of the river is beyond the crop tolerance. So, the farmers do not desire to grow any irrigated kharif-I crop. Vertical lift gate was not installed during the implementation. A vertical lift gate needs to be installed to retain rain water for cultivation of low areas.

Road Network

The scheme area is traversed by a good number of Kutcha roads and two main Pucca roads (Narail-Lohagara-Mahajan and Narail-Baze Babra). The total length of Kutcha road is about 190 km and Pucca road is about 50 km.

Low Lying Water Bodies/Beels

In the project area, there are several like Pateswari beel, Chenchuri beel, Nala beel, Mauli beel etc. which are mainly seasonal and become almost dry in the dry season. But these low lying water bodies get submerged during the monsoon, having depth up to 3.0 m.

Inundation

The present inundation status based on average rainfall as reported by a recent World Bank/UNDP sponsored fisheries sector study is given in Table 2.5. This compares reasonably with the Consultant's model simulation results corresponding to a 1 in 5 year rainfall situation (refer Table 2.23) if allowance is given for the different rainfall events used in the two cases.

TABLE 2.5

Existing Flooding Conditions

Month	Gross Area Flooded (ha)			
	F0	F1	F2	F3 + F4
April	25560	0	0	0
May	25560	0	0	0
June	23300	2250	0	0
July	17170	4910	3480	0
August	13070	4660	6810	1020
September	10510	4610	7060	3380
October	11020	4610	7170	2760
November	17880	7470	2870	0
December	23510	2050	0	0
January	25560	0	0	0
February	25560	0	0	0
March	25560	0	0	0

Source: Based on Monograph on Selected Floodplain Areas by EPC Ltd. in 1989 for the Ministry of Fisheries and Livestock and the World Bank/UNDP.

2.3.3 Existing Agriculture

Land Use and Cropping Patterns

At present, the total NCA of the project is 17,900 ha and out of that 2580 ha is irrigated which is about 14% of the total NCA.

Rice is the predominant crop in the project area. Broadcast aus and aman are major crops (29% and 39% of the total NCA respectively) grown. Local transplanted aman rice is also important and where supplementary irrigation is available modern aman is also grown. jute, kheshari, gram, lentil, wheat, mustard, chilies and onion are the main rainfed rabi crops. Local boro is also grown with irrigation. Sugarcane, banana and papaya are the important perennial crops.

The elevation of land in relation to flooding during rainy season and the permeability and soil moisture criteria in the winter season are considered to be the major factors determining the types of crops, cropping patterns and their intensity. Availability of irrigation water determine growing of irrigated crop especially boro rice.

The main cropping patterns followed presently by the farmers in the project area are single and double cropping and minor triple and perennial cropping . A field survey conducted in 33 villages selected randomly but covering the project area reveals that about 51% of the total NCA is under single cropping, 42% under double cropping 4% under triple cropping systems and 4% under perennial crops. Within the single cropping system, mixed broadcast

aus and b.aman occupy about 45% while broadcast aman by itself occupies 33 percent. But within double cropping system, mixed broadcast aus and aman and rabi occupy about 40%, broadcast aman and boro (HYV) 21% and aus/jute and rabi 20%.

The dominant single, double and triple cropping patterns are as follows:

(i) Single cropping pattern :

- (a) Mixed aus and b.aman - Fallow
- (b) Broadcast aman - Fallow
- (c) T.aman (L) - Fallow
- (d) Boro - Fallow

(ii) Double cropping pattern :

- (a) Mixed aus and b.aman - Rabi (Pulse, mustard, spices, wheat etc.)
- (b) Broadcast aman - boro (HYV)
- (c) Aus/Jute - Rabi (Pulses, mustard, wheat, vegetables etc.)
- (d) Broadcast aman - Rabi (Pulse, mustard)

(iii) Triple cropping pattern :

- (a) B.aus (L) - T.aman (L) - Rabi (Pulse, mustard, spices etc.)

(iv) Perennial crops :

- (a) Banana, papaya, betelvine etc.

The cropping intensity ranges between 171 to 180 percent under irrigated and 142 to 153 percent under rainfed conditions in the different planning units. The overall cropping intensity of the project area is 148 percent.

The present cropped area by land types for individual planning unit is shown in Table 7 of Appendix I and a summary of the present cropping area both under irrigated and rainfed is shown in Table 2.6.

Irrigation

The present modes of irrigation in the project area are mainly shallow tubewells (STW) and low lift pumps (LLP). There are limited numbers of deep tubewells (DTW). Due to scarcity of surface water and saline intrusion, the number of LLPs has not shown any increase in the recent years. On the other hand the number of STW are rapidly increasing. The use of STW for irrigation from 1984-85 to 1991-92 in the project area is given in Table 2.7 which shows the rapid increasing trend in recent years. However, during the field visit the farmers reported shortage of irrigation water and indicated their preference to surface water irrigation rather than groundwater irrigation because :

- Groundwater contains more iron which reduces soil fertility (This may be due to fixation of phosphate and Potassium in the soil in the unavailable form);
- Cost of use of surface water is less than the groundwater;
- Groundwater irrigation equipment is difficult to handle and repair.

TABLE 2.6

Summary of Present Cropping

Crop	Area in Hectare									Percent of Total NCA
	SW 5			SW 10			Grand Total			
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	
Kharif										
B Aus	0	2,646	2,646	0	2,590	2,590	0	5236	5236	29
M Aus	249	78	327	193	14	208	443	92	534	3
B Aman	0	2,892	2,892	0	2,419	2,419	0	5310	5310	30
LT Aman	363	338	702	286	2,242	2,528	649	2581	3230	18
M Aman	380	384	764	331	709	1,040	711	1093	1804	10
Jute	0	609	609	0	501	501	0	1110	1110	6
Sugarcane	16	253	269	21	125	146	37	378	415	2
Rabi										
L Boro	87	47	134	46	167	213	133	215	347	2
M Boro	795	0	795	701	0	701	1496	0	1496	8
M Wheat	366	422	788	245	78	323	611	500	1111	6
Potato	7	46	54	13	221	234	20	267	287	2
Pulses	33	1,455	1,488	30	1,065	1,095	63	2519	2583	14
Oilseeds	45	726	771	140	1,150	1,289	185	1876	2060	12
Spices	12	115	127	11	36	47	23	151	174	1
Minor Crops	57	152	208	86	178	264	143	330	473	3
Orchards	0	100	100	0	170	170	0	270	270	1
Totals	2410	10263	12,673	2,103	11,664	13,767	4513	21927	26440	
Total NCA	1,407	7,493	8,900	1,168	7,832	9,000	2575	15325	17900	
Average CI	171%	137%	142%	180%	149%	153%	175%	143%	148%	

TABLE 2.7

Growth of Shallow Tubewells

Thana	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1991-92
Kalia	33	39	38	38	51	54	71
Lohagara	275	300	350	400	500	704	834
Narail	205	314	271	418	661	704	735
Total	513 (100)	653 (127)	659 (128)	856 (167)	1212 (236)	1462 (285)	1640 (320)

Figures in parenthesis represent the trend of change in percentage, taking the 1984-85 figures as 100.

Inputs, Yields and Production

A detailed cropwise requirements of human labour, bullock power and other inputs for obtaining optimum yield are given in Table 8 of Appendix 1. Crop yields under both irrigated and rainfed conditions have been calculated based on the average of five years BBS data.

The present production based on yield (Table 8 & Appendix 1) for different crops under irrigated and rainfed conditions by planning units is presented in Table 2.8.

TABLE 2.8

Present Crop Production

Crop	Production in Tonne								
	SW 5			SW 10			Grand Total		
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall
Kharif									
B Aus	0	3175	3175	0	3108	3108	0	6283	6283
M Aus	723	225	948	561	41	602	1283	266	1550
B Aman	0	3470	3470	0	2902	2902	0	6373	6373
LT Aman	691	642	1333	543	4261	4804	1234	4903	6137
M Aman	1215	1229	2444	1060	2268	3328	2275	3497	5772
Jute	0	1035	1035	0	852	852	0	1887	1887
Sugarcane	782	10122	10904	1056	5011	6067	1838	15133	16971
Rabi									
L Boro	165	90	255	87	318	404	252	408	660
M Boro	3498	0	3498	3084	0	3084	6583	0	6583
M Wheat	878	717	1595	588	132	720	1466	850	2316
Potato	58	371	456	158	1765	1922	243	2136	2379
Pulses	22	989	1012	20	724	744	43	1713	1756
Oilseeds	37	603	460	116	954	1070	153	1557	1710
Spices	44	427	470	41	131	173	85	558	643
Minor Crops	6	15	21	9	18	27	15	33	48
Orchards	0	256	256	0	435	435	0	691	691

Crop Damage and Production Problem

During rainy season, a major part of the area remains flooded and only about 22% of the net cultivated area is above flood level. T.aman cannot be grown other than in shallow flood areas. Highlands become very dry even in monsoon season when there is no rain for almost a week or so and t.aman fails to develop and produce satisfactorily. Because of this shallow to moderately/deeply flooding local variety of aus and broadcast aman either singly or mixed together are grown in about 59% of the project area with poor yield and long growing period. The crop is sometimes damaged due to submergence from sudden rise of flood water especially when there is prolonged heavy rainfall. A major part of the project area is slow draining and it generally causes a delay in sowing rabi crops. Even the well drained soil areas where rabi crops could be grown on time, soil moisture is depleted quickly affecting wheat, pulses, oilseeds, vegetables and other crops to suffer from moisture stress.

2.3.4 Existing Fisheries

Introduction

Rehabilitation of existing Chenchuri Beel FCD project which is located in Narail district between the Nabaganga and Chitra rivers provides a chance to review any impacts on the local fisheries and to take such remedial action as is possible. The BWDB Project area is protected from river flooding by about 85 km of earthen embankment. The empoldered area of the project comprises a number of beel areas, Chenchuri beel, Nala beel, Mauli beel, Pateswari beel and some other small beels. Despite its name the SPARRSO images do not show any significant perennial beel areas, and Chenchuri beel fish production would have been based mainly on the khals and the seasonal beels and floodplain subsistence catch. Post project benefits will have accrued mainly to fish pond owners and to any borrow-pits

that have been developed for fish production. The proposed project aims at year round irrigation so that the rehabilitation work will be intended to restore FCD integrity. This bound to impact on any remaining floodplain fish and river fishing cannot be expected to improve. However, there may be prospects of expanding aquaculture in the five small depressions, khals, borrow-pits and ponds of the project area after necessary rehabilitation.

Fish Production

The gross area of the Chenchuri beel is estimated to be 25,560 ha, net cultivable area is estimated to be 17,900 ha and area of floodplain fisheries estimated to be 14,000 ha without project condition and 9,000 ha with project. The most important khal traversing the beel is Pateswari khal arising from Chitra river on the south-west and going upto Nala beel almost near the northern border. The other khals are (a) Biliarchar khal, (b) Bagdanga khal on the west falling in Chitra river, (c) Modinar khal-Naturia khal on the south falling in Nabaganga river and (d) Baghbaria khal on the south-east falling in Nabaganga river. Regulators on the embankments control the connections of these khals with the concerned rivers. Prior to empoldering, capture fishery operations were a major activity in the beels but empolderment turned the perennial beels into seasonal beels, dried up after December and used for rice cultivation and no resident species of fish left for future propagation of stock. Table 2.9 shows that production of Chenchuri beel capture fisheries declined by 68 percent over the period of seven years, from 1344 tonnes in 1983/84 to 427 tonnes in 1989/90 but production of culture fisheries increased by 95 percent over the same period, from 245 tonnes in 1983/84 to 478 tonnes in 1989/90.

TABLE 2.9

Chenchuri Beel Fish Production (Tonnes)

Fishery	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Capture Fishery							
Beels	418	200	204	227	200	168	236
Floodplain	926	111	820	558	319	272	191
Total Capture Fish	1344	1311	1024	785	519	440	427
Culture Fishery							
Ponds	245	266	294	301	321	339	478
Total Culture Fish	245	266	294	301	321	339	478
Overall Total	1589	1577	1318	1086	840	779	905

Source : Consultant's estimate based on DOF Fish Catch Statistics of Bangladesh 1983/90

Note: Heavy mortality of catfish, livefish, snakeheads and miscellaneous fishes, which constitute 70 percent of beel fishery catch, caused due to Ulcerative Disease Syndrome in 1988 & 1989.

FCD Impacts.

FCD interventions for enhancement of food grain production have adversely affected life cycles of most of the species of Chenchuri beel fish. Floodplain fish stocks originate each year from fish which have over-wintered in the beels or from the rivers, either as fry in the case of fish which spawn prior to monsoon flood, or as adult fish seeking suitable spawning areas in the newly flooded lands. It follows that beel draining and riverside embankment greatly reduced the annual recruitment of fish which constitute the Chenchuri beel fish catch. The overall annual loss to Chenchuri beel capture fisheries by 1989/90 was 917 tonnes (Valued Tk. 27.5 million) per year compared with 1983/84 production level.

This thrust on foodgrain production has adversely affected natural fish production in the open waters within and outside the empoldered areas. Juveniles of fish and prawn can no longer enter the inundated lands within the embanked area from rivers outside for grazing and early growth. Nor do new born young of fish breeding in khals or beels within the empoldered area got opportunities to grow for the required length of time in the monsoon inundated land as because drying up of such inundated area are hastened by induced drainage.

Studies undertaken under Third Fisheries Project for inclusion of this beel for floodplain stocking program show that beel fish production has declined by about 95 percent between 1983/84 and 1988/89 from 418 tonnes in 1988/84 to 20 tonnes in 1988/89. This seems to be an under estimate of the actual catch. FAP 12 findings suggested losses of beel fish catch upto 75 percent.

Action is now necessary to prevent any further loss of perennial beel areas as a result of drainage works and for their improvement by means of re-excavation if necessary, bunding, stock enhancement and rational management.

Socio-Economic Aspects

The Fishing Communities

The fishing community which is widely dispersed throughout the project area, mostly belongs to lowercast Hindu community. 6,000 fishermen live in Narail thana. Of these, about 3,000 live in villages in the periphery of the beel area. Members of rural house holds in villages around the beel area carry out part-time fishing in water within and around Chenchuri beel.

Full-time fishermen undertake exploitation of fish resources in rivers, beels, khals etc. on commercial consideration. They also harvest fish from private ponds on share basis or on hire basis. Full-time fishermen gain access to fishing in rivers, beels khals etc. by making payment of rents or fees of the owners or lease holders. Part-time or non-fisherman undertake fishing in beel, khal, flood land etc. for home consumption as well as for supplementation of income.

Jalmohals, although few in number, are leased by fishermen groups. The economic condition of the fishing community within the project area is becoming very deplorable as the fish catch declined due to implementation of the FCD project in the area. Besides, with the increase in population in the project area, fishing activities are not enough to maintain family with bare necessities. However, within the fishing community, only those who have some cultivable land are financially little better off.

Ownership of Fishing Rights and Fisheries

The water areas like rivers, khals and beels are owned by the Government in the Ministry of Land. Government owned segment of rivers or a beel is called jalmohal. In the district, management of such jalmohals is done by the Additional Deputy Commissioners (Revenue) of the districts. Jalmohals are leased out by auction. Lease holders control the access to fishing in the jalmohals under their respective lease. Fishermen obtain access to fishing rights by paying the lease holder the fees/rents determined and demanded by the lease holders or the duly authorised representatives on the fishing grounds. This pattern of access to fishing is traditional and both fishermen and lease holders coexist without conflict.

2.4 Climate and Hydrology

2.4.1 Rainfall

The nearest rainfall station to the project area is located at Narail (R-461). There are other rainfall stations in the vicinity of the project area located at Bhusna (R-404), Haridaspur (R-409), Abhoynagar (R-451), Jessore (R-456), Salikha (R-462), Khulna (R-510) and Mollahat (R-511). Rainfall records at all these stations were available for the period 1965 to 1989 with a few gaps in the record at some stations. Of these, the stations at Khulna and Jessore are climatic stations. The data at Jessore is thought to be more reliable. The location of the rainfall stations are shown in Figure 2.7.

Annual rainfall data at Narail was checked for trends using the Armsen test and no evidence of trend was found. A double mass plot was drawn between the cumulative annual rainfall at Narail and the cumulative annual rainfall at Jessore to check for consistency of data. Data at Khulna was not used for checking the record at Narail as there is evidence of trend in the long term records at Khulna as shown in Volume 5. The double mass plot is shown in Figure 2.8. It can also be seen from Figure 2.8 that the rainfall records at Narail do not show any discrepancies and have been adopted for analysis at the project area.

Basic statistics of the rainfall at Narail is shown in Table 2.10. The mean, median and 80% dependable monthly rainfall is shown in Table 2.11. The mean annual rainfall in the area is 1718 mm, median annual rainfall is 1721 mm and the 80% dependable annual rainfall is 1361 mm. Figure 2.9 shows the monthly rainfall pattern at Narail. The rainfall pattern shows a single flattened peak occurring in July and August and as would be expected in this region, approximately 71% of the annual rainfall occurs in the monsoon season from June to September. Box plots of the monthly data at Narail are shown in Figure 2.10.

Frequency analysis of daily rainfall data was carried out to compute the storm rainfall frequencies. Extreme value analysis was done by fitting General Extreme Value distributions to the data and the distribution which gave the best fit was chosen for the station. The results of the 1 day, 2 day, 5 day and 10 day rainfall totals for various return periods are shown in Table 2.12.

2.4.2 Climate

The nearest climatic stations to the project area are located at Jessore (E-17) and at Khulna (E-20). Climatic parameters including monthly maximum, minimum and mean temperature data, mean monthly relative humidity data, mean monthly wind speed data, mean monthly sunshine data and monthly evaporation data were available at the two climatic stations. The records were available for the period 1965 to 1990 and generally, the records at Jessore were longer than at Khulna. Climatic parameters at both stations are shown in Tables 2.13 to 2.15 and Figures 2.11 and 2.12.

The mean monthly temperature varies from a minimum in January of approximately 19°C to a peak of 30°C in May. Between April and October, the temperature remains fairly constant with changes of about 2°C only. Average wind speed at Jessore is 6.3 knots with a peak in April. The region experiences an average of 6.8 hours of sunshine including 7 months with more than 7.5 hours of sunshine.

Evaporation in Bangladesh is usually measured using a modified Class A Pan which has an extra 5 inches of freeboard above the water surface as compared to a normal Class A Pan. A pan coefficient of 0.7 is used by BWDB to convert pan evaporation to open water evaporation. The mean annual evaporation at Jessore is 1037 mm with a peak occurring in April. At Khulna the mean annual evaporation is 1049 mm.

TABLE 2.10
Basic Statistics of Rainfall at Narail (R-461)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Years of Data	30	29	29	29	28	29	29	29	28	28	29	29	25
Mean	7.7	20.3	43.4	82.4	180.9	308.1	339.3	336.8	241.6	130.2	27.6	9.1	1718.3
Std Dev	14.8	25.6	47.6	60.2	95	137.4	126.8	160.8	136.5	87.1	44.5	22.8	313.1
Skew	2.7	1.1	0.9	0.3	0.5	1.3	0.3	0.3	1.2	0.8	1.8	2.8	0.1
Kurtosis	7.4	0	-0.5	-1.1	-0.8	1.9	-0.6	-1.1	1	0.1	2.6	6.8	-1.2
Minimum	0	0	0	0	53.1	128.4	94	92.3	39.3	5.1	0	0	1180.2
Maximum	68.6	82.4	157.4	204.4	411.4	755.9	593.8	653.5	629.5	353	175.3	88.1	2217
Lower cutoff	-9.6	-41.5	-96.4	-127.5	-153.5	26.4	18.9	-168.1	-4.4	-62.9	-47.8	-4.8	678
Lower fourth	0	0	1.1	25.1	95.1	221.2	258.5	201.5	162.5	73.7	0	0	1447.3
Median	0	13.7	30.5	73.2	164	274.3	335.9	330.6	200.4	111.6	2.5	0	1721.4
Upper fourth	6.4	27.6	66.2	126.9	260.9	351.1	418.1	447.9	273.8	164.8	31.9	3.2	1960.1
Upper cutoff	16	69.1	163.7	279.5	509.5	545.9	657.7	817.5	440.6	301.3	79.8	8	2729.4
Outliers	20.3	79.2	-1	-1	-1	579	-1	-1	469.6	322.7	99.8	10.1	
Outliers	28	82.4	-1	-1	-1	755.9	-1	-1	558.9	353	108.5	11.4	
Outliers	37.8	-1	-1	-1	-1	-1	-1	-1	629.5	-1	123.2	14	
Outliers	68.6	-1	-1	-1	-1	-1	-1	-1	-1	-1	175.3	20.4	
Outliers	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	25.4	
Outliers	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	87.6	
Outliers	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	88.1	
Outliers	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
80% dependable	0	0	0	17.8	82.5	183.8	204.3	147.5	121	33.3	0	0	1361

TABLE 2.11

Monthly Rainfall at Narail (R-461) (mm)

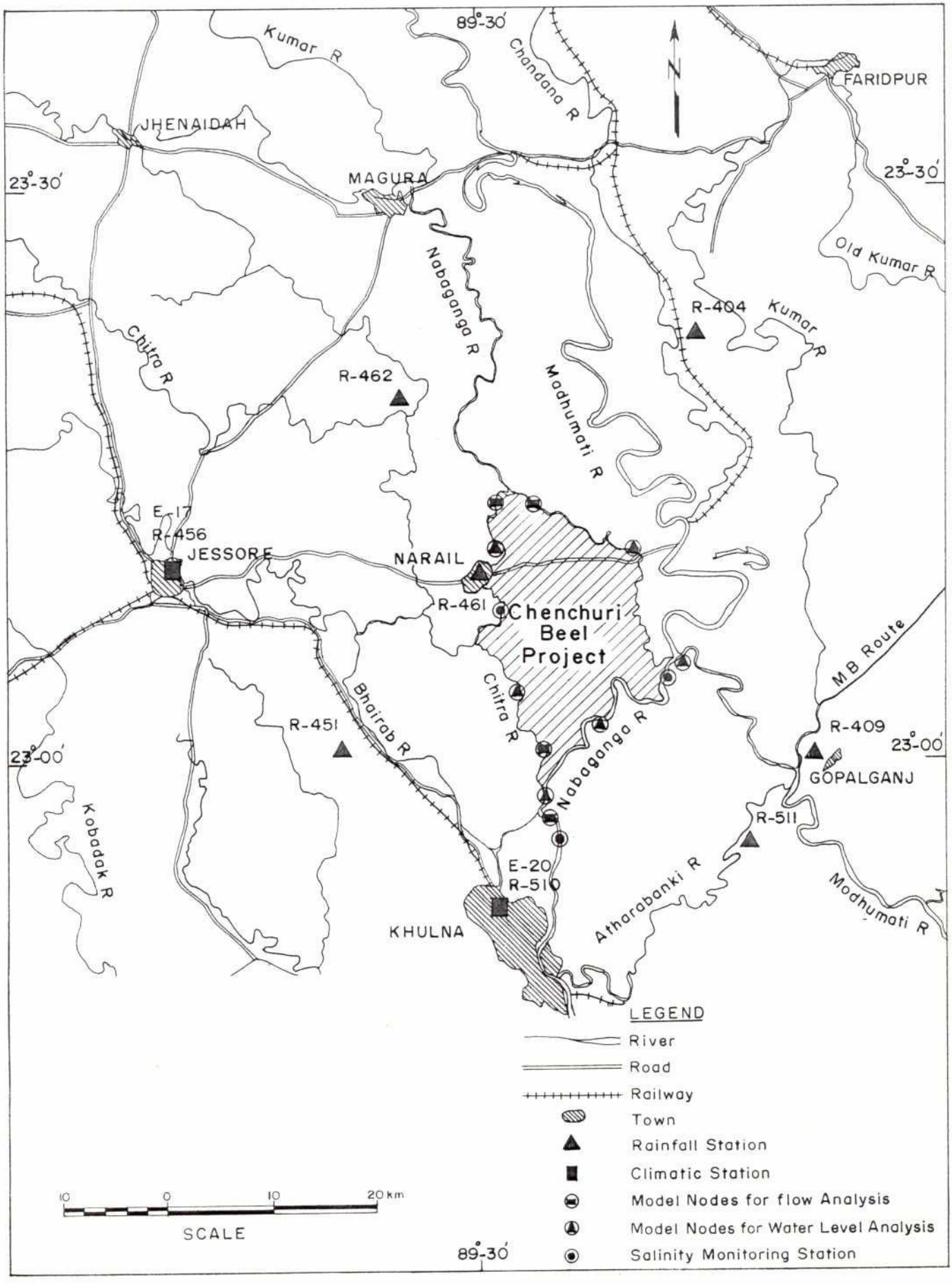
	Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann*	Ann#
Mean	Narail	7.7	20.3	43.4	82.4	180.9	308.1	339.3	336.8	241.6	130.2	27.6	9.1	1727.4	1718.3
Median	Narail	0.0	13.7	30.5	73.2	164.0	274.3	335.9	330.6	200.4	111.6	2.5	0.0	1536.7	1721.4
80% dependable	Narail	0.0	0.0	0.0	17.8	82.5	183.8	204.3	147.5	121.0	33.3	0.0	0.0	790.2	1361.0

[vp\chen-tab\tab2-10]

* Sum of monthly rainfall

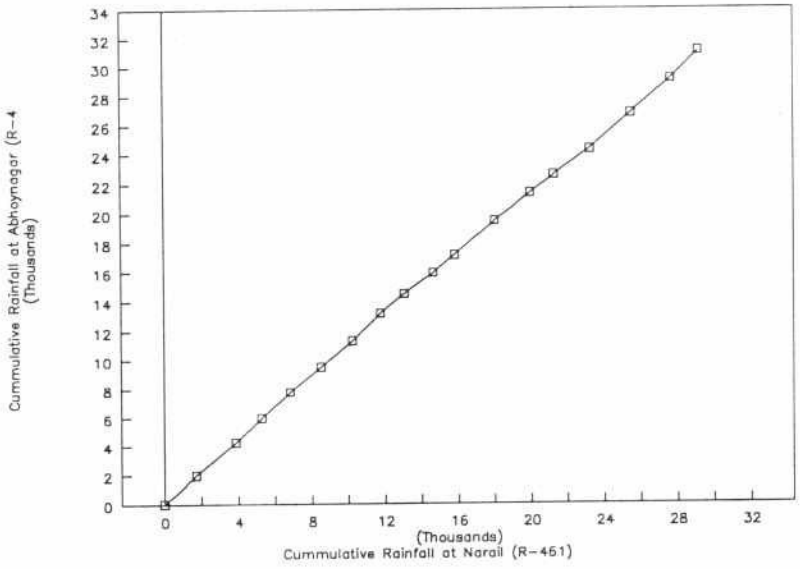
\# annual rainfall estimated from all annual rainfall values for complete years.

Figure 2.7

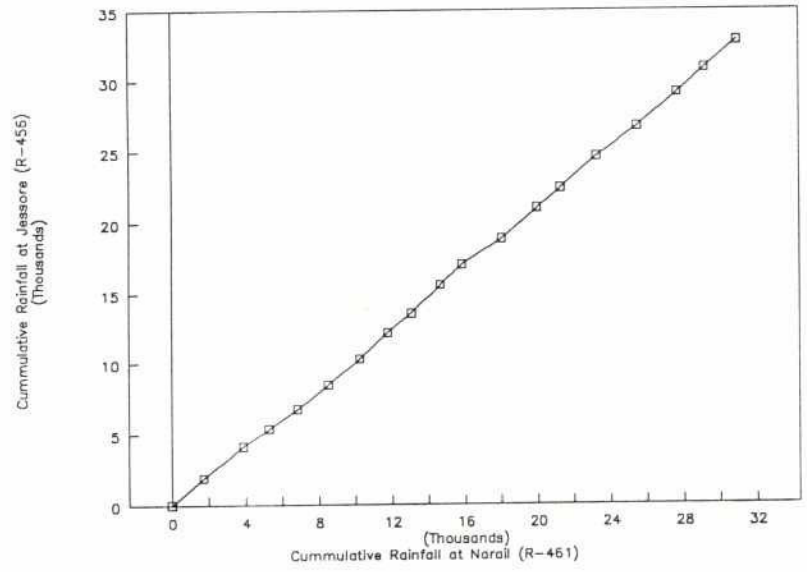


Location of Hydroclimatic Stations

Figure 2.8



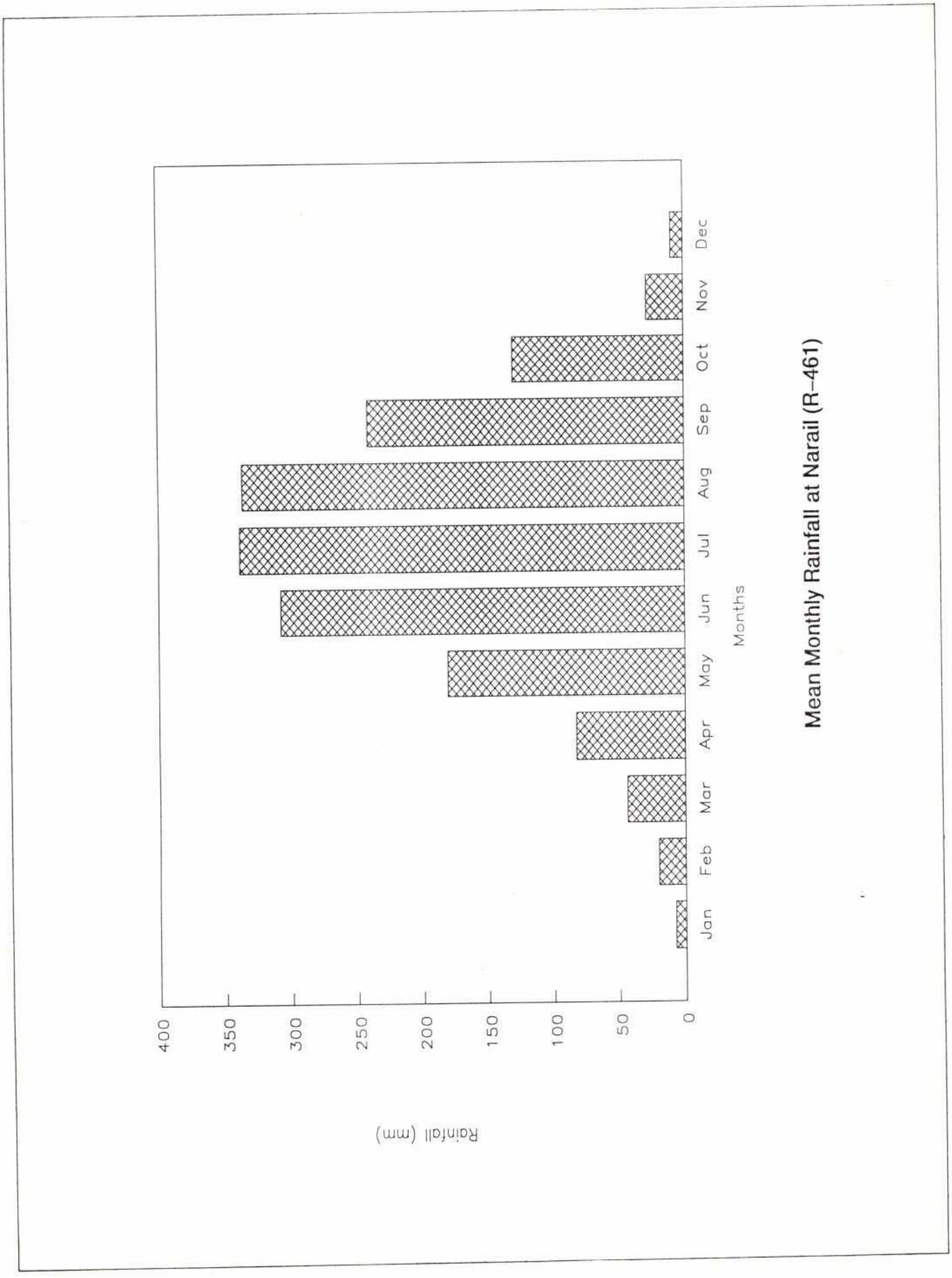
Double Mass Plot of Narail (R-461) versus Abhaynagar (R-451)



Double Mass Plot of Narail (R-461) versus Jessore (R-456)

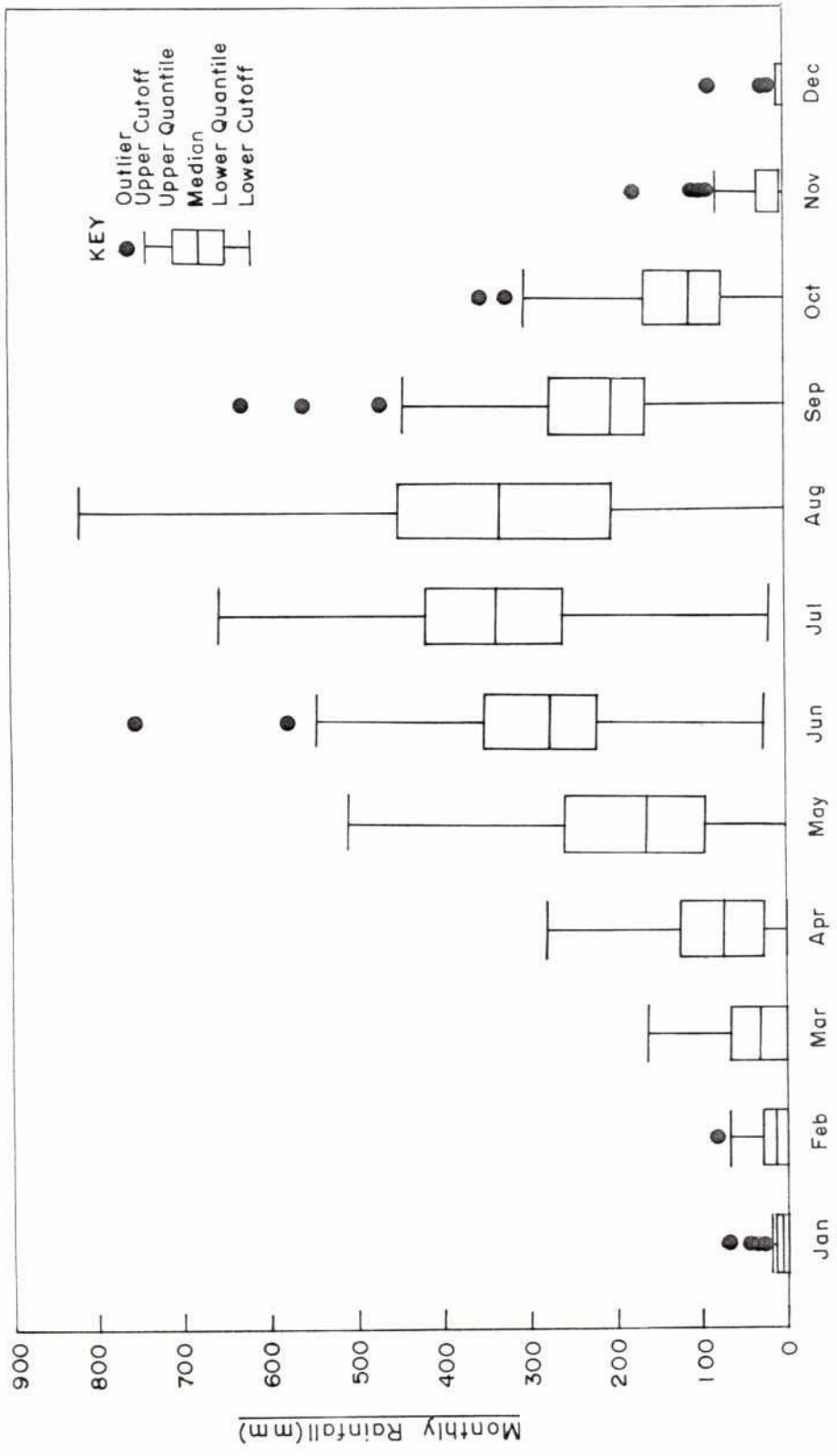
Double Mass Plot of Narail Versus Abhaynagar / Jessore

Figure 2.9



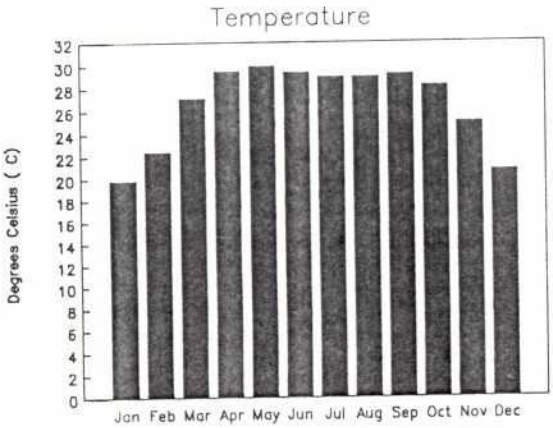
Mean Monthly Rainfall at Narail

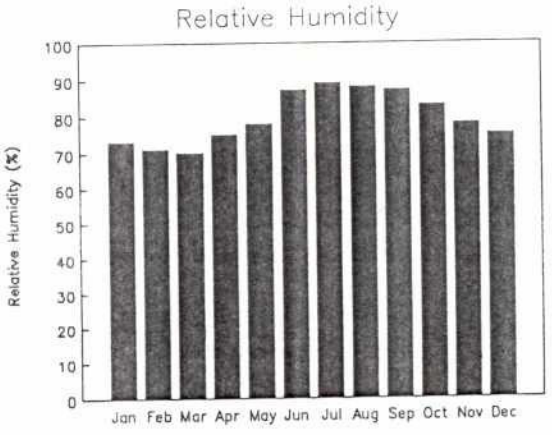
Figure 2.10

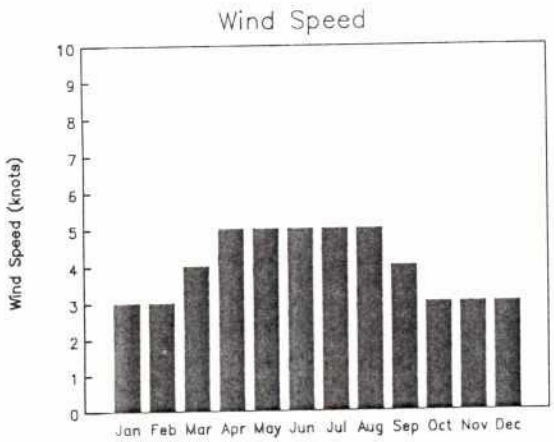


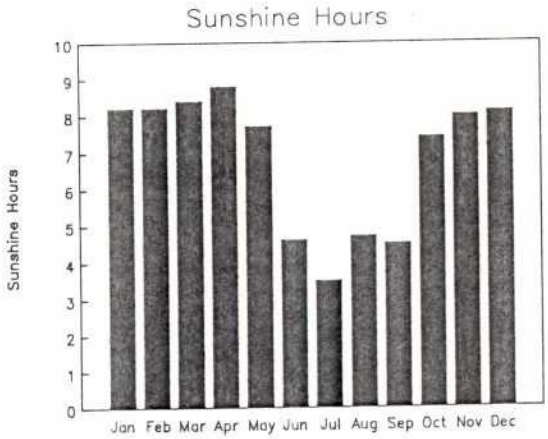
Box Plots of Monthly Rainfall at Narail (R-461)

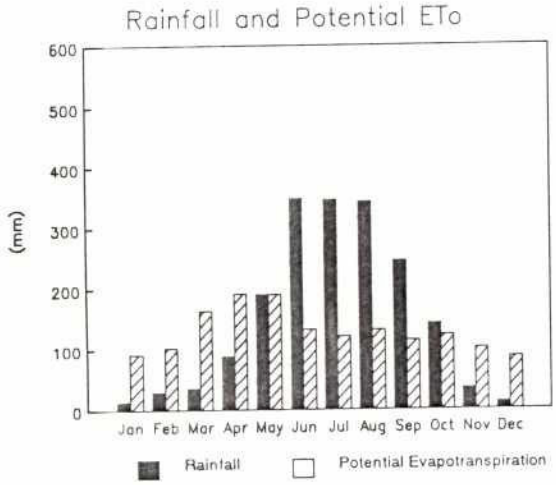
Figure 2.11





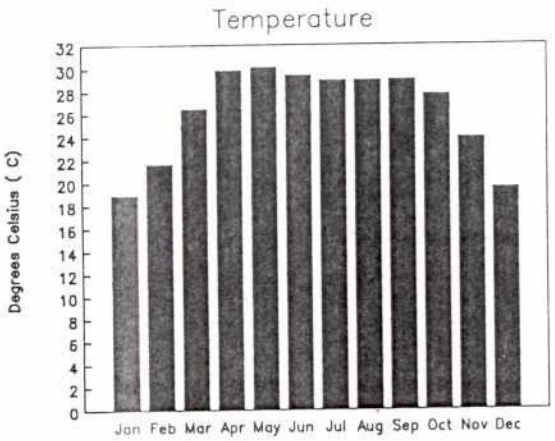


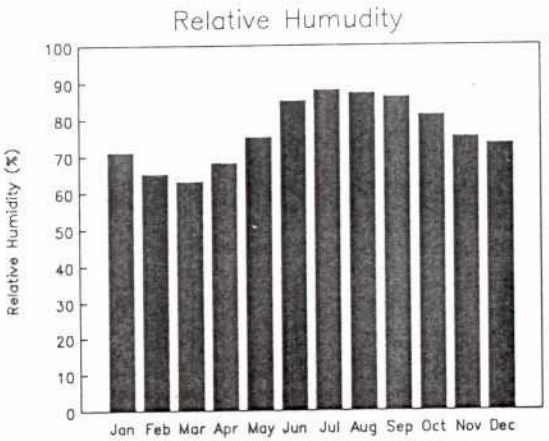


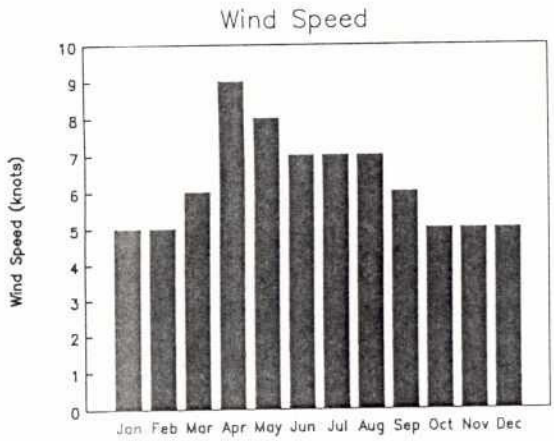


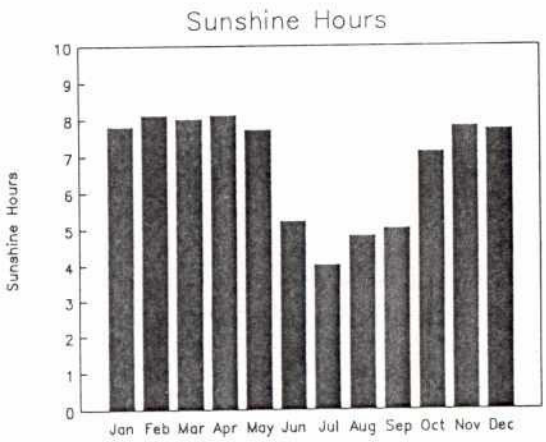
Climatic Data at Khulna

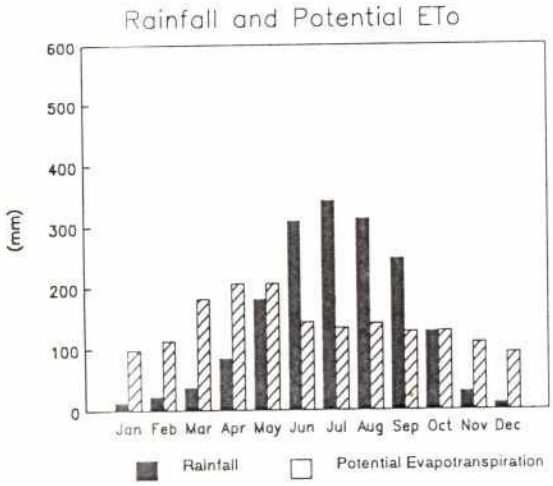
Figure 2.12











Climatic Data at Jessore

TABLE 2.12
Design Storm Frequencies at Narail (R-461) (mm)

Station No.	Station Name	Return Period (years)							Fitted Distribution
		2	5	10	20	50	100	200	
1-day maximum rainfall	Narail	129	182	221	261	319	365	415	GEV 2
2-day maximum rainfall	Narail	170	246	300	355	431	492	556	GEV 2
5-day maximum rainfall	Narail	242	343	412	479	568	637	706	GEV 2
10-day maximum rainfall	Narail	297	404	471	533	610	665	718	GEV 3

Evapotranspiration was calculated from mean monthly values of climatic data. The Doorenbos and Pruitt modification of the Penman method as outlined in the FAO Irrigation and Drainage Paper No.24 is widely applied in Bangladesh and was used for estimating the potential evapotranspiration. Estimates of solar radiation and mean duration of maximum possible sunshine hours were made from standard tables based on latitudes. A reflection coefficient of 0.25 was used. Wind speed data is reported by BMD as an average for the day in knots for the predominant wind direction at 10 m height. Estimates of potential evapotranspiration are sensitive to wind data and efforts should be made to corroborate the results with actual field measurements in the future. Monthly evapotranspiration computed at Jessore and Khulna are shown in Table 2.16. The annual modified Penman potential evapotranspiration at Jessore is 1675 mm and at Khulna is 1547 mm. Previous estimates made by BARC are also shown in Table 2.16. It can be seen that the recent calculations of potential evapotranspiration are higher than estimates made previously by BARC. This discrepancy may be due in part to the availability of longer climatic records which result in better estimates.

It may be noted here that the calculated annual potential evapotranspiration values are higher than the reported annual pan evaporation values by as much as 65%. This discrepancy cannot be explained and needs to be looked at carefully if pan evaporation data is to be used. A higher reliability is attached to the computed potential evapotranspiration as it is a function of a number of climatic parameters and does not rely on the measurement of a single parameter.

2.4.3 Drainage Parameters

The results of the simulation runs of the NAM model for the 25 year series from 1964 to 1989 were analysed and the long term monthly means are presented in Table 2.17. The project area is covered by NAM catchments SW10 and SW5. The mean annual runoff from the catchment is of the order of 700 mm which is approximately 40% of the annual rainfall in the region. The 1 in 5 year and 1 in 10 year, 1 day and 10 day maximum runoff was also analysed and the results are shown in Table 2.18. It can be seen that there is little difference between a 10 day maximum runoff rate and a 1 day maximum runoff rate for various return periods. The 10 day maximum runoff rate for a 1 in 5 year event is 10 mm/day as compared to 12 mm/day for a 1 in 10 year event. The runoff rate for a 1 day maximum runoff for a 1 in 5 year event on the other hand is 10.5 mm/day as compared to 12.5 mm/day for a 1 in 10 year event.

TABLE 2.13
Mean Monthly Temperature (°C) (1965-1990)

	Khulna			Jessore		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Jan	26.4	19.8	13.1	25.8	18.9	11.6
Feb	28.9	22.4	15.8	28.9	21.6	14.2
Mar	33.3	27.1	20.8	33.3	26.4	19.5
Apr	34.7	29.5	24.2	35.8	29.8	23.7
May	34.1	29.9	25.5	35.1	30.1	25.0
Jun	32.5	29.4	26.3	32.9	29.4	25.8
Jul	31.7	29.0	26.2	31.9	28.9	25.9
Aug	31.5	29.0	26.2	31.9	28.9	25.9
Sep	32.0	29.2	26.1	32.3	29.0	25.6
Oct	32.0	28.2	24.4	31.9	27.7	23.3
Nov	30.1	25.0	19.8	29.7	23.9	18.0
Dec	26.8	20.7	14.5	26.4	19.5	12.4
Annual	31.2	26.6	21.9	31.3	26.2	20.9

Source: BMD

TABLE 2.14

Mean Monthly Relative Humidity (%), Wind Speed (Knots) and Bright Sunshine Hours (1965-1990)

	Relative Humidity		Wind Speed		Bright Sunshine Hours	
	Khulna	Jessore	Khulna	Jessore	Khulna	Jessore
Jan	73	71	3	5	8.2	7.8
Feb	71	65	3	5	8.2	8.1
Mar	70	63	4	6	8.4	8.0
Apr	75	68	5	9	8.8	8.1
May	78	75	5	8	7.7	7.7
Jun	87	85	5	7	4.6	5.2
Jul	89	88	5	7	3.5	4.0
Aug	88	87	5	7	4.7	4.8
Sep	87	86	4	6	4.5	5.0
Oct	83	81	3	5	7.4	7.1
Nov	78	75	3	5	8.0	7.8
Dec	75	73	3	5	8.1	7.7
Annual	80	76	4.0	6.3	6.8	6.8

[vp\chen-tab\tab2-13]

Source: BMD
Note: Wind speed is reported as the mean 24 hourly value in the predominant direction at 10 m height

TABLE 2.15

Mean Monthly Evaporation (mm) (1965-1990)

Month	Khulna	Jessore
Jan	62	61
Feb	73	70
Mar	111	113
Apr	131	132
May	129	120
Jun	96	93
Jul	77	78
Aug	82	79
Sep	74	73
Oct	77	80
Nov	72	71
Dec	64	66
Annual	1049	1037

TABLE 2.16

Modified Penman Potential Evapotranspiration (mm)

Month	1		2	
	Khulna	Jessore	Khulna	Jessore
Jan	91	98	88	92
Feb	102	113	107	109
Mar	163	181	150	168
Apr	191	206	162	214
May	190	206	171	216
Jun	132	143	115	140
Jul	121	133	118	139
Aug	131	140	113	137
Sep	115	127	112	123
Oct	122	128	120	126
Nov	101	109	103	100
Dec	87	92	88	85
Annual	1547	1675	1448	1648

1. Source : Computed from recent climatic data
2. Source : BARC Soils and Irrigation Publication No. 11, 1982

TABLE 2.17
Long Term Rainfall-Runoff Simulation in NAM Catchments (1964-1989)

Catchment	Parameter		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann	% of RF
	Rainfall (mm)	Mean	8.13	18.08	46.26	102.67	201.97	304.69	339.70	307.38	254.20	123.92	29.78	9.24	1746	
		Median	3.80	11.80	32.70	85.30	204.10	261.30	308.60	289.80	218.80	104.30	16.90	0.10	1538	
		80%	0.00	1.90	2.80	42.70	127.50	206.10	238.30	189.10	177.20	61.10	0.00	0.00	1047	
SUW10	Runoff (mm)	Mean	0.89	0.00	0.37	1.91	11.25	45.91	99.37	153.69	183.11	158.81	56.19	12.27	724	41.5
		Median	0.00	0.00	0.00	0.49	5.53	28.40	72.11	136.14	164.01	154.83	45.22	6.87	614	39.9
		80%	0.00	0.00	0.00	0.00	1.34	16.90	52.08	100.15	123.02	110.02	30.80	4.92	439	42.0
	Recharge (mm)	Mean	0.08	0.18	1.06	6.99	26.19	49.53	59.77	61.45	58.13	51.09	17.68	3.07	335	19.2
		Median	0.00	0.00	0.00	2.80	26.80	54.10	61.50	62.00	60.00	62.00	10.50	0.00	340	22.1
		80%	0.00	0.00	0.00	0.00	13.20	39.90	60.50	62.00	60.00	45.60	2.40	0.00	284	27.1
	Rainfall (mm)	Mean	10.12	21.02	41.09	87.42	190.35	317.38	359.14	334.13	257.88	129.31	28.62	10.83	1787	
		Median	4.60	13.80	29.10	73.60	171.30	275.10	338.80	308.30	206.50	123.00	18.60	0.00	1563	
		80%	0.00	0.80	2.40	35.90	118.60	203.00	266.60	214.30	157.20	74.60	0.70	0.00	1074	
SUW14	Runoff (mm)	Mean	0.05	0.04	0.26	0.74	6.68	41.04	126.89	174.15	166.34	124.24	34.92	2.84	678	37.9
		Median	0.00	0.00	0.00	0.11	3.30	20.90	120.88	160.07	134.01	114.59	17.90	0.00	572	36.6
		80%	0.00	0.00	0.00	0.00	0.48	6.31	53.81	127.93	110.31	53.04	1.90	0.00	354	32.9
	Recharge (mm)	Mean	2.12	2.34	4.53	13.18	49.92	91.05	116.79	120.17	107.86	80.52	19.63	5.70	614	34.3
		Median	0.50	0.30	0.60	12.80	43.40	93.70	123.90	124.00	112.20	92.10	10.30	0.10	614	39.3
		80%	0.00	0.00	0.00	0.70	28.60	69.30	115.40	117.10	97.60	43.30	0.40	0.00	472	44.0

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TABLE 2.18

Simulated Maximum Runoff Rates

NAM Catchment	Area (Sqkm)	10 day maximum runoff (mm/day)		10 day maximum runoff (mm/day)	
		1 in 5 year	1 in 10 year	1 in 5 year	1 in 10 year
SW 10	638	10.1	12.1	10.5	12.6
SW 14	1471	10	11.9	10.4	12.5

2.4.4 Flow in the Nabaganga and Chitra Rivers

From the 25 year 1-D hydrodynamic simulation run for the current scenario, the flows at various nodes in the study area were analysed and the results are shown in Table 2.19 and Figure 2.13. The location of the model nodes are shown in Figure 2.7. The long term average flows in the rivers and their direction of flow are shown in Figure 2.14. The Nabaganga splits into two channels at Kalachandpur, with the dominant channel carrying the major flows called the Chitra and the minor channel being called the Nabaganga. The long term average flow in the Chitra is of the order of 50 m^3/s and the flow in the Nabaganga between Bardia and Kalachandpur is approximately 9 m^3/s flowing from Bardia towards Kalachandpur. At Bardia, the Nabaganga is linked to the Madhumati via the Halifax cut where it receives a significant part of the Madhumati flows and drains in a south-westerly direction till it meets the Chitra near Gazirhat. The average flow in the Nabaganga at Gazirhat is approximately 1388 m^3/s.

The 80% dependable annual flow in the Chitra is 32 m^3/s, in the Nabaganga between Bardia and Kalachandpur it is 6 m^3/s and in the Nabaganga at Gazirhat it is 1066 m^3/s.

TABLE 2.19
Long Term Monthly Average Flow (cumecs)

No.	River	Chainage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
23	Nabaganga_L	27.5	187	132	92	103	179	593	2522	4625	4573	2452	835	362	1388
43	Chitra	125.8	2	1	1	2	10	38	85	141	179	133	37	8	53
44	Chitra	155.8	2	1	1	2	10	43	84	112	158	149	43	9	51
47	Nabaganga_U	157.0	0	0	0	0	0	-1	-15	-39	-37	-12	-2	-1	-9

80% Dependable Monthly Flow (cumecs)

No.	River	Chainage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
23	Nabaganga_L	27.5	72	39	21	21	88	363	1925	3752	3868	1941	506	201	1066
43	Chitra	125.8	1	0	0	1	3	11	32	93	136	87	19	4	32
44	Chitra	155.8	1	0	0	0	2	12	27	44	100	106	20	4	26
47	Nabaganga_U	157.0	0	0	0	0	0	0	-11	-28	-28	-5	-1	0	-6

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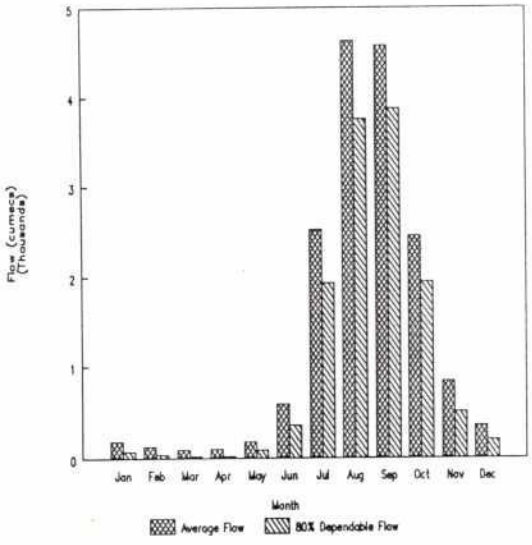
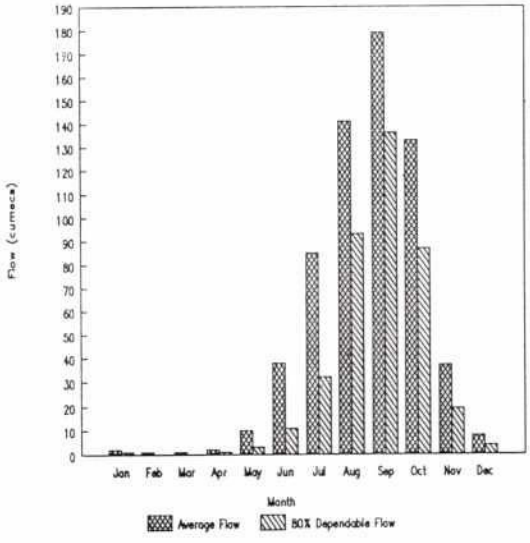
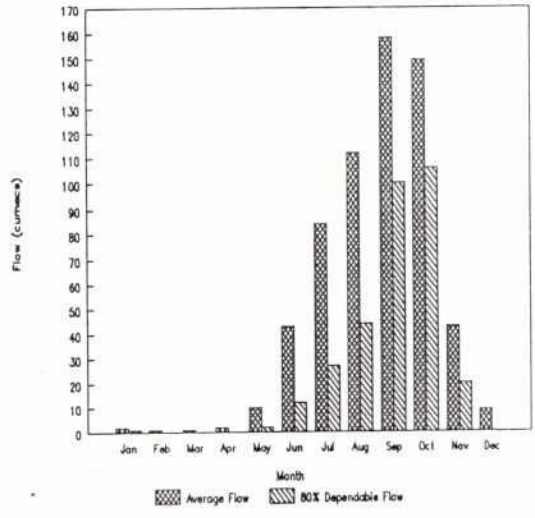
Figure 2.13



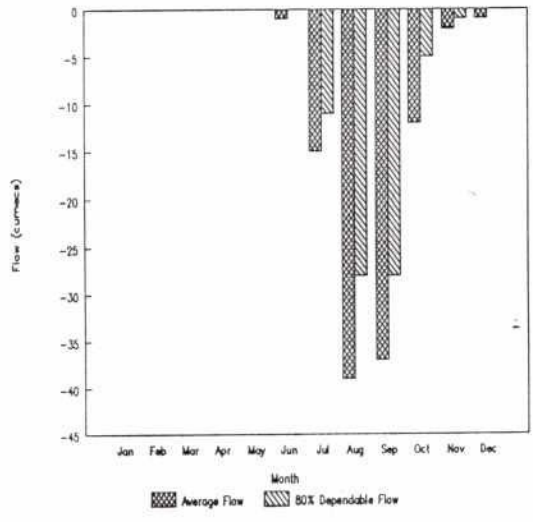
Node No. 23 Nabaganga_L (Ch. 27.5 km)



Node No. 43 Chitra (Ch. 125.8 km)



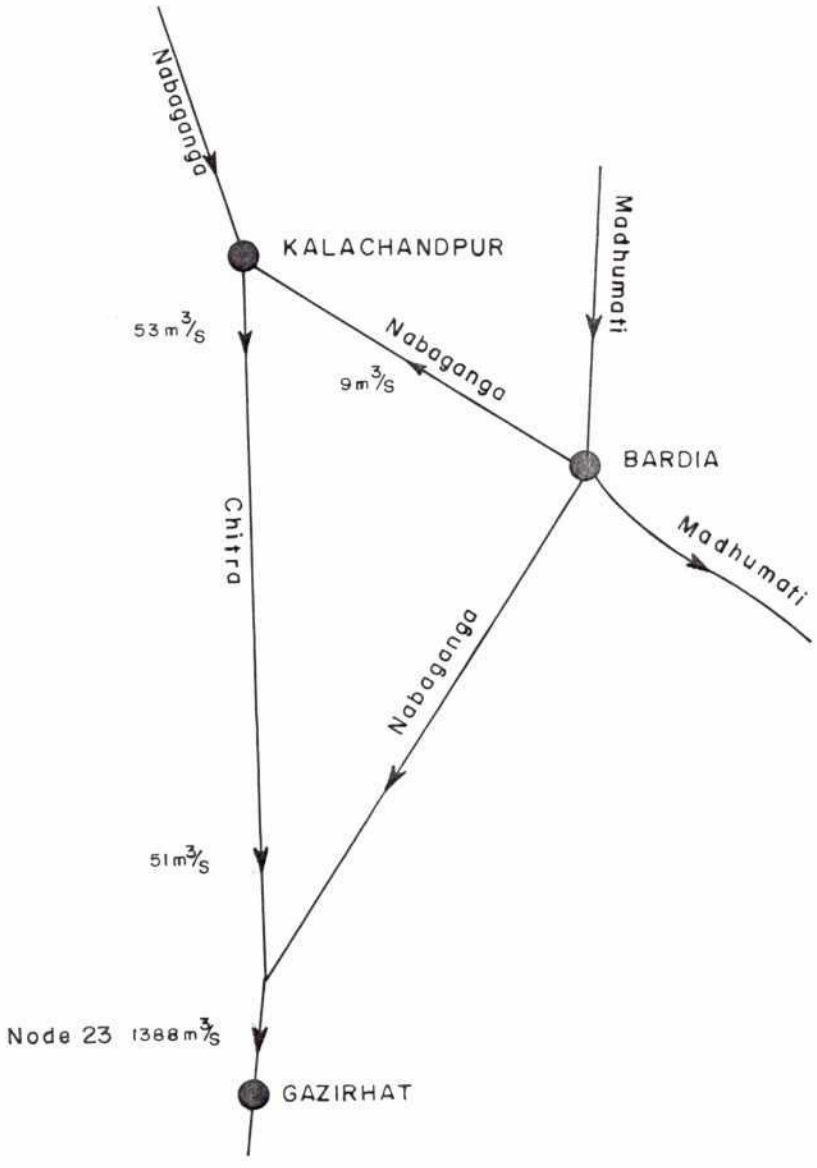
Node No. 44 Chitra (Ch. 155.8 km)



Node No. 47 Nabaganga_U (Ch. 157 km)

Note: (–)ve flows indicate that the direction of flow in the channel is opposite to that in the main drainage channels in the region.

Figure 2.14



Note: Flows shown are long term average annual flows computed at Hydrodynamic model nodes.

Schematic Map of Major Rivers in the Project Area

2.4.5 Peak Water Levels

Peak water levels at 6 nodes bordering the study area were available from the 25 year 1-D hydrodynamic model simulation run for the current scenario. The locations of these nodes is shown in Figure 2.7. Frequency analysis of peak water levels was done by fitting a 3 Parameter Log-Normal distribution to the simulated data as recommended by FAP-25. The results are shown in Table 2.20. The 1 in 100 year peak water level on the Chitra is 4.32 m. On the Nabaganga at the northern end of the study area, the 1 in 100 year flood level is 4.77 m whereas on the south-eastern border it is 4.47 m. The highest flood level for a 1 in 100 year event in the region is at Bardia where it is 5.00 m.

TABLE 2.20

Simulated Annual Peak Water Levels for Different Return Periods (MPWD)

Model Node No.	River	Chainage (km)	Return Period (Year)						
			2	5	10	20	25	50	100
16	Nabaganga_L	29.000	3.63	8.80	3.91	4.01	4.05	4.15	4.25
17	Nabaganga_M	17.250	3.75	3.95	4.08	4.20	4.24	4.35	4.47
24	Madhumati	181.500	4.16	4.42	4.57	4.71	4.75	4.88	5.00
38	Chitra	131.500	3.70	3.89	4.00	4.10	4.13	4.23	4.32
39	Chitra	151.505	3.64	3.83	3.94	4.05	4.08	4.18	4.28
42	Nabaganga_U	164.000	3.97	4.22	4.37	4.50	4.54	4.65	4.77

2.4.6 Salinity

Salinity is being monitored at 3 stations in the rivers bordering the study area. These are at Gobrahat, Bardia and Gazirhat and their locations are shown in Figure 2.7. Long term surface salinity data was available from the Ganges Study from 1976 to 1990. Data is sampled at high and low water slacks on a fortnightly basis. Monthly maximum salinity data has been compiled and is shown in Table 2.21. The mean monthly maximum salinity reaches a peak of 2316 micro-mhos in May at Bardia, and it reaches a peak in April of 637 micro-mhos at Gobrahat. It may be noted that salinity values recorded during 1988-89 and 1990-91 at all three stations were significantly higher than the data recorded in earlier years. There is evidence of an increasing trend in the monthly maximum salinity in the region.

TABLE 2.21

Mean Monthly Maximum Salinity (Micro-Mhos at 25 Degree Celsius)

Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul to Oct	Nov	Dec
Bardia	423	480	763	1640	2316	494		335	380
Gazirhat	495	577	1809	3993	3239	674		320	371
Gobraghat	598	616	617	637	634	374		419	532

2.5 Proposed Engineering Interventions

2.5.1 Introduction

As described in Section 2.2, the beneficiaries of the existing FCD development have identified the need for introducing controlled flooding, controlled drainage and irrigation. In addition, the artisan fishermen of the area require an increase in the fisheries potential. The farmers and fishermen have also highlighted the need for improved O&M. Consequently the proposed engineering interventions will not only have to satisfy the physical requirements relating to flooding, drainage and irrigation, but also be compatible with the need to introduce an appropriate O&M procedure that could attract beneficiary participation in the O&M activities.

2.5.2 Controlled Flooding

The project area is already protected by a series of flood control embankment and road embankment along the Chitra and the Nabaganga rivers which together surround the area. There are eight drainage outfall regulators of which six also have provision for inflow of water into the protected area from the river during the monsoon period. It is proposed that controlled flooding of the project area should be effected through regulators.

However the existing regulators are located in the lower reaches of the Chitra and the lower Nabaganga and consequently, considering the topographic and river stage levels, their effectiveness in pushing flows towards higher grounds within the project area would be minimal. Additional gates would be required further upstream on the lower Nabaganga.

The new gates should be appropriately located to also allow any possible introduction of fish fry or fingerlings to beel areas with the flood inflow. This would depend on obtaining an up-to-date contour map of the area during any future feasibility study.

Furthermore, the future study should also investigate the necessary measures for protecting the FC embankment at Noagram which breached on four occasions.

2.5.3 Proposed Drainage Improvement

A plot of the river stage contours for the months of July, August and September of the Chitra and the Nabaganga rivers (for the reaches surrounding the project area) based on the simulation of measured daily flows for a particular year that corresponds to an approximately 1 in 5 year return period shows that the project area, particularly areas south of the Narail to Lohagara road, would be subjected to drainage congestion in view of the relatively low land levels. The simulation results further showed that the drainage congestion would last, on an average, about five weeks. This broadly agrees with the information collected during the field assessment. The results also indicated that drainage disposal into the lower reaches of the Chitra would be a relatively favoured route.

The existing skeletal drainage network is probably meant to convey the local rainfall runoff directly to the outfall regulators without any formalised retention in the higher grounds to reduce any excessive inundation behind the outfalls. This excessive inundation could be controlled by adopting compartmentalisation of the project area.

2.5.4 Compartmentalisation for Controlled Drainage

The concept of compartmentalisation for controlled flooding and drainage is based on temporary retention of flood/local runoff within each subcompartment, or any other smaller

operational unit, to avoid accumulation of the flood/runoff from the entire area at the main outfall location. Compartmentalisation will also facilitate integrated water management for irrigation, drainage and fisheries.

2.5.5 Options for Irrigation Development

Three options have been considered for the provision of irrigation facilities : a surface water full gravity system, a surface water low lift pumping system (LLP) and a groundwater tubewell system. The dry season river stage levels of the Chitra and the Nabaganga are low compared to the irrigation area ground levels and therefore a full gravity system is not feasible. An assessment of the hydrogeological potential of the area (Volume 5 : Hydrogeology) indicates that though presently only about 33% of the overall groundwater potential has been utilised, any further groundwater development might impinge on the rural water supply systems which depend on hand operated tubewells.

A low lift pumping system based on a low level network of canals and associated low lift pumps (to lift water from the canals and on to the farms) could be the appropriate choice for this project considering the dry season low river stage levels.

It is assumed that the provision, operation and maintenance of the low lift pumps will be the sole responsibility of the farmers (or any private enterprises that would wish to provide this service and charge the farmers accordingly). Consequently, the government's development burden would be comparatively lower. This would also encourage the participation of beneficiaries in the development.

2.5.6 Proposed Development

Compartmentalisation

The proposed development considers the provision of drainage facilities to a total gross area of about 25,560 ha (NCA = 18930 ha) which included the area under the recently commissioned Chenchuri Irrigation Project (NCA = 1030 ha).

It is proposed to divide the project area into 14 sub-compartments and a preliminary layout is shown in Figure 2.15. As per FAP 20 guidelines, the following three criteria have been taken into account in delineating the sub-compartments :

(a) Hydrology/Drainage Criteria

The hydrological or drainage boundaries have been considered as the primary criteria for establishing sub-compartment boundaries;

(b) Existing Road Network

Since most of the existing roads in the project area are on embankment, using them as compartment dykes would appreciably reduce the costs relating to land acquisition and dyke construction;

(c) Local Government Administrative Boundary

In order to ensure that each sub-compartment could operate under a single set of guidelines and resources, it is essential that none of the sub-compartments falls within the jurisdiction of more than one local government administration.

Areas under the different sub-compartments are given in Table 2.22.

TABLE 2.22

Sub-compartment Areas

Sub-compartment No.	Gross Area (ha)	Homestead Area (ha)	Gross Cultivable Area (ha)	Net Cultivable Area (ha)
1	2200	560	1640	1520
2	1480	610	870	800
3	2930	760	2180	2010
4	2620	860	1770	1630
5	1840	130	1710	1600
6	2570	690	1880	1740
7	860	90	770	710
8	1240	200	1040	970
9	2010	300	1700	1590
10	2500	300	2200	2040
11	1860	200	1670	1540
12	740	100	640	600
13	1260	100	1160	1080
14	1450	250	1200	1110
Total	25560	5140	20420	18930

Drainage Improvement

The contribution of compartmentalisation and controlled drainage in transforming the deeply flooded areas (F2, F3 and F4) into lands of moderate flooding (that would suit enhanced agricultural production) has been assessed. The assessment has been carried out based on collected field information (existing watercourse routes, culverts, roads, embankments, village boundaries, etc) and computer simulation of the flood routing process.

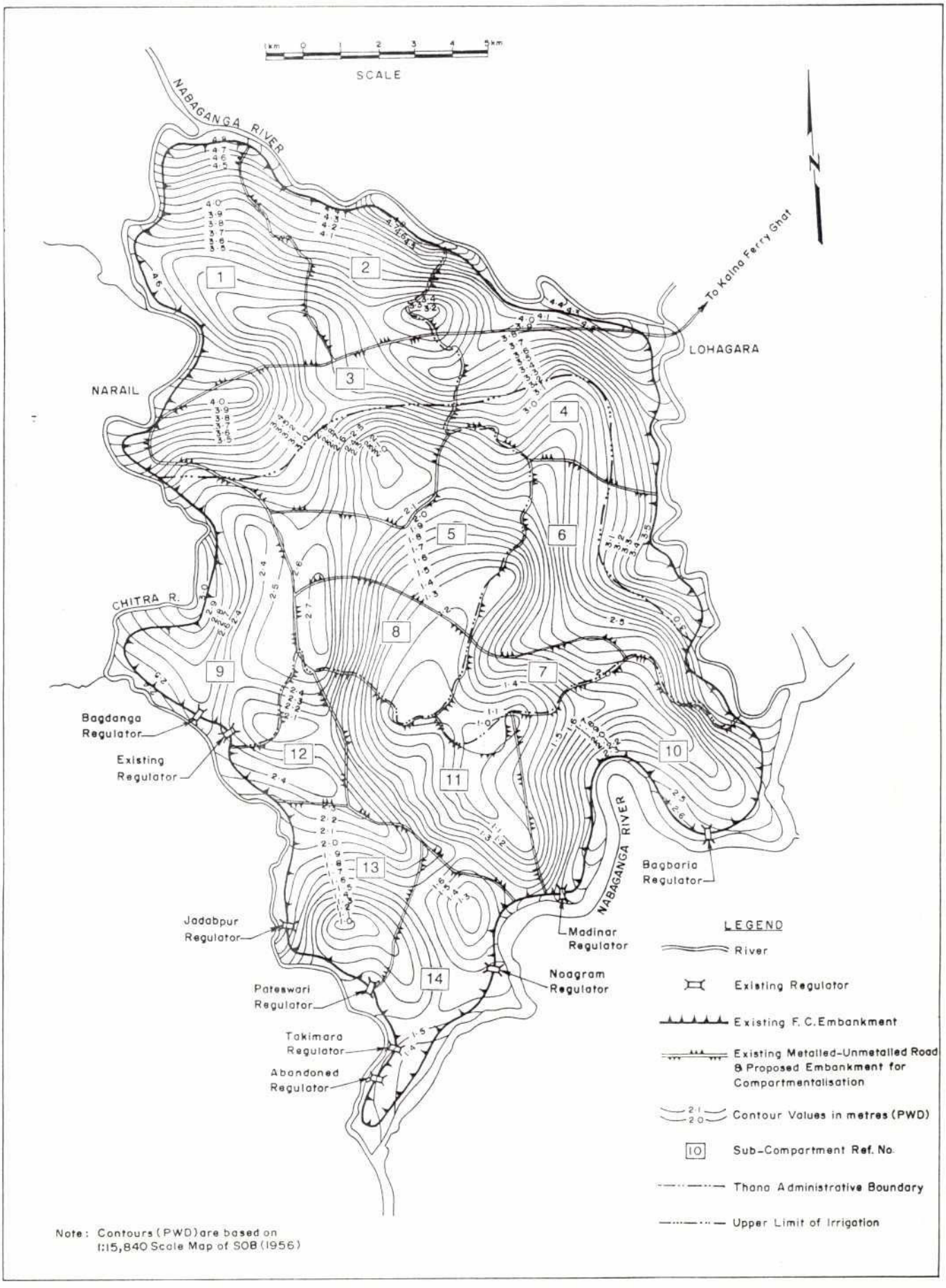
The Flood routing was carried out using complete time series of runoff and river stage levels for a particular year in which the annual total rainfall relates to a 1 in 5 year return period event. The simulation results in a time series of areas under different inundation depths. Since the simulation has been carried out at 10-day intervals, the areas under the different depths of flooding can be assumed to have a duration of about 5 days. The worst inundation situations with project and without project area are given in Table 2.23.

Irrigation Development

An irrigation system based on a low level network of canals has its own limitation relating to topography. In order to avoid deep excavation of canals in areas of high ground, the proposed canal network is limited to areas below the 3.0 m (PWD) contour. Consequently, the expected maximum depth (excavation) of canal bed is 3.0m, and the total irrigation area available within the 3.0 m (PWD) contour is about 13,600 ha (NCA).

The low level network of irrigation canals could be appropriately positioned to also convey drainage flows to suit particular requirements at any given time.

Figure 2.15



Proposed Compartmentalisation

TABLE 2.23
Flooding Corresponding to 1 in 5 Year Rainfall
(Gross Area in Km²)

Sub-Comp. No.	Area Gross (Km²)	Base Case (without project)					Scenario (with Project)				
		F0		F1		F2, F3 & F4	F0		F1		F2
		Flood Free	0-30 cm	30-60 cm	60-90 cm	> 90 cm	Flood Free	0-30 cm	30-60 cm	60-90 cm	90-180 cm
1	22.0						7.3	4.9	6.0	0.9	2.9
2	14.8						13.0	1.8	0.0	0.0	0.0
3	29.3						16.8	3.8	3.2	3.4	2.1
4	26.2						10.4	5.2	5.2	2.8	2.6
5	18.5						5.3	3.3	3.3	5.1	1.4
6	25.7						10.0	4.8	4.7	4.4	1.8
7	8.5						5.1	3.4	0.0	0.0	0.0
8	12.4						4.3	1.1	1.1	4.8	1.1
9	20.1						12.6	6.5	1.0	0.0	0.0
10	25.0						6.5	7.0	5.1	5.2	1.3
11	18.6						6.8	5.3	5.3	0.4	0.7
12	7.4						0.0	0.0	2.5	2.8	2.1
13	12.6						1.6	2.9	2.5	4.4	1.2
14	14.5						0.0	0.0	2.0	11.1	1.4
Sub-Total	255.6	74.3	18.5	28.6	32.2	102.0	99.5	49.9	42.0	45.5	18.6
Total		92.8		60.8		102.0	149.5		87.5		18.6
% of Total Area		36		24		40	59		34		7

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Note : Flooded areas are based on model simulation results
Base Case does not involve sub-compartments

2.5.7 Proposed Works

A preliminary layout of the proposed network of channels for the dual purpose of conveying irrigation water (mainly during the dry season and pre-monsoon periods) and drainage flow (rainfall runoff and return flows of irrigation) is shown in Figure 2.16. Detailed topographic surveys will have to be carried out during any future feasibility study to correctly set the bed profiles of these channels corresponding to the river stage levels of the Chitra and the Nabaganga (also taking note of the tidal backup) in order to allow gravity inflow.

A basic design of the canal/drain network for a sample area of about 2050 ha (NCA), which covers the entire sub-compartment No. 10 has been carried out (Figures 2.17 and 2.18). It considers the capacity required for drainage disposal of the runoff contributing area and for the irrigation supply for the lower Nabaganga River. Cost estimate of the irrigation/drainage system for the project area has been based on this sample area design.

Rehabilitation of existing regulators at Pateswari, Bagbaria, Madinar and Takimara, including replacement of missing flap gates, has been taken under the proposed works.

2.5.8 Cost Estimate

Cost estimate for rehabilitating and improving the existing project has been prepared based on Mid 1991 schedule of rates of BWDB (Khulna). 25% has been added to the base cost estimate to cover for any unforseen items of work and another 15% for engineering and administrative cost during construction. The estimated cost of civil works for the sample area of 2050 ha is 39.5 M Tk. In addition, LLPs are estimated to cost at the rate of 40,000 Tk. per 20 ha irrigation unit.

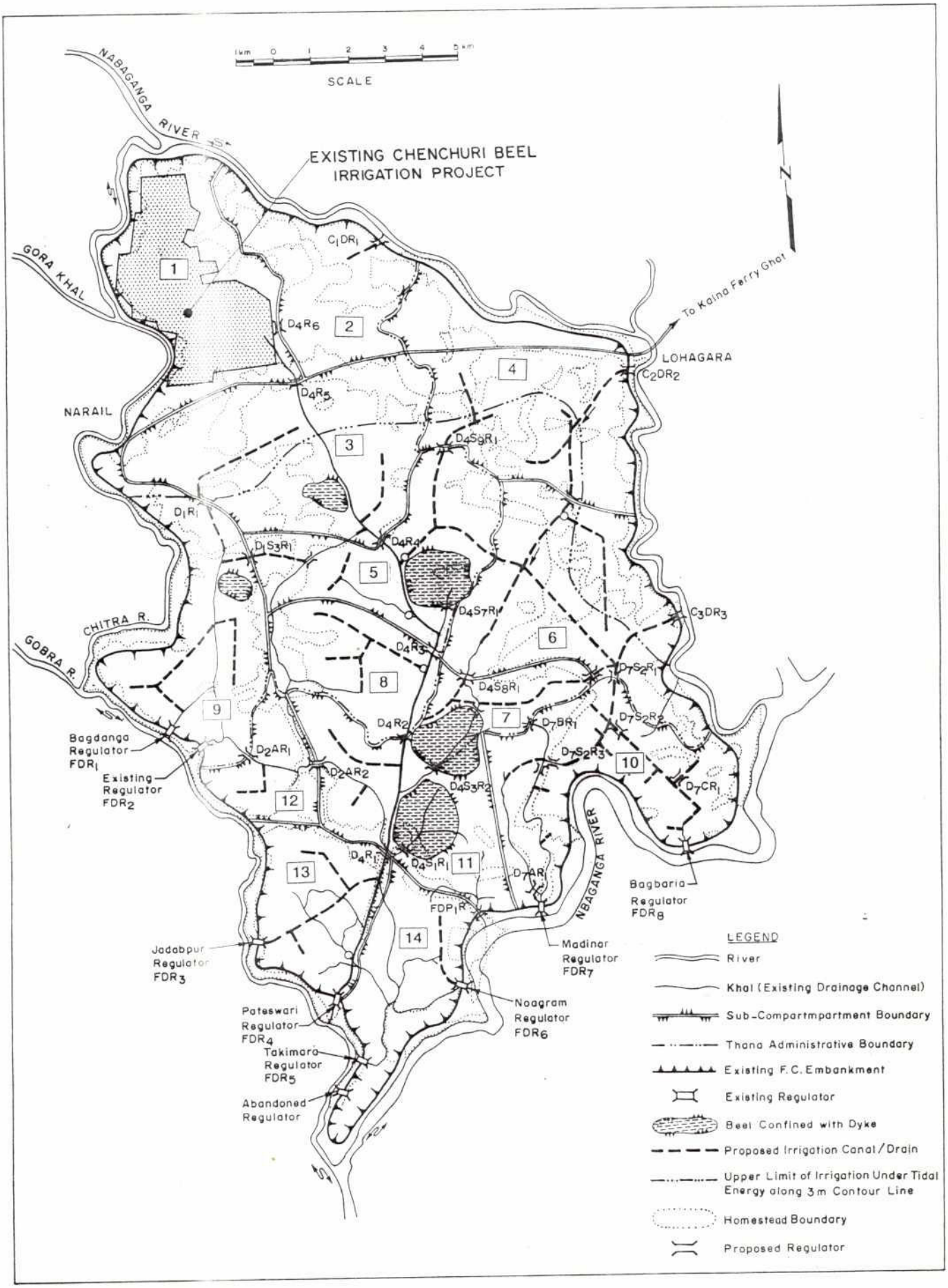
The estimated cost of the proposed compartmentalisation and provision of low level network of channels, including the associated water control structures, is 325 M Tk. In addition, the cost of rehabilitating the existing regulators is estimated at 9 M Tk. These costs have been estimated based on the cost assessment for a sample area of about 2050 ha (Table 2.24).

TABLE 2.24

Summary of Estimated Cost of Development of 2050 ha

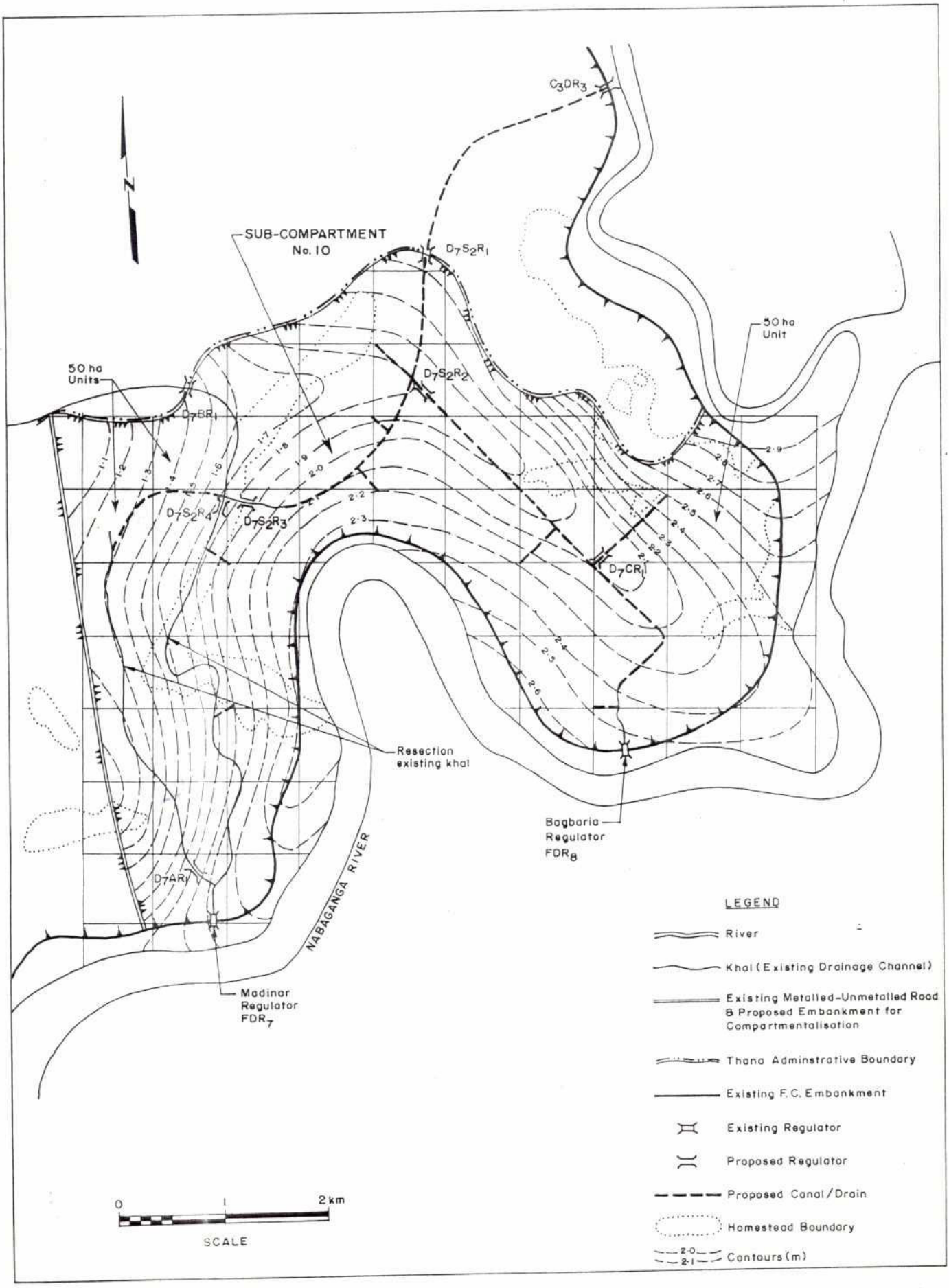
Item of Works	Quantity	Unit	Unit Rate (Tk)	Amount (M Tk)
Excavation of Canal/drain	0.20	m3	26	5.20
Hydraulic structures/cum bridge	6	Nos	1,500,000	9.00
Foot bridges over canal/drain	7	Nos	500,000	3.50
Land acquisition	42	Ha	250,000	10.50
Base cost				28.20
Add contingencies for unforeseen items, Engg. and Administration				11.30
Total for developing the Sample Area 2050 ha				39.50

Figure 2.16

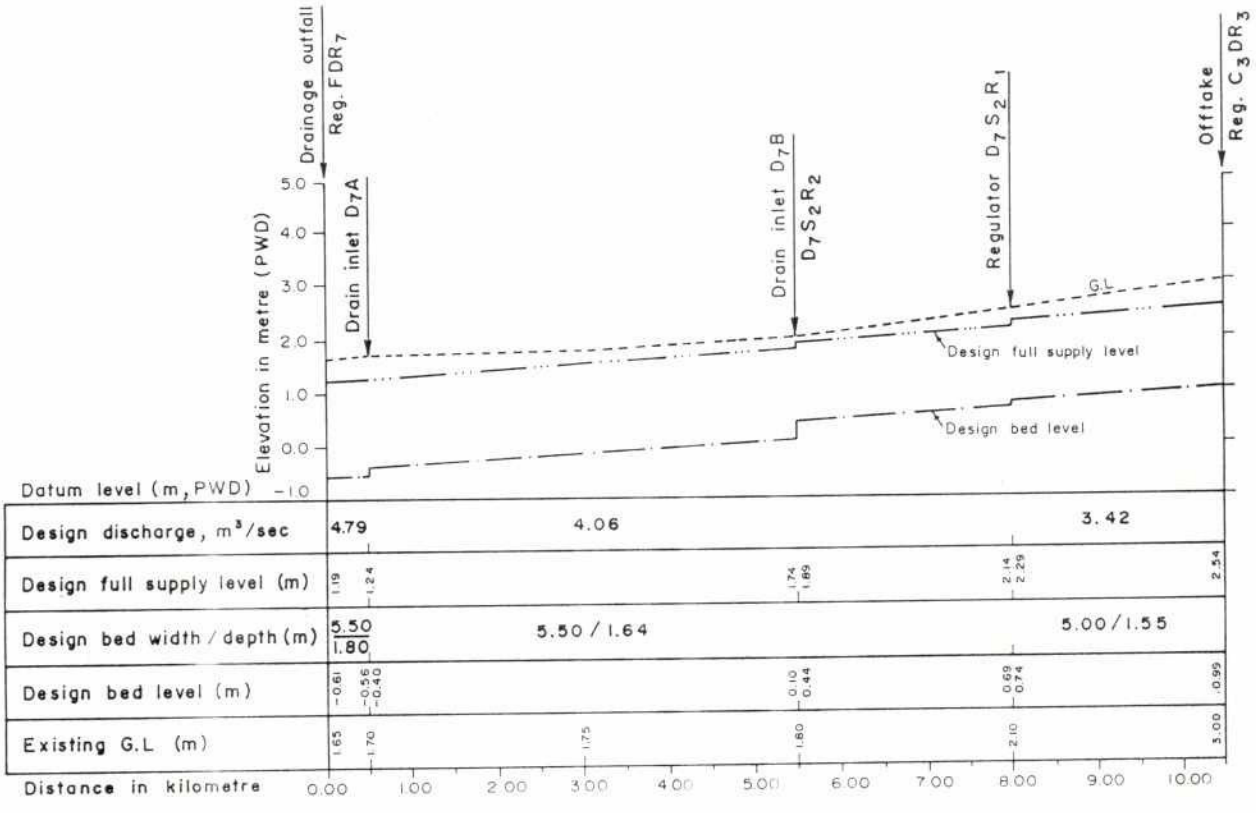


Proposed Canal/Drain Network

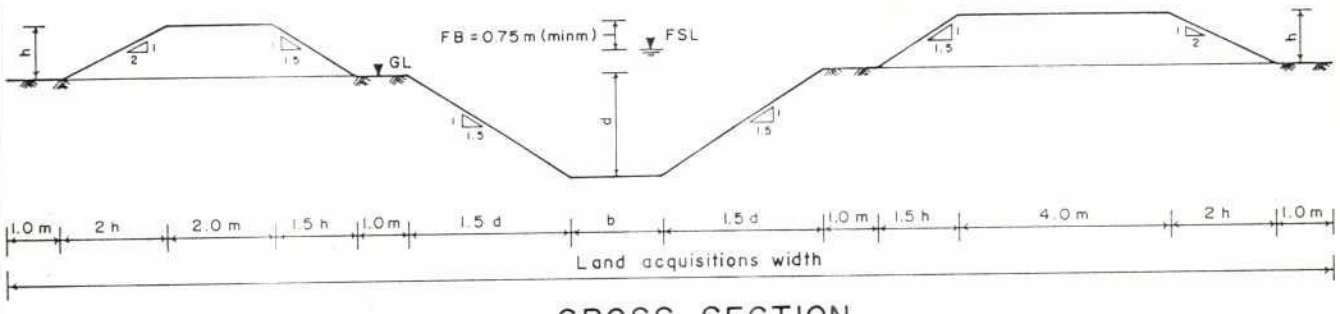
Figure 2. 17



Typical Network for a Sample Area



LONG SECTION
DRAIN D_7



CROSS SECTION

Proposed Long & Cross Section of Channel

2.6 Proposed Agricultural Development

2.6.1 Changes in Land Type

Controlled flooding and drainage incorporating compartmentalisation will bring major changes in the land type according to flood depth. The net cultivated area on average flooding conditions in the pre-project (from MPO) and future with project condition (derived by Consultants) are shown Table 2.25. It can be seen from the Table that there will be more land available under F0 and F1 land type where the agricultural productivity will be relatively high.

Furthermore, the estimated inundation pattern for the whole year based on the drainage flow routing using a 10-day time series (Section 2.5.5) shows the extent of land available for HYV crops in each month. According to the simulation results, after the proposed engineering interventions, about 15,000 ha (NCA) would become available to support 2-3 crops (cultivation) per year, while another 1,500 ha could support two crops and a further 1,000 ha 1-2 crops and 1,500 ha only one crop as illustrated in Figure 2.19. The Figure also shows the present situation.

At present 36% of the net cultivated area is highland (F0 land), 24% is F1, 28% of the area is medium lowland (F2 land) and 12% of the area is lowland (F3+F4 land) (Table 2.25).

With project, the proportion of land types is estimated to be changed to 59%, 34% and 7% of F0, F1 and F2 lands respectively. The change in land type will convert a high proportion of mixed aus and b.aman area into t.aman area, a major part of which will be suitable to grow modern rice varieties. The land use and cropping pattern will also change considerably with the provision of irrigation facility.

TABLE 2.25

Land Type : Present and Future with Project

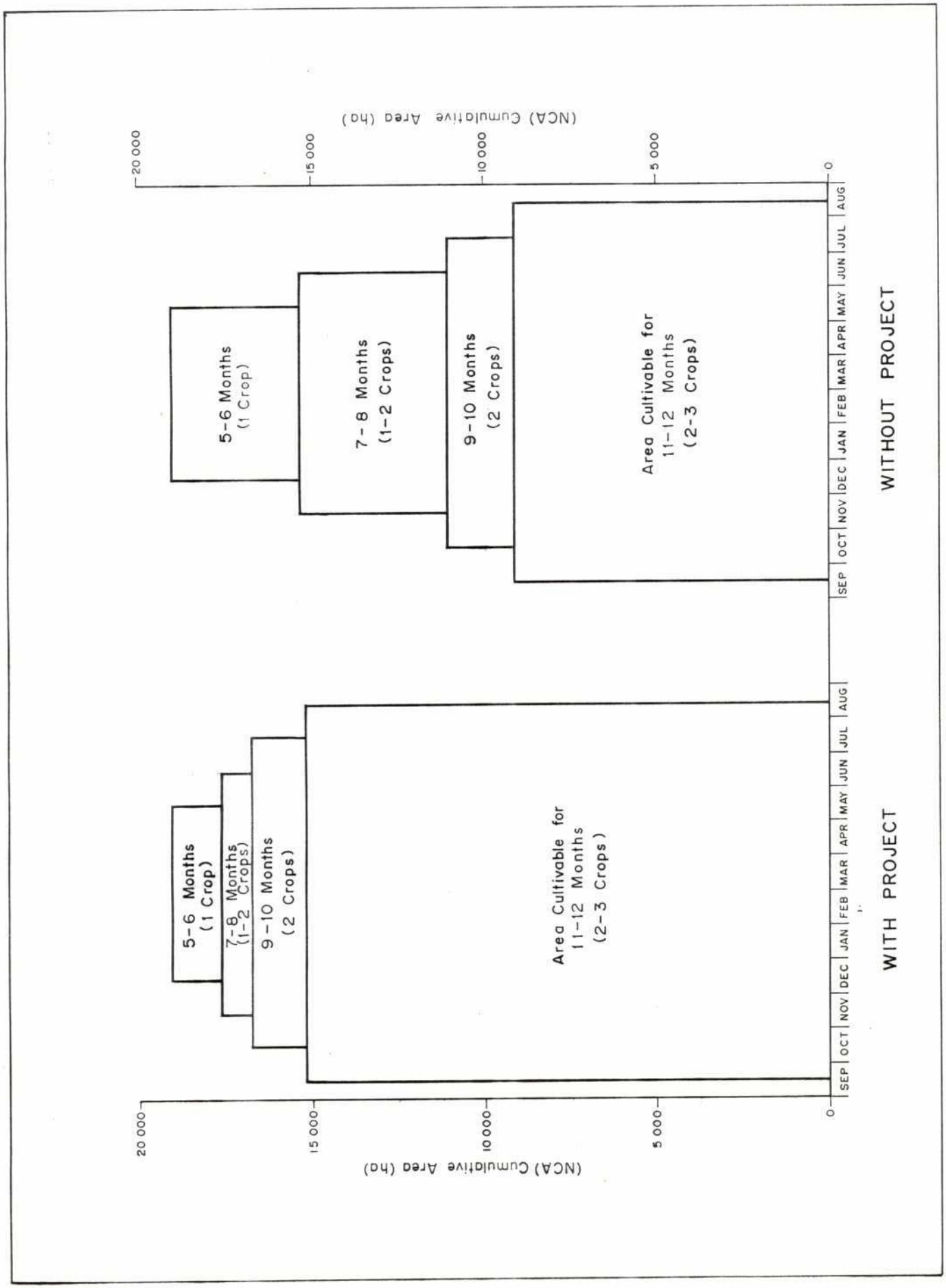
Planning Unit	NCA in Hectare						
	Present				Future with Project		
	F0	F1	F2	F3/4	F0	F1	F2
SW 5	3560	2770	1800	770	5250	3030	620
SW 10	2880	1530	3210	1380	5310	3060	630
Total	6440	4300	5010	2150	10560	6090	1250
Average % of Total	36	24	28	12	59	34	7

Source: Present from MPO and future with Project Consultants' estimate.

2.6.2 Crops and Cropping Patterns

Due to the changes in land type, the cropped area is expected to change assuming that more irrigation in the rabi season and supplementary irrigation in the late monsoon season will be available though there will be no major change in cropping patterns (Table 2.26). With the availability of irrigation water, the area under modern high yielding boro varieties will increase from 8% to 27% of the total NCA. Low yielding broadcast aus and aman will

Figure 2.19



Land Availability for Crop Production

be replaced substantially by transplanted rice of which major portion will be modern rice. In F0 and F1 land, there will be more areas of modern (36% of total NCA) and local transplanted aman rice (27% of the total NCA) under supplementary irrigated condition. A number of high yielding rice varieties developed recently by BRRI will be suitable for aus, aman and boro seasons having variable life cycles and seedlings and plant heights. There will be no restriction in selecting rice varieties to fit into the future cropping patterns.

TABLE 2.26

Crop Distribution in/ha (average) Farm

Crop	Land Use	
	At present (ha)	Future project (ha)
Kharif		
B Aus	0.29	0.23
M Aus	0.03	0.17
B Aman	0.30	0.04
L T Aman	0.18	0.27
M Aman	0.10	0.36
Jute	0.06	0.04
Sugarcane	0.02	0.04
Rabi		
L Boro	0.02	0.00
M Boro	0.08	0.27
M Wheat	0.06	0.19
Potato	0.02	0.01
Pulses	0.14	0.10
Oilseeds	0.12	0.10
Spices	0.01	0.01
Minor crops	0.03	0.05
Orchards	0.02	0.02
Totals Croped Area	1.48	1.91
Net Cropped Area	1.00	1.00
Cropping Intensity	148%	191%

A detailed 'with project' scenario in respect of changes in land types and irrigation, for each Planning Unit is given in Table 7 of Appendix 1 and a summary of future cropping area in each Planning Unit is shown in Table 2.27. A typical future crop calendar for SW5 is given as an illustration in Figure 2.20.

The trend of jute area is decreasing and it is not an irrigated crop and the market price is low and unattractive to the farmers. However, some areas (4% of the total NCA) of jute have been shown in the future pattern so that it may meet the farmers' individual and local demands.

Future Crop Calendar

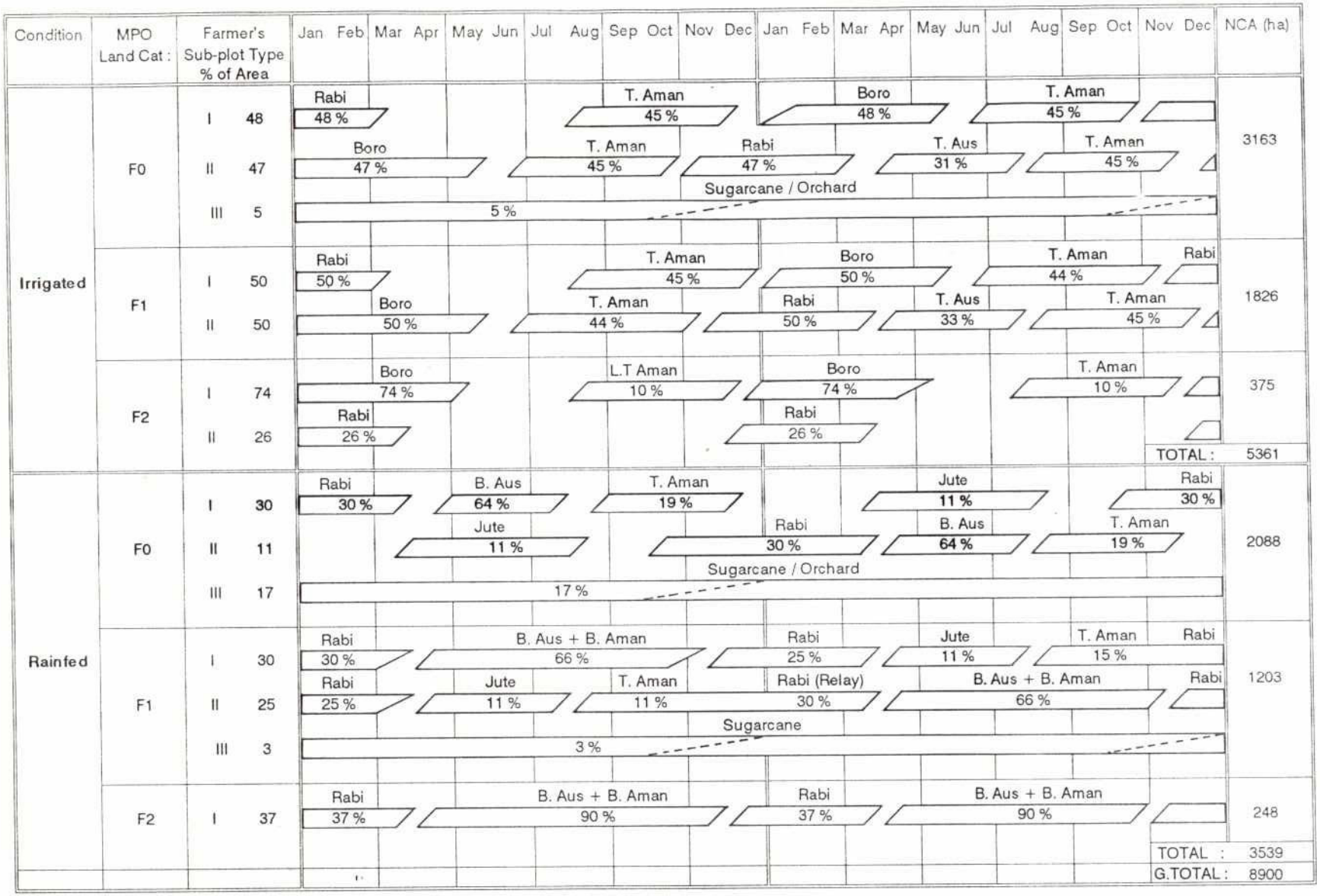


Figure 2.20

TABLE 2.27

Summary of Future Cropping

Crop	Area in Hectare									Percent of Total NCA
	SW 5			SW 10			Grand Total			
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	
Kharif										
B Aus	0	1,949	1,949	0	2,194	2,194	0	4,143	4,413	23
M Aus	1,588	48	1,636	1,379	21	1,399	2,966	69	3,035	17
B Aman	0	346	346	0	365	365	0	711	711	4
LT Aman	1,549	213	1,763	1,319	1,718	3,037	2,868	1,931	4,799	27
M Aman	2,976	364	3,339	2,376	807	3,183	5,352	1,170	6,522	36
Jute	0	368	368	0	428	428	0	796	796	4
Sugarcane	149	267	416	166	154	320	315	421	736	4
Rabi										
L Boro	0	0	0	0	0	0	0	0	0	0
M Boro	2,780	0	2,780	2,004	0	2,004	4,784	0	4,784	27
M Wheat	1,765	163	1,928	1,453	58	1,512	3,218	221	3,440	19
Potato	28	29	57	62	120	182	91	149	240	1
Pulses	178	707	885	170	649	819	348	1,356	1,704	10
Oilseeds	213	325	537	583	671	1,253	796	995	1,791	10
Spices	86	70	156	66	33	99	152	103	255	1
Minor Crops	289	87	376	372	129	501	661	216	877	5
Orchards	0	127	127	0	269	269	0	396	396	2
Totals	11,602	5,062	16,664	9,950	7,615	17,565	21,552	12,677	34,229	
Total NCA	5,361	3,539	8,900	4,371	4,629	9,000	9732	8,168	17,990	
Average CI	216%	143%	187%	228%	164%	195%	221%	155%	191%	

The requirement of water for wheat is much less than boro and as such there will be substantial increase in wheat area. Varieties developed by BARI specially like 'Agrahayan' for late planting will be more suitable in the project area. Though there will be no considerable reduction of the area of pulses and oilseeds due to introduction of irrigation but still the area will reduce because of their low yield and non-availability of high yielding varieties at farm level. Moreover, farmers will continue to grow these crops due to land suitability and increase of high market price in recent years. There will be also some increase of areas under sugarcane and minor crops (mainly vegetables) due to change of land type and development of irrigation facilities.

2.6.3 Cropping Intensity

The present and future with project cropping intensities in each planning unit under irrigated and rainfed conditions are presented in Table 2.28. In both the planning units the cropping intensity is expected to increase under irrigated and rainfed conditions but the overall change is more in the case of irrigated condition (175% to 221%).

2.6.4 Inputs

With the development of irrigation facilities, high yielding varieties will be grown and consequently higher quantities of manures, fertilisers and pesticides will be used. To realise the optimum yield potentials and to retain a stable productivity of various crops the demand for institutional soft credit for purchasing higher quantities of inputs will increase.

TABLE 2.28

Cropping Intensity : Present and Future with Project

Planning Unit	Cropping Intensity (%)					
	Present			Future with Project		
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall
SW 5	171	137	142	216	143	187
SW 10	180	149	153	228	164	195
Average	175	143	148	221	155	191

Therefore, in order to obtain the increased crop yields under irrigated agriculture, high quality of seeds, optimum dose of fertilisers and pesticides as well as appropriate management practices are needed. A comparative statement of present and future with project inputs is given in Table 2.29. The Table reveals that the requirement of all kinds of inputs for almost all the crops will increase substantially with the project.

TABLE 2.29

Present and Future Input use of Major Crops

Inputs	Present (Tonne)	Future with Project (Tonne)	Change (%)
Urea	832	2193	264
TSP	358	1050	293
MP	134	382	284
Pesticides	7	18	260
Seeds			
a. Rice (L)	1057	581	55
b. Rice (M)	115	430	374
c. Wheat	144	447	310
d. Jute	11	8	72
e. Sugarcane	2075	3681	177
f. Potato	287	240	83

Source: Consultants' estimate

With project, the requirement of modern rice seed would be about four times and wheat seed would be more than three times of the present use. At present BADC through its seed multiplication farms and contract growers system produces quality seeds for distribution among farmers. Considering to the country's requirement, BADC is assessed to produce and supply about 5% of rice, 18% of wheat, 10% of jute and 15% of selected vegetable seeds. It shows that the supply of quality seeds is highly inadequate to meet the farmers' present demand and in future it will be more acute. As a result, farmers are forced to use their own seeds or buy locally produced seeds which are often mixed or of substandard quality. To ensure optimum yield it is required to strengthen the seed sub-sector to produce and supply the required quantity of seeds through public and private seed enterprise development.

The present level of application of fertilisers in the project area is low. With project, it is expected that the demand for fertilisers and pesticides will increase about three times. In the project area due to the continuous flooding in the past (and some areas also at present) in certain low lying areas, there are deficiencies of Zn and S which may cause sterility of grain. These deficiencies can be arrested by applying organic manures and other micro nutrients (like copper, manganese, molybdenum etc).

As the area of HYV rice and wheat crops will increase, the use of pesticides and other agro-chemicals will increase substantially (Table 2.29). Generally farmers use pesticides indiscriminately due to the lack of proper knowledge of dosage, method and time of application and use of appropriate type of chemicals. Besides due to private trading of agro-chemicals, very often low quality products are marketed. Therefore, it is needed to train the farmers in applying agro-chemicals in proper time and appropriate dosage and type. Simultaneously efforts should be made to ensure quality of the agro-chemicals now marketed through the private entrepreneurship sector.

2.6.5 Crop Production

The future production based on yield (Table 8 in Appendix 1) for the different crops under irrigated and rainfed conditions is shown in Table 2.30.

TABLE 2.30

Future Crop Production

Crop	Production in Tonne								
	SW 5			SW 10			Grand Total		
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall
Kharif									
B Aus	0	2339	2339	0	2632	2632	0	4971	4971
M Aus	4604	140	4744	3999	60	4058	8603	199	8802
B Aman	0	415	415	0	438	438	0	853	853
L T Aman	2944	405	3349	2505	3264	5769	5449	3670	9119
M Aman	9522	1163	10685	7604	2582	10186	17126	3745	20871
Jute	0	625	625	0	727	727	0	1353	1353
Sugarcane	7456	10662	18118	8303	6176	14479	15759	16838	32597
Rabi									
L Boro	0	0	0	0	0	0	0	0	0
M Boro	12233	0	12233	8818	0	8818	21052	0	21052
M Wheat	4236	278	4513	3488	99	3587	7724	376	8100
Potato	340	231	572	747	960	1707	1088	1191	2279
Pulses	121	481	602	115	441	557	237	922	1159
Oilseeds	177	269	446	484	557	1040	660	826	1486
Spices	319	258	577	245	121	366	564	380	943
Minor crops	29	9	38	38	13	51	67	22	89
Orchards	0	324	324	0	689	689	0	1013	1013

A comparative statement showing the present and future production of various crops and their change is presented in Table 2.31. The Table reveals that after the development of irrigation facilities in the project area there will be an additional cereal production of about 38,100 tonnes. This increase of production is mainly due to increase in HYV areas under irrigated condition. For understandable reasons the production of pulses, oilseeds, potato and jute will decrease. There will be increases in production of sugarcane, spices and orchard crops like banana, papaya etc.

TABLE 2.31

Changes in Crop Production : Present and Future with Project

'Figure in Tonne'

Crop	Present Production			Future Production			Change		
	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall
Kharif									
B Aus	0	6283	6283	0	4971	4971	0	-1312	-1312
M Aus	1283	266	1550	8603	199	8802	7319	-67	7253
B Aman	0	6373	6373	0	853	853	0	-5520	-5520
LT Aman	1234	4903	6137	5449	3670	9119	4215	-1233	2982
M Aman	2275	3497	5772	17126	3745	20871	14852	248	15100
Jute	0	1887	1887	0	1353	1353	0	-534	-534
Sugarcane	1838	15133	16971	15759	16838	32597	13922	1705	15627
Rabi									
L Boro	252	408	660	0	0	0	-252	-408	-660
M Boro	6583	0	6583	21052	0	21052	14469	0	14469
M Wheat	1466	850	2316	7724	376	8100	6258	-473	5785
Potato	243	2136	2379	1088	1191	2279	845	-945	-100
Pulses	43	1713	1756	237	922	1159	194	-791	-598
Oilseeds	153	1557	1710	660	826	1486	507	-731	-224
Spices	85	558	643	564	380	943	479	-178	300
Minor Crops	15	33	48	67	22	89	53	-11	41
Orchards	0	691	691	0	1013	1013	0	323	323

2.6.6 Farm Employment

At present with 148 percent cropping intensity, dominated with local varieties of crops under rainfed condition, the annual labour requirement of the project area is about three million man-days. The labour requirement is expected to increase to about five million man-days with the development of future project facilities (Table 2.32).

Increased area under labour intensive high yielding varieties (specially in case of modern t.aus, t.aman, boro and wheat, the increase is about 468%, 262%, 220% and 210% respectively) and high cropping intensity (191%) would promote the farm employment opportunities by about 50% over the present level leading to the reduction in the rural unemployment in the project area.

2.6.7 Future Fisheries Development Potential in Beels

The design of the proposed compartments of the Chenchuri Beel Rehabilitation Project made leaving all the existing five small beels, having a total area of 930 ha, outside the compartments. Each of these beels will be dyked keeping its link with adjacent river through the existing water control structure. These beels will provide a habitat suitable for development of open water aquaculture provided re-excavation is done to maintain a minimum water level of two meters in the beels year round.

A major constraint to beel aquaculture is posed by the presence of predatory fishes effective control of which is not generally possible. This problem can, however, be addressed by stocking the beel waters with large size fingerlings of 15-20 cm in length and about 50g by weight. Required quantity of such quality fingerlings can be produced rearing hatchery produced fry in nursery/rearing ponds at the periphery of each beel. This will ensure better survival rate of stocked fish, and also will eliminate the difficult and costly transportation involved. Production cost of the fingerlings can be kept to a minimum.

TABLE 2.32

Farm Employment : Present and Future with Project

Crop	Number of Mandays (ha)	Present		Future with Project	
		Area (ha)	Total Mandays ('000)	Area (ha)	Total Mandays ('000)
Kharif					
B Aus	130	5236	681	4143	539
M Aus	180	534	96	3035	546
B Aman	102	5310	542	711	72
LT Aman	125	3230	404	4799	600
M Aman	160	1804	289	5622	1044
Jute	180	1110	200	796	143
Sugarcane	263	415	109	736	194
Rabi					
L Boro	167	347	58	0	0
M Boro	188	1496	281	4784	899
M Wheat	121	1111	134	3440	416
Potato	213	287	61	240	51
Pulses	64	2583	165	1704	109
Oilseeds	79	2060	163	1791	141
Spices	188	174	33	255	48
Minor Crops	105	473	50	877	92
Orchards	185	270	50	396	73
Total			3,315		4,968
% Change					150

In polyculture right combination of both local and exotic carps will require to be stocked. Consideration should be given to stock large proportion of fast growing species and Calum feeder, such as Catla, Ruhu, Mrigal, Silver carp, Grass carp, Mirror carp and Thai Sarpunti, Exotic species of fish is likely to breed in the beel habitat and may help natural recruitment to the beel fishery. As the beels will have a link with the adjacent rivers through a khal, natural recruitment of quality and miscellaneous species of fishes also expected. Beels link with the adjacent rivers through Khals will help maintain a required water level and daily exchange of waters as well. This will ensure fertilization of beel waters thus requirement of supplemental diet would be minimal. By adoption of semi-intensive poly culture technology in beel waters, it should be possible to harvest minimum of 1500 tonnes of fish per hectare annually. To achieve this production target beel waters should be stocked at a rate of 2140 fish (wt:107kg) per hectare subject to mortality rate of 30 percent. The quantity of fish stocked, production cost and benefit are given in Table 2.33.

2.6.8 Conclusion on Fisheries Aspect

Prior to FCD project, floodplain capture fisheries area of the Chenchuri Beel was 14,000 hectares but it has reduced to 9000 hectares on completion of project in 1986/87, Most of perennial beels turned into seasonal beels and now used for rice production in dry season. Chenchuri Beel FCD improvement Scheme will have further impact on still existing floodplain fisheries in the area. The floodplain fisheries, in the long run, will not exist and will gradually be replaced by expensive culture based fisheries in khals, beels and borrow-tits. Fish production in the area will increase manifold as shown in Table 2.34, but benefit of the project will go to the people who can invest capital in fish farming. Most of the poor full-time fishermen will lose their age-old profession. Displaced fishermen should however be organised into groups by the NGOs in association with the DOF and be put them in fish farming gin beels, khals and borrow-pits providing them training needed for fish farming.

TABLE 2.33

Production Cost and Benefit in Semi-intensive Polyculture

Sl. No. Beel	Water Area (Ha)	Quantity of Fish Stocked (Kg)	Cost of Fish Stocked ('000 Tk)	Cost of Feed, Fertilizer Labour & Others ('000 Tk.)	Total Production Cost (4+5) ('000 Tk.)	Yield mt	Gross Value ('000 Tk.)	Net Benefit (8+6) ('000 Tk.)
1	2	3	4	5	6	7	8	9
1	51	5457.00	218.28	897.35	1115.63	76.50	2677.50	1561.87
2	75	8025.00	321.00	1319.63	1640.63	112.50	3937.50	2296.87
3	192	20544.00	821.76	3378.24	4200.00	288.00	10080.00	5880.00
4	251	26857.00	1074.28	4416.35	5490.63	376.50	13177.50	7686.87
5	284	30388.00	1215.52	4996.98	6212.50	426.00	14910.00	8697.50
Total	853	91271.00	3650.84	15008.54	18659.38	1279.50	44782.5	26123.12

Source : Consultants estimate based on polyculture demonstration results of Aquaculture Extension Project, Mymensingh (DOF)

TABLE 2.34

Manifold Increase in Fish Production

Area : ha
Yield : tonnes

Project Status		Capture Fishery				Culture Fishery						Total Yield
		Beels		Floodplain		Beels		Borrow-pit & Khals		Ponds		
		Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	
Prior to Completion of FCD Project (Yield of 1983/84)		900	84	14000	926	-	-	-	-	244	254	1589
After Completion of FCD Project in 1986/87 (Yield of 1989/90)		900	236	9000	148	-	-	-	-	244	478	862
After Implementation of Proposed FCD Improvement Project	Without Aqua-Culture Project	900	48	7160	57	-	-	-	-	244	278	583
	With Aqua-Culture Project	-	-	7030	-	853	1271	130	130	244	732	2141

Source : Consultants estimate based on Fish Catch Statistics of Bangladesh (DOF) 1983/90.

2.7 O & M, Cost Recovery and Institutional Issues

2.7.1 General

Field appraisal of the existing Chenchuri Beel FCD Project infrastructure reveals shortcomings in the operation and maintenance (O&M) of the flood control and drainage system. The reason generally quoted by the concerned government staff for the poor O&M status is the non-availability of the required funds. Apparently, annual O & M budget allocations to BWDB, the government agency that is responsible for these field activities in addition to project implementation, are used mainly for paying staff salaries. However, an equally important reason for the poor O&M status is that there are no separate offices or staff at district level (and lower levels) for project implementation and O&M, and all the available staff at these offices are almost fully committed to only project implementation work. The appraisal also revealed that the project beneficiaries do not pay any annual charges for the existing facilities; the project in fact does not generate its own funds to meet the cost of any O & M activities.

Cost recovery from the beneficiaries of water resources cum irrigated agricultural development projects is a complex issue. FCD/I projects do not have the same and/or equal impact on all beneficiaries: benefits could vary from one project to another, also vary from one plot to another within the same project. Moreover, in Bangladesh the provision of flood control and drainage (implementation, maintenance, etc) has been traditionally considerd the responsibility of the government.

Though there have been statutory provisions since 1976 for collection of water rates from farmers benefitting from any BWDB sponsored FCD/I developments, the actual collection has been next to nothing in the whole of Bangladesh, possibly in keeping with the above traditional view. However, recent field surveys, including the one the Consultant conducted in the Chenchuri Beel areas, indicate that the farmers appear to appreciate the linkage between poor O&M and low agricultural production (reduced area, yields, etc) and show willingness to at least participate (providing free labour) in maintenance work. However, the present statutory provision by which the BWDB is responsible for both the assessment of water rates and their collection does not appear to be the correct procedure to achieve cost recovery in view of the slow confidence build-up between government agencies and beneficiaries. It would be prudent to involve the beneficiaries, as well as the others who would be expected to subsequently provide support facilities to the beneficiaries, when determining the water rate for each project.

The government, on the other hand, appreciating the importance of cost recovery for project sustainability has initiated a number of studies through its relevant agencies to identify suitable mechanisms for achieving it.

2.7.2 Related O&M Studies

BWDB have been carrying out the following four major programmes under external aid to study the present status of O&M in various projects and identify suitable measures for improved O&M and cost recovery:

(a) Systems Rehabilitation Project

(b) Second Small Scale Flood Control, Drainage and Irrigation Project

(c) G-K Rehabilitation Project

(d) Early Implementation Project

In addition, LGEB has been carrying out similar studies with particular emphasis on participation of thana and other lower level local government institutions (Unions) in promoting these activities.

There is on-going pilot programme of the Systems Rehabilitation Project to formulate and operate suitable measures for achieving cost recovery. This is attached to the Ichamati Unit of the Karnafuli Irrigation Project (near Sylhet, Northeast Region of Bangladesh). However, the progress in implementing the required measures has been slow. The programme endeavours to enlist the support of the relevant staff of the local government institutions (thanas and unions) and NGOs to form viable Water User Groups which would then take responsibility for collecting the water rates as well as participating in O&M activities.

2.7.3 Constraints to Operation and Maintenance

A preliminary assessment of the existing FCD/I projects in the Southwest Area and a more detailed examination of the Chenchuri Beel FCD Project show that generally the major constraints for operation and maintenance are the lack of trained O&M staff and necessary funds to meet the requirement. In addition, in some of the existing projects the following constraints have been noted:

- inadequate capacity of some of the drainage structures, particularly due to the prevalence of high river stages outside the embankments;
- social conflicts of different interested groups inside the project, particularly in polder areas, and also influence of the local elites;
- conflicts between farmers on high and low lands and between farmers within the protected area and outside;
- lack of specific and clear demarcation of responsibility among the operational staff;
- lack of adequate coordination between the different government agencies that hold responsibilities for giving specific services/support to the project beneficiaries;
- lack of beneficiary participation;
- theft of fall boards used in water control structures.

2.7.4 Routine and Remedial Maintenance

Routine maintenance is a periodical exercise to keep a system in optimal working condition at all times. The importance of routine maintenance for a system's longevity should not noticeably vary for different systems, whether they are pump stations, water control structures or flood control embankments. considering that routine maintenance needs to be carried out on a regular basis, the related activities should be scheduled in the same manner as that for activities relating to system operation.

Remedial maintenance relates to any repairs to a system after a failure, fault or damage. Its cost could be comparatively very high depending on the extent of the failure/damage. It is generally a one-off failure brought about by a catastrophic event; but failures due to poor design are not uncommon.

Any proposed measures for cost recovery from beneficiaries need to consider the above difference in the two types of maintenance and should not pass the cost of remedial maintenance to the beneficiaries.

2.7.5 People's Participation

The importance of beneficiary or people's participation in planning, implementation, operation and maintenance of projects relating to water and agricultural development cannot be over emphasised, particularly in hydrologically and hydromorphologically complex areas in the Southwest Area. The generally conflicting needs of the people in the area (agricultural, fisheries, domestic and industrial) make the development issues further complex. The people of the area have much to offer to the technocrats to enable them identify possibly the local issues and negative impacts of certain interventions, and importantly understand the people's needs. These issues and conflicting needs are much in evidence in the Chenchuri Beel Project.

Evidence from many FCD/I schemes suggests that project implementation, operation and overall socio-economic benefits are better when people are involved at all stages of project development, and people's participation could be achieved more effectively in small-scale projects than large-scale projects.

2.7.6 Support of NGOs

The interviewed farmers in the project area value the support they receive from various non-governmental agencies (NGO) and consequently place a lot of confidence on them. Indeed, NGOs operating at the village and thana level may provide the best option for helping to organise farmers' groups and to link them to the local government institutions in the area.

Furthermore, the experience gained by some of the NGOs in terms of identifying and realising local community needs has enabled them to achieve considerable insight into appropriate methodology and measures for successful development at local level.

2.7.8 Proposed Measures for Implementation, O&M and Cost Recovery

It is recommended that BWDB shall establish separate offices for project implementation and O&M at district levels. In addition to their primary responsibilities, these offices shall encourage beneficiary participation at the implementation and O&M stages for which the staff will need to coordinate with other relevant government agencies and local NGOs.

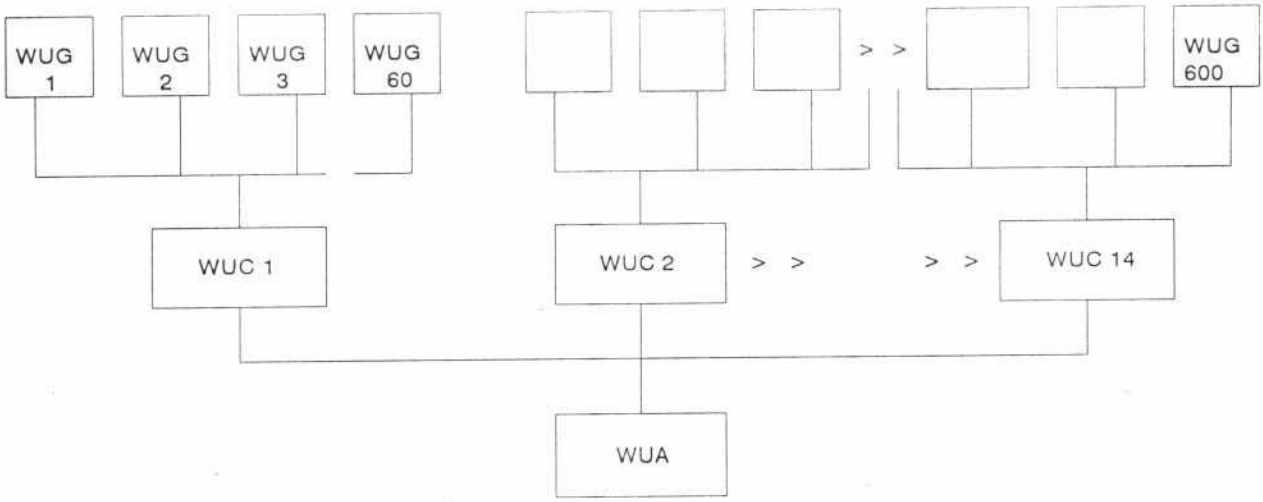
The cost of operation and routine maintenance should be recovered from the beneficiaries. This could be accomplished by imposing appropriate water rates that reflect the benefits that result from the project works and associated infrastructure. Further studies may be needed to identify a more balanced procedure for determining water rate for each project that takes into account not only the individual farmer's landholding but also its potential for enhanced agricultural production.

Taking cognisance of the related issues discussed herein above and the need to have an effective O&M programme for the proposed Chenchuri Beel Rehabilitation Project in which the beneficiaries could actively participate, an institutional set-up as shown in Table 2.35 is recommended. It allows for beneficiary participation not only in O&M activities but also in the initial activities relating to project planning and implementation.

Considering that there are about 300 villages in the project area, a total of 600 water user groups (the smallest co-operative unit that could possibly operate as an entity with its own low lift pump or shallow tubewell) could be expected to be set up. Each water user group would cover an area of between 20 ha and 30 ha. As part of the proposed engineering interventions, the project area is intended to be divided into 14 sub-compartments. It is

estimated that there would be between 25 and 50 water user groups in each sub-compartment. It is recommended that each sub-compartment should have a separate water user committee formed by representatives of the integral water user groups. A water user association, comprising a representative from each sub-compartment, would have to coordinate the management of the whole project. Table 2.35 summarises the composition and responsibilities of each tier of the institutional set-up.

TABLE 2-35
Recommended Institutional Arrangement for Implementation, Operation & Maintenance And Cost Recovery



Name of Water User Units	Composition of Water User Units	Responsibilities of Water User Units	Participating Agencies
Water User Group (WUG)	20-50 ha Canal Unit. 10-20 farmers associated with a LLP or outlet to form Water User Group.	Responsible for provision of watercourses / field channels / pumps and their O & M.	Supported by field extension staff involved in Agriculture, Fisheries etc. and NGOs.
Water User Committee (WUC)	500-1500 ha sub-compartment. One representative from each WUG within a sub-compartment.	Participate in main, secondary and tertiary canals/drains network planning; Organise WUGs to participate in tertiary canals/drains construction on the basis of payment for work done. Responsible for cost recovery to finance O & M of the main, secondary and tertiary network. Organise WUGs to participate in all O & M activities on the basis of payment for work done.	BWDB staff supported by Union Parishad staff & NGOs. -- Do -- Union Parishad staff supported by BWDB staff and NGOs. -- Do --
Water User Association (WUA)	Covers the entire project (17,900 ha) WUA comprises a representative from each WUC, SDE of BWDB and a representative from relevant government agencies (DAE, BRDB, LGED, BADC etc.). WUA shall be chaired by the XEN of BWDB O & M Division.	Participate in formulating O & M criteria and work programme for each of the sub compartments. Coordinate and supervise the activities of all WUCs and WUGs. Liaise with relevant Government and other agencies.	----

[vp\tab2-35]

2.8 Economic Analyses

2.8.1 Introduction

The analyses of the economic benefits from the proposed Chenchuri Beel Rehabilitation Project are based on MPO and BBS data supplemented by the Consultants' own field studies. The analyses are preliminary and at a pre-feasibility level. They follow the May 1992 FPCO Guidelines for Project Assessment. The approach to the evaluation of costs and benefits is described in detail in Volume 10, Economics.

2.8.2 The Project Area and Scope

The Chenchuri Beel Rehabilitation Project is designed to rehabilitate and expand FCD/I works in an existing scheme that has been operating since 1982/83. The new investment will provide for year round surface irrigation by low lift pump (LLP) and significantly reduce F3/4 and F2 flood areas that still exist by improving drainage and providing a network of FCD compartments within the project area.

The present scheme, project area resources and cropping patterns have been described earlier.

The project will impact on a net cultivable area (NCA) of 17900 ha in view of the introduction of compartmentalisation and controlled drainage to the entire existing project area. Irrigation water supply facilities will be limited to areas below the 3.0m (PWD) contour and the benefitting area would be about 13,600 ha. However, new LLP irrigation may not cover all this potential irrigation area since not all farmers can be expected to wish to invest in a LLP or to become a member of a group that will need to be formed for each LLP because of the small size of individual land holdings. In the economic analysis it has been assumed that between 60-70% of the irrigable area would have new LLP facility.

The project area falls within two Planning Units, SW5 and SW10. The present condition of each PU within the project is summarised in Table 2.36 in terms of the NCA by flood category and type of cultivation, whether rainfed or irrigated. At present about 15320 ha are rainfed and 2580 ha irrigated within the total project area of 17900 ha. Without the project it is expected that a further 900 ha will become irrigated from ground and surface water sources during the next decade. This is an estimate conservatively based on an assessment of available groundwater resources. The forecast changes are also set out in the table. These form the basis for the derivation of the without project position for the study analyses in Tables 1 and 2 of Appendix 1. The areas with project are discussed in Section 2.8.4 (c) (refer Table 2.44).

2.8.3 Costs

Financial and Economic Prices

In accordance with FPCO's requirements 1991 prices have been used in all the study analyses. Financial prices have been converted to economic values using the conversion factors (CF) provided by FPCO in its Guidelines for Project Assessment noted earlier. A full account of the basis for costs is given in Volume 10, Economics.

Capital and Operation and Maintenance Costs

Development costs were derived from a number of sources and where necessary inflated to 1991 prices.

Construction costs were based on unit rates supplied by BWDB O & M Circles in SWA and the Khulna Zone Highways Department. Unit rates from the five different sources within SWA showed no great divergence and average rates were used for all projects. The prevailing rate for earthworks used by BWDB is based on manual labour. While it has been accepted that a large part of the work will continue to be labour intensive the standard of materials, fill procedures and compaction will have to be raised if maintenance is to be kept to acceptable levels and the unit rate of Tk 40/m^3 has been adopted for embankments, drains and canals to allow for this.

TABLE 2.36

Present and Future Net Cropped Area Without Project

	Rainfed				
	F0	F1	F2	F3/4	Total
PRESENT					
Rainfed					
SW5	3020	2180	1600	690	7490
SW10	2400	1300	2970	1160	7830
Sub-Total	5420	3480	4570	1850	15320
Irrigated					
SW5	540	590	200	80	1410
SW10	480	230	240	220	1170
Sub-Total	1020	820	440	300	2580
TOTAL					17900
FUTURE (1)					
Rainfed					
SW5	2920	2040	1440	670	7070
SW10	2300	1150	2800	1100	7350
Sub-Total	5220	3190	4240	1770	14420
Irrigated					
SW5	640	730	360	100	1830
SW10	580	380	410	280	1650
Sub-Total	1220	1110	770	380	3480
Total					17900

Source: Consultants' estimates.
(1) New irrigation without the project = 900 ha

Irrigation development and equipment costs are based on prices supplied by BADC and a number of private sector equipment suppliers and contractors.

Operation and maintenance costs include an amount of 3% pa of the capital cost for earthworks and 2% pa for structures from the year following the capital expenditure.

Land acquisition for civil works was priced at a compensation rate of Tk 250,000 a hectare in the financial analysis and at the approximate value of production foregone of Tk 8720/ha a year in the economic analyses.

Details of engineering costs are given in Section 2.5.7. The capital and operating costs for LLPs (2 cusec capacity irrigating 20 ha) used in the analyses are given in Tables 2.37 and 2.38 respectively. Capital and O & M costs assuming 40% electric and 60% diesel powered pumping are set out in Table 2.39. Provision is made for LLP replacement every eight years.

TABLE 2.37

Capital Costs LLP (54 l/s, 2 cusec) (1991 values)

Taka

Item	Financial			Conv'n Factor	Economic		
	Local	Foreign	Total		Local	Foreign	Total
Electric:							
Pump etc	10000	0	10000	0.62	6200	0	6200
Engine	25000	0	25000	0.62	15500	0	15500
Accessories	5000	0	5000	0.62	3100	0	3100
Power supply[2]	24650	0	24650	0.64	15846	0	15846
Total	64650	0	64650	0.63	40646	0	40646
Diesel:							
Pump etc	1000	0	1000	0.62	6200	0	6200
Engine	3625	31375	35000	0.62	2248	19453	21700
Accessories	5000	0	5000	0.62	3100	0	3100
Total	18625	31375	50000	0.62	11548	19453	31000

Source: Consultants estimates.

Notes : (1) 541/s sufficient for 20 Ha
(2) Costed separately on basis of Tk160000/Km and 0.14Km distribution system costs and Tk2250 connection cost each LLP

Distribution system	Financial	Conv'n factor	Economic
Capital			
Connection	2250	0.87	1958
Distribution	22400	0.62	13888
Total	24650	0.64	15846

TABLE 2.38

LLP Operating Costs (54 l/s, 2 cusec) (1991 values)

Taka/Year

Item	Financial			Conv'n Factor	Economic		
	Local	Foreign	Total		Local	Foreign	Total
Electric:							
Operator	9000	0	9000	0.87	7830	0	7830
Repair/pa	900	600	1500	0.87	783	522	1305
Energy	28000	0	28000	1.54	43120	0	43120
Total	37900	600	38500	1.36	51733	522	52255
Tk/Ha			1925				2613
Diesel:							
Operator	9000	0	9000	0.87	7830	0	7830
Repair/pa	1440	960	2400	0.87	1253	835	2088
Energy	40600	0	40600	0.63	25578	0	25578
Total	51040	960	52000	0.68	34661	835	35496
Tk/Ha			2600				1775

Source: Consultants estimates.

TABLE 2.39

Capital and O & M Costs for Diesel and Electric Pumps

	100%E/100		Proportion	40%E/60%D	
	Financial	Economic		Financial	Economic
Capital:					
Electric	64650	40646	0.40	25860	16258
Diesel	50000	31000	0.60	30000	18600
Total				55860	34858
O & M: Tk/ha/yr					
Electric	1925	2613	0.40	770	1045
Diesel	2600	1775	0.60	1560	1065
Total				2330	2110

Note: E = Electric Pumps; D = Diesel Pumps.

Project Capital Costs

The Chenchuri Beel Rehabilitation Project will be developed over four years and require an investment of M Tk 334 at 1991 prices inclusive of 25% for physical contingencies and 15% for engineering overheads. At 1991 economic values (ref Volume 10, Economics) this is equivalent to M Tk 202.

The phasing and breakdown of capital investment is given in Table 2.40. In addition there will be an investment of up to 8.6 M Tk (M Tk 5.3 economic value) every eight years to replace LLPs (ref Table 2.46).

The investment costs are equivalent to Tk 18680/ha NCA at financial prices and Tk 11310/ha NCA at economic values.

The phasing of the development is discussed earlier in the report. For the economic analysis it has been assumed that not all farmers who have the opportunity to purchase and install LLPs will do so. The area of project LLP irrigation has been calculated as the potential irrigable area (13600 ha) less existing tubewells and LLPs (2070 ha) within this potential irrigable area; then assuming that 66% of the remaining area (11530 ha) is used for project LLP irrigation, an area of 7660 ha.

The present 1991, division of irrigation sources in the whole project area (17,900 ha) is:

	SW5 Ha	SW10 Ha	Project Area Ha
DTW	30	20	50
STW/DSSTW	1020	490	1510
LLLP	190	320	510
Gravity	170	340	510
Total	1410	1170	2580

TABLE 2.40

CHENCHURI BEEL REHABILITATION PROJECT COSTS

(1991 Prices)

Year	1	2	3	4	5	6	7	8	Total
Irrigable Area	0	383	456	2134	4892	7044	7660	7660	
Total Area	8592	17900	17900	17900	17900	17900	17900	17900	
Lost Area	430	895	895	895	895	895	895	895	
COSTS									
Financial (M Tk)									
Capital :									
land aquisition	30.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	55.00
									0.00
earthworks	59.00	59.00	0.00	0.00	0.00	0.00	0.00	0.00	118.00
structures	60.00	80.00	0.00	0.00	0.00	0.00	0.00	0.00	140.00
pumps (1)	0.00	4.25	8.55	8.60	0.00	0.00	0.00	0.00	21.39
sub-total	149.00	168.25	8.55	8.60	0.00	0.00	0.00	0.00	334.39
Recurrent :									
pumping O&M	0.00	0.00	0.89	1.06	4.97	11.25	16.41	17.85	
earthworks	0.00	1.77	3.54	3.54	3.54	3.54	3.54	3.54	
structures	0.00	1.20	2.80	2.80	2.80	2.80	2.80	2.80	
sub-total	0.00	2.97	7.23	7.40	11.31	17.59	22.75	24.19	
TOTAL	149.00	171.22	15.78	16.00	11.31	17.59	22.75	24.19	
Economic (M Tk)									
Capital :									
earthworks	40.71	40.71	0.00	0.00	0.00	0.00	0.00	0.00	81.42
structures	46.20	61.60	0.00	0.00	0.00	0.00	0.00	0.00	107.80
pumps	0.00	2.63	5.30	5.34	0.00	0.00	0.00	0.00	13.27
sub-total	86.91	104.94	5.30	5.34	0.00	0.00	0.00	0.00	202.49
Recurrent :									
pumping O&M	0.00	0.00	0.81	0.96	4.50	10.19	14.86	16.16	
earthworks	0.00	1.22	2.44	2.44	2.44	2.44	2.44	2.44	
structures	0.00	0.92	2.16	2.16	2.16	2.16	2.16	2.16	
land loss	3.78	7.87	7.87	7.87	7.87	7.87	7.87	7.87	
sub-total	3.78	10.01	13.28	13.43	16.97	22.66	27.33	28.63	
TOTAL	90.69	114.95	18.58	18.77	16.97	22.66	27.33	28.63	

Source : consultants estimates .

Note : Costs are based on --- 54 l/s capacity low lift pumps , replaced every 8 years .

--- Coverage 20 Ha .

--- 66% LLP uptake = 66% area irrigated at full development

--- 40% electric , 60% diesel @ Tk55860

Details in Volume 10 , Economics .

To irrigate the 7660 ha under the project will require 383 LLPs of 2 cusec capacity each of which will irrigate 20 hectares. Table 2.41 shows the expected schedule of LLP installation.

TABLE 2.41

Schedule of Project Low Lift Pump Installation and Build-up of Irrigated Area

Project year	SW5		SW10		Total	
	LLP (1)	Cum. Ha (2)	LLP (1)	Cum. Ha (2)	LLP (1)	Cum. Ha (2)
1	-	-	-	-	-	-
2	41	246	35	210	76	456
3	82	1148	71	986	153	2134
4	83	2630	71	2262	154	5886
5	-	3788	-	3256	-	7044
6	-	4120	-	3540	-	7660
Total	206		177		383	

Source: Consultants estimates.

(1) Number installed each year.
(2) See text, cumulative area.

It is assumed that the final net area irrigated by each LLP will take three years to achieve: 30% during the year of installation, 80% in year 2 and 100% thereafter (see Appendix 1 Tables 3 and 4). The project irrigated area will rise from 456 ha in year 2 to 7660 ha in year 6 but the full benefits will occur in year 9 (ref Table 2.45).

Recurrent Costs

Table 2.40 sets out the recurrent, operation and maintenance costs for the first 8 years of the project. These exclude direct crop production expenses and institutional costs. The former are included in the crop gross margins used in the analyses. The latter is expected will be borne by the implementing agencies; BWDB, DAE and a number of NGOs. But is possible that these organisations will have to provide some services to the project beyond their present capacity. At this, pre-feasibility stage it has not been possible to quantify this requirement and provision is included in the 25% physical contingency built into the costs in Table 2.40

Recurrent costs will rise to M Tk 24.2 (M Tk 20.8 economic) a year by year 6. This excludes the cost of replacement LLPs which are shown as a capital cost from year 10 in the cost-benefit flow (refer Table 2.46).

2.8.4 Benefits

General

Project benefits will arise from flood protection and drainage with year round irrigation. The assessment of benefits are confined to those arising from these factors. These direct quantifiable benefits may be considered the minimum that can be expected. However they can be enhanced if improvements are made in other sectors : credit, production support

services, institution strengthening for example. Such developments are not confined to the Chenchuri Beel project however and are not, therefore, included in the present analyses. The direct benefits fall into two categories:

(i) higher output arising from improved water regimes and land resource conditions, particularly from changes in flood categories from deeper to shallower and more briefly flooded areas, and

(ii) the reduction in agricultural and non-agricultural damage from floods that do not occur every year.

Penalties can also be expected from changes in water resource conditions which particularly affects capture fisheries.

Sections (a) and (b) summarise the basis for the figures used in the project analyses and these are presented in greater detail in Volume 10, Economics. Section (c) sets out the figures for the Chenchuri Beel Rehabilitation Project used in the analyses.

(a) Production Benefits

The project's principal benefits are those expected from crop production. Three possible sources of benefit were considered; yield, cropping pattern and annual flood damage.

Yield

Under in-field conditions annual variations in water regimes, including flooding, are such that it is not possible to measure FCD benefits in terms of yield changes within each type of crop.

Cropping patterns

Each flood zone category; F0, F1 etc; is associated with a distinct cropping pattern as illustrated earlier in the report. These relate to both annual cropping intensity and to the types of rice and other crops that are grown. In the kharif season there is an increase in the proportion of sugarcane and HYV rice and a decrease in the other major crops, jute and local rice varieties from the deeper flooded areas (F2, F3/4) to shallower areas (F0, F1).

Under rainfed conditions, areas within the project will lose the boro rice crop that is grown in the F3/4 areas. The proportion of high value spices and vegetables - mainly sweet potatoes will rise. The wheat area will decrease as a result of the lower soil moisture regimes in F0 and F1 areas.

Irrigation, whether in conjunction with FCD works or not, leads to benefits from a higher cropping intensity, in particular a major increase in boro rice production.

When irrigated areas are within FCD development, where F0 and F1 areas predominate, there is a major shift from local to HYV boro rice as illustrated by the following data from SWA as a whole :

	F0	F1	F2	F3/4
Irrigated Rice:				
Local (%)	0	5	2	43
HYV (%)	100	95	98	57

Under irrigation in the less deeply flooded areas rabi cropping also exhibits higher proportions of wheat, spices and other high value crops such as vegetables and potatoes.

Unusual flood damage

Table 2.42 sets out the extent of damage to crops from unusual floods. Damage is expressed as the proportion of the total crop area and is the average reported by BBS during the 19 years, from 1971 to 1989. In the study analyses the economic value of these crop losses, at 1991 prices, has been added to the benefit from changes in cropping patterns discussed above. The benefits would not accrue if irrigation is provided without FCD works.

TABLE 2.42

Kharif Season Average Crop Losses due to Floods 1971-1989
(Percent total crop area)

Planning Unit	Aus L	Aus M	Aman B	Aman TL	Aman TM	Jute	Sugarcane
SW 5, 10	3.04	3.3	6.25	1.32	3.4	4.06	0.25

Source: Derived from BBS data.

(b) Penalties

Previous studies including FAP 12/13 have established that reduction in flood levels adversely affects capture fisheries. Detailed information on the likely effect from the operation of the Gorai river and related irrigation works are not available. However using data from FAP 12/13 and the SWA data that are available for the project Pus an assessment of the losses in production value have been made and included as a cost of the augmentation project. The basis for the loss estimates is given in Table 2.43.

TABLE 2.43

Capture Fisheries Losses Resulting from FCD Development (1991 Prices)

Source of Loss	Loss Kg/Ha	Financial				Economic				
		income Tk/Kg	costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	income Tk/Kg	costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	G M Tk000/ Km²
Flood Plain:										
not flooded before	0	0	0	0	0	0	0	0	0	0
flooded before										
now dry	37	35	10	25	925	44	7	37	1356	136
still flooded	20	35	10	25	500	44	7	37	733	73

Sources: Consultants estimates and FAP 12/13 reports.

In the study analyses the following has been assumed:

Flood Plain: F3/4 and F2 areas that are eliminated by FCD works are lost completely and F2 areas that remain suffer the partial loss quantified in Table 2.43.

Since it is considered unlikely that fisheries the two project Pus are now fully productive as a result of already existing works the analyses assumed that 15% of the estimated full fisheries losses are applied as a penalty to the development.

As far as possible project works will avoid adversely affecting the area of beels and baors and the loss of production from these areas will be minimal.

(c) Project Benefits

Benefits will accrue to the project from year 3 after construction is complete and the first LLPs fielded in year 2 are operational. From this time there will be improved drainage throughout the project area resulting in the virtual elimination of F3/4 land and reduction in the extent of F2 land. Benefits from FCD will then be realised over 7660 ha of irrigation from LLPs installed as a result of the project will then be phased in as illustrated in Table 2.45.

By year 12 at full development the benefits will accrue to 7660 ha of project FCD and surface irrigation and FCD only benefits from a further 10240 ha of which 8170 ha will be rainfed and 2070 ha irrigated by the presently installed tubewells and LLPs. The division of these areas by PU is shown in Table 2.44.

TABLE 2.44

Project Net Cropped Areas

Planning Unit	Rainfed	Non Project Irrigation	Total	Project Irrigation	Total
SW 5	3540	1240	4780	4120	8900
SW10	4630	830	5460	3540	9000
Total	8170	2070	10240	7660	17900

Source: Consultants' estimates.

The resulting benefits from the improved cultivation conditions are summarised in Table 2.45. Table also shows the additional benefits from reduced crop damage from flooding that can be expected. This will also occur from year 3.

TABLE 2.45

Chenchuri Beel Rehabilitation Project Cost/Benefit Flow (M Tk)

Project Year	Incremental Crop Benefit		Total	Reduced Crop Damage		Total	TOTAL
	SW5	SW10		SW5	SW10		
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	25.093	31.806	56.90	2.04	2.20	4.24	61.14
4	31.212	39.388	70.60	2.05	2.21	4.27	74.87
5	45.84	36.789	82.63	2.07	2.22	4.29	86.92
6	57.16	61.868	119.03	2.08	2.23	4.31	123.34
7	60.048	64.436	124.48	2.10	2.24	4.34	128.82
8	59.548	64.11	123.66	2.11	2.25	4.36	128.02
9	59.047	63.784	122.83	2.12	2.26	4.38	127.21
10	58.546	63.458	122.00	2.14	2.27	4.41	126.41
11	58.046	63.132	121.18	2.15	2.28	4.43	125.61
12-30	57.545	62.806	120.35	2.16	2.29	4.45	124.80

Source: Consultants' estimates.

Appendix 1 presents the detailed build up of benefits for each Planning Unit. The benefits are derived from the detailed cropping patterns and the crop budgets for each PU set out in Appendix 1, which also sets out the average annual crop losses from flooding between 1971 and 1989 in the two project Pus.

For fisheries losses the following figures are used in the analyses from year 3.

	M Tk/year
SW5	0.53
SW10	0.99
Total	1.52

2.8.5 Economic Analysis

Base Case

The benefit-cost flow at 1991 economic values is set out in Table 2.46. The proposed development will have an EIRR of 30.7% over a 30 year period with a net present value (NPV) of MTk 352 assuming the opportunity cost of capital is 12% as specified in FPCO's GPA. The benefit/cost ratio will be 2.0.

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TABLE 2.46

CHENCHURI BEEL REHABILITATION PROJECT COST BENEFIT FLOW

BASE CASE (1991 economic values in M Tk)

Year	Costs				Benefits			
	Capital	Recc't	Fishery Loss	Total	Crop Benefits	Flood Damage	Incr'tal Benefits	Net Benefits
1	86.91	3.78	0.00	90.69	0.00	0.00	0.00	-90.69
2	104.94	10.01	1.52	116.47	0.00	0.00	0.00	-116.47
3	5.30	13.28	1.52	20.10	56.90	4.24	61.14	41.04
4	5.34	13.43	1.52	20.29	70.60	4.27	74.87	54.58
5	0.00	16.97	1.52	18.49	82.63	4.29	86.92	68.43
6	0.00	22.66	1.52	24.18	119.03	4.31	123.34	99.16
7	0.00	27.33	1.52	28.85	124.48	4.34	128.82	99.97
8	0.00	28.63	1.52	30.15	123.66	4.36	128.02	97.87
9	0.00	28.63	1.52	30.15	122.83	4.38	127.21	97.06
10	2.63	28.63	1.52	32.78	122.00	4.41	126.41	93.63
11	5.30	28.63	1.52	35.45	121.18	4.43	125.61	90.16
12	5.34	28.63	1.52	35.49	120.35	4.45	124.80	89.31
13	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
14	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
15	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
16	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
17	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
18	2.63	28.63	1.52	32.78	120.35	4.45	124.80	92.02
19	5.30	28.63	1.52	35.45	120.35	4.45	124.80	89.35
20	5.34	28.63	1.52	35.49	120.35	4.45	124.80	89.31
21	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
22	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
23	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
24	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
25	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
26	2.63	28.63	1.52	32.78	120.35	4.45	124.80	92.02
27	5.30	28.63	1.52	35.45	120.35	4.45	124.80	89.35
28	5.34	28.63	1.52	35.49	120.35	4.45	124.80	89.31
29	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65
30	0.00	28.63	1.52	30.15	120.35	4.45	124.80	94.65

[vp\chen-tab\tab2-46]

EIRR	%	30.68	
NPV (12%)	MTk	351.89	
NPV costs	MTk	347.94	
NPV benefits	MTk	699.83	351.89
B/C ratio		2.01	
Switching values			
costs plus		101.12	%
benefits minus		(-) 50.28155	%

Sensitivity Analyses

The results of sensitivity analyses carried out are given below:

	Base Case	Costs x1.2	Benefits x0.8	Costs x1. + Benefit x0.8	Benefits delayed 2 years
EIRR	30.7	25.3	24.1	19.2	20.7
NPV MTk	351.9	282.3	211.9	142.3	212.8
B/C ratio	2.01	1.68	1.61	1.34	1.62

The project is sensitive to both increases in costs and reduction of benefits. However the project is robust in that even if costs increase by 20% and benefits fall by a similar proportion the EIRR still remain above 19% compared to the 12% required under FPCO's Guidelines and the B/C ratio falls to 1.34.

The switching values, the amount by which costs or incremental benefits increase or decrease to reduce the EIRR to 12% are:

Costs increased by 101.12%

Benefits decreased by 50.28%

2.9 Social Impact Assessment

2.9.1 General

The assessment of the existing sociological situation in the project area and the needs of the people living therein is based on a field study by a multi-disciplinary team of the Consultants which included interviews in 33 villages within the project.

The sampling technique followed in this survey is absolutely purposive breaking down the agricultural population into five groups on the basis of their operated landholding. The other two groups focused here are the most vulnerable women headed households and the economically worsening fishermen group. Equal weights are put to each of the seven groups classified here.

2.9.2 Existing Situation

Household Categories

The household categories and their respective landholding ranges in the study area are as follows :

Household Category	Operated Land (ha)	No of Households
Landless	0.00-0.20	8
Marginal Farmers	0.21-0.50	8
Small	0.51-1.00	8
Medium	1.01-2.00	8
Large	2.01 and above	8
Women Headed	--	8
Fishermen	--	8
Total		56

Demographics and literacy

The total population of the sample households is 335 with a male female sex ratio of 1.04 which is fairly close to the national figure (1.06). Our survey results suggest that the family size of the respondents is 6.0 (national is 5.6) with the highest 8.9 for the large farmers' group and the lowest 3.12 for the women headed households (Table 2.47).

Literacy

The literacy rate of our respondents is much higher compared to the national or even the Southwest area average. The average literacy rate is about 43% for all groups. Among the agricultural population, quite obviously, the large farmers group is having the highest rate of 62.5% and the lowest being the poverty ridden landless group. The women respondents show the most disappointing picture with 100% illiteracy although the national figure is very low.

Of the total respondents only 25% have had primary education, about 14.% SSC level and less than 4% have had HSC and above.

TABLE 2.47

Family Size and Educational Level

Groups	No of respondents	Population				Family size	Education		
		Male (M)	Female (F)	Total	Ratio M/F		Illiterate	Primary	SSC and above
Landless	8	21	22	43	0.95	5.4	75.0	12.5	12.5
Marginal	8	27	22	49	1.23	6.1	37.5	50.0	12.5
Small	8	31	22	53	1.41	6.6	37.5	37.5	25.0
Medium	8	24	35	59	0.69	7.4	37.5	25.0	37.5
Large	8	38	33	71	1.15	8.9	37.5	25.0	37.5
Farmers	40	141	134	275	1.05	6.9	45.0	30.0	25.0
Women	8	12	13	25	0.92	3.1	100.0	00.0	00.0
Fishermen	8	18	17	35	1.06	4.4	75.0	25.0	00.0
All	56	171	164	335	1.04	6.0	57.1	25.0	17.9

Occupation and Employment

Quite obviously, agriculture is the major occupation of the population in the study area of 66% for all groups and 92.5% for the farmers (Table 2.48). Among all 66% are doing self cultivation, 18% are practising sharecropping.

Working as agricultural labour force is the predominant secondary occupation which is about 52%. This figure for the landless and the marginal farmers is significantly high - about 60% and 71% respectively due to their very low land holding size. Business and others comes afterwards which are mainly observed among the medium and large farmers (Table 2.49). Off farm economic activities like poultry, fisheries, cattle rearing etc, are also hardly found in the project area. Although majority of the population are engaged in agriculture the way of cultivation is still highly traditional. Irrigation water facilities are not found to be adequate for majority of the population and the means of irrigation are mostly in the hands of the rich farmers who usually sell water to the poor farmers at the price of one fourth of the total yield.

Landless and marginal farmers are predominantly the labour force in this area. Women labour force is almost absent in this area implying social and religious conservation. The average wage rate for the male is Tk 25/day and that for the female is Tk 15/day.

Income and Expenditure

Our survey results suggest that the average per capita income level is fairly low in this area compared to the national as well as the Southwest area figures. The average per capita income of the project area for all groups is about Tk 3334 of which the farmers' average is Tk 3272. Among the agricultural population the landless group, not surprisingly, has the lowest per capita income figure which is only Tk 1778, undoubtedly a quite disappointing figure for any standard of living. Among all groups although the large farmers' group shows a better situation still this is well below the national average which is approximately Tk 8400 per capita per annum.

And in accordance with the low level of income the, quite rationally, the per capita expenditure is fairly low which is about Tk 3298 for all groups and Tk 3223 for the farmers'as given in the following Table :

	LL	MF	SF	MDF	LF	Farmer Average	Fishermen	Women	All groups
Per capita Income (Tk)	1778	1939	3827	3791	5025	3272	2177	3042	3334
Per capita expenditure (Tk)	2091	1837	3431	3616	5138	3223	2281	3042	3298

Note: 1) LL - Landless; MF - Marginal Farmers; SF - Small Farmers; MDF - Medium Farmers; LF -Large Farmers.

Nutrition and Health

Until adequate caloric intake is reached, a positive correlation is found to exist between the level of income and food intake. The Chenchuri beel project area is characterised by high level of poverty in accordance with its the very low level of income. Malnutrition is, therefore, a common feature of this area. Although the data shows a reasonable per capita caloric intake, unfortunately almost 80% of that is through cereals (mostly rice) while the

average protein intake is less than 10% as seen in the following Table :

	LL	MF	SF	MDF	LF	F.Total	Women	Fishermen
Cereals	1420 (81)	2061 (79)	2419 (77)	2169 (72)	3560 (76)	2311 (76)	1210 (79)	2172 (79)
Fish/Meat/ Pulses	119 (7)	195 (8)	297 (9)	334 (11)	617 (13)	327 (11)	83 (5)	294 (11)
Vegetables	224 (12)	344 (13)	430 (14)	516 (17)	533 (11)	413 (13)	241 (16)	275 (10)
Total	1763 (100)	2600 (100)	3146 (100)	3019 (100)	4710 (100)	3051 (100)	1534 (100)	2741 (100)

Note: 1) LL - Landless; MF - Marginal Farmers; SF - Small Farmers; MDF - Medium Farmers; LF -Large Farmers.

2) Numbers in parentheses are the percentages of the total.

With regard to safe drinking water, one of the most important socio-economic indicators, most of the inhabitants have got access to the available relatively safest drinking water facility - the hand tubewells. It is found from the survey that about 36% of the respondents have got tubewell in their own house and 54% replied that the tubewells are within 100 yds from them and the rest 10% lying within 200 yds.

Although the area seems to have been enjoying better drinking water facilities gastric, fever, diarhhoea etc are the most common diseases found in the decending order of frequency with 77%, 63% and 52% respectively (Table 2.50).

Credit facilities

Both institutional and noninstitutional sources of credit/loans are available in this area. But mostly the poor agricultural people are observed to be very much reluctant to approach the institutional sources, and therefore take loans from the noninstitutional sources at very high rates of interest which are in many cases as high as 100% or even more. The reason behind their reluctance is in most cases the hazards associated with their service and some administrative pitfalls. But the rich farmers mostly take credits from the institutional sources, overcoming the troubles by dint of their economical as well as social status, where the interest is very low - about 12% - as opposed to the noninstitutional sources, as illustrated in the following Table.

	L. L	MF	SF	MDF	LF	Women	Fishermen
Commercial Banks	-	-	-	-	63	-	-
Krishi Bank	-	-	-	62	35	-	-
Money lenders	-	83	33	15	3	-	100
Relatives/ neighbours	100	17	67	23	-	100	-
Total	100	100	100	100	100	100	100

Source : Consultant's field survey

NGOs

May be the poor socio-economic feature of the area attracted a number of NGOs to work on. The major NGOs working in this area are Proshikha Manobik Unnayan Kendra (Dhaka), Kazer Dak, Esho Samaj Gori, Banchte Shekha and Gono Shahajjo Sangstha etc who are actually working with the most vulnarable groups - the landless and marginal farmers groups. Their areas of activities cover group formation, agricultural credit, poultry, cattle rearing, small business, child and adult education, skill development, health care services, sanitation, fisheries, social forestry etc, with the objective of poverty eradication and social development.

TABLE 2.48

Primary Occupation and Employment

Main Occupation	Landless Farmer		Marginal Farmer		Small Farmer		Medium Farmer		Large Farmer		Farmer Total		Women		Fisherman		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture	5	62.5	8	100	8	100	8	100	8	100	37	92.5					37	66.0
Fishery	1	12.5									1	2.5			8	100	9	16.0
Capture	1	12.5									1	2.5					1	1.8
Agri Labour	1	12.5									1	2.5	6	75.0			7	12.5
Non-Agri Labour													2	25.0			2	3.6
Business																		
Others																		
Total	8	100	8	100	8	100	8	100	8	100	40	100	8	100	8	100	56	100

TABLE 2.49

Secondary Occupation and Employment

Secondary Occupation	Landless Farmer (LF)		Marginal Farmer (MF)		Small Farmer (SF)		Medium Farmer (MF)		Large Farmer (LF)		Farmer Total		Women		Fisherman		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Fishery Capture	1	20									1	4.3					1	4.0
Agri Labour	3	60	5	71.4	4	57.1					12	52.2			1	100	13	52.0
Non-Agri Labour	1	20	2	28.6	2	28.6	2	100	2	100	9	39.1					9	36.0
Business					1	14.3					1	4.3	1	100			2	8.0
Others																		
Total	5	100	7	100	7	100	2	100	2	100	23	100	1	100	1	100	25	100

TABLE 2.50

Health Status

Diseases	Landless Farmer		Marginal Farmer		Small Farmer		Medium Farmer		Large Farmer		Farmer Total		Women		Fisherman		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Chicken Pox			3	37.5	4	50.0	2	25.0	4	50.0	13	32.5			1	12.5	14	25.0
Dysentry	2	25.0	7	87.5	4	50.0	2	25.0	5	62.5	20	50.0	2	25.0	4	50.0	26	46.4
Diarrhoea	5	62.5	3	37.5	1	12.5	5	62.5	4	50.0	18	45.0	5	62.5	6	75.0	29	51.8
Gastric	7	87.5	3	37.5	8	100	7	87.5	6	75.0	31	77.5	5	62.5	7	87.5	43	76.8
Fever	4	50.0	3	37.5	3	37.5	5	62.5	6	75.0	21	52.5	7	87.5	7	87.5	35	62.5
Others	2	25.0	3	37.5	6	75.0	3	37.5	5	62.5	19	47.5			1	12.5	20	35.7
Total Respondents	8	100	8	100	8	100	8	100	8	100	40	100	8	100	8	100	56	100

2.9.3 Future Socio-economic Impacts

Economic together with social benefits are expected to accrue from the suggested compartmentalisation scheme with the objective of optimum use of the available water resources in the Chenchuri beel project. The area is presently characterised by low level of agricultural production causing a high level of poverty. The direct benefit out of the project will of course go to the agricultural population by way of opening up a wide range of opportunity for HYV cultivation. Improvement in the agricultural production and fish productivity will accelerate the mobility of the economic activities. As a consequence, increase in employment opportunities for the agricultural and non-agricultural population, improvement in the wage situation, improvement in the standard of living etc will take place implying a step forward towards poverty alleviation - the major concern of most of the projects. Undoubtedly, the most vulnerable social groups, the landless and the marginal farmers, will be positively benefitted, to a great extent, through the process of being taken up from below the absolute poverty line and will develop entrepreneurial ability of some people also.

Improved standard of living will enable the rural people to afford better health and sanitation facilities in addition to achieving better nutritional levels. They are expected to enjoy improved quality of life if they are guided in the correct direction as far as the health and hygiene are concerned.

Construction of some new embankments and proper maintenance of the old ones as required by the implementation of the project will provide an improved rural transport and land communication facilities to the inhabitants which will, presumably, also create some new jobs in this area. The project would also reduce inundation (local runoff) of the low lying areas, thus giving further security to life and agricultural production.

As far as the operation and maintenance of the project is concerned the beneficiaries of the project will participate spontaneously with the view to protect themselves from any further devastation and their agricultural benefits.

As low as 1 to 2 percent of land will have to be acquired for the construction of the canal and drain network and short lengths of new embankments which will be a disbenifit as far as the beneficiaries are concerned. But this is an inevitable situation which goes with implementing any structural project. Compensatory measures will have to be provided for the affected people.

Another major disbenefit identified is with the fisheries. It is estimated that the area of floodplains for fisheries will be reduced by approximately 37% due to the implementation of the project which needs to be assessed with greater emphasis in any future feasibility studies. Embankments will create hindrance to the natural movement of the open water fisheries and therefore will affect the traditional capture fishing community which, eventually, will likely to lead them to change their profession. However, there would be potential for fisheries programmes in the secured beels and in the canal/drain network.

2.10 Initial Environmental Impact Evaluation

2.10.1 Introduction

The Chenchuri Beel FCD project is located in a triangular land area, bounded on the southeast and southwest by the Nabaganga and Chitra rivers, and by the upper Nabaganga in the north. The area has already been subjected to FCD works, and these further works will compartmentalise the beel. A map of the project area showing sub-compartments is given in Figure 2.15.

2.10.2 Scoping

The Important Environmental Components (IECs) that have ben used for the Regional Plan assessment are used here; in addition to which are three IECs reflecting the economic and operational aspects of the project, at this pre-feasibility stage.

2.10.3 Impact Evaluation

The project has been assessed by considering each IEC and ascribing a value to each component on a scale of $\pm$ 5. The evaluation taken into account the impact that the project would have on the environmental component in terms of its importance; it spatial magnitude; the permanence of the impact; reversibility and whether there are cumulative affects. It has not been possible at this pre-feasibility stage to attempt to weight values or rank the IECs.

The values have been presented in a matrix form, to allow the pattern of beneficial/negative affects to be simply demonstrated (Table 2.51).

2.10.4 Consideration of Potential Project Impacts

Table 2.51 shows that the project is largely neutral, with negative impacts in all elements, but these are largely suitable for mitigation or are minor.

The project will rapidly benefit a number of areas starting in SW5 and SW10. During the construction works, which will add to the distribution of income throughout local communities.

Most of the benefits of the project will relate to the safeguarding of homesteads. Some irrigation will be available through LLPs, and the drainage channels may be used for irrigation water in the dry season. With the availability of irrigation, more land will be turned over to crops, and tree clearance in the village groves can be expected.

A new road network along the burms will be developed, which will benefit local communities within the project area. Commercial transport will be largely unaffected. Riverine communities that rely on boat transport will be disadvantaged by the barriers to movement posed by barrages and structures.

Improved agriculture should improve the diet of local communities. Conversely, the increase in open water surfaces brought about by the channel network, may increase the risk from water borne diseases, especially insect vectors. The problems of water related disease will increase if people use the drainage system for bathing and drinking purposes.

The main negative impacts relate to complexity of internal water management, water related disease, and concerns over the impacts on fisheries.

The means exist within the project concept to safeguard the beel fisheries. The project seeks to retain many of the beel areas, which will held as reservoirs behind embankments with control structures. It is proposed that the drainage links with the rivers could be used to allow fish spawn and fingerlings into these reservoir, to maintain the beel fisheries. This degree of water management may be hard to achieve in practice, and adds to the complexity of the project.

2.10.5 Mitigation of Negative Impacts

Most of the project's negative environmental impacts can be offset by mitigation.

Fisheries

Little can be done, other than has already been catered for in project design, to safeguard or improve the river fisheries (and natural floodplain recruitment). The problems generally associated between FCD scheme and floodplain fisheries apply here.

The main worry with respect to the maintenance of the beel fisheries will be the complexity of water management to ensure stock replenishment at the appropriate time. This may need further extension services and public participation/awareness training, and is an aspect that should be covered in more detail in the feasibility studies.

Artisanal Transport

This problem primarily relates to the use of small country boats, as the road network is likely to be improved by the project. On the main rivers, incorporation of small locks would provide an adequate technical means of overcoming this problem. There are both maintenance and administrative costs associated with this mitigation. It is probable that a lock-keeper may be required in each case, to collect any tolls and to ensure locks are efficiently used to conserve water loss.

Water Quality

The degree of pollution from agrochemicals is impossible to quantity; neither can any systems for mitigation be proposed at this stage. What will be necessary is for a monitoring programme to be set in place to monitor agrochemical pollution, and react to water quality changes. Development of this programme should be considered in detail as part of the feasibility study.

Water related diseases are always more probable with any increases in water surfaces, or freshwater bodies. Insect vector larvae that breed in water can be controlled by chemical means, or by ensuring surface disturbance. Where local hydraulic heads allow, channels should have miniweirs and riffles to break up the water surface by turbulence. This has the added advantage of increasing dissolved oxygen levels which will aid in the self-purification of dissolved organic pollutants in the water.

Diseases transmitted in water can be avoided by good personal hygiene. Ensuring that village have access to year-round groundwater supplies for drinking will ensure that D&I channels are not used for potable purposed. Villages should also have sufficient pit latrines to ensure that open defecation in or near the channels does not occur. These measures, coupled with hygiene education, could be put in place by suitable NGOs as a mitigation component of the project.

2.10.6 Risks to Project Viability

The project is essentially neutral. It will make relatively little change to the existing environmental situation in this area o the Southwest Region.

TABLE 2.51

Multi Criteria Impact Assessment

CHENCHURI BEEL FCD (PRE - FEASIBILITY)											
ENVIRONMENTAL COMPONENT	Impact Analysis : Multi - Criteria Values										
	+5	+4	+3	+2	+1	+0	-1	-2	-3	-4	-5
PHYSICAL / CHEMICAL											
PC 1 Erosion of river banks											
PC 2 FCD works											
PC 3 Containment of flood											
PC 4 Intervention land loss											
PC 5 Change in Salinity											
PC 6 Change in water quality											
PC 7 Dredging impacts											
BIOLOGICAL / ECOLOGICAL											
BE 1 Floodplain fisheries											
BE 2 Spawn / shrim capture											
BE 3 River fisheries											
BE 4 Shrimp / fish culture											
BE 5 Social forestry											
BE 6 Sundarbans											
BE 7 Wildlife / bio-diversity											
SOCIOLOGICAL / CULTURAL											
SC 1 Security of homesteads											
SC 2 Agriculture livelihoods											
SC 3 Fishery livelihoods											
SC 4 Artisanal transport											
SC 5 Commercial transport											
SC 6 Nutrition											
SC 7 Water supplies											
SC 8 Water related disease											
ECONOMIC / OPERATIONAL											
EO 1 Distribution of income											
EO 2 Benefit generation rate											
EO 3 Operational complexity											

vp\chen-tab\tab2.51

The project does however have a link to the Gorai augmentation proposals. Not only will this provide water down the Chitra river (although this is earmarked for Khulna), return flows from upstream agriculture will also down the Nabaganga. These flows may reduce the salinity in the lower Nabaganga, which would be beneficial to irrigation from this river using LLPs. Thus there will be a positive benefit to the Chenchuri Beel Project as a result of Gorai augmentation.

No negative risks to the project have been identified at this stage.

2.10.7 Recommendations for Feasibility Study

A full Environmental Impact assessment (EIA) is necessary at the feasibility study stage.

It is suggested that the feasibility stage EIA should include consideration of the following in addition to the standard assessments made :

(1) peoples' participation to determine the communities/groups that will require project modifications to ensure mitigation from negative impacts.

(2) targeting of viable options for maintenance of river bio-diversity.

(3) consideration of viable options for maintenance of river bio-diversity.

(4) incorporation into project plans of public health measures to include groundwater supplies, sanitation and education on hygiene and vector control.

(5) assessment of the means to maximize transport option in (road and water) through the project.

2.11 TOR for Feasibility Study

2.11.1 Introduction

Chenchuri Beel FCD Project, a mainly flood control and drainage scheme was implemented about 10 years ago to provide security against large scale inundation to a gross area of about 25,560 ha with the objective to increase agriculture production. This objective has not yet been achieved and a FAO/World Bank Report (1989) identified the need for further improvement to drainage; increase in irrigation supply and the introduction of an appropriate O&M system. The proposed Chenchuri Beel Rehabilitation Project is aimed at meeting these needs.

2.11.2 Project

The existing scheme is located in thanas Narail, Lohagora and Kalia of Narail District. The area is adjacent to other similar existing FCD projects: Bamankhali-Barnali FC Sub-project to the north, Singia Nebugati Beel Drainage Scheme and the Barnal-Salimpur Kolabashukhali Project to the southwest and southeast, respectively and the Madhumati-Nabaganga Project to the north east. The project area is surrounded by the rivers Chitra and Nabaganga.

The corner of the project area nearest to Jessore is about 33 km to the southwest, and a metalled road in reasonable condition leads to this point. However, the need to use a ferry to cross the Chitra to reach the project makes the area comparatively remote.

The World Bank's Hardcore Programme Report of February 1973 recommended certain criteria for selection of flood control projects which would contribute to a rapid increase in food production, be self contained and would eliminate the problems of salinity, flooding and drainage congestion. On the basis of this, the original project was identified by FAO/World Bank, appraised by a mission in 1978 and implemented in 1982/83. A project completion report relating to this scheme was prepared by FAO/World Bank in 1987 (revised 1989) after a field assessment and records review.

The proposed development considers the provision of drainage facilities to a total gross area of about 25,560 ha (NCA = 18930 ha) which includes an area of 1030 ha under the recently completed Chenchuri Irrigation Project.

It is proposed to adopt the concept of compartmentalisation as evolved by FAP20 and the project area will be divided into 14 sub-compartments. The contribution of compartmentalisation and controlled drainage in transforming the deeply flooded areas (F2, F3 & F4) into lands of moderate flooding has been assessed under the pre-feasibility study and its conclusion is that, out of 40% of the total area which are presently deeply flooded 23% will be converted into relatively low flooded (F0 and F1) areas and 7% moderately flooded (F2) categories.

In order to achieve maximum benefit, irrigation will be provided by a system of low level network of canals with LLPs. It is expected that the cropping intensity for the whole project area will increase from 148% to 191%.

A preliminary economic analysis carried out show the project to be economically viable with an EIRR of nearly 31%.

Capture fisheries has been a major employment before the original project was completed. The capture fisheries catch area reduced from 14,000 ha to about 9,000 ha after the completion of the Project in 1986/87 as most of the perennial beels were turned into seasonal beels and converted into rice fields. Although capture fisheries will continue to

decline it is proposed to include a substantial element for developing culture fisheries as part of the Project.

O & M and Institutional aspects were studied at the pre-feasibility stage and some recommendations have been made. This will be further studied with the people's participation and detailed recommendations will be made.

The preliminary limited social survey conducted during the pre-feasibility study stage revealed that the average income levels to the project area (Tk 3334) are much lower than the Southwest Area and the national average (Tk 8400). The Project area is characterised by high level of poverty and low employment. The Project hopefully will bring benefits to these people who are in the vulnerable groups and an extensive study of social aspects including ways of income generation and income distribution will be studied.

An Initial Environmental Examination (IEE) was carried out during the pre-feasibility study stage and the conclusion is that on balance the project will be largely neutral and the negative impacts could be mitigated. A full Environmental Impact Assessment (EIA) is proposed at the feasibility study stage.

2.11.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-economical, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Hydraulic Designs

Carryout detailed study of the drainage of the area and review the basic concepts of compartmentalisation as proposed in the pre-feasibility study. Analyse each sub-compartment and design appropriate drainage models including structures. Design of new embankments should take into account existing villages, settlements etc and land acquisition must be kept to a minimum.

Assess the ground water and surface water potential and propose options for providing irrigation facilities including conveyance canals and structures. In designing the irrigation

and drainage works, future operation and maintenance should be taken into account which should be easy to operate and maintain with minimum of expertise, by the beneficiaries.

Study the impact of the proposed Gorai Augmentation Project on the Project and prepare outline proposals for future expansion.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPVs. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

3 PADMA - KUMAR SCHEME

3.1 Introduction

General

The proposed integrated development covers a gross area of 51,000 ha and involves the provision of flood control and drainage to a total net cultivable area of 39,000 ha and irrigation facilities to 31,000 ha within the protected area. The location of the proposed scheme is shown in Figures 1.1 and 3.1.

The scheme could form the first stage in the integrated development of most of the areas bounded by the Padma rightbank, Madhumati left bank, MB route canal and the road linking Kamarkhali with Faridpur (PUs SW6 and SW7). The development of the remaining areas outside this scheme would have to depend on any future dry season augmentation of the Gorai/Madhumati River.

Present Status

The project area, which is mainly referred to as the Low Ganges Floodplain on the basis of an agro-ecological definition, is generally a low lying basin southwest of Faridpur. Only about 12% of the area remains free of any inundation during an average monsoon, while about 50% stays inundated to depths exceeding a metre. The area also includes parts of the Faridpur Comprehensive Drainage Scheme (Area II), which are in need of rehabilitation. During the 1987 and 1988 floods most of the area was inundated and remained so for long periods. The Padma right bank embankment has been extended upto the Arial Khan mouth under the Food for Work Programme since the 1988 over bank flooding. However, gaps have been left in the extension reach to incorporate sluice/flush gates, when funds become available.

According to the BARC soil survey, the top soils are generally light textured having predominantly moderate permeability. Estimates based on MPO data, CIDA survey information (1991) and the Consultant's data collection, indicate that about 18% of the total area is presently under irrigated agriculture, particularly in support of HYV Aus crop. In the other areas, rainfed agriculture is generally practiced (local varieties of Aus/Aman, Jute, etc).

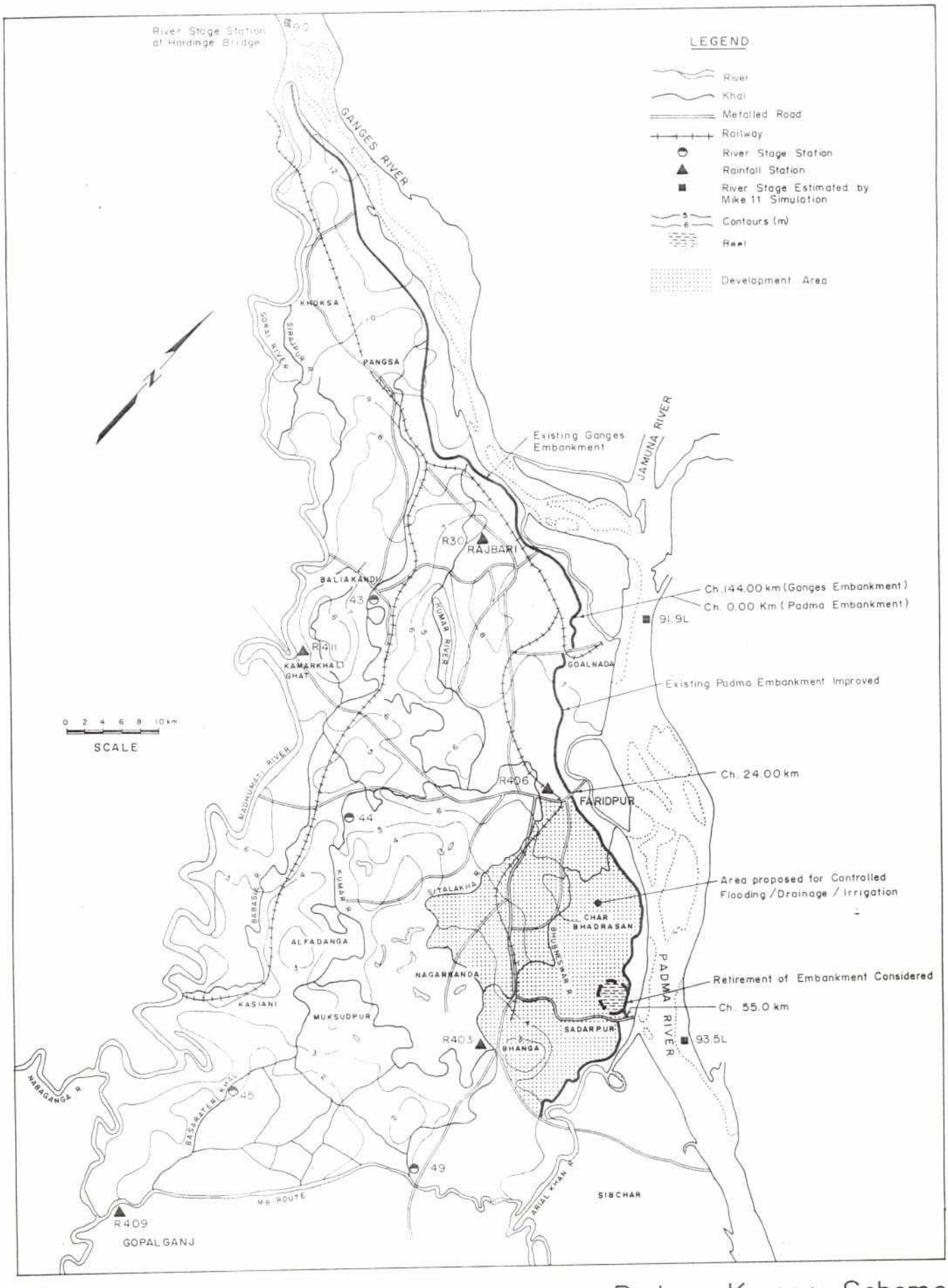
Objectives

Taking into account the regular flooding/inundation of large areas to depths exceeding a metre and the relatively low productivity in Boro/Rabi cultivation, the proposed integrated development would allow the farmers to practice controlled flooding, controlled drainage or irrigation to suit their requirements, ie increase cropping intensity and yields by adopting a better water management. Another important objective is to make better use of the existing beels for fish production and for conserving extra water from the monsoon to irrigate some adjacent areas during the subsequent Boro/Rabi season.

Relevant Previous Studies

IECO's South West Regional Plan (1980) had identified potential schemes (Eastern Irrigation Compartments) for immediate stage development, which fall within the proposed project area. Improvement of drainage of the Kumar basin was studied under the Second Small Scale Flood Control, Drainage and Irrigation Project (1991-92) and the design for a small FCDI scheme (about 7,000 ha) bordering the north bank of MB canal is in progress. FAP 25 has carried out flood modelling of the major river systems, including the Ganges and the Padma and the study Report (June 1992) has provided information on extreme flood events

Figure 3.1



Padma - Kumar Scheme
Stage - 1

and recommendations on flood embankment crest design levels. In addition, FAPs 1, 9B and 21 have examined different embankment protective measures and FAP 20 has studied the compartmentalisation concept.

3.2 Hydrology and Hydraulics

Hydrology

Analysis of the rainfall records of the five stations in the vicinity of the project area (R-30 at Rajbari, R-403 at Bhanga, R-406 at Faridpur, R-409 at Haridaspur and R-411 at Madhukhali) and other neighbouring stations, show that the mean annual rainfall for the area is about 1800 mm and the maximum monthly rainfall during this mean year is 371 mm in July. The 80% dependable monthly rainfall figures for the five stations, given below, show that an Aus crop would require supplementary irrigation during the first half of its cropping season (ie in April and May)

Station	80% Dependable Rainfall (mm)				
	Feb	March	April	May	June
Rajbari R-30	0	0	55	123	185
Bhanga R-403	0	3	70	95	251
Faridpur R-406	0	4	68	166	225
Haridaspur R-409	0	0	40	89	221
Madhukhali R-411	0	0	13	78	214

Maximum 10 day cumulative rainfall values relating to certain selected return intervals were determined on the basis of a frequency analysis of the daily rainfall records and are as follows:

Station	10 Day Cumulative Rainfall (mm) Return Periods (Years)			
	2	5	10	20
Rajbari R-30	275	380	460	546
Bhanga R-403	277	368	428	486
Faridpur R-406	264	362	427	489
Haridaspur R-409	317	412	475	535
Madhikhali R-411	271	393	473	550

The relevant predictions of water levels of extreme flood events for the Ganges and Padma, which were obtained from the FAP 25 study, are as follows:

Stations	Rivers	River Levels (m PWD)Return Periods (Years)			
		10	25	50	100
Hardinge Bridge	Ganges	14.86	14.96	15.02	15.09
Baruria	Padma	8.86	9.16	9.39	9.63
Mawa	Padma	6.41	6.68	6.90	7.13

An examination of the above extreme water levels indicates that the difference between the 25 year and 100 year levels is 0.13 m for the Ganges at Hardinge Bridge and about 0.46 m for the Padma (between Baruria and Mawa). The FAP 25 study has assigned an indicative return interval for the 1988 flood event as 55 and 58 years at Baruria and Mawa, respectively.

A preliminary estimate of the present status of inundation in the project area due to drainage congestion and/or overbank spilling of the Padma was made on the basis of the relevant MPO data, CIDA survey data (1991) and the Consultant's 1992 field information. The areas under different depths of inundation (F0 = less than 0.3m; F1 = 0.3m to 0.9m; F2 = 0.9 to 1.8m; F3 = 1.8m to 3.6m and F4 > 3.6m), are tabulated below together with the expected extent of inundation (indicative only) if compartmentalisation is adopted in the project area to allow controlled drainage.

Planning Unit	Area (ha)	Existing Inundation (ha)				Post -Project Inundation (ha)		
		F0	F1	F2	F3/4	F0	F1	F2
SW 7	39,000	4100	10700	13600	10600	19500	17500	2000

The mean monthly dry weather flow levels in the Ganges, at the Chandana River intake structure, vary and are too low compared with the bank level and the corresponding farming lands (10 m - 7 m PWD) for gravity abstraction of irrigation water. The mean dry weather flow in the Padma generally follows a route away from the right bank at the location of the Kumar intake near Faridpur (about 5 km away) and, therefore, a gravity abstraction from the Padma to support any irrigation scheme in the neighbourhood is not feasible or sustainable. A series of floating pumps along the Padma and the Arial Khan has been considered.

A preliminary examination of the groundwater potential in the project area shows that there is some scope for increased utilisation in Planning Unit SW7 and SC1. However, additional field investigation would have to be carried out, particularly to assess the impact of increased groundwater utilisation on the existing rural water supply.

Hydraulics

Considering the existing irrigated agriculture in the project area, the groundwater and surface water potentials and constraints, the proposed development of additional irrigation facilities is as follows:

Floating Pump (surface water) - 6,000 ha
Tubewell (groundwater) - 24,000 ha

An initial assessment of some of the beels in the project area shows that they could be improved by deepening and by providing containment bunds and used for conserving increased amounts of rainfall runoff. The conserved water could have a multipurpose use, ie fisheries development and irrigation of small local areas (a total of 1000 ha) for Rabi/Boro cropping.

3.3 Engineering

The planning of the integrated development, including the outline design of some of the components of the engineering works, have been carried out based on the relevant hydrology and hydraulics information and on the BWDB/FCDIII design criteria. The proposed development would include the resectioning of existing 67 km embankment on the Padma right bank (from east of Rajbari to the Arial Khan mouth) and provision of sluice/flushing gates to allow controlled flooding and drainage; the provision of about 25 floating pumps

at selected locations on the Padma and the Arial Khan and each having upto 300 l/s capacity; the improvement of the existing network of khals, drains, streams, etc and the provision of additional canals/drains for the distribution of the irrigation water, totalling up to 112 km; the construction of additional drains to enhance the existing drainage outside the irrigation area (about 60 km) and the improvement of the beels. The network of rural roads (with culverts, etc) while included and costed, has yet to be identified in detail.

It should be noted that, while the cost of STWs has been allowed for in the costings, it is presumed these would be provided by the users.

3.4 Economic Analysis

The Padma - Kumar Scheme lies in PU SW7 and SC1, would have a gross area of 51,000 ha and a NCA of 39,000 ha. The following Table provides a breakdown of the flood categories , rainfed and irrigated areas.

Padma - Kumar : Crop Areas Without and With Development

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed :					
SW 7	3400	8800	11200	8800	32,200
Irrigated :					
SW 7	700	1900	2400	1800	6800
Total	4100	10700	13600	10600	39000
With Project					
Rainfed :					
SW 7	4000	3600	400	0	8000
Irrigated:					
SW 7	15500	13900	1600	0	31000
Total	19500	17500	2000	0	39000

Source : Consultant's estimates based on MPO data.

The present cropped area and their division between rainfed and irrigated production have been derived from data for each PU, assuming that the same proportions apply to the project area. Future areas with the proposed development include 31,000 ha of irrigation and 8,000 ha rainfed, which will benefit from FCD only.

Costs

The capital cost, which include 25% physical contingencies and 15% for administration, are estimated at M Tk 955 (M Tk 611 at economic values), equivalent to Tk 24,500/ha over the 39,000 ha NCA.

In common with most other SWA schemes there will be a 14% foreign exchange (FE) component in the capital costs, approximately M Tk 119. This is predominantly for the

floating pumps and STWs. The earthworks will have no FE component as they will be constructed using local labour with some mechanical compaction.

Recurrent annual and O and M costs, at full development, will total M Tk 126 or say Tk 3230 /ha. The economic value would be M Tk 88, excluding the value of land lost to earthworks etc which is included as an opportunity cost in the economic analysis. The breakdown of capital and economic costs is shown in the following Table, while the economic conversion factor and other base assumptions are given in Appendix 2.

Padma - Kumar : Capital and Recurrent Costs (1991 Prices)

	Project Year					Total
	1	2	3	4	5	
Financial (M Tk)						
Capital Cost:						
FCD :						
Land acquisition	80	83				163
Earthworks	60	77				137
Structure	30	73				103
Irrigation/Drainage:						
STW/floating pumps (1)		74	90	100		264
Earthworks	45	45	30			120
Structure		40	60	68		168
Sub Total	215	392	180	168		955
Recurrent Cost (O & M):						
STW/floating pumps (1)			31	70	113	
Earthworks		3	6	7	8	
Structure			2	4	5	
Sub Total		3	39	81	126	
Economic (M Tk)						
Capital Cost:						
Earthworks	72	84	21			177
Structure	23	87	46	53		209
STW/floating pumps		63	77	85		225
Sub Total	95	234	144	138		611
Recurrent Cost (O & M):						
STW/floating pumps (1)			21	48	78	
Earthworks		2	4	5	6	
Structure			2	3	4	
Land loss (2)		10	20	30	30	
Sub Total		12	47	86	118	

Source : Consultant's estimates
Note : (1) Pumping cost all diesel
(2) Opportunity cost of land lost to works, 5% value of production foregone.

Benefits

As described in Appendix 2 benefits would be generated by changes in cropping patterns resulting from reclassification of areas between the different flood categories (F0, F1 etc), from the elimination of damage to crops from unusual flood events and from year round irrigation.

Changes in Cropping Patterns and Irrigation

The changes in flood categories are tabulated in the first Section of 3.4. The value of the without and with project production and the incremental benefits expected from the scheme are given in the following Table which also includes the benefits from the irrigated areas developed under the project.

Padma - Kumar : Crop Production Benefits from FCD and Irrigation (1991 Economic Values)

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed :					
Unit Benefit (Tk/ha)					
SW 7	11168	8408	7084	5609	
Total Benefit (M Tk)					
SW 7	38	74	79	50	241
Irrigated:					
Unit Benefit (Tk/ha)					
SW 7	33083	27346	19239	17545	
Total Benefit (M Tk)					
SW 7	23	52	46	32	153
TOTAL	61	126	125	82	394
With Project					
Rainfed :					
Unit Benefit (Tk/ha)					
SW 7	11168	8408	7084	5609	
Total Benefit (M Tk)					
SW 7	45	29	3		77
Irrigated:					
Unit Benefit (Tk/ha)					
SW 7	33083	27346	19239	17545	
Total Benefit (M Tk)					
SW 7	513	380	31		924
TOTAL	558	409	34		1001
Incremental Benefit M Tk					607

Source : Consultant's estimates based on MPO data. Crop areas given in an earlier table.

Reduction in Flood Damage

Appendix 2 discusses the extent of damage that has been reported in SWA between 1971 and 1989. The average annual damage has been estimated as M Tk 28 at 1991 economic values.

The sum of the incremental benefits from the agricultural production and the reduced flood damages is M Tk 635, which is used in the cash flow analysis.

Benefit Build Up

The build up of benefits would follow the deployment of STWs and floating pumps and development of the gravity distribution system. Benefits from FCD and irrigation will be after three years from the start of development of each area, with the following overall result:

	Project Years						
	1	2	3	4	5	6	7
Percent final	-	-	6	29	65	93	100
Benefit (M Tk)			38	184	413	590	635

Change in Fisheries Production

Floodplain fisheries are expected to be reduced by M Tk 102 annually once the FCD embankments are complete. The estimate is on the assumption that F2 and F3/4 lands lost would not be available for fishing and that the remaining F2 areas would provide a reduced catch.

The estimated areas lost would be:

	F2	F3/4	Total
Present (ha)	43640	30270	73910
Future (ha)	6600	-	6600
Complete loss to fisheries (ha)	37040	30270	67310
Partial loss (ha)	6600	-	6600

The value lost would be:

67310 ha @ Tk 1360	=	M Tk 91.55
6600 ha @ Tk 733	=	M Tk 4.84
		M Tk 96.39

There are about 730 ha of beels and baors in the scheme area of which some may be fully lost to fisheries and 547 ha would face reduced output. The annual value of these water when MTk 5.69, added to flood plain losses, will result in about M Tk 102 to be set against the forecast increase in crop production.

Padma - Kumar : Benefit - Cost Cash Flow

Year	Costs (M Tk)				Incremental Benefits (M Tk)
	Capital	O&M and Production	Fish Loss	Total	
1	95	0	0	95	0
2	234	12	0	246	0
3	144	47	60	251	38
4	138	86	90	314	184
5	0	118	102	220	413
6	0	118	102	220	590
7	0	118	102	220	635
8	0	118	102	220	635
9	0	118	102	220	635
10	150	118	102	370	635
11	0	118	102	220	635
12	0	118	102	220	635
13	0	118	102	220	635
14	0	118	102	220	635
15	0	118	102	220	635
16	0	118	102	220	635
17	150	118	102	370	635
18	0	118	102	220	635
19	0	118	102	220	635
20	0	118	102	220	635
21	0	118	102	220	635
22	0	118	102	220	635
23	0	118	102	220	635
24	150	118	102	370	635
25	0	118	102	220	635
26	0	118	102	220	635
27	0	118	102	220	635
28	0	118	102	220	635
29	0	118	102	220	635
30	0	118	102	220	635

EIRR %	32.5
NPV (12%)	1339.81
NPV Costs	1844.55
NPV benefits	3184.36
B/C	1.73

Source : Consultant's estimates.

The project is expected to result in an EIRR of 32.5 % and at a 12 % discount rate, a NPV of M Tk 1340, the B/C ratio would be 1.73.

Sensitivity analyses were carried out with the following results:

	EIRR %	NPV (12%) M Tk	B/C ratio
Capital costs x 1.2	29.0	1231	1.63
Recurrent costs x 1.2	30.1	1202	1.61
Total costs x 1.2	25.1	971	1.44
Benefits x 0.8	23.9	703	1.38
Benefits delayed 2 years	19.4	659	1.36
Total costs x 1.2 and Total benefits x 0.8	21.1	595	1.30
Base Analysis	32.5	1340	1.73

The project appears robust.

3.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 3.1, from which it is evident that the project shows a wide spread of positive and negative benefits, which extend into the moderately negative range. There should be some positive benefits with respect to flood protection and artisanal transport may be improved by the extension and rehabilitation of the embankments. The distribution of income and the rate of benefit achievement also appears to be positive.

On the negative side there are likely to be important impacts for which mitigation requirements are uncertain at this stage. For example, the impact on floodplain fisheries would increase the pressures on stock recruitment and little in the way of mitigation is obvious at present. The abstraction of groundwater for irrigation would need more study as to actual locations in order to determine its impact and on the means and costs of possible mitigation, as it may have a significant impact on local rural supplies. Also bricks and aggregate requirements could seriously impact on the local village grove timber production which may extend to areas outside the project boundaries.

Changes would be expected in water quality due to more intensive agriculture and both river fisheries and inland beel fisheries could expect reduced production, with complementary losses in fishery livelihoods. The pumping and irrigation components of the scheme would increase operational complexity and O&M requirements. Land losses would be relatively small though in areas of local to the embankments and some problems with water related disease may occur, which will require remedial measures.

Table 3.1

Padma - Kumar Scheme - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection				X							
PC/2 River channel works						X					
PC/3 Containment of river floods						X					
PC/4 Intervention of land loss							X				
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality								X			
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration									X		
BE/2 Spawn/shrimp larvae capture						X					
BE/3 River & estuarine fisheries								X			
BE/4 Shrimp & fish culture								X			
BE/5 Social forestry/village groves											
BE/6 Plantation forests						X			X		
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads				X							
SC/2 Agricultural livelihoods				X							
SC/3 Fishing livelihoods								X			
SC/4 Artisanal transport						X					
SC/5 Commercial transport						X					
SC/6 Nutrition				X							
SC/7 Potable water supplies									X		
SC/8 Water related disease											
SC/9 Social/cultural sites											
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income				X							
EO/2 Rate of benefit generation				X							
EO/3 Operational complexity								X			

3.6 TOR for Feasibility Study

3.6.1 Introduction

The proposed integrated development covers a gross area of 51,000 ha and involves the provision of flood control and drainage to a total net cultivable area of 39,000 ha and irrigation facilities to 31,000 ha within the protected area.

The scheme could form the first stage in the integrated development of most of the areas bounded by the Padma right bank, Madhumati left bank, MB route canal and the road linking Kamarkhali with Faridpur. The development of the remaining areas outside this scheme would have to depend on any future dry season augmentation of the Gorai/Madhumati River.

3.6.2 Project

The project area, which is mainly referred to as the Low Ganges Floodplain on the basis of an agro-ecological definition, is generally a low lying basin southwest of Faridpur. Only about 12% of the area remains free of any inundation during an average monsoon, while about 50% stays inundated to depths exceeding a metre. The area also includes parts of the Faridpur Comprehensive Drainage Scheme (Area II), which are in need of rehabilitation. During the 1987 and 1988 floods most of the area was inundated and remained so for long periods. The Padma right bank embankment has been extended upto the Arial Khan mouth under the Food for Work Programme since the 1988 floods. However, gaps have been left in the extension reach to incorporate sluice/flush gates, when funds become available.

According to the BARC soil survey, the top soils are generally light textured having predominantly moderate permeability. Estimates based on MPO data, CIDA survey information (1991) and preliminary surveys, indicate that about 18% of the total area is presently under irrigated agriculture, particularly in support of HYV Aus crop. In the other areas, rainfed agriculture is generally practiced (local varieties of Aus/Aman, Jute, etc).

Taking into account the regular flooding/inundation of large areas to depths exceeding a metre and the relatively low productivity in Boro/Rabi cultivation, the proposed integrated development would allow the farmers to practice controlled flooding, controlled drainage or irrigation to suit their requirements, ie increase cropping intensity and yields by adopting a better water management. Another important objective is to make better use of the existing beels for fish production and for conserving extra water from the monsoon to irrigate some adjacent areas during the subsequent Boro/Rabi season.

IECO's South West Regional Plan (1980) had identified potential schemes (Eastern Irrigation Compartments) for immediate stage development, which fall within the proposed project area. Improvement of drainage of the Kumar basin was studied under the Second Small Scale Flood Control, Drainage and Irrigation Project (1991-92) and the design for a small FCDI scheme (about 7,000 ha) bordering the north bank of MB canal is in progress. FAP 25 has carried out flood modelling of the major river systems, including the Ganges and the Padma and the study Report (June 1992) has provided information on extreme flood events and recommendations on flood embankment crest design levels. In addition, FAPs 1, 9B and 21 have examined different embankment protective measures and FAP 20 has studied the compartmentalisation concept.

The Project involves the completion and upgrading of existing Padma R.B. embankment (about 67 km) and improving drainage in the areas behind the embankment by controlled flooding and controlled drainage. Irrigation during the dry season will be provided by a series of floating pumps along the Padma and the Arial Khan rivers. Existing beel areas will

be improved by deepening and providing containment bunds. The conserved water will be used for a variety of purposes including fisheries and dry season agriculture.

3.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-economical, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Carryout a survey of the existing Padma R.B. embankment including cross-sections at every 25 metres. Carryout investigations to assess the condition of foundation of the existing embankment.

Hydraulic Designs

Review the designs of the existing embankment (about 67 km) and carryout revised designs to BWDB/FCD III design criteria.

Study the existing drainage pattern of the Project Area and carryout drainage design models using the concept of compartmentalisation including provision of sluices, flushing gates etc for controlled flooding and drainage.

It is proposed to provide about 25 floating pumps (capacity about 300 l/s) at suitable locations on the Padma and the Arial Khan. By means of surveys select suitable locations for the pumps and carryout designs for intake canals and other network of canals and drains including structures. Additional drains would be required to improve the existing drainage and improvement of beels.

The project also proposes to use STW for irrigation and guidelines of site selection, location etc would be required.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Carryout an assessment of the beel areas that could be used for agriculture as well as fisheries. Assess the benefits to be included in the economic analysis.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Propose ways of improving the beel areas for capture and culture fisheries and recommend appropriate species, etc. for stocking.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPVs. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

4 NARAIL FCDI SCHEME

4.1 Introduction

General

The proposed Narail FCDI scheme is located in the thanas Narail and Abhaynagar and also covers parts of the Planning Unit (PU) SW 10. The scheme is adjacent to the following projects : Chenchuri Beel Drainage project to the east, the Dhalgram Bara Khal Regulator scheme and the Chitra - Bhairab - Afra project, the Jhenaidah -Khulna Road to the West and the Singia - Nabugati project to the south. The gross area of the scheme is about 35,100 ha with a net cultivable area of 27,000 ha. The location of the scheme is shown in Figure 1.1.

Present Status

The proposed scheme area suffers from the overbank spill and drainage congestion problems due to surface runoff. From the ground elevations and water levels for a typical average year (1982), it is apparent that the proposed scheme would be flooded by an overbank flow of 1 m PWD.

The proposed scheme is situated in the Low Ganges Flood Plain and Peat Basins agro-ecological region and the percolation rates in the development area is generally within the low to medium range. The land category of the scheme area is generally within the F_2 land type. About 2,000 ha is already under irrigated agriculture.

Objectives

The objective of the proposal is to introduce an integrated development in the area by incorporating measures for enhanced water utilisation for agriculture, fisheries (in beels), etc. The measures would allow the beneficiaries to have controlled flooding/drainage and irrigation.

Previous Studies

There have been no studies for this particular area.

4.2 Hydrology and Hydraulics

Hydrology

There is one rainfall station at Narail (R-461) adjacent to the scheme area which indicates the mean annual rainfall is about 1718 mm. The maximum and minimum rainfall values of this mean year are 339 mm (July) and 8 mm (January) and the 80% dependable annual rainfall is 790 mm. Frequency analysis of storms for 10 day maximum cumulative rainfall (mm) gives the following return periods:

Station	10 Day Cumulative Maximum Rainfall (mm) Return Period (years)				
	2	5	10	20	50
Narail (R-461)	297	404	471	533	610

An estimate of the present areas of inundation in the study area has been made on the basis of MPO data, CIDA survey data (1991) and the Consultant's 1992 field information. The areas under the different depths of inundation (F_0 = less than 0.3 m; F_1 = 0.3 to 0.9 m; F_2 = 0.9 to 1.8 m; F_3 = 1.8 to 3.6 m and F_4 > 3.6 m) are given in the following Table. The Table also shows the reduced areas that might be achieved after the proposed measures for controlled flooding/drainage are introduced.

PU NO	Area (ha)	Existing Inundation Areas (ha)				Post-Project Inundation Area (ha)		
		F0	F1	F2	F3+4	F0	F1	F2
SW10	27000	5240	6370	12000	3390	10620	15300	1080

Hydraulics

The proposed scheme is encircled by the Chitra and Bhairab rivers, both of which are tidal. According to the results from the model studies (MIKE 11), in April (month of the lowest river levels), the Chitra (Station 39) and the Bhairab (Station 36) rivers have the following average 10 day maximum, minimum and mean levels:

River	Chitra	Bhairab
Type of Data	Water Level (m PWD)	Water Level (m PWD)
Average of 10 day Maximum	1.27	1.43
Average of 10 day Minimum	-0.03	-0.11
Average of 10 day Mean	0.60	0.61

Ground levels along the Chitra vary from 3.5 to 1.5 m PWD and thus abstraction from these two rivers would be possible by a low level network of canals/drains. The water would propagate laterally into the area under tidal influence and farmers could also use water from these two rivers for dry season irrigation by using LLPs. Salinity concentrations at the abstraction locations of these two river lie within the tolerance limits of crops even in the dry season. The hydraulics of the proposed scheme would be improved by incorporating dwarf embankments with water control structures to provide localised storage, preventing the water moving quickly to the outfalls.

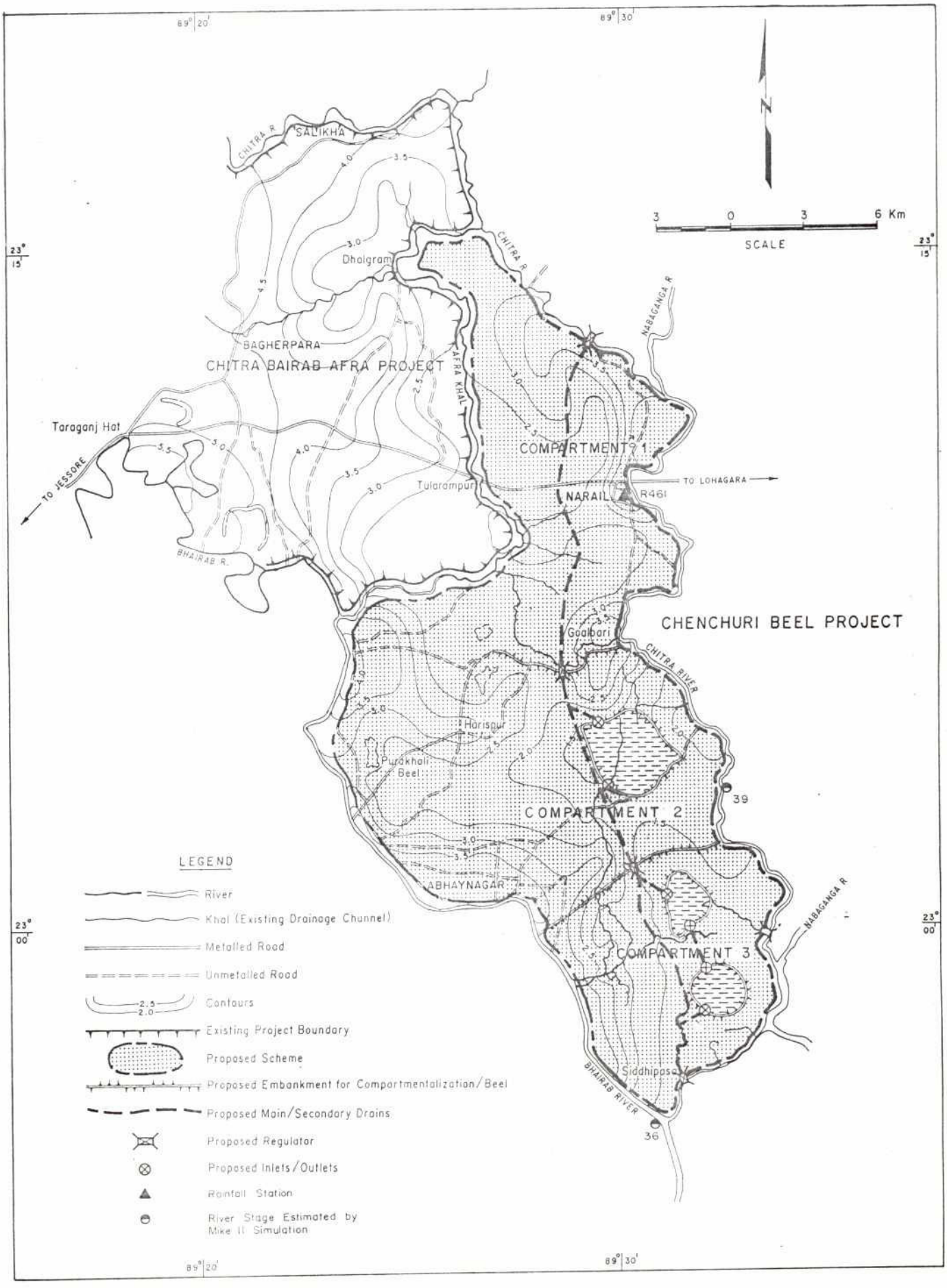
4.3 Engineering

The proposed scheme would have to be protected from flooding mainly by Chitra river and this could be achieved by constructing 2.5 m high embankments along the right bank of Chitra. Bank levels of Bhairab are generally high but embankments would need to be raised to the design crest level in local areas.

The area would be subdivided into several small compartments to ensure localised retention of surface runoff for improving drainage and irrigation. Drainage congestion in the lower pockets would also be improved.

Surface water abstraction by LLP would be used to increase the irrigated area in the dry season and in the wet season in emergencies. The localised poldering by dwarf embankment would provide a more equitable distribution of water to the scheme areas, and could be abstracted from the Chitra and Bhairab rivers.

Figure 4.1



Narail FCDI Scheme

The existing beels within the proposed development area would be excluded from the drainage system. They would, however, be connected to the water conveyance system (canals/drains) for the purpose of supplying them with water to suit any fishery development programmes. This would be achieved through controlled flooding.

Beneficiary participation is an important aspect and would be taken into account from the planning to implementation stages and could be introduced in the project formulation process. A project layout map is given in Figure 4.1.

4.4 Economic Analysis

Introduction

The proposals for the Narail FCDI Project cover a gross area of 31,500 ha with a NCA of 27,000 ha all within PU SW 10, allowing full flood control and drainage together with irrigation using LLPs will be developed. The present and future areas of flood classes within the 27,000 ha NCA are as follows :

Crop Areas without and with Development (ha).

Planning Unit	Flood Class				Total (ha)
	F0	F1	F2	F3/4	
Without Project					
Rainfed					
SW 10	4360	5330	11070	2750	23510
Irrigated					
SW 10	880	1040	940	630	3490
Total	5240	6370	12010	3380	27000
With Project					
Rainfed					
SW 10	3140	4540	320	-	8000
Irrigated	7480	10740	780	-	19000
SW 10					
Total	10620	15280	1100		27000

Source: Consultant's estimates.

The present cropped areas and their division between rainfed and irrigated production, have been derived from data for the whole PU, assuming that the same proportions apply to the project area.

Costs

The capital cost, including 25% physical contingencies and 15% engineering/admin provisions, will be M Tk 649 (M Tk 399 at economic values), equivalent to Tk 24037/ha. In common with most other SWA FCD/I schemes, the foreign exchange (FE) content is low and earthworks will be constructed using local labour with some mechanical compaction. The FE requirement is estimated at M Tk 28.08 for the LLPs. In the costings it has been

assumed that there will be some electric powered pumps and a general ratio of one electric to eight diesel powered LLPs has been taken.

Recurrent and O & M costs at full development will total M Tk 121.8 annually (M Tk 107.20 at economic values), almost Tk 4511/ha. The breakdown of capital and economic costs is shown in the following Table and the economic conversion factor and other base assumptions are presented in Appendix 2.

Capital and Recurrent Costs 1991 Prices.

	Project Year			Total
	1	2	3	
Area (ha) lost (2)	783	1755	1755	
Financial (M Tk)				
Capital Cost:				
Land acquisition	61	47	0	108
FC Embankment:				
Earth works	72	0	0	72
Structure	18	0	0	18
Irrigation/Drainage:				
Pumps: LLP/STW	0	54	0	54
Earth works	58	112	0	170
Structure	81	146	0	227
Sub Total	290	359	0	649
Recurrent Cost (O & M):				
Pumping LLP/STW	0	0	109.62	
Earth work	0	3.88	7.24	
Structure	0	1.98	4.90	
Sub Total	0	5.86	121.76	
Economic (M TK)				
Capital Cost:				
Earth works	89.42	77.00	0.00	166.42
Structure	76.23	112.27	0.00	188.50
Pumps : LLP/STW	0.00	44.06	0.00	44.06
Sub Total	165.65	233.33	0.00	398.98
Recurrent Cost (O & M):				
Pumping : LLP/STW (1)	0.00	0.00	82.76	
Earth works	0.00	2.68	4.99	
Structure	0.00	1.53	3.76	
Land loss (2)	6.98	15.64	15.64	
Sub Total	6.98	19.85	107.15	

Source: Consultant's estimates.

Note : (1) Tk/Ha pumping cost, 1 electric to 8 diesel
(2) opportunity cost of land lost to works, 5% value of production foregone

Benefits

As described in Appendix 2, benefits will be generated by FCD from changes in cropping patterns resulting from redistribution of areas between the different flood categories (F0, F1 etc), by the elimination of damage to crops from unusual flood events and from year round irrigation.

Changes in Cropping Patterns

The changes in flood categories are shown in this section's first Table. The value of the without and with project production and the incremental benefits expected from the scheme are given in the same Table. It is expected that in general farmers will take two years to adapt to the new FCD conditions and that the use of LLP will rapidly build up over the same period. The rate of build up used in the analyses is:

Project Year	Cumulative percent
3	30
4	80
5	100

Benefit will begin to be realised in project year 3, once construction is complete and the management is set in place. The benefits will accrue as follows:

	Year		
	3	4	5
Percent	30	80	100
M Tk	82	220	275

Reduction in Flood Damage

Appendix 2 discusses the extent of damage that has been reported in SWA between 1971 and 1989. For the SW10 PU, in the Narail Project area, the average annual damage has been estimated as M Tk 6.81 at 1991 economic values.

This figure has been included in the analyses from year three immediately after the FCD works are completed, bringing total annual benefits to M Tk 275.00. The origin of the benefits is given in the following Table :

Crop Production Benefits from FCD and Irrigation (1991 Economic Values).

	Flood class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed:					
Tk/ha	11412	10275	5716	5069	
Area ha	4360	5330	11070	2750	23510
Value M Tk	49.76	54.76	63.28	13.94	181.74
Irrigated:					
Unit Benefit (Tk/ha)	23109	22501	12161	5736	
Area (ha)	880	1040	940	630	3490
Total Benefit (M Tk)	20.33	23.40	11.43	3.61	58.77
Total (M Tk)	70.09	78.16	74.71	17.55	240.51
With Project					
Rainfed:					
Tk/ha	11412	10275	5716	5069	-
Area ha	3140	4540	320	-	8000
Value M Tk	35.83	46.65	1.83	-	84.31
Irrigated :					
Unit Benefit (Tk/ha)	23109	22501	12161	5736	
Area (ha)	7480	10740	7800	-	26020
Total Benefit (M Tk)	172.86	241.66	9.49	-	424.01
Total Benefit (M Tk)	208.69	288.11	11.32	-	508.32
Incremental Benefit M Tk	138.86	159.42	(65.22)	(17.55)	267.81
Flood damage reduction					6.81
Total incremental benefit					274

Source: Consultant's estimates.

Change in Fisheries Production

Floodplain fisheries are expected to be reduced by M Tk 20.14 annually when the FCD embankments are complete. The estimate is on the assumption that F2 and F3/4 land lost will not be available for fisheries and that the remaining F2 areas will provide a reduced catch. The estimated areas lost will be:

	F2		F3/4		Total
present ha	12000		3390		15390
future ha	1100	-		1100	
complete loss to fisheries ha		12000		3390	15390
partial loss ha		1100		-	1100

The value of the lost areas will be :

15390 ha at Tk 1360 = M Tk 18.73
1100 ha at Tk 733 = M Tk 0.79

M Tk 19.52

There are about 80 ha of beels and baors in the scheme area of which a quarter may be fully lost to fisheries and 60 ha will face reduced output. The annual value of these waters, when M Tk 0.62 is added to flood plain losses, will result in about M Tk 20.14 to be set against the forecast increase in crop production.

Economic Evaluation

The Table that follows gives the benefit cost flow for the FCDI Project.

Benefit Cost flow (1991 Economic Values)

Year	Costs (M Tk)				Incremental Benefits (M Tk)
	Capital	O & M Production	Fish Loss	Total	
1	165.65	6.98	10.07	182.7	0.00
2	233.33	19.85	20.14	273.32	0.00
3	0	107.15	20.14	127.29	82.00
4	0	107.15	20.14	127.29	220.00
5	0	107.15	20.14	127.29	275.00
6	0	107.15	20.14	127.29	275.00
7	0	107.15	20.14	127.29	275.00
8	0	107.15	20.14	127.29	275.00
9	44.06	107.15	20.14	171.35	275.00
10	0	107.15	20.14	127.29	275.00
11	0	107.15	20.14	127.29	275.00
12	0	107.15	20.14	127.29	275.00
13	0	107.15	20.14	127.29	275.00
14	0	107.15	20.14	127.29	275.00
15	0	107.15	20.14	127.29	275.00
16	44.06	107.15	20.14	171.35	275.00
17	0	107.15	20.14	127.29	275.00
18	0	107.15	20.14	127.29	275.00
19	0	107.15	20.14	127.29	275.00
20	0	107.15	20.14	127.29	275.00
21	0	107.15	20.14	127.29	275.00
22	0	107.15	20.14	127.29	275.00
23	44.06	107.15	20.14	171.35	275.00
24	0	107.15	20.14	127.29	275.00
25	0	107.15	20.14	127.29	275.00
26	0	107.15	20.14	127.29	275.00
27	0	107.15	20.14	127.29	275.00
28	0	107.15	20.14	127.29	275.00
29	0	107.15	20.14	127.29	275.00
30	44.06	107.15	20.14	171.35	275.00

EIRR %	21.00
NPV (12%)	359.73
NPV costs	1219.63
NPV benefit	1579.35
B/C ratio	1.29

Source: Consultant's estimates.

The project is expected to result in an EIRR of 21 % and, at a 12% discount rate a NPV of M Tk 359.73, and the B/C ratio will be 1.29.

Sensitivity analyses were carried out with the following results:

	EIRR %	NPV (12%) M Tk	B/C ratio
Capital costs x 1.2	18.9	287	1.22
Recurrent costs x1.2	18.3	219	1.16
Total costs x 1.2	15.6	116	1.08
Benefits x 0.8	14.9	44	1.04
Benefits delayed 2 years	12.8	24	1.02
Total costs x 1.2 and benefits x 0.8	11.7	-28	0.98
Base analysis	21.0	359.73	1.29

4.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 4.1. The project shows a number of negative aspects, with relatively few offsetting benefits. On the positive side the project is expected to increase agricultural livelihoods and nutrition within the project area, as well as showing an expected high rate of benefit achievement and ease of operation.

Negative impacts relate to the expected moderately negative impact on floodplain, the river and beel fisheries in the area. Slight negative impacts are expected with respect to land losses and agrochemical impact. Local impacts on the village grove timber supplies relate to concerns over the brick requirements for aggregate for structures, which themselves, would also have a negative impact on artisanal boat transport. There are also concerns over the possibility of an increases in water related disease.

Table 4.1

Narail Scheme - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection					X						
PC/2 River channel works						X					
PC/3 Containment of river floods					X						
PC/4 Intervention of land loss							X				
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality							X				
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration									X		
BE/2 Spawn/shrimp larvae capture						X					
BE/3 River & estuarine fisheries								X			
BE/4 Shrimp & fish culture								X			
BE/5 Social forestry/village groves							X				
BE/6 Plantation forests						X					
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads					X						
SC/2 Agricultural livelihoods				X							
SC/3 Fishing livelihoods						X					
SC/4 Artisanal transport							X				
SC/5 Commercial transport						X					
SC/6 Nutrition				X							
SC/7 Potable water supplies							X				
SC/8 Water related disease											
SC/9 Social/cultural sites											
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income					X						
EO/2 Rate of benefit generation				X							
EO/3 Operational complexity				X							

4.6 TOR for Feasibility Study

4.6.1 Introduction

The proposed Narail FCDI scheme is located in the thanas Narail and Abhaynagar. The scheme is adjacent to the following projects: Chenchuri Beel Drainage project to the east, the Dhalgram Bara Khal Regulator scheme and the Chitra - Bhairab - Afra project, the Jhenaidah -Khulna Road to the West and the Singia -Nabugati project to the south. The gross area of the scheme is about 35,100 ha with a net cultivable area of 27,000 ha.

The area suffers from the overbank spill and drainage congestion problems due to surface runoff. From the ground elevations and water levels for a typical average year, it is apparent that the proposed scheme would be flooded by an overbank flow of 1 m PWD.

4.6.2 Project

The proposed scheme is situated in the Low Ganges Flood Plain and Peat Basins agro-ecological region and the percolation rates in the development area is generally within the low to medium range. The land category of the scheme area is generally within the F_2 land type. About 2,000 ha is already under irrigated agriculture.

The objective of the proposal is to introduce an integrated development in the area by incorporating measures for enhanced water utilisation for agriculture, fisheries (in beels), etc. The measures would allow the beneficiaries to have controlled flooding/drainage and irrigation.

The proposed scheme would have to be protected from flooding mainly from Chitra river, and this could be achieved by constructing 2.5 m high embankments along the right bank of Chitra. Bank levels of Bhairab are generally high and existing embankments would need to be raised to the design crest level in local areas.

The area would be subdivided into several small compartments to ensure localised retention of surface runoff for improving drainage and irrigation. Drainage congestion in the lower pockets would also be improved.

Surface water abstraction by LLPs would be used to increase the irrigated area in the dry season and in the wet season for supplementary irrigation. The localised poldering by dwarf embankment would provide a more equitable distribution of water to the scheme areas, and could be abstracted from the Chitra and Bhairab rivers.

The existing beels within the proposed development area would be excluded from the drainage system. They would, however, be connected to the water conveyance system (canals/drains) for the purpose of supplying them with water to suit any fishery development programmes. This would be achieved through controlled flooding.

Beneficiary participation is an important aspect and would be taken into account from the planning to implementation stages and will be introduced in the project formulation process.

4.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-economical, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Carryout longitudinal and cross-sectional survey of existing embankments.

Hydraulic Designs

Review existing design of embankments and upgrade if necessary. Design of new embankments should take into account existing villages, settlements etc and land acquisition must be kept to a minimum.

Carryout detailed study of the drainage of the area and review the basic concepts of compartmentalisation as proposed in the pre-feasibility study. Analyse each sub-compartment and design appropriate drainage models including structures.

Assess the ground water and surface water potential and propose options for providing irrigation facilities including conveyance canals and structures. In designing the irrigation and drainage works, future operation and maintenance should be taken into account which should be easy to operate and maintain with minimum of expertise, by the beneficiaries.

Study the impact of the proposed Gorai Augmentation Project on the Project and prepare outline proposals for future expansion.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPVS. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

5 ARIAL KHAN - BISARKANDI SCHEME

5.1 Introduction

General

The proposed scheme, which is in Planning Units (PU) SC 1 and SC 3 is located on the right bank of the Arial Khan and covers parts of Sibchar, Rajair, Madaripur and Kalkini thanas of Madaripur District; Bhanga (Faridpur District); Kotwalipara (Gopalganj District); Agailjhora and Gournadi thanas of Barisal District. It lies 6 km to the north of Satla-Bagda Project and west of Kalkini FCD project. The gross area of the scheme is about 93,630 ha, with a net cultivable area (NCA) of 72,000 ha of which 47,000 ha is considered for irrigation. The location of the scheme is shown in Figure 1.1 and a project layout map (Figure 5.1) gives the alignments/locations of the major development works.

Present Status

The area is situated within the agro-ecological zone referred to as the Lower Ganges River Floodplain. It has a relatively flat relief with ground level varying from 5.0 m (PWD) in north-east to 1.0 m in the south-west. During an average monsoon, due to overbank spilling of the Arial Khan and the local rainfall runoff, about 50% of the area is inundated to depths exceeding a metre, which stays for periods of 6 to 8 weeks. In 1987 and 1988 almost the entire area remained inundated for long periods.

Estimates from field data indicate that irrigated agriculture in the NCA covers about 15,600 ha (12,000 ha is based on surface water and 3,600 ha on groundwater) and mainly relates to Boro cultivation. Predominantly local varieties are cultivated (Aus/Aman) during the monsoon period.

According to the BARC soil survey, the top soil in the project area is generally medium textured, having predominantly medium permeability.

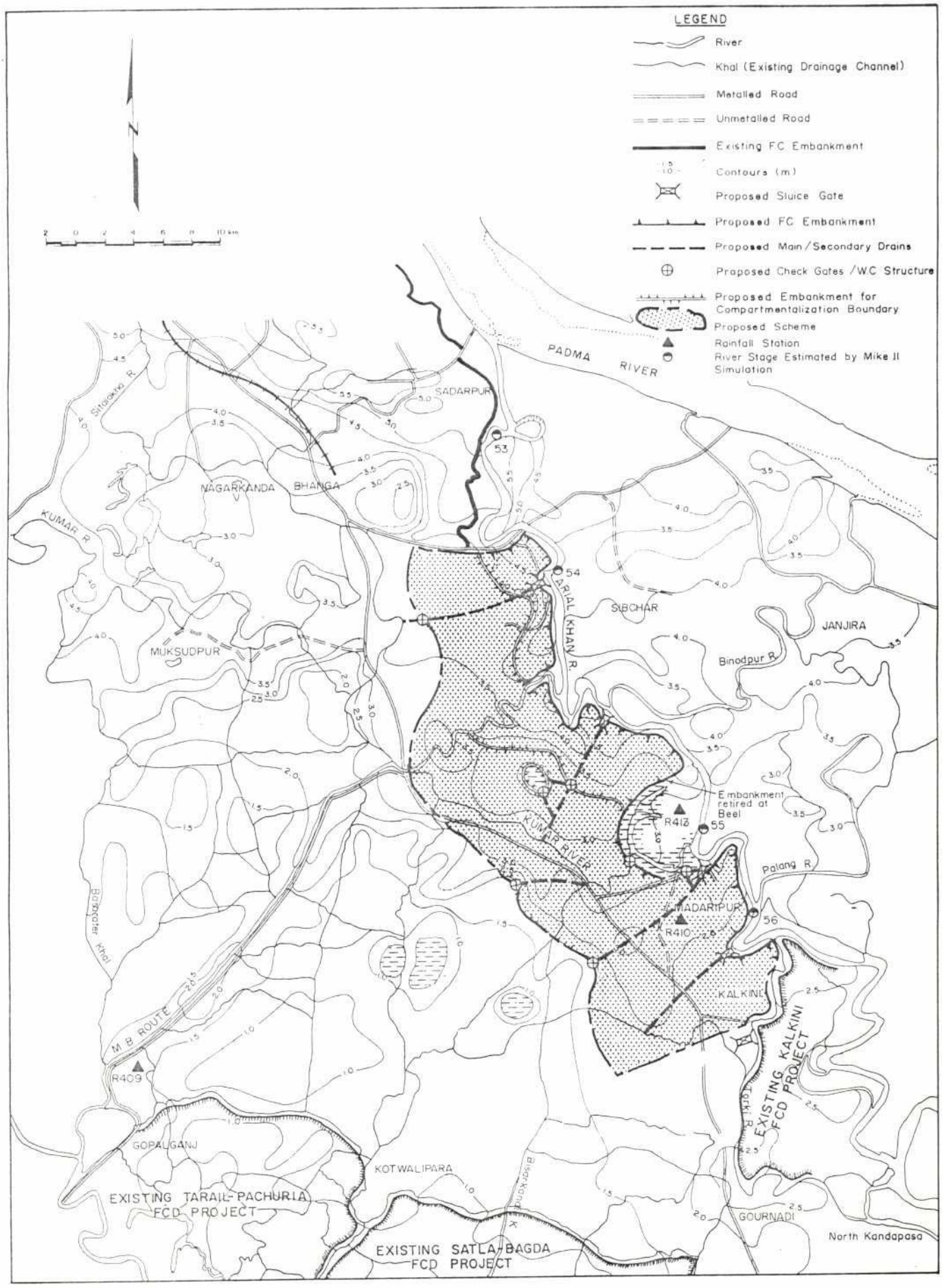
Objectives

The regular flooding of the area during the monsoon and the low (extent) of Boro/Rabi cultivation due to the scarcity of an affordable mode of irrigation in the area, has restricted agricultural development. Thus, it is proposed to introduce an integrated scheme that would allow the farmers to practice controlled flooding, controlled drainage and irrigation to suit their requirements ie to extend cropping season, increase cropping intensity and improve annual yields. Another important objective of the development is to make better use of the existing beels for fish production and conserving extra water for subsequent use in irrigation during the dry season.

Previous Studies

IECO in its feasibility study report (South West Regional Plan, Dec 1980) recommended the early development of a large drainage complex on the right bank of the Arial Khan, north of Barisal and this proposal could form an integral part of the much larger IECO drainage complex. A potential project (Ramsil Kafulbari: 7,000 ha), which was identified by BWDB in a feasibility study carried out in 1987 lies within the area proposed in this report.

Figure 5.1



Arial Khan - Bisarkandi Scheme

5.2 Hydrology and Hydraulics

Hydrology

Analyses of rainfall records of the three stations in the vicinity of the project area (R-409 at Haridaspur, R-410 at Madaripur and R-413 at Palong) and other neighbouring stations indicate that the mean annual rainfall for the area is about 1960 mm. Also, during this mean year, July receives the maximum rainfall (380 mm) and January has the lowest (8 mm). Maximum 10 day cumulative rainfall values relating to different return intervals were determined on the basis of a frequency analysis of the daily rainfall records and are tabulated below :

10 Day Cumulative Rainfall for Different Return Periods (mm)

Rainfall Station No	Return Periods (years)			
	2	5	10	20
R 409	317	412	475	535
R 410	310	414	482	548
R 413	308	430	511	588

Arial Khan River is one of the main regional rivers and, being an important distributary of the Padma, was an integral part of the hydraulic model used in this study. Flow simulations using the available water level and discharge records and follow-on frequency analyses give the following maximum water levels relating to selected return periods for the Arial Khan at four locations (stations) :

Station No	Chainage (km)	Maximum Water Levels (m PWD) Return Periods (years)			
		2	5	10	20
53	9.0	6.47	6.85	7.07	7.27
54	30.5	5.47	5.81	6.01	6.17
55	53.0	4.65	4.93	5.08	5.20
56	64.0	4.41	4.67	4.82	4.95

The maximum water level of the Arial Khan at Madaripur (Station 55) during the 1988 floods was 5.59 m (PWD), which would equate to a return period of about 1 in 50 years.

Project areas under different depths of inundation (defined in Section 10.4) have been estimated based on MPO and CIDA flood survey data and are as follows:

PU	Project Area (ha)	Existing Inundation Area (ha)				Post-Project Inundation Area (ha)		
		F0	F1	F2	F3 + F4	F0	F1	F2
SC 1	48240	6910	19070	19060	3200	19300	26330	2610
SC 3	23760	2320	10200	8030	3210	9310	12930	1520

The flow simulation analyses also provided water level data corresponding to the 10 day (consecutive days) average of the daily maximum, minimum and mean water levels for April 1982 (river levels are the lowest in April and 1982 is considered an average flood year). The average water levels are as follows:

Station No	Chainage (km)	10 Day Average Water Level (m PWD)		
		Maximum	Minimum	Mean
53	9.0	2.15	1.92	2.03
54	30.5	1.64	1.48	1.57
55	53.0	1.48	0.95	1.17
56	64.0	1.47	0.80	1.10

It is apparent from the above Table that the tidal influence on the Arial Khan is greatest in the south. For example, at the most northerly station (chainage 9.0 km), the difference between the average maximum (high tide) and minimum (low tide) water levels in April (1982) is 0.23 m, while at chainage 64.0 km it is 0.67 m.

The Arial Khan has flows exceeding 120 cumecs even during the driest month in 1982. The Bisarkandi, however, mainly brings in water to the project area that it receives from the larger rivers (Swarupkati and Madhumati) during high tide.

Recorded salinity levels in the Arial Khan and Bisarkandi Rivers are relatively low, ie the average maximum salinity in the dry months is less than 500 micro-Mhos and thus much lower than the tolerance limit for irrigation.

Preliminary studies of groundwater in the project area shows a potential for further utilisation for irrigated agriculture. However, additional investigation needs to be carried out, particularly to assess its impact on the existing rural water supply facilities, before it could be implemented.

After consideration of the estimated present irrigation, groundwater and surface water potentials and constraints, the following development of additional irrigated areas only is proposed :

Planning Units (ha)	SC 1	SC 3	Total
Net (irrigable) Areas	31330	15670	47000
Areas under existing irrigation			
- groundwater	1330	670	2000
- surface water	4600	2300	6900
Recommended Areas			
- groundwater	14670	7330	22000
- surface water	16670	8330	25000

While significant areas of beels will be lost as a result of reduced flooding, preliminary assessment of some of them show that they could be improved ie by conserving increased amounts of rainfall runoff for irrigation following Boro/Rabi crop and enhancing fisheries development. It is estimated that beel water conservation could irrigate a total area of about 2,400 ha.

The peak surface water requirement for irrigating the remaining 30,000 ha is 36 cumecs of which 20 cumecs and 16 cumecs would come from the Arial Khan and Bisarkandi, respectively.

5.3 Engineering

The integrated development and outline design of some of the major components of the engineering works have been carried out based on the relevant hydrologic/hydraulic information and on the BWDB/FCD III design criteria.

The project would provide a 52 km long interior embankment, about 3 m high, along the right bank of the Arial Khan. It would incorporate four gates for water intake; a low level network of canals/drains of varying sizes having a total length of about 490 km to distribute the irrigation water in the dry season and dispose the drainage in the monsoon; compartmentalisation; STWs and LLPs; and water control structures. The network of rural roads (with culverts, etc), while included and costed, has yet to be identified in detail.

5.4 Economic Analysis

Introduction

The Arial Khan - Bisarkandi scheme has a gross area of 93,630 ha and provide full FCD for a NCA of 72,000 ha, within which year round irrigation would be established for a NCA of 47,000 ha. The physical development of the scheme would be phased over four years. Irrigation would mainly be surface using LLPs, 39,300 ha, but there will be STWs for a NCA of 7,700 ha. As shown in the following Table, the projects 93,630 ha gross area falls within two PUs; SC 1 and SC 3. The Table compares the areas of flood classes before and after the proposed development.

Arial Khan Bisarkandi Scheme : Crop Areas (ha)

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed :					
SC 1	6080	15200	13780	2540	37600
SC 3	2230	7830	5780	2960	18800
Sub Total	8310	23030	19560	5500	56400
Irrigated:					
SC 1	570	3680	5520	630	10400
SC 3	260	2380	2120	440	5200
Sub Total	830	6060	7640	1070	15600
TOTAL	9140	29090	27200	6570	72000
With Project					
Rainfed :					
SC 1	6670	8960	1040	-	16670
SC 3	3150	4440	740	-	8330
Sub Total	9820	13400	1780	-	25000
Irrigated:					
SC 1	12530	17230	1570	-	31330
SC 3	6270	8620	780	-	15670
Sub Total	18800	25850	2350	-	47000
TOTAL	28620	39250	4130	-	72000

Source : Consultant's estimates derived from MPO data.

The rainfed and irrigated areas which are derived from MPO data for each of the three PUs will change as shown below:

Percent total NCA	Rainfed	Irrigated
Before development	78%	22%
After development	35%	65%

Land of flood classes F0 and F1 would increase by over 50% from 35,900 to 68,100 ha. With the equivalent decline in areas of deeped floodig, F2 and F3/4, the latter would be eliminated under the development proposals.

Costs

Capital costs spread over four years would total M Tk 1587, equivalent to Tk 22040 /ha NCA at 1991 financial prices and inclusive of 25% physical contingencies and 15% for administrative costs. The breakdown of the costs and the economic cost (M Tk 1039) is given in the following Table. The STWs and LLPs to be installed would all be diesel powered. Earthworks and structures would largely be constructed using local labours though some machine compaction is provided for in the costings.

The estimated foreign exchange component is M Tk 131 for the STW and LLP components.

Annual recurrent and O and M costs at full development would be M Tk 238 (M Tk 220 at economic values), equivalent to Tk 3300 /ha. Direct crop production costs are included in the benefit figures, which are based on crop gross margins under the different cultivation regimes.

Five percent of the gross area is expected to be lost permanently to physical works ie an area of 4680 ha with an annual economic value of M Tk 54. The NCA included in the scheme is net of this area.

Benefits

As described in Appendix 2, benefits would accrue from:

- changes in cropping resulting from alterations in flood conditions
- irrigation and
- elimination of damage done by unusual flood events.

The changes in the areas of the different flood classes was shown earlier in an earlier Table, as was the change in the irrigated area that would occur. The results of these changes is set out in the following Table.

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Arial Khan - Bisarkandi Scheme. Capital and Recurrent Costs

	Project Year					Total
	1	2	3	4	5	
Area (ha) Lost	796	2153	3511	4681	4681	
Financial (M Tk)						
Capital Cost						
Land acquisition	70	60	45	30	0	205
FC Embankment:						
Earthworks	35	45	0	0	0	80
Structure	152	13	0	0	0	165
Irrigation/Drainage:						
STW	0	0	121	121	0	242
LLP	0	0	24	26	0	50
Earthworks	70	116	116	104	0	406
Structure	0	122	150	167	0	438
Sub Total	327	356	456	448	0	1587
Recurrent Cost (O & M)						
LLP	0	0	0	86	172	
STW	0	0	22	50	50	
Earthworks	0	2	6	8	10	
Structure	0	0	2	4	6	
Sub Total	0	2.55	30.15	147.58	237.55	
Economic (M Tk)						
Capital Cost						
Earthworks	79.61	120.90	70.38	64.10	0	332
Structure	117.39	106.57	109.40	123.96	0	457
Pumping station	0.00	0.00	0.00	0.00	0	0
LLP	0.00	0.00	22.00	21.00	0	43
STW	0.00	0.00	103.00	102.00	0	205
Sub Total	197	227	304	311	0	1039
Recurrent Cost (O & M)						
Pumping (2): LLP	0	0	0	60.50	121.01	
STW	0	0.00	15.45	34.34	34.34	
Earthworks	0.00	1.59	3.97	5.42	6.71	
Structure	0.00	0.18	1.51	2.90	4.44	
Land loss	9.20	24.88	40.57	54.09	54.09	
Sub Total	9.20	26.66	61.51	157.26	220.59	

Source : Consultant's estimates (see Main Report Appendix 2 for economic conversion).

(1) Land lost to earthworks. Valued in the economic analysis at its opportunity cost.
(2) All diesel powered STWs and LLPs.

Arial Khan - Bisarkandi Scheme Benefit - Cost Flow at 1991 Economic Values

Year	Costs				Incremental Benefits
	Capital	Receipt	Fish Loss	Total	
1	197.00	9.20	0.00	206.20	0.00
2	227.00	26.66	23.84	277.50	0.00
3	304.00	61.51	47.67	413.18	114.00
4	311.00	157.26	47.67	515.93	384.00
5	0.00	220.59	47.67	268.26	613.00
6	0.00	220.59	47.67	268.26	673.00
7	0.00	220.59	47.67	268.26	902.00
8	0.00	220.59	47.67	268.26	902.00
9	0.00	220.59	47.67	268.26	902.00
10	76.20	220.59	47.67	344.46	902.00
11	78.72	220.59	47.67	346.98	902.00
12	0.00	220.59	47.67	268.26	902.00
13	0.00	220.59	47.67	268.26	902.00
14	0.00	220.59	47.67	268.26	902.00
15	0.00	220.59	47.67	268.26	902.00
16	0.00	220.59	47.67	268.26	902.00
17	76.20	220.59	47.67	344.46	902.00
18	78.72	220.59	47.67	346.98	902.00
19	0.00	220.59	47.67	268.26	902.00
20	0.00	220.59	47.67	268.26	902.00
21	0.00	220.59	47.67	268.26	902.00
22	0.00	220.59	47.67	268.26	902.00
23	0.00	220.59	47.67	268.26	902.00
24	76.20	220.59	47.67	344.46	902.00
25	78.72	220.59	47.67	346.98	902.00
26	0.00	220.59	47.67	268.26	902.00
27	0.00	220.59	47.67	268.26	902.00
28	0.00	220.59	47.67	268.26	902.00
29	0.00	220.59	47.67	268.26	902.00
30	0.00	220.59	47.67	268.26	902.00

EIRR %	33.70
NPV (12%)	2122.13
NPV costs	2453.14
NPV benefits	4575.27
B/C ratio	1.87

Source : Consultant's estimates.

The project is forecast to achieve a EIRR of 33.70 with a NPV (at 12%) of M Tk 2122 and B/C ratio of 1.87.

Arial Khan-Bisarkandi Scheme : Crop Production Benefits from FCD and Irrigation (1991 Economic values)

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Scheme					
Rainfed :					
Unit Benefit (Tk/ha)					
SC1	12658	8568	7548	6442	
SC3	15720	10419	6932	5482	
Total Benefit (M Tk)					
SC1	76.96	130.23	104.01	16.36	327.57
SC3	35.06	81.58	40.07	16.23	172.93
Sub Total (M Tk)	112.02	211.81	144.08	32.59	500.50
Irrigated :					
Unit Benefit (Tk/ha)					
SC1	38709	29805	18531	12478	
SC3	31424	28352	18178	6337	
Total Benefit (M Tk)					
SC1	22.06	109.68	102.29	7.86	241.90
SC3	8.17	67.48	38.54	2.79	108.80
Sub Total (M Tk)	30.23	177.16	140.83	10.65	350.70
TOTAL (M Tk)	126.685	392.178	248.932	63.868	851.20
With Scheme					
Rainfed :					
Unit Benefit (Tk/ha)					
SC1	12658	8568	7548	6442	
SC3	15720	10419	6932	5482	
Total Benefit (M Tk)					
SC1	84.43	76.77	7.85	0.00	169.05
SC3	49.50	46.26	5.13	0.00	100.91
Sub Total (M Tk)	133.93	123.03	12.98	0.00	269.96
Irrigated :					
Unit Benefit (Tk/ha)					
SC1	38709	29805	18531	12478	
SC3	31424	28352	18178	6337	
Total Benefit (M Tk)					
SC1	485.02	513.54	29.09	0.00	1027.66
SC3	197.03	244.39	14.18	0.00	455.60
Sub Total (M Tk)	682.05	757.93	43.27	0.00	1483.26
TOTAL (M Tk)	746.108	838.566	49.945	49.945	1753.22
Incremental Benefit (M Tk)	902.02				

Source: Consultant's estimates. Crop areas given in an earlier table.

The build up of benefit would follow the deployment of LLPs and STWs and development of the gravity distribution system. Benefits from FCD and irrigation will be over two years from when each area is developed with the following overall result.

	Project Year						
	1	2	3	4	5	6	7
Percent final benefit	-	-	13 114	43 384	70 613	75 673	100 903

The total annual incremental benefits to the proposed scheme therefore would be M Tk 902.0.

Change in Fisheries Production

Floodplain fisheries are expected to be reduced by M Tk 45.74 each year when the FCD embankments are made. The estimate is made on the assumption that F2 and F3/4 land lost would not be available for fishing and that the remaining F2 areas will provide a reduced catch.

The estimated areas lost would be:

			Total
	F2	F3/4	
Present ha	25210	10890	36100
Future ha	3900	-	3900
Complete loss to fisheries ha	21310	10890	32200
Partial loss ha	3900	-	3900

The value lost would be :

32196 ha	at Tk 1300	=	M Tk 41.86
3900 ha	at Tk 733	=	M Tk 2.86
			M Tk 44.72

There are about 132 ha of beels and baors in the scheme area of which some may be fully lost to fisheries and 99 ha will face reduced output. The annual value of these waters is M Tk 1.02 and when added to flood plain losses would result in about M Tk 45.74 be set against the forecast increase in crop production.

Economic Analysis

The Table that follows gives the benefit cost flow for the scheme.

Sensitivity analyses are carried out with the following results:

	EIRR %	NPV (12%) M Tk	B/C ratio
Capital costs x 1.2	29.7	1952	1.74
Recurrent costs x 1.2	31.1	1866	1.67
Total costs x 1.2	26.9	1632	1.55
Benefits x 0.8	25.2	1207	1.49
Benefits delayed 2 years	20.1	1144	1.47
Total cost x 1.2 and Total benefit x 0.8	22.4	1037	1.40
Base analysis	33.7	2122	1.87

5.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 5.1, from which it is evident that the project shows few negative features, while providing benefits by improvements in agricultural livelihoods; flood protection; potential improvement in artisanal transport along a new embankment; an early achievement of benefit as well as an improvement in income distribution, through improved irrigated agriculture.

Negative aspects of the scheme should be slight and relate to land loss due to interventions and changes in water quality through more intensive agriculture and use of agrochemicals. Further negative impacts on the floodplain fishery through increased FCD structures are likely, as is some impact on village groves (an indication of the amount of brick and aggregate required and assuming no improvement in the use of timber for brickfields). Potable water supplies may also suffer from some local losses due to the groundwater irrigation component. The scheme is also considered to have a degree of operational complexity, both through O&M requirements and the inter-institutional links necessary for its success.

TABLE 5.1

Arial Khan Scheme - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection						X					
PC/2 River channel works											
PC/3 Containment of river floods					X						
PC/4 Intervention of land loss							X				
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality							X				
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration											
BE/2 Spawn/shrimp larvae capture							X				
BE/3 River & estuarine fisheries						X					
BE/4 Shrimp & fish culture						X					
BE/5 Social forestry/village groves							X				
BE/6 Plantation forests						X					
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads					X						
SC/2 Agricultural livelihoods			X								
SC/3 Fishing livelihoods						X					
SC/4 Artisanal transport				X							
SC/5 Commercial transport						X					
SC/6 Nutrition				X							
SC/7 Potable water supplies							X				
SC/8 Water related disease						X					
SC/9 Social/cultural sites						X					
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income				X							
EO/2 Rate of benefit generation				X							
EO/3 Operational complexity							X				

5.6 TOR for Feasibility Study

5.6.1 Introduction

The Project area covering a gross area of about 93,630 ha is situated within the agro-ecological zone referred to as the Lower Ganges River Floodplain. It has a relatively flat relief with ground level varying from 5.0 m (PWD) in north-east to 1.0 m in the south-west. During an average monsoon, due to overbank spilling of the Arial Khan and the local rainfall runoff, about 50% of the area is inundated to depths exceeding a metre, which stays for periods of 6 to 8 weeks. In 1987 and 1988 almost the entire area remained inundated for long periods.

It is estimated that irrigated agriculture in the NCA covers about 15,600 ha (12,000 ha is based on surface water and 3,600 ha on groundwater) and mainly relates to Boro cultivation. Predominantly local varieties are cultivated (Aus/Aman) during the monsoon period.

According to the BARC soil survey, the top soil in the project area is generally medium textured, having predominantly medium permeability.

The regular flooding of the area during the monsoon and the low extent of Boro/Rabi cultivation due to the scarcity of an affordable mode of irrigation in the area, has restricted agricultural development. Thus, it is proposed to introduce an integrated scheme that would allow the farmers to practice controlled flooding, controlled drainage and irrigation to suit their requirements ie to extend cropping season, increase cropping intensity and improve annual yields. Another important objective of the development is to make better use of the existing beels for fish production and conserving extra water for subsequent use in irrigation during the dry season.

5.6.2 Project

The proposed scheme, is located on the right bank of the Arial Khan and covers parts of Sibchar, Rajair, Madaripur and Kalkini thanas of Madaripur District; Bhanga (Faridpur District); Kotwalipara (Gopalganj District); Agailjhora and Gournadi thanas of Barisal District. It lies 6 km to the north of Satla-Bagda Project and west of Kalkini FCD project. The gross area of the scheme is about 93,630 ha, with a net cultivable area (NCA) of 72,000 ha of which 47,000 ha is considered for irrigation.

IECO in its feasibility study report (South West Regional Plan, Dec 1980) recommended the early development of a large drainage complex on the right bank of the Arial Khan, north of Barisal and this proposal could form an integral part of the much larger IECO drainage complex. A potential project (Ramsil Kafulbari: 7,000 ha), which was identified by BWDB in a feasibility study carried out in 1987 lies within the area proposed.

The project would provide a 52 km long interior embankment, about 3 m high, along the right bank of the Arial Khan. It would incorporate four gates for water intake; a low level network of canals/drains of varying sizes having a total length of about 490 km to distribute the irrigation water in the dry season and dispose the drainage in the monsoon; compartmentalisation; STWs and LLPs; and water control structures.

5.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-ecological, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Carryout surveys along the proposed alignment of the embankments including cross-sections.

Hydraulic Designs

Carryout design of the embankments proposed. When designing embankments care should be taken to take account of existing villages, settlements etc and land acquisition must be kept to a minimum.

Carryout detailed study of the drainage of the area and review the basic concepts of compartmentalisation as proposed in the pre-feasibility study. Analyse each sub-compartment and design appropriate drainage models including structures.

Assess the ground water and surface water potential and propose options for providing irrigation facilities including conveyance canals and structures. In designing the irrigation and drainage works, future operation and maintenance should be taken into account which should be easy to operate and maintain with minimum of expertise, by the beneficiaries.

Study the impact of the proposed Gorai Augmentation Project on the Project and prepare outline proposals for future expansion.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPV's. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

6 SWARUPKATI FCDI SCHEME

6.1 Introduction

General

The scheme area is located 30 km west of Barisal town within the jurisdiction of Swarupkati, Kaukhali and Banaripara thanas of Pirojpur Zila & Wazirpur thana of the Barisal Zila (see Figure 1.1), which fall under FAP-4's Planning Unit (PU) SC4. The scheme area is triangular in shape and bounded on the north by the Jhanjhania khal/Harta Nadi (22.75 km); on the southeast by Saynda/Swarupkati river (33.50 km) and on the southwest by Kaliganga (lower Madhumati) river (30.25 km). All the rivers are tidal and water is free from adverse salinity effects even in the dry season.

Local projects are: Barisal Irrigation Project (BIP) Phase-I to the southeast; Satla Bagda FCD Project to the north and CEP Polders 36/1 & 36/2 to the west of the northern end of SW boundary of the scheme. All of the above projects are separated from this scheme by the rivers.

Gross area of the scheme is 16,910 ha with an approximate net cultivable area of 13000 ha. About 2120 ha of the net area, in PU SC4 is irrigated by LLP and STW.

Present Status

No development programme, except some minor irrigation schemes by LLP/STW, has yet been taken up in the area. The scheme area falls within Ganges Tidal Floodplain of agro-ecological region. The land category is of medium lowland and the soil type is mostly silt loam to silty clay with heavy texture top soil and low permeability. The land is fertile and the major crops of T. Aman, B. Aus, B. Aman, Vegetables and Rabi are grown without irrigation.

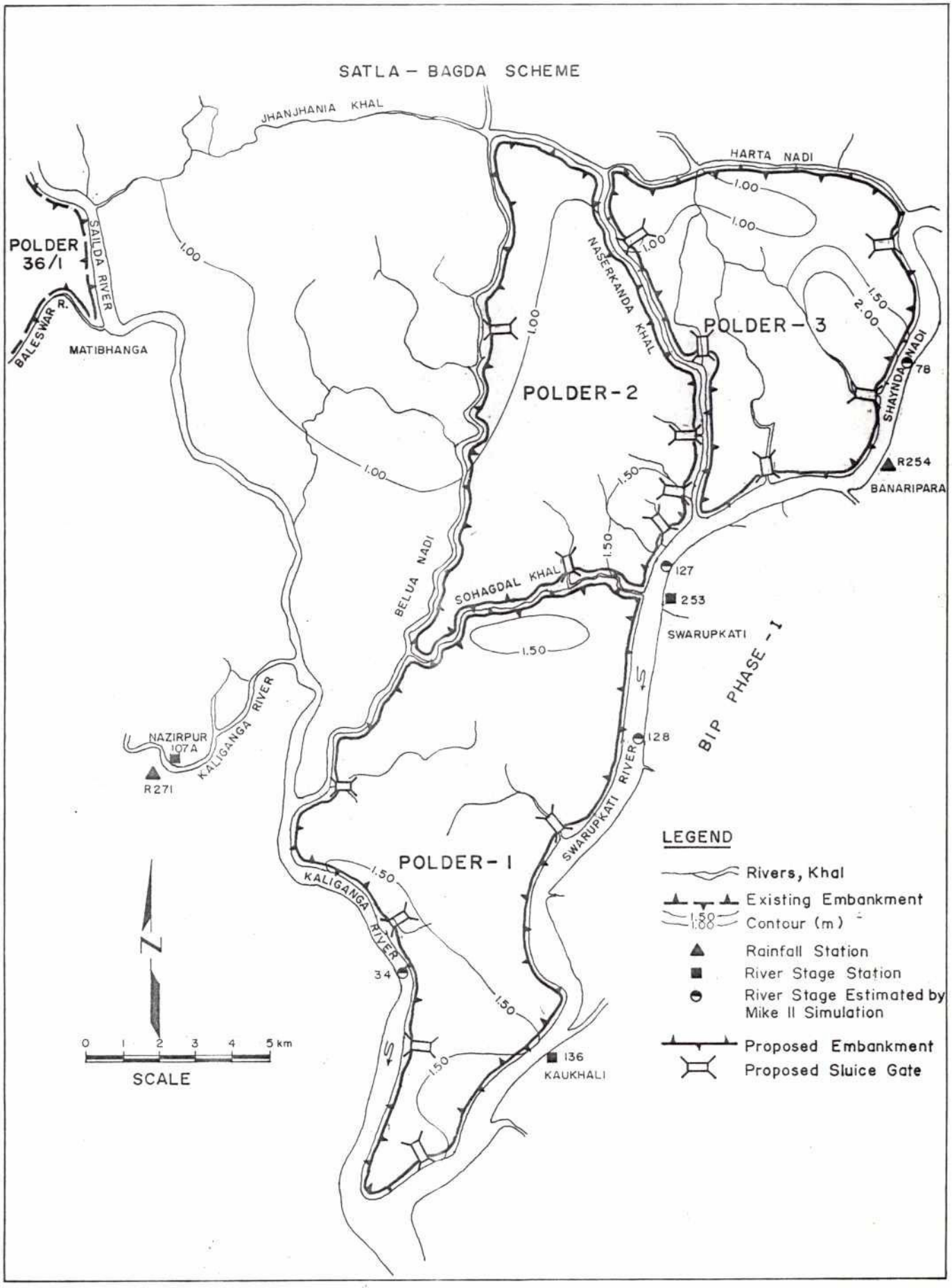
Objectives

The objective of the proposed scheme is the introduction of an integrated development by incorporating appropriate measures for enhanced water utilisation for agriculture, fisheries (if any) etc. The measures would allow the beneficiaries to have controlled flooding/drainage and irrigation by surface water. In particular, the measures would encourage beneficiary and private sector participation by way of local resources mobilisation, while assisting them to achieve the targeted objective.

Previous studies

The scheme area falls into the "Eastern Irrigation Compartment" under a Southwest Regional Plan study conducted by IECO. The area was included in the Gournadi Irrigation Complex under a long term development programme for surface water use from Ganges Barrage (IECO Report, 1980). Also, in the National Water Plan, Phase-II, 1991, this area is recommended for development through a FCDI scheme with irrigation by both surface water and groundwater.

Figure 6. 1



Swarupkati Scheme

6.2 Hydrology and Hydraulics

Hydrology

There is no rainfall station inside the scheme area, but the one at Banaripara (R- 254) is the nearest and thought to be most representative, the Nazirpur station (R- 271) is also adjacent. Analyses from these stations indicates that mean annual rainfall ranges from 2050 mm in north to 2150 mm in the south, thus giving a mean annual rainfall for the area of 2100 mm. Analyses show that the 80% dependable annual rainfall for Banaripara station is 1059 mm, which may be considered valid for this area. It is observed that mean monthly minimum and maximum rainfall for the area (Banaripara station) varies from 7.1 mm (January) to 414.6 mm (July) and most of the rainfall occurs between months of April through October. The frequency analysis for design storm, giving the 10 day maximum rainfall for different return periods, is as follows (Banaripara station):

Station	10 Day Maximum Rainfall (mm) Return Periods (years)					
	2	5	10	20	50	100
Banaripara Station No. 254	330	451	530	605	700	770

An estimate of the present areas of inundation of the project area has been made on the basis of MPO data, CIDA survey data (1991) and the Consultant's 1992 field information. The area under different depths of inundation, together with likely inundated areas after implementation, are given below :

PU	Project Area (ha)	Existing Inundation Area (ha)				Post-project Inundation Area (ha)		
		F0	F1	F2	F3+F4	F0	F1	F2
SC 4	13000	1130	4420	4120	3330	840	11510	650

From the above Table it can be seen that inundation would reduce significantly as a result of incorporating compartmentalisation.

Hydraulics

The hydraulics of the proposed scheme is governed by the adjacent and internal rivers, all of which are tidal. In the Swarupkati there are two hydrometric stations, at Swarupkati (Station No. 253) and at Kaukhali (Station No. 136), and on the Kaliganga there is one at Nazirpur (Station No. 107A). Model studies (MIKE 11) show that yearly mean maximum and minimum water levels of Swarupkati and Kaliganga rivers are 1.42 m and -0.31m and 1.30 m and 0.15 m, respectively.

Instantaneous maximum water levels for various return periods are as follows:

River	Chainage of Section (km)	Levels (m) and Return period (years)					
		2	5	10	25	50	100
Saynda	5.50	2.08	2.19	2.27	2.36	2.43	2.50
Swarupkati	0.00	2.04	2.16	2.24	2.33	2.40	2.46
Kaliganga	21.80	2.20	2.36	2.47	2.63	2.75	2.87

For the average hydraulic year (1982), analyses of 10 day periods for each month indicates that February has the lowest water levels for the Saynda/Swarupkati/Kaliganga rivers. The average maximum, minimum and mean water level of the rivers are as follows :

River	Chainage of Section (km)	Average of 10 day level for February (m PWD)		
		Maximum	Minimum	Mean
Saynda	5.50	0.80	-0.22	0.26
Swarupkati	0.00	1.00	-0.52	0.24
Kaliganga	21.80	1.05	-0.67	0.19

Analyses of the ground levels indicates the area is suitable for gravity flow through a low level network of canals/drains from the rivers but farmers would have to adopt LLP to irrigate their farms. The southern side of the scheme area has, on average, a level of 1.45 m, north eastern and north western sides of the area have an average elevation at 1.30 m and northern centre of the side has a lower elevation at 0.75 m. Average slope of land from three sides towards the north centre of the area is about 1 in 100,000.

Though the surrounding rivers are tidal, their waters are found to be fresh. Data for the saline station at Kaukhali on Swarupkati river show a maximum salinity of 423 mmhos, which is well below the permissible limit for paddy cultivation.

6.3 Engineering

The proposed scheme will promote integrated development in order to achieve the necessary provisions for controlled flooding, controlled drainage, compartmentalisation and irrigation. For controlled flooding, embankments and water control structures are required along the peripheral river bank.

Similarly, drainage systems would also be such that all the run-off need not be drained out and part or all the run-off could be retained for agriculture, fisheries etc. To achieve the necessary benefits, compartmentalisation would be essential and these marginal embankments could be used or developed as roads. Sections of new embankments would be required together with water control structures (regulators, check structures etc) and an irrigation and drainage canal system. The scheme area would be subdivided into three major areas, being separated by internal rivers. Each of these sub-division could be considered as one of four polders which could be developed individually or simultaneously. Irrigation canals would be fed by gravity from the adjacent rivers through water control structures and use would be made of LLPs. The impact of these withdrawals on river salinity requires further study. Land acquisition would be needed.

Any existing beels within the proposed development area would be excluded from the drainage system. They would, however, be connected to the water conveyance system (canals & drains) for fisheries. Major components of the engineering works for the scheme are given in Section 6.4 along with capital cost. Indicative location of structures may also be seen in Figure 6.1.

6.4 Economic Analysis

Introduction

The Swarupkati FCDI project will cover a gross area of 16910 ha in PU SC4. The development involves flood control and drainage measures together with surface irrigation for the whole net cultivable area (NCA) of 13000 ha. The following Table provides a breakdown of the flood categories, rainfed and irrigated within the project area.

Swarupkati FCDI Crop Areas Without and With Development (ha)

Planning Unit	F0	F1	F2	F3/4	Total
Without Project					
Rainfed :					
SC 4	1050	3610	3220	3000	10,880
Irrigated :					
SC 4	85	810	900	325	2120
Total	1135	4420	4120	3325	13000
With Project					
Rainfed :					
SC 4	180	2670	150	-	3000
Irrigated :					
SC 4	640	8860	500	-	10,000
Total	820	11530	650	-	13000

Source : Consultant's estimates based on MPO data.

Costs

The following Table sets out the capital and recurrent costs for the schemes.

Swarupkati FCDI : Capital and Recurrent Costs

Item	Year			Total
	1	2	3	
Area Ha	5330	7670	0	13000
Financial (M Tk)				
Capital Cost:				
Land acquisition	47	29	0.00	76
FC Embankment:				
Earthwork	52	6	0.00	58
Structure	45	6	0.00	51
Irrigation/Drainage:				
Pumps: LLP	0	26	0.00	26
Earthworks	23	59	0.00	82
Structure	34	80	0.00	114
Sub Total	201	206	0.00	407
Recurrent Cost (O & M):				
Pumping LLP	0	0	50.96	
Earthworks	0	1.37	3.34	
Structure	0	0.80	2.51	
Sub Total	0	2.17	56.81	
Economic (M Tk)				
Capital Cost:				
Land acquisition	48.11	69.23	0.00	117.34
Earthworks	51.47	45.24	0.00	96.71
Structure	60.73	65.86	0.00	126.59
Pumps: LLP	0.00	20.14	0.00	20.14
Sub Total	160.31	200.47	0.00	360.78
Recurrent Cost (O & M):				
Pumping : LLP	0	0	41.99	
Earthworks	0.00	0.95	2.30	
Structure	0.00	0.62	1.93	
Sub Total	0.00	1.57	46.22	

Source : Consultant's estimates.

Construction would take place over two years at a financial cost of M Tk 339 (MTk 311 at economic values), which includes a foreign exchange (FE) element of 3% which is made up as follows :

	Local M Tk	FE	Tota	FE %
Earthworks	140.00	-	140.00	-
Structures	165.00	-	165.00	-
Pumps	14.21	11.79	26.00	45.40
Land acquisition	76.00	-	76.00	-
Total (M Tk)	395.21	11.79	407.00	45.40

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Recurrent cost will total M Tk 56.81 each year (M Tk 46.22 economic) with a small FE element of M Tk 1.6 attributed to the operation of the low lift pumps. In these calculations it has been assumed that 25% will be electrically powered and 75% diesel operated.

The costs include 25% for physical contingencies and 15% for engineering and administration costs.

The financial to economic conversion factors are given in Appendix 2.

Benefits

As discussed in Appendix 2, benefits will be generated by FCD from changes in cropping patterns resulting from redistribution of areas between the different flood categories, (F_0, F_1 etc) and from the elimination of damage to crops from unusual flood events (Appendix 2)

Changes in Cropping Pattern

The changes in flood categories were shown earlier in this section and the value of the 'without' and with project production and the incremental benefits expected from the scheme are given in the following Table. It is expected that farmers as a group will take two years to adapt to the new FCD conditions and that the use of LLP will rapidly build up over the same period.

Swarupkati FCDI : Crop Production, Benefits from FCD and Irrigation at 1991 Economic Values

Planning Units	Flood Category				Total
	F_0	F_1	F_2	$F_{3/4}$	
Without Project					
Rainfed :					
Unit Benefit (Tk/ha) SC 4	15934	11163	6956	5235	
Total Benefit (M Tk) SC 4	16.63	40.30	22.40	15.71	95.13
Irrigated :					
Unit Benefit (Tk/ha) SC 4	24589	23406	12334	8693	
Total Benefit (M Tk) SC 4	2.09	18.96	11.10	2.82	34.97
Total (M Tk)	18.72	59.26	33.50	18.53	130.11
With Project					
Rainfed :					
Unit Benefit (Tk/ha) SC 4	15934	11163	6956	5235	
Total Benefit (M Tk) SC 4	2.87	29.81	1.04	-	33.72
Irrigated :					
Unit Benefit (Tk/ha) SC 4	24589	23406	12334		
Total Benefit (M Tk) SC 4	15.74	207.38	6.17	-	229.28
Total (M Tk)	18.61	237.19	7.20	-	263.00
Incremental Benefit M Tk					132.89

Source : Consultant's estimates (crop areas given earlier)

The pattern of build up used in the analyses is

	Annual Percent	Cumulative Pecent	
Project Year	3	20	20
	4	60	80
	5	20	100

Benefits will begin to be realised in project year 3 once construction is complete and management is set in place. The benefits will accrue as follows:

	Year 3	Year 4	5 on
Percent	20	80	100
M Tk	27.0	107.0	134.0

Reduction in Flood Damage

Appendix 2 discusses the extent of damage that has been reported in SWA between 1971 and 1989. For the PU in the Swarupkati Project, the average annual damage has been MTk 1.358 at 1991 economic values.

In the analyses this figure has been included from year three immediately after the FCD works are completed, bringing total annual benefits to MTk 134.0.

Change in Fisheries Production

Floodplain fisheries are expected to be reduced by MTk 8.90 each year when the FCD embankment are made. The estimate is based on the assumption that all F2 and F3/4 land lost will not be available for fishing and that the remaining F2 areas will provide a reduced catch. The estimated economic value lost will be:

	F2	F3/4	Total
Present ha	4100	2680	6780
Future ha	680	-	680
Completly lost to Fisheries ha	3420	2680	6100
Partial loss ha	680	-	680

The value lost will be :

6100 ha @ Tk 1360	=	MTk 8.30
680 ha @ Tk 733	=	MTk 0.50
		MTk 8.80

There are about 12 ha of beels and baors in the scheme area of which a greater number will be fully lost to fisheries and 9 ha will face reduced output. The value of these water when MTk 0.10/year is added to flood plain losses, will result in about MTk 8.90 to be set against the forecast increase in crop production

Swarupkati FCDI : Benefit Cost Flow (1991 Economic Values.)

Year	Costs				Incremental Benefits
	Capital	Receipt	Fish loss	Total	
1	160	0	4.50	164.5	27
2	200.47	1.57	8.90	210.94	107.00
3	0	46.22	8.90	55.12	134.00
4	0	47.79	8.90	56.69	134.00
5	0	47.79	8.90	56.69	134.00
6	0	47.79	8.90	56.69	134.00
7	0	47.79	8.90	56.69	134.00
8	0	47.79	8.90	56.69	134.00
9	20.14	47.79	8.90	76.83	134.00
10	0	47.79	8.90	56.69	134.00
11	0	47.79	8.90	56.69	134.00
12	0	47.79	8.90	56.69	134.00
13	0	47.79	8.90	56.69	134.00
14	0	47.79	8.90	56.69	134.00
15	0	47.79	8.90	56.69	134.00
16	20.14	47.79	8.90	76.83	134.00
17	0	47.79	8.90	56.69	134.00
18	0	47.79	8.90	56.69	134.00
19	0	47.79	8.90	56.69	134.00
20	0	47.79	8.90	56.69	134.00
21	0	47.79	8.90	56.69	134.00
22	0	47.79	8.90	56.69	134.00
23	20.14	47.79	8.90	76.83	134.00
24	0	47.79	8.90	56.69	134.00
25	0	47.79	8.90	56.69	134.00
26	0	47.79	8.90	56.69	134.00
27	0	47.79	8.90	56.69	134.00
28	0	47.79	8.90	56.69	134.00
29	0	47.79	8.90	56.69	134.00
30	20.14	47.79	8.90	76.83	134.00

Source : Consultant's estimates

EIIR % = 29.60
NPV (12%) = 275.25
NPV Costs = 687.72
NPV Benefits = 962.97
B / C = 1.40

Economic Evaluation

The base benefit cost flows for the Swarupkati Project is presented in the Table above. The project will give an EIRR of 29.6% with a NPV of MTk 275 at 12% discount rates over a 30 year life.

Sensitivity analyses were undertaken with following results:

	EIRR %	NPV (12%) M Tk	B/C ratio
Capital cost + 20%	21.9	212	1.28
Recurrent cost + 20%	24.4	214	1.29
All costs + 20%	18.9	138	1.17
Benefits x 0.8	17.6	83	1.13
Benefits delayed 2 years	15.4	72	1.11
Base Analysis	29.6	275	1.40

6.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 6.1, from which it is evident that the project shows a range of benefits and negative impacts.

The scheme shows up as moderately positive in the expected rate of benefit achievement, as well as giving positive returns for likely increases in agricultural livelihood and nutrition. The project is moderately negative in its expected impact on the floodplain fisheries and this is further reflected as negative impacts on fishery livelihoods and river fisheries. The scheme also shows a degree of operational complexity.

6.6. TOR for Feasibility Studies

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6.6.1 Introduction

The Project area is located 30 km west of Barisal town within the jurisdiction of Swarupkati, Kaukhali and Banaripara thanas of Pirojpur Zila & Wazirpur thana of the Barisal Zila. The scheme area is triangular in shape and bounded on the north by the Jhanjhania khal/Harta Nadi (22.75 km); on the southeast by Saynda/Swarupkati river (33.50 km) and on the southwest by Kaliganga (lower Madhumati) river (30.25 km). All the rivers are tidal and water is generally free from adverse salinity effects even in the dry season.

Local projects are: Barisal Irrigation Project (BIP) Phase-I to the southeast; Satla Bagda FCD Project to the north and CEP Polders 36/1 & 36/2 to the west of the northern end of SW boundary of the scheme.

Gross area of the scheme is 16,910 ha with an approximate net cultivable area of 13000 ha. About 6,200 ha of the net area is irrigated by LLPs, 1000 ha by STWs, while there appears to be no development by DTWs.

No development programme, except some minor irrigation schemes by LLP/STW, has yet been taken up in the area. The scheme area falls within Ganges Tidal Floodplain of agro-ecological region. The land category is of medium lowland and the soil type is mostly silt loam to silty clay with heavy texture top soil and low permeability. The land is fertile and the major crops of T. Aman, B. Aus, B. Aman, Vegetables and Rabi are grown without irrigation.

6.6.2 Project

The objective of the proposed scheme is the introduction of an integrated development by incorporating appropriate measures for enhanced water utilisation for agriculture, fisheries etc. The measures would allow the beneficiaries to have controlled flooding/drainage and irrigation by surface water. In particular, the measures would encourage beneficiary and private sector participation by way of local resources mobilisation, while assisting them to achieve the targeted objective.

The scheme area falls into the "Eastern Irrigation Compartment" under a Southwest Regional Plan study conducted by IECO. The area was included in the Gournadi Irrigation Complex under a long term development programme for surface water use from Ganges Barrage (IECO Report, 1980). Also, in the National Water Plan, Phase-II, 1991, this area is recommended for development through a FCDI scheme with irrigation by both surface water and groundwater.

The proposed scheme will promote integrated development in order to achieve the necessary provisions for controlled flooding, controlled drainage, compartmentalisation and irrigation. For controlled flooding, embankments and water control structures are required along the peripheral river bank.

To achieve the necessary benefits, compartmentalisation would be essential and these marginal embankments could be used or developed as roads. Sections of new embankments would be required together with water control structures (regulators, check structures etc) and an irrigation and drainage canal system. The scheme area would be subdivided into three major areas, being separated by internal rivers. Each of these sub-division could be considered as one of three polders which could be developed individually or simultaneously. Irrigation canals would be fed by gravity from the adjacent rivers through water control structures and use would be made of LLPs.

Any existing beels within the proposed development area would be excluded from the drainage system. They would, however, be connected to the water conveyance system (canals & drains) for fisheries.

TABLE 6.1

Swarupkati Component - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+ 4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection					X						
PC/2 River channel works						X					
PC/3 Containment of river floods					X						
PC/4 Intervention of land loss							X				
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality							X				
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration									X		
BE/2 Spawn/shrimp larvae capture						X					
BE/3 River & estuarine fisheries								X			
BE/4 Shrimp & fish culture							X				
BE/5 Social forestry/village groves							X				
BE/6 Plantation forests						X					
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads					X						
SC/2 Agricultural livelihoods				X							
SC/3 Fishing livelihoods							X				
SC/4 Artisanal transport								X			
SC/5 Commercial transport						X					
SC/6 Nutrition				X							
SC/7 Potable water supplies						X					
SC/8 Water related disease							X				
SC/9 Social/cultural sites						X					
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income					X						
EO/2 Rate of benefit generation			X								
EO/3 Operational complexity								X			

6.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-economical, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout longitudinal and cross-sectional surveys along the proposed embankments.

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Hydraulic Designs

Review the designs of existing embankments and upgrade if necessary.

Carryout design of new embankments proposed including structures. Design of new embankments should take into account existing villages, settlements etc and land acquisition must be kept to a minimum.

Carryout detailed study of the drainage of the area and review the basic concepts of compartmentalisation as proposed in the pre-feasibility study. Analyse each sub-compartment and design appropriate drainage models including structures.

Assess the ground water and surface water potential and propose options for providing irrigation facilities including conveyance canals and structures. In designing the irrigation and drainage works, future operation and maintenance should be borne in mind which should be easy to operate and maintain with minimum of expertise, by the beneficiaries.

Study the impact of withdrawals from rivers on salinity. Proposals for the maintenance of the rivers together with costs should be given.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPVS. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

7 BARISAL IRRIGATION REHABILITATION SCHEME

7.1 Introduction

General

The existing Barisal Irrigation Project (BIP) encompasses seven thanas namely Kotwali. Babuganj and Bakerganj of Barisal District, Jhalkati, Nalchiti and Rajapur of Jhalkati District and Kawkhali of Perojpur District. The area falls in the Planning Units (PU) SC5, SC6, SC7 and part of SC11. The gross project area is about 157,100 ha of which 107,400 ha is cultivable and 72,000 ha of that is irrigable (Figure 7.1).

The project area contains a large number of khals and creeks of which 1149 km are perennial, 1146 km semi-perennial and 330 km seasonal. While the perennial khals have sufficient water to meet the dry season irrigation, the semi-perennial khals only have water at high tide periods during dry season and the seasonal creeks only have water during monsoon season.

According to the BARC soil survey, the top soil in the project area is light to medium textured in the west and southern areas, but is heavy in the east. The soil permeabilities range from rapid to moderate.

Analysis of the existing situation and from discussion with the BIP field officials, indicate that out of the total irrigable area of 72,000 ha, an area of about 40,500 ha is directly connected to perennial water and can be irrigated by the 2 cusec pumps (LLPs) without constructing any infrastructure. The remaining area of about 31,500 ha would rely on semi-perennial and seasonal sources and require double lifting, ie primary pumping from the perennial sources to feed the semi-perennial and seasonal khals and then subsequent secondary pumping (LLP) to the farms (Figure 7.1). Thus, an area of 40,500 ha (56%) is under single lift and 31,500 ha (44%) is under double lift irrigation systems.

The World Bank identified and approved the project in 1972-75 as it would increase the food production by improving irrigation facilities. The proposed new cropping pattern was to include Aus, Aman and Boro cultivation within the irrigable project area and increase the cropping intensity from 155% to 225%.

The project was developed in two phases namely, Phase I, 83,000 ha (gross) (42,000 ha net) and Phase II, 73,000 ha (gross) (30,000 ha net). Phase I was developed during 1975-80 and Phase II during 1980-85.

The engineering works comprised 78 primary pumping stations (installing 81 pumps of 25 cusec each), 3450 secondary pumps (2 cusecs), 584 regulators including 78 combined with pumping stations, re-excavation of 1131 km of existing creeks and other ancillary works. The implementation of the project was based on a study and design carried out by NEDECO financed by the International Development Agency (IDA) and European Economic Community (EEC).

Present Status

The BIP, which is one of the major irrigation projects in the Southwest Area, is unfortunately now obsolete, inspite of being completed only 7 years ago. While the 44% of the irrigable area under double lift system was initially acceptable to the farmers when they were being subsidised, most farmers stopped using the system when the subsidy was withdrawn during 1989/90. The present estimate is that an area of 8000 ha (20% of the single lift area) was under Boro cultivation during the 1991/92 season.

It appears that the severe short-comings of this project were due to various factors including socio-economic problems, agro-climatic conditions, defect in support services, technical problems etc. This is despite the fact there is sufficient irrigation water. During a recent visit to the field it was observed that the farmers welcome a single lift gravity irrigation for the whole area.

Objectives

This prefeasibility study examines the issues and needs in a sample area of about 16,000 ha within the existing project and assesses the economics of introducing measures that would bring more of the irrigable area under a single stage pumping.

Previous Studies

In addition to original project study described earlier, a special study on the constraints in achieving full potential of the BIP was undertaken by a World Bank Resident Mission during July - August 1982. Subsequently there was a review by a team from the BUET during 1990-91.

7.2 Hydrology and Hydraulics

Hydrology

There are three rainfall recording stations namely, Barisal (R-258), Bakerganj (R-252) and Jhalkati (R-264) in the project area. Results from analyses of rainfall records are as follows:

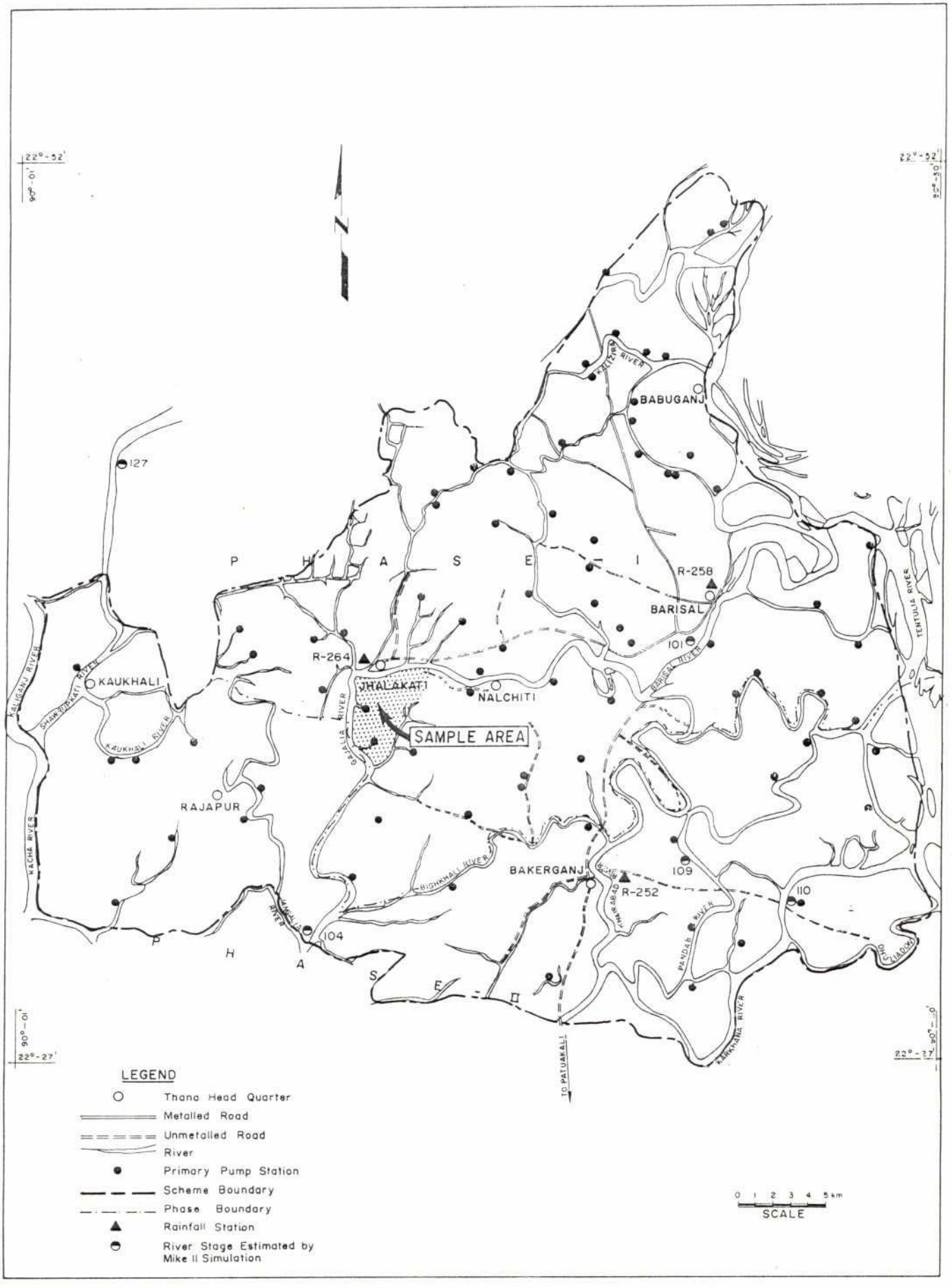
Station	Monthly 80% Dependable Rainfall in mm			Annual Rainfall in mm		10 Year Maximums in mm		
	April	May	June	80% dependable	Mean	1 day	2 days	10 days
Bakerganj (K-252)	27.1	83.5	280.5	1224.3	2178.0	188	285	579
Barisal (K-258)	51.2	98.8	243.5	1240.1	2174.6	225	302	544
Jhalakati (K-264)	19.6	92.7	230.6	996.5	2011.3	240	343	536

It is clear from the above that HYV Aus/Boro cannot be grown without irrigated water supply.

While the rivers are tidal, the quality of water is well within the permissible limit for agriculture.

There are many water level recording stations in the area and the 10 day mean of daily mean water level for the year 1982 (which is considered as an average flood year) and maximum 10 year water level for five selected stations are given in the following Table. The mean monthly maximum salinities in micro-Mhos at 25 degrees celsius, are given in the subsequent Table for four stations within the project area for the months from November through June.

Figure 7.1



Barisal Irrigation Rehabilitation Scheme

Name of Station	1982 - 10 days mean of daily mean water level (m PWD)												10 yrs water level in m (PWD)
	March			April			May			June			
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	
Bishkhali 101	0.33	0.33	0.46	0.66	0.72	0.98	0.91	0.82	1.06	1.22	1.34	1.55	2.59
Bishkhali 104	0.24	0.27	0.36	0.55	0.65	0.78	0.70	0.61	1.79	1.02	1.02	1.14	2.37
Pandab 109	0.27	0.28	0.39	0.58	0.66	0.87	0.77	0.68	0.88	1.11	1.15	1.30	2.58
Dhulia(Arial Khan) 110	0.32	0.31	0.44	0.63	0.68	0.92	0.86	0.78	0.98	1.16	1.27	1.42	2.52
Swarupkati 127	0.17	0.22	0.30	0.49	0.60	0.74	0.65	0.57	0.74	0.99	1.01	1.11	2.24

Note: 1st, 2nd and 3rd = decades

Mean Monthly Salinity (Micro-Mhos at 25 Degrees Celsius)

Sl No	Name of Station	Months							
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Babuganj	239	272	284	309	340	291	265	220
2	Barisal	260	256	294	334	325	311	249	212
3	Jhalkati	252	242	250	265	240	220	195	185
4	Kawkhali	195	220	238	250	280	220	150	130

Hydraulics

Considering the locations of primary pumping stations and LLPs over the project area, the following maximum abstractions would be required for the development of the entire irrigation area.

Name of River	Estimated abstraction by cumecs			Remarks
	Large pump	LLP (single lift)	Total	
Arial Khan	10.1	10.6	20.7	In comparison with capacity of rivers, the quantities abstracted are negligible
Barisal/Gazali/Bishkhali	16.9	14.2	31.1	
Swarupkati	3.0	11.0	14.0	
Total	30.0	35.8	65.8	

This quantity, sufficient for the entire irrigable area of the BIP, is available and could be supplied to the farms in two ways namely:

Option I.

The semi-perennial/seasonal khals could be dredged to convert them into perennial sources for single stage irrigation by LLP.

Option 2

The retention and supply level of the creeks within the existing two lift system area could be raised to convert it into a single lift gravity irrigation system like that of GK project but, unlike the GK project, there should be no shortage of water.

7.3 Engineering

Implementation of Option 2 for an area covering 16,000 ha is considered here as a Phase I rehabilitation, ie to convert some of the areas presently under the double lift system, would require:

(i) Creek banks raised about 1.00m above the existing bank level

(ii) Modification of the height of all gates, including lifting arrangements

(iii) Regulator cut-off depths increased as required by head differences

(iv) Replacement of existing primary diesels by electrical pumps to simplify the system and reduce O & M cost

(v) Develop 11 KV transmission lines, transformers and other equipment for about 50% of the area

Constraints for this option are

- navigation during monsoon, as gates will be kept closed for HYV Aman irrigation and,
- land acquisition for creek development.

7.4 Economic Analysis

Introduction

The proposals for the rehabilitation of the Barisal Irrigation Scheme covers a part of the scheme that at present receives no water for irrigation. The proposed rehabilitation covers a gross area of 20800 ha of which 16000 ha are cropped and lies in three PUs:

	Gross Area	Net Area
SC 5	6500	5000
SC 7	6500	5000
SC 11	7800	6000
	20800	16000

The proposals include no flood control with only the rehabilitation of unused irrigation and related drainage distribution systems. Irrigation will be by LLP.

Table below sets out the present and future, with project crop areas included in the development.

Barisal Irrigation Project - Crop Areas without and with Development (Hectares)

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed					
SC 7	1400	3500	100	0	5000
SC 5	1100	2800	700	400	5000
SC 11	1200	4800	0	0	6000
Total	3700	11100	800	400	16000
With Project					
SC 7	1400	3500	100	0	5000
SC 5	1100	2800	700	400	5000
SC 11	1200	4800	0	0	6000
Total	3700	11100	800	400	16000

Source : Consultant's estimates.

Costs

Capital costs spread over two year will total M Tk 311 equivalent to Tk 19440 /ha and inclusive of 25% physical contingencies and 15% engineering/admin provisions. The breakdown of the costs and the economic cost (M Tk 199) is provided in the following Table.

Barisal Irrigation Rehabilitation Project : Capital and Recurrent Costs

	Project Year			Total
	1	2	3	
Area Lost	320	800	800	
Financial (M Tk)				
Capital Cost:				
Land acquisition	20	60	0	31
FC Embankment:				
Earthworks	65	69	0	125
Structure	40	46	0	109
Irrigation/Drainage:				
Pumps: LLP	0	0	0	46
Earthworks	0	0	0	0
Structure	0	0	0	0
Sub Total	125	186	0	311
Recurrent Cost (O & M):				
Pumping: LLP	0	0	50.64	
Earthworks	0	1.95	3.75	
Structure	0	0.8	2.18	
Sub Total	0	2.75	56.57	
Economic (M Tk)				
Capital Cost:				
Earthworks	44.85	41.40	0.00	86.25
Structure	30.80	53.13	0.00	83.93
Pumps: LLP	0.00	28.52	0.00	28.52
Sub Total	75.65	123.05	0.00	198.70
Recurrent Cost (O & M):				
Pumping: LLP	0.00	0.00	66.24	
Earthworks	0.00	1.35	2.59	
Structure	0.00	0.62	1.68	
Land loss	2.28	5.71	5.71	
Sub Total	2.28	7.67	76.22	

Source : Consultant's estimates.

The foreign exchange component will be minimal. All the pumping will by LLP and electric powered. Annual O & M costs are estimated at M Tk 56.6 (Tk 3536 /ha) - M Tk 76.2 at economic prices.

The proposed physical works will remove 1920 ha - 5.5% of the gross area from cultivation. The economic analysis includes this at the value of rainfed crops that will be foregone. The 16000 ha NCA included in the scheme is net of this area.

Benefits

Benefits will be generated only from irrigation. No FCD works are proposed. The incremental benefit at full development is estimated on the basis of existing cropping patterns under irrigation in the three Pus within which the project is to be situated (SC 5, SC 7 and SC 11) at M Tk 161.53 each year (Tk 10100 /ha). The benefit is expected to be achieved by project year 5, three years after rehabilitation is completed.

Project Year		3	4	5
M Tk	48.50	129.32	161.53	

Details are presented in the following Table. As in the other project analyses the benefits are based on the current levels of cultivation and local market prices (Appendix 2 Main Report).

The project will have no effect upon fisheries within its boundaries.

Barisal Irrigation Rehabilitation Project - Crop Production Benefits (1991 Economic Values)

	Flood Category				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed :					
Unit Benefit (Tk/ha)					
SC 7	9611	7995	7218	2987	
SC 5	9102	7312	4074	3296	
SC 11	7989	5829	4050	0	
Area (ha)					
SC 7	1400	3500	100	0	5000
SC 5	1100	2800	700	400	5000
SC 11	1200	4800	0	0	6000
Total	3700	11100	800	400	16000
Total Benefit (M Tk)					
SC 7	13.455	27.983	0.722	0.000	42.160
SC 5	10.012	20.474	2.852	1.318	34.656
SC 11	9.587	27.979	0.000	0.000	37.566
TOTAL (M Tk)	33.054	76.435	3.574	1.318	114.381
With Project					
Irrigated:					
Unit Benefit (Tk/ha)					
SC 7	22411	18719	9792	9792	
SC 5	19746	18502	3939	3939	
SC 11	18826	15240	0	0	
Area (ha)					
SC 7	1400	3500	0	0	5000
SC 5	1100	2800	400	400	5000
SC 11	1200	4800	0	0	6000
Total	3700	11100	400	400	16000
Total Benefit (M Tk)					
SC 7	31.375	65.517	0.000	0.000	97.803
SC 5	21.721	51.806	1.576	1.576	82.489
SC 11	22.591	73.152	0.000	0.000	95.743
TOTAL (M Tk)	75.687	190.474	1.576	1.576	276.035
Incremental Benefit M Tk					161.653

Economic Analysis

The benefit-cost flow for the project's base analysis is shown in the Table below. Over a 30 year life the result will be:

EIRR 24.6%
NPV at 12% M Tk 250.9
B/C ratio 1.37

This well exceeds the target of a 12% rate of return.

The results of the sensitivity analyses were in all cases in excess of 12%. The lowest being if benefits were delayed for two years as shown.

Barisal Irrigation Rehabilitation Project - Benefit Cost Flow (1991 Economic Values)

Year	Costs				Incremental Benefits	Net Benefits
	Capital	Receipt	Fish loss	Total		
1	75.65	2.28	0	77.93	0	-77.93
2	123.05	7.67	0	130.72	0	-130.72
3	0	76.22	0	76.22	48.5	-27.72
4	0	76.22	0	76.22	129.32	53.1
5	0	76.22	0	76.22	161.65	85.43
6	0	76.22	0	76.22	161.65	85.43
7	0	76.22	0	76.22	161.65	85.43
8	0	76.22	0	76.22	161.65	85.43
9	28.52	76.22	0	104.74	161.65	56.91
10	0	76.22	0	76.22	161.65	85.43
11	0	76.22	0	76.22	161.65	85.43
12	0	76.22	0	76.22	161.65	85.43
13	0	76.22	0	76.22	161.65	85.43
14	0	76.22	0	76.22	161.65	85.43
15	0	76.22	0	76.22	161.65	85.43
16	28.52	76.22	0	104.74	161.65	56.91
17	0	76.22	0	76.22	161.65	85.43
18	0	76.22	0	76.22	161.65	85.43
19	0	76.22	0	76.22	161.65	85.43
20	0	76.22	0	76.22	161.65	85.91
21	0	76.22	0	76.22	161.65	85.91
22	0	76.22	0	76.22	161.65	85.91
23	28.52	76.22	0	104.74	161.65	56.91
24	0	76.22	0	76.22	161.65	85.43
25	0	76.22	0	76.22	161.65	85.43
26	0	76.22	0	76.22	161.65	85.43
27	0	76.22	0	76.22	161.65	85.43
28	0	76.22	0	76.22	161.65	85.91
29	0	76.22	0	76.22	161.65	85.91
30	28.52	76.22	0	104.74	161.65	56.91

EIRR % 24.55
NPV (12%) 250.91
NPV Costs 676.93
NPV Benefits 927.84
B/C ratio 1.37

Sensitivity Analysis:

	EIRR %	NPV 12%	B/C ratio
Capital costs + 20%	21.5	214.18	1.30
Recurrent costs + 20%	19.7	152.25	1.20
Total costs + 20%	17.2	115.52	1.14
Benefits - 20%	15.6	65.34	1.10
Benefits delayed 2 years	13.8	53.62	1.08
Base	24.6	250.9	1.37

Costs and benefits would, respectively have to increase by 37% and decrease by 27% to result in a 12% EIRR.

7.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 7.1, from which it is evident that it is a neutral scheme, which is to be expected from what is essentially a rehabilitation project. Whilst the rate of benefit achieved may be high, the operational problems that may arise in the pumping abstraction aspects of the scheme are, especially in view of its present problems, considered as negative impacts. A slight negative impact may occur from water related disease, which is, importantly, already a serious problem in the district.

Table 7.1

Barisal Irrigation Rehabilitation Project - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection						X					
PC/2 River channel works						X					
PC/3 Containment of river floods						X					
PC/4 Intervention of land loss						X					
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality						X					
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration						X					
BE/2 Spawn/shrimp larvae capture						X					
BE/3 River & estuarine fisheries						X					
BE/4 Shrimp & fish culture						X					
BE/5 Social forestry/village groves						X					
BE/6 Plantation forests						X					
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads						X					
SC/2 Agricultural livelihoods					X						
SC/3 Fishing livelihoods						X					
SC/4 Artisanal transport						X					
SC/5 Commercial transport						X					
SC/6 Nutrition					X						
SC/7 Potable water supplies						X					
SC/8 Water related disease											
SC/9 Social/cultural sites						X					
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income						X					
EO/2 Rate of benefit generation			X								
EO/3 Operational complexity											

7.6 TOR for Feasibility Study

7.6.1 Introduction

The existing project identified in the 1970's by the World Bank developed in two phases (Phase I, 42,000 ha, net, and Phase II, 30,00 ha, net) between 1975 and 1985. The project relies on 78 primary pumping stations and over 3400 secondary pumps (2 cusecs) for irrigation. However, the project has not achieved its objectives for various reasons. The principle reason being socio-economic. Due to a disparity in the system (some farmers depend only on secondary pumps while others depend both on primary and secondary pumps), farmers are reluctant to pay the water fees and the primary pumps were stopped.

7.6.2 Project

The objective of the project is to rehabilitate the project in a sample area of about (16,000 ha) by retention of adequate water levels in the creeks within the existing two tier lift system and convert into a single lift gravity irrigation system.

The rehabilitation works will cover:

- raising of creek banks by about 1.00 M
- modifications to regulator gates and lifting mechanism
- modifications to regulators
- replacement of existing primary diesel pumps by electric pumps
- provide 11 KV transmission lines, transformer and other equipment.

The study of socio-economic needs of the beneficiaries together with their participation in the planning, design, implementation and eventual O & M of the project will be a key element of the Project.

7.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-ecological, social and environmental data required for the project
- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Survey the existing embankments including cross-sections.

Carryout an inventory survey of existing structures including pumping stations noting their conditions etc.

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Hydraulic Designs

Review the existing designs of the irrigation system and propose improvements and modifications to existing structures bearing in mind only single lift pumping will be provided with gravity feed to fields. Redesign the existing canal/drainage system to suit the above.

Carryout preliminary designs for converting the existing diesel powered pumps to electric including 110V transmission lines and associated electrical works.

Study the tidal characteristics of the rivers/creeks and recommend a suitable and realistic operation procedure.

Prepare a comprehensive O & M manual for the pumping and irrigation systems.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPV[s]. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

8 BISHKHALI FCDI SCHEME

8.1 Introduction

General

The proposed scheme, which covers a gross area of 27,300 ha, is located on the right bank of the Bishkhali River and covers polders 39/2-B1, 39/2-B2, 39/2-C1 and 39/2-C2. It is included in Planning Unit (PU) SC 11. Towards the north, the scheme borders Barisal Irrigation Project (Phase II area) and CEP Polder 39/1 is about 12 km away to the south. The net cultivable area of the scheme is 21,000 ha which is shown in Figure 8.1.

Present Status

The development area is situated within the agro-ecological zone referred to as the Ganges Tidal Flood Plain. According to the BARC soil survey, the top soil in the project area is generally medium textured, having rapid permeability. The eastern half of the area experiences annual flooding from the Bishkhali River, but flood depths seldom exceed 1.0 m, the average ground level being about 1.5 m (PWD). B.Aus and T. Aman are the predominant crops in the area, with less than 15% of the area is under irrigated agriculture, which generally takes place during the pre-monsoon period.

Objectives

The objective of the proposed scheme is to achieve an integrated development that would allow the farmers to practice some controlled flooding, controlled drainage but mainly by irrigation to suit their requirements ie to extend the cropping season and improve yields.

Previous Studies

There have been no studies of this particular area.

8.2 Hydrology and Hydraulics

Hydrology

Analyses of rainfall records in vicinity of the project area (Bhandaria, R-259) and other neighbouring stations, shows that the mean annual rainfall for the area is about 2350 mm. Also, during this mean year, July receives the maximum rainfall (450 mm), while January has the lowest (8 mm). Maximum 10 day cumulative rainfall values relating to different return periods were determined on the basis of a frequency analysis of the daily rainfall records, which are tabulated below:

Station	10 Day Cumulative Rainfall (mm) Return Period (years)			
	2	5	10	20
Bhandaria (R-259)	402	532	630	733

The Bishkhali River is one of the major coastal rivers and model flow simulations using the available water level and discharge records were undertaken. The frequency analyses gave the following maximum water level values relating to selected return periods for the Bishkhali River for two cross sections, one upstream and the other downstream of the project area (see Figure 8.1):

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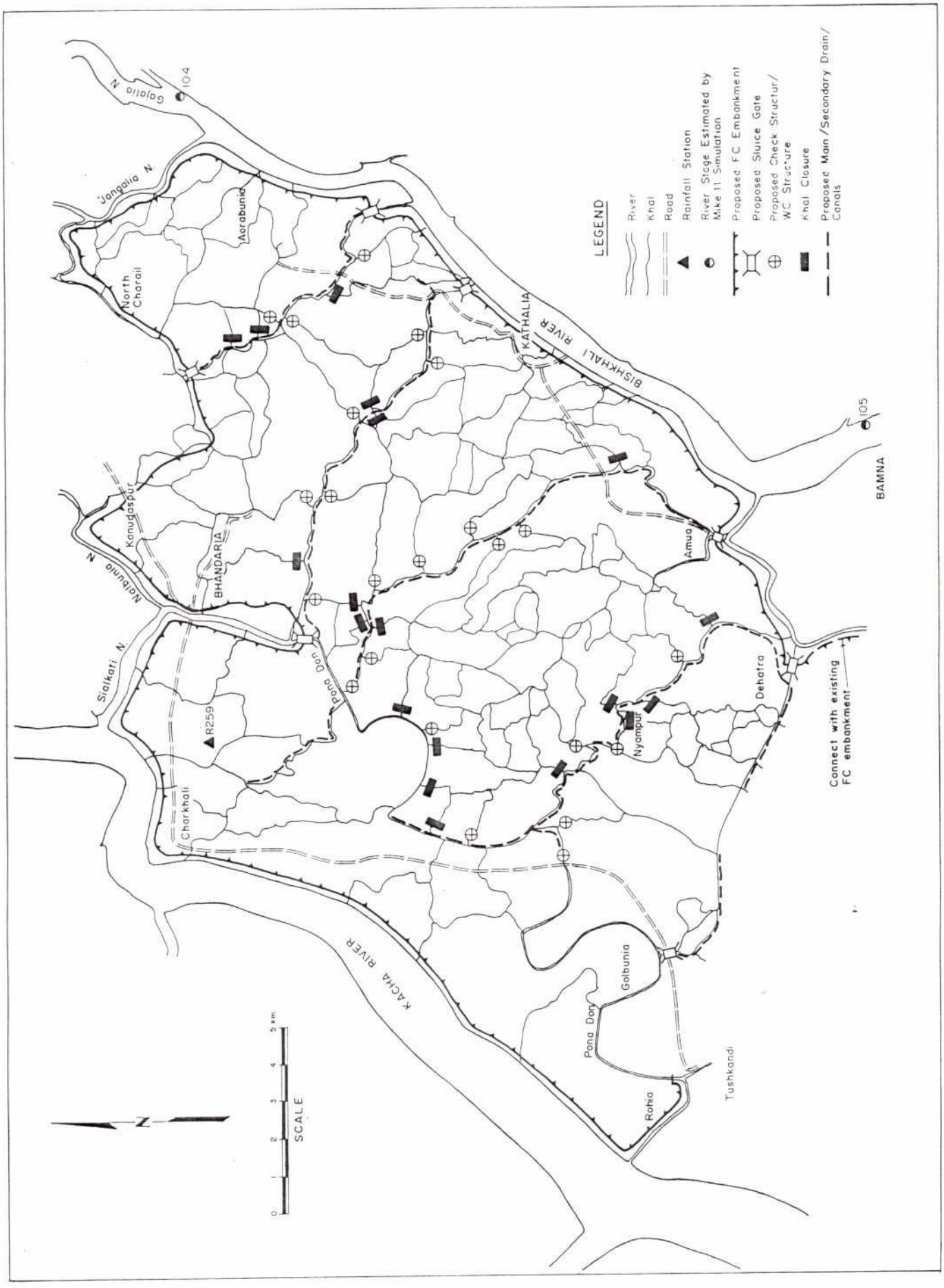
Figure 8.1



Bishkhali FCDI Scheme

Station No	Chainage (Km)	Return Periods in Years				
		2	5	10	20	50
104	21.5	2.15	2.29	2.37	2.46	2.56
105	44.5	2.61	2.77	2.56	2.95	3.06

The flow simulation analyses also provide the following water level data corresponding to the 10 day (consecutive days) average of the daily maximum, minimum and mean water levels at the two cross sections in January, April and August 1982, which is considered an average flood year for the coastal rivers.

Bishkhali River : 10-Day Average Water Levels (M-PWD) in 1982

	January			April			August		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Station 104									
Maximum	1.34	1.23	1.27	1.37	1.38	1.51	1.69	1.68	1.58
Minimum	-0.66	-0.57	-0.62	-0.29	-0.11	-0.19	0.44	0.32	0.32
Mean	0.37	0.33	0.24	0.55	0.65	0.78	1.19	1.16	1.09
Station 105									
Maximum	1.55	1.38	1.41	1.55	1.56	1.83	1.87	1.91	1.70
Minimum	-0.86	-0.73	-0.78	-0.41	-0.22	-0.36	0.16	-0.02	0.10
Mean	0.33	0.30	0.21	0.52	0.64	0.74	0.98	0.97	0.94

Note : 1st, 2nd and 3rd = decades

A preliminary estimate of the present areas of inundation due to drainage congestion and/or overbank spilling of the Bishkhali River was compared with relevant MPO data and CIDA survey data (1991) and the areas (extent) under different depths of inundation, are tabulated below. The Table shows that the areas remain unaltered after implementation as development is based around pumped irrigation.

Pre and Post Project Inundation Estimates

PU	Area (ha)	Existing Inundation Area (ha)				Post-Project Inundation Area (ha)		
		F0	F1	F2	F3+4	F0	F1	F2
SC-11	21,000	6430	14550	20	0	8,400	11,550	1,050

Though the tidal effect in the Bishkhali River extends northwards beyond the project area even during the monsoons the average river salinity in April is about 360 micro-Mhos ie below the limit for irrigation water when taking into consideration the present soil salinity level.

Hydraulics

Consideration has been given to the peak water level of the Bishkhali and the ground levels of the development area. This shows it is necessary to provide an embankment along the right bank, incorporating sluice/intake gates at suitable locations to allow controlled flooding, controlled drainage and irrigation. The river flood level corresponding to a return period of 1 in 20 years is 2.95 m PWD.

8.3 Engineering

Planning of the proposed integrated development and outline designs of some of the engineering works have been carried out, based on the relevant hydrological/hydraulic information and on the BWDB/FCD III design criteria.

The project would provide 22 km of internal embankments, 2.5 m high and a low level network of canals/drains of varying sizes, having a total length of about 300 km. They would incorporate control structures to distribute the water abstracted by gravity from the Bishkhali River, making good use of tidal propagation and are a major component of the engineering works. The network of rural roads (including culverts, etc), included and costed in the proposed development, has yet to be identified in detail.

Any existing beels within the development area would be connected to the canal/drainage network with structural measures to allow inflow and outflow as necessary to promote fisheries development. Where possible the beel storage would also be used for conserving water for subsequent irrigation.

8.4 Economic Analysis

Introduction

The proposed Bishkhali project involves the development of 21,000 ha of LLP irrigation all within SC 11. There is very little flood land but some FCD works are included as protection against unusual flooding. The project has a gross area of about 27,300 ha with a NCA of 21,000 ha made up as shown in the following Table. The areas to be brought under irrigation are also given in the following Table. At present there is no irrigation in the project area, though other parts of PU SC 11 do benefit from it.

Bishkhali Irrigation Project Crop Areas Without and With Development (ha)

Planning Unit	Flood Class				Total
	F0	F1	F2	F3/4	
Without Project					
Rainfed					
SC 11	6,430	14,550	20	-	21,000
Irrigated					
SC 11	-	-	-	-	-
Total	6,430	14,550	20	-	21,000
With Project					
Irrigated					
SC 11	6,430	14,550	20	-	21,000

Source : Consultant's estimates.

Costs

The capital cost, including 25% physical contingencies and 15% engineering/admin provisions, would be M Tk 469 (M Tk 294 at economic values) equivalent to just over Tk 22300 /ha. The foreign exchange content is low and earthworks will be constructed using local labour with some mechanical compaction. The FE requirement is estimated at MTk 20.50 for the LLP component. In the costings it has been assumed that there will be some electric powered pumps and a general ratio of one electric to eight diesel powered LLPs has been taken.

Recurrent and O & M costs at full development would total M Tk 94.10 (M Tk 81.90 at economic values) each year, or Tk 3900 /ha. The breakdown of capital and economic cost is shown in the following table and the economic conversion factor and other base assumptions are presented in Appendix 2.

Bishkhali Irrigation Project - Capital and Recurrent Costs (1991 Prices)

Item	Year			Total
	1	2	3	
Area (ha) lost (1)	727	1200	1200	
Financial (M Tk)				
Capital Cost:				
Land aquisition	42	26	0	72
FC Embankment:				
Earthworks	35	0	0	35
Structure	9	0	0	9
Irrigation/Drainage:				
Pumps: LLP	0	39	0	39
Earthworks	46	88	0	134
Structures	50	130	0	180
Sub total	185	285	0	469
Recurrent Cost (O & M):				
Pumping: LLP (2)	0	0	85	
Earthworks	0	2.45	5.0	
Structure	0	1.15	3.78	
Sub total	0	3.60	94.1	
Economic (M Tk)				
Capital Cost:				
Earthworks	56.15	60.40	0.00	116.55
Structure	44.46	101.06	0.00	145.52
Pumps; LLP	0.00	32.13	0.00	32.13
Sub total	100.62	193.59	0.00	294.20
Recurrent Cost (O & M):				
Pumping: LLP (2)	0.00	0.00	64.36	
Earthworks	0.00	1.70	3.5	
Structure	0.00	0.90	2.90	
Landloss (1)	6.75	11.15	11.15	
Sub total	6.75	13.70	81.90	

Source: Consultant's estimates.

Note : (1) Tk/ha opportunity cost of land lost to works, 5% value of production foregone,
(2) Tk/ha pumping cost, 1 electric to 8 diesel

Benefits

Benefits will accrue mainly from the provision of year round surface irrigation. This will total MTk 206.70 at full development, Tk 9840 /ha. net of direct growing costs. In addition, there will be a benefit of MTk 2.0 (Tk 95/ha) as a result of the elimination of average annual crop losses due to flooding. This represents 1.47% of the total crop over the 19 years, 1971 to 1989 (see Appendix 2)

Farmers are expected to react rapidly to the opportunities to purchase pumps once the distribution system is constructed. In the base analysis benefits are taken up over three years from project completion in year 3. The rate of benefit build up after completion being; year 1: 30%; year 2: 80%; year 3: 100%. The actual figures are as follows:

	Project Year		
	3	4	5
M Tk. irrigation	62.01	165.35	206.70
M Tk. flood protection	2.00	2.00	2.00
TOTAL M Tk	64.01	167.35	208.70

The derivation of cropping benefits from irrigation are as follows:

Bishkhali Irrigation Project Crop Production Benefits

	Flood Class				Total M Tk
	F0	F1	F2	F3/4	
Without Project					
Rainfed					
Unit Benefit (Tk/ha)	6990	5100	3543.75	-	
Area (ha)	6432	14551	17.5	-	21,000
Total Benefit (M Tk)	51.42	82.19	0.06	-	136.29
Irrigated					
Unit Benefit (Tk/ha)	-	-	-	-	-
Area (ha)	-	-	-	-	-
Total Benefit (M Tk)	-	-	-	-	-
Total M Tk	54.42	82.19	0.06	-	136.29
With Project					
Irrigated					
Unit Benefit (Tk/ha)	16473	13335	5590	-	
Area (ha)	6431	14551	17.5	-	21,000
Total Benefit (M Tk)	121.14	221.76	0.08		343
Incremental Benefit (M Tk)	67.09	139.57	0.02		206.70
Flood damage reduction (M Tk)					2.00
Total incremental benefit (M Tk)					208.70

Source : Consultant's estimates. (Value figures rounded)

Change in Fishery Production

There is no loss expected in fisheries output due to the scheme. No change will occur in the flood class area and no beels or baors lie within the project's boundaries.

Economic Evaluation

The base case benefit - cost flow and results of the analysis at 1991 economic values are given in the following Table:

Bishkhali Irrigation Project. Benefit - Cost Flow (1991, Economic Values)

Year	Costs				Crop Benefits	Benefit Flood Damage	Incr'tal Beneffits	Net Benefits
	Capital	Receipt	Fish Loss	Total				
1	100.62	0	0.00	100.62	0.00	0	0	-100.62
2	193.75	13.72	0.00	207.47	0.00	0	0	-207.47
3	0	81.91	0.00	81.91	26.00	2	64	-17.91
4	0	81.91	0.00	81.91	265.33	2	267.33	185.42
5	0	81.91	0.00	81.91	206.66	2	208.66	126.75
6	0	81.91	0.00	81.91	206.66	2	208.66	126.75
7	0	81.91	0.00	81.91	206.66	2	208.66	126.75
8	0	81.91	0.00	81.91	206.66	2	208.66	126.75
9	32.13	81.91	0.00	114.04	206.66	2	208.66	94.62
10	0	81.91	0.00	81.91	206.66	2	208.66	126.75
11	0	81.91	0.00	81.91	206.66	2	208.66	126.75
12	0	81.91	0.00	81.91	206.66	2	208.66	126.75
13	0	81.91	0.00	81.91	206.66	2	208.66	126.75
14	0	81.91	0.00	81.91	206.66	2	208.66	126.75
15	0	81.91	0.00	81.91	206.66	2	208.66	126.75
16	32.13	81.91	0.00	114.04	206.66	2	208.66	94.62
17	0	81.91	0.00	81.91	206.66	2	208.66	126.75
18	0	81.91	0.00	81.91	206.66	2	208.66	126.75
19	0	81.91	0.00	81.91	206.66	2	208.66	126.75
20	0	81.91	0.00	81.91	206.66	2	208.66	126.75
21	0	81.91	0.00	81.91	206.66	2	208.66	126.75
22	0	81.91	0.00	81.91	206.66	2	208.66	126.75
23	32.13	81.91	0.00	114.04	206.66	2	208.66	94.62
24	0	81.91	0.00	81.91	206.66	2	208.66	126.75
25	0	81.91	0.00	81.91	206.66	2	208.66	126.75
26	0	81.91	0.00	81.91	206.66	2	208.66	126.75
27	0	81.91	0.00	81.91	206.66	2	208.66	126.75
28	0	81.91	0.00	81.91	206.66	2	208.66	126.75
29	0	81.91	0.00	81.91	206.66	2	208.66	126.75
30	32.13	81.91	0.00	114.04	206.66	2	208.66	94.62

EIRR % 30.09
NPV (12%) 465.60
NPV Costs 796.87
NPV benefits 1262.47
B/C ratio 1.58

Switching values
costs plus 58.42802 %
benefits minus (-)36.8798 %

Source: Consultant's estimates.

The project will result in an EIRR of 30.1 with a NPV of M Tk 465 at the 12% discount. The benefit cost ratio will be 1.58.

Sensitivity analyses were carried out with the followig results:

	EIRR %	NPV (12%) M Tk	B/C ratio
Capital costs x 1.2	22.2	306.22	1.32
Benefits x 0.8	20.9	213.10	1.27
Total costs x 1.2 and benefits x 0.8	14.0	53.73	1.06
Base analysis	30.1	466	1.58

Should costs increase by 20% and benefits fall by 20% or are delayed, the project will realise an EIRR of about 14%. The switching values calculated are

Costs : + 58.4%

Benefits : (-) 36.9% after which the 12% rate of return will not be attained.

8.5 Environmental Assessment

The initial environmental assessment of this scheme is summarised in Table 8.1, which shows a project very similar in form to that proposed for the Swarupkati scheme. The main positive impact is that the rate of benefit achievement is expected to be high.

On the negative side the project shows likely impacts on floodplain and river fisheries and some impact on village groves as a result of the brick/aggregate requirements. Further negative impacts relate to the impact on artisanal water transport and the complexities this introduces into the project. Slight negative impacts are expected with respect to land loss and localised agrochemical/water quality problems; beel fisheries and fishery livelihoods; rural water supplies and water related disease.

TABLE 8.1

Bishkhali Scheme - Initial Environmental Assessment

Environmental Component	MULTI - CRITERIA ANALYSIS VALUES										
	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
PHYSICAL/CHEMICAL											
PC/1 River erosion protection					X						
PC/2 River channel works						X					
PC/3 Containment of river floods					X						
PC/4 Intervention of land loss							X				
PC/5 Reduction in salinity						X					
PC/6 Changes in water quality							X				
BIOLOGICAL/ECOLOGICAL											
BE/1 Floodplain fish migration								X			
BE/2 Spawn/shrimp larvae capture						X					
BE/3 River & estuarine fisheries								X			
BE/4 Shrimp & fish culture							X				
BE/5 Social forestry/village groves								X			
BE/6 Plantation forests						X					
BE/7 Sundarbans forest						X					
BE/8 Bio-diversity conservation						X					
SOCIOLOGICAL/CULTURAL											
SC/1 Security of homesteads					X						
SC/2 Agricultural livelihoods						X					
SC/3 Fishing livelihoods							X				
SC/4 Artisanal transport								X			
SC/5 Commercial transport						X					
SC/6 Nutrition							X				
SC/7 Potable water supplies							X				
SC/8 Water related disease						X					
SC/9 Social/cultural sites											
ECONOMIC/OPERATIONAL											
EO/1 Distribution of income						X					
EO/2 Rate of benefit generation				X							
EO/3 Operational complexity								X			

8.6 TOR for Feasibility Study

8.6.1 Introduction

The proposed scheme, which covers a gross area of 27,300 ha, is located on the right bank of the Bishkhali River and covers polders 39/2-B1, 39/2-B2, 39/2-C1 and 39/2-C2. Towards the north, the scheme borders Barisal Irrigation Project (Phase II area) and CEP Polder 39/1 is about 12 km away to the south. The net cultivable area of the scheme is about 21,000 ha.

The development area is situated within the agro-ecological zone referred to as the Ganges Tidal Flood Plain. According to the BARC soil survey, the top soil in the project area is generally medium textured, having rapid permeability. The eastern half of the area experiences annual flooding from the Bishkhali River, but flood depths seldom exceed 1.0 m, the average ground level being about 1.5 m (PWD). B.Aus and T. Aman are the predominant crops in the area, with less than 15% of the area is under irrigated agriculture, which generally takes place during the pre-monsoon period.

8.6.2 Project

The objective of the proposed scheme is to achieve an integrated development that would allow the farmers to practice some controlled flooding, controlled drainage but mainly by irrigation to suit their requirements ie to extend the cropping season and improve yields.

There have been no studies of this particular area.

The project would provide 22 km of internal embankments, 2.5 m high and a low level network of canals/drains of varying sizes, having a total length of about 300 km. They would incorporate control structures to distribute the water abstracted by gravity from the Bishkhali River, making good use of tidal propagation and are a major component of the engineering works. The network of rural roads (including culverts, etc), included and costed in the proposed development during the pre-feasibility study stage, has yet to be identified in detail.

Any existing beels within the development area would be connected to the canal/drainage network with structural measures to allow inflow and outflow as necessary to promote fisheries development. Where possible the beel storage would also be used for conserving water for subsequent irrigation.

8.6.3 Study Requirements

Data Collection

- Re-examine and review all existing reports and data
- Collect available maps, aerial photographs, spot imagery of the project area
- Collect available hydrological and meteorological data including water levels and discharges of rivers in the project area
- Collect data on salinity of the area surrounding the project and initiate primary data collection, as required
- Collect agro-ecological, social and environmental data required for the project

- Collect data on prices including unit price for engineering items for cost-benefit analysis.

Survey and Investigation

Carryout surveys along the existing and proposed alignment of the embankments including cross-sections.

Carryout surveys of khals/creeks within the project area.

Carryout topographical surveys including levelling and geotechnical surveys with testing in key areas of substantial structures.

Hydraulic Designs

Carryout design of the embankments proposed. When designing embankments care should be taken to take account of existing villages, settlements etc and land acquisition must be kept to a minimum.

Carryout detailed study of the drainage of the area and review the basic concepts of compartmentalisation as proposed in the pre-feasibility study. Analyse each sub-compartment and design appropriate drainage models including structures.

Study the tidal characteristics of the Bishkhali the kacha, rivers and other creeks which bounds the Project area and recommend a suitable method of operation of the scheme using the tidal propagation for gravity flow.

Agriculture

Carryout a survey of the existing agricultural procedures including cropping patterns, yields, inputs etc and propose new cropping patterns (if appropriate) and identify areas for improvement, including diversification, improved varieties etc.

Fisheries

Carryout a survey of the existing fisheries in the wet and dry season and the impact on them with the Project. Propose ways of improving capture fisheries and recommend means for introducing and expanding culture fisheries.

Advice on 'fish-friendly' structures to be incorporated in the design.

Navigation

Carryout a survey of the existing navigation particularly of country boats in the wet and dry seasons and estimate the benefits, impacts and disbenefits of the project.

Advise the design engineer on design of navigation locks to be incorporated in the design of structures.

Social Studies

Carryout a detailed socio-economic study adopting an appropriate method (RRA type) to assess the present situation, the needs of the population, expected impact of the project

on the social fabric; ways and means of improving the social status of the people, particularly of the landless, low-income and women; income generation and income distribution methods, credit facilities etc.

Environmental Studies

Carryout a full EIA to identify the impacts of the Project on the environment including recommending mitigatory measures to counter negative impacts. In addition, viable options for maintaining the bio-diversity of rivers and water bodies should be recommended.

Economic Analyses

Carryout economic analyses of the Project including EIRR and NPV[s]. Benefits should include agriculture, reduction to flood damage, fisheries, etc. A comprehensive sensitivity analyses to changes in costs, benefits and to less tangible impacts such as social or environmental constraints should also be taken into account. Any costs arising out of mitigatory measures proposed should be taken into account in the overall costs.

Institutions and Operation & Maintenance

Study the existing O & M practice and their shortcomings and recommend realistic proposals for O & M with beneficiary participation and cost recovery methods. The experience of similar studies currently on-going or recently completed should be taken into account in examining this aspect.

Study the institutional aspects including proposals for strengthening of the concerned government agencies with respect to water resource planning, design, construction and O & M.

People's Participation

People's participation should be a key feature of the planning process and detailed consultations and participatory meetings should be held with the people of the Project Area and their views taken into account in the planning, designing, implementation and O & M stages.

The support of the NGOs working locally should be sought and their experience should form the basis of further refinement.

Programming

Prepare an outline programme covering the detailed design, contract documents, tendering and the construction phases including costs, cash flow and economic returns.

Reporting

An Inception Report will be presented at the end of month 2 and an Interim Report at the end of month 6. The Final Report will be presented one month before completion.

Appendices

Appendix 1

Chenchuri Beel Agro. Economic Details

APPENDIX 1

Chenchuri Beel Rehabilitation Project

1. Present and Future Productions

Present and future without Project Crop Production Values and Build up of with Project Crop Production Value (1991 Economic Values).

Without Project

Tables 1 and 2 set out the present and future crop areas without the proposeed project by flood category and whether rainfed or irrigated for the two Planning Units affected by the Project SW5 and SW10.

With Project

Tables 3 and 4 provide similar data for the with project case and Tables 5 and 6 show the expected built up of project irrigation and project FCD only area benefits that were applied to the economic analyses in this volume.

2 Crop Gross Margins

The attached crop gross margins for each of the projects planning units at 1991 economic values were used in the calculation of benefits to the Chenchuri Beel Rehabilitation Project. Detailed background to the budgets are given in Volume 6 - Land Resources, Agriculture and Fisheries and Volume 10, Economics. The gross margins are net of direct growing costs. The figures used in the analyses for irrigated crops in addition have deducted the costs of irrigation by 2 cusec capacity LLP for all with-project LLP irrigation and for non-project irrigated areas by the costs for each hectare of different pump type mixes found at present in each PU. The unit costs applied to arrive at these were:

	Diesel powered		Electric powered
DTW			
Tk/ha/a	3795		4957
ratio	0.8		0.2
Combined Tk/ha/a		4027	
STW/DSSTW			
Tk/ha/a	2835		3097
ratio	0.9		0.1
Combined Tk/ha/a		2861	
LLP 1 cusec (1)			
Tk/ha/a	2765		3910
ratio	0.9		0.1
Combined Tk/ha/a		2880	
LLP 2 cusec (1)			
Tk/ha/a	1775		2613
ratio	0.8		0.2
Combined Tk/ha/a		1943	

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TABLE 1
NET BENEFIT FROM CROP PRODUCTION (without project)
(1991 economic values)

PLANNING UNIT SW5

	Rainfed					Irrigated					
	F0	F1	F2	F3\4	Total	F0	F1	F2	F3\4	Total	TOTAL
Present											
Area (ha)	1856	3040	2035	563	7494	320	783	235	68	1406	8900
Unit Benefit (Tk/ha)	8668	7238	5309	4161		22299	20012	10954	8491		
Total Benefit (M Tk)	16.088	22.004	10.804	2.343	51.238	7.136	15.669	2.574	0.577	25.957	73.628
									less irrig. costs	3.566	
Future - project											
Area (ha)	1733	2839	1901	526	6999	433	1059	318	91	1901	8900
Unit Benefit (Tk/ha)	8668	7238	5309	4161		22299	20012	10954	8491		
Total Benefit (M Tk)	15.022	20.549	10.092	2.189	47.851	9.655	21.193	3.483	0.773	35.104	78.134
									less irrig. costs	4.822	

Tk/Ha present : 8273 Tk/Ha future : 8779

AVERAGE ANNUAL CROP DAMAGE 1971-1989

	Present			Future		
	Loss %	Value MTk/an	Loss MTk/an	Loss %	Value MTk/an	Loss MTk/an
	2.770	73.628	2.040	2.770	78.134	2.164

Year	1	2	3	4	5	6	7	8	9	10
Loss Value (M Tk/year)	2.040	2.053	2.067	2.081	2.095	2.109	2.123	2.137	2.150	2.164

Source : consultants' estimates

TABLE 2
NET BENEFIT FROM CROP PRODUCTION (without project)
(1991 economic values)

PLANNING UNIT SW10

	Rainfed					Irrigated					
	F0	F1	F2	F3\4	Total	F0	F1	F2	F3\4	Total	TOTAL
Present											
Area (ha)	1453	1775	3688	915	7831	296	346	314	213	1169	9000
Unit Benefit (Tk/ha)	11412	10275	5716	5069		23109	22501	12161	5736		
Total Benefit (M Tk)	16.58	18.24	21.08	4.64	60.54	6.84	7.79	3.82	1.22	19.67	77.84
									less irrig. costs	2.361	
Future - project											
Area (ha)	1376	1681	3493	867	7417	401	469	425	288	1583	9000
Unit Benefit (Tk/ha)	11412	10275	5716	5069		23109	22501	12161	5736		
Total Benefit (M Tk)	15.70	17.27	19.97	4.39	57.34	9.27	10.55	5.17	1.65	26.64	80.78
									less irrig. costs	3.199	

Tk/Ha present : 8649 Tk/Ha future : 8975

AVERAGE ANNUAL CROP DAMAGE 1971-1989

	Present			Future		
	Loss %	Value MTk/an	Loss MTk/an	Loss %	Value MTk/an	Loss MTk/an
	2.83	77.843	2.203	2.83	80.777	2.286

Year	1	2	3	4	5	6	7	8	9	10
Loss Value (MTk/year)	2.203	2.212	2.221	2.231	2.240	2.249	2.258	2.268	2.277	2.286

Source : consultants' estimates

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TABLE 3

WITH PROJECT BENEFITS SW 5 (1991 economic values)

Rainfed	Proposed Irrigable Area (ha)			Total
Area (ha)	STW	LLP	Total	Area (ha)
3539	1241	4120	5361	8900

LLP irrigation is considered as the project development

	Rainfed				STW Irrigated				LLP Irrigated				Total
	F0	F1	F2	Sub-Total	F0	F1	F2	Sub-Total	F0	F1	F2	Sub-Total	
Area (ha)	2088	1203	248	3539	732	422	87	1241	2431	1401	288	4120	8900
Unit Benefit (Tk/ha)	8668	7238	5309	--	22299	20012	10954	--	22299	20012	10954	--	--
Total Benefit (M Tk)	18.099	8.707	1.317	28.123	16.323	8.445	0.953	25.721	54.209	28.037	3.155	85.401	135.678

non project irrigation costs	MTk	3.566
benefit net of non project irrigation costs	MTk	50.278
Non project gross benefit	Tk/Ha	11264
Project irrigation benefit	Tk/Ha	20728
Non project net benefit	Tk/Ha	10518

TABLE 4

WITH PROJECT BENEFITS SW 10 (1991 economic values)

Rainfed	Proposed Irrigable Area (ha)			Total
Area (ha)	STW	LLP	Total	Area (ha)
4629	831	3541	4372	9000

LLP irrigation is considered as the project development

	Rainfed				STW Irrigated				LLP Irrigated				Total
	F0	F1	F2	Sub-Total	F0	F1	F2	Sub-Total	F0	F1	F2	Sub-Total	
Area (ha)	2731	1574	324	4629	490	282	58	830	2089	1204	248	3541	9000
Unit Benefit (Tk/ha)	11412	10275	5716	--	23109	22501	12161	--	23109	22501	12161	--	--
Total Benefit (M Tk)	31.166	16.173	1.852	49.191	11.323	6.345	0.705	18.373	48.275	27.091	3.016	78.382	145.946

non project irrig costs		MTk	2.361		
benefit net of non project irrigation costs		MTk	65.204		
Non project gross benefit		Tk/Ha	12375		
Project irrigation benefit		Tk/Ha	22136	net Tk/Ha	9539
Non project net benefit		Tk/Ha	11942		

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TABLE 5

WITH PROJECT BENEFIT BUILD UP SW 5 (1991 economic values)

90% LLP uptake	% pa approx	20	40	40	0	0	0	0	100		
Ha\LLP = 20		41.2	82.4	82.4	0	0	0	0	206		
	rounded	41	82	83	0	0	0	0	206		
Build-up rate area\annum x			0.3	0.8	1	1	1	1	1	1	1
Project year	New LLP #	Area Ha 1	2	3	4	5	6	7	8	9	10
2	41	246	656	820	820	820	820	820	820	820	820
3	82	0	492	1312	1640	1640	1640	1640	1640	1640	1640
4	83	0	0	498	1328	1660	1660	1660	1660	1660	1660
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9-30	0	0	0	0	0	0	0	0	0	0	0
Total irrigated	206	246	1148	2630	3788	4120	4120	4120	4120	4120	4120
Total rainfed	8900	8654	7752	6270	5112	4780	4780	4780	4780	4780	4780
Net Benefit (crops) Mill Tk											
2		5.099	13.598	16.997	16.997	16.997	16.997	16.997	16.997	16.997	16.997
3		0.000	10.198	27.184	33.993	33.993	33.993	33.993	33.993	33.993	33.993
4		0.000	0.000	10.322	27.526	34.407	34.407	34.407	34.407	34.407	34.407
5		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9-30		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total		5.099	23.796	54.503	78.516	85.397	85.397	85.397	85.397	85.397	85.397
RAINFED AREA WITH PROJECT											
Area Ha		8900	7752	6270	5112	4780	4780	4780	4780	4780	4780
Tk/Ha		10519	10519	10519	10519	10519	10519	10519	10519	10519	10519
Total MTk		93.619	81.543	65.954	53.773	50.281	50.281	50.281	50.281	50.281	50.281
TOTAL BENEFIT MTk		98.718	105.339	120.457	132.289	135.678	135.678	135.678	135.678	135.678	135.678
WITHOUT PROJECT	Year	1	2	3	4	5	6	7	8	9	10-30
Area Ha		8900	8900	8900	8900	8900	8900	8900	8900	8900	8900
Tk/Ha		8273	8329	8385	8442	8498	8554	8610	8667	8723	8779
Total MTk		73.630	74.130	74.630	75.131	75.631	76.132	76.632	77.132	77.633	78.133

NOTES

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Area = gross area covered by project from year 4 when project works in place to reduce flooding from the river and improved drainage resulting from lower river levels .

Tk/Ha = project year 1 Tk8273 to Tk 8779 in year 10 in even annual stages .

TABLE 6

WITH PROJECT BENEFIT BUILD UP SW 10 (1991 economic values)

90% LLP uptake	%pa approx	20	40	40	0	0	0	0	0	100	
Ha\LLP = 20		35.4	70.8	70.8	0	0	0	0	0	177	
	rounded	35	71	71	0	0	0	0	0	177	
Build-up rate area\annum x			0.3	0.8	1	1	1	1	1	1	1
Project year	New LLP #	1	2	Area Ha 3	4	5	6	7	8	9	10
2	35	210	560	700	700	700	700	700	700	700	700
3	71	0	426	1136	1420	1420	1420	1420	1420	1420	1420
4	71	0	0	426	1136	1420	1420	1420	1420	1420	1420
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9-30	0	0	0	0	0	0	0	0	0	0	0
Total irrigated	177	210	986	2262	3256	3540	3540	3540	3540	3540	3540
Total rainfed	9000	8790	8014	6738	5744	5460	5460	5460	5460	5460	5460
Net Benefit (crops) Mill Tk											
2		4.649	12.396	15.495	15.495	15.495	15.495	15.495	15.495	15.495	15.495
3		0.000	9.430	25.146	31.433	31.433	31.433	31.433	31.433	31.433	31.433
4		0.000	0.000	9.430	25.146	31.433	31.433	31.433	31.433	31.433	31.433
5		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9-30		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total		4.649	21.826	50.071	72.074	78.361	78.361	78.361	78.361	78.361	78.361
RAINFED AREA WITH PROJECT											
Area Ha		8790	8014	6738	5744	5460	5460	5460	5460	5460	5460
Tk/Ha		11946	11946	11946	11946	11946	11946	11946	11946	11946	11946
Total MTk		105.005	95.735	65.225	68.618	65.225	65.225	65.225	65.225	65.225	65.225
TOTAL BENEFIT MTk		109.654	117.561	115.296	140.692	143.586	143.586	143.586	143.586	143.586	143.586
WITHOUT PROJECT	Year	1	2	3	4	5	6	7	8	9	10-30
Area Ha		9000	9000	9000	9000	9000	9000	9000	9000	9000	9000
Tk/Ha		8649	8685	8721	8758	8794	8830	8866	8903	8939	8975
Total MTk		77.841	78.167	78.493	78.819	79.145	79.471	79.797	80.123	80.449	80.775

NOTES

Area = gross area covered by project from year 4 when project works in place to reduce flooding from the river and improved drainage resulting from lower river levels .

Tk/Ha = project year 1 Tk8649 to Tk 8975 in year 10 in even annual stages .

TABLE 7
Future Croped Area by Land Type

Planning Unit : SW 5

CROP	IRRIGATED			NON-IRRIGATED			Totals		
	F0	F1	F2	F0	F1	F2	Irrigated	Rainfed	Overall
Kharif									
B Aus	0	0	0	1316	597	36	0	1,949	1,949
M Aus	990	598	0	17	31	0	1,588	48	1,636
B Aman	0	0	0	0	166	180	0	346	346
L T Aman	452	1060	38	105	104	4	1,549	213	1,763
M Aman	2412	564	0	287	77	0	2,976	364	3,339
Jute	0	0	0	223	129	16	0	368	368
Sugarcane	142	7	0	233	34	0	149	267	416
	0	0	0	0	0	0	0	0	0
Rabi	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
L Boro	0	0	0	0	0	0	0	0	0
M Boro	1565	937	279	0	0	0	2,780	0	2,780
M Wheat	1099	582	84	48	99	16	1,765	163	1,928
Potato	8	20	1	26	1	2	28	29	57
Pulses	105	69	4	333	330	44	178	707	885
Oilseeds	122	82	9	142	158	25	213	325	537
Spices	65	22	0	35	33	2	86	70	156
Minor crops	140	145	5	38	47	2	289	87	376
Orchards	0	0	0	127	0	0	0	127	127
Totals	7,098	4,085	419	2,930	1,806	327	11,602	5,062	16,664
Total NCA	3,163	1,823	375	2,088	1,203	248	5,361	3,539	8,900
Average CI	224%	224%	112%	140%	150%	132%	216%	143%	187%

Planning Units : SW 10

CROP	IRRIGATED			NON-IRRIGATED			Totals		
	F0	F1	F2	F0	F1	F2	Irrigated	Rainfed	Overall
Kharif									
B Aus	0	0	0	1461	665	68	0	2,194	2,194
M Aus	1028	351	0	19	1	0	1,379	21	1,399
B Aman	0	0	0	0	169	196	0	365	365
L T Aman	558	730	31	759	931	28	1,319	1,718	3,037
M Aman	1785	591	0	609	197	0	2,376	807	3,183
Jute	0	0	0	267	151	10	0	428	428
Sugarcane	137	29	0	127	28	0	166	154	320
Rabi									
L Boro	0	0	0	0	0	0	0	0	0
M Boro	1006	736	262	0	0	0	2,004	0	2,004
M Wheat	1059	360	34	30	27	1	1,453	58	1,512
Potato	39	20	3	100	1	18	62	120	182
Pulses	116	50	4	421	178	49	170	649	819
Oilseeds	262	293	28	374	249	48	583	671	1,253
Spices	37	29	0	18	14	0	66	33	99
Minor crops	104	262	6	54	72	3	372	129	501
Orchards	0	0	0	269	0	0	0	269	269
Totals	6,132	3,449	369	4,509	2,684	422	9,950	7,615	17,565
Total NCA	2,579	1,486	306	2,731	1,574	324	4,371	4,629	9,000
Average CI	238%	232%	121%	165%	171%	130%	228%	164%	195%

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TABLE 8
Crop physical Inputs and yields

Name of Crop	Human Labour (Manday)	Bullock-Pair-day	Seed Kg	Pesticides Kg	Manures (Ton) Cowdung	Fertilizers (kg)					Production (Ton)	
						Urea	T.S.P	M.P	Gypsum +	Zinc +	Main Product	by Product
B. Aus (R)	130	35	90	-	1.00	15	-	-	-	-	1.2	2.4
Aus (M) (IR)	180	42	30	0.50	1.00	70	40	10	-	-	2.9	2.9
T. Aman (L) (R)	125	35	30	0.50	-	30	10	-	-	-	1.9	3.8
B. Aman (R)	102	35	90	-	-	-	-	-	-	-	1.2	2.4
T. Aman (M) (IR)	160	35	30	1.00	-	80	40	15	30	-	3.2	3.2
Boro (L) (IR)	167	42	30	0.25	-	25	-	-	-	-	1.9	3.8
Boro (M) (IR)	188	42	30	1.00	-	160	80	30	60	4	4.4	4.4
Wheat (R)	107	35	130	0.50	1.50	80	25	10	-	-	1.7	1.7
Wheat (IR)	121	35	130	0.50	1.50	120	60	30	60	4	2.4	2.4
Jute (R)	180	42	10	0.50	1.50	30	10	8	-	-	1.7	3.4
Sugarcane (R)	243	42	5000	1.00	2.00	120	90	30	-	-	41.0	-
Sugarcane (IR)	283	42	5000	1.00	2.00	140	100	40	60	5	50.0	-
Potato (R)	195	45	1000	0.50	1.00	80	40	20	-	-	8.0	-
Potato (IR)	231	45	1000	1.00	2.00	120	65	60	60	4	12.0	-
Lentil (R)	70	25	30	-	-	-	-	-	-	-	0.7	0.7
Kheshari (R)	47	*	40	-	-	-	-	-	-	-	0.7	0.7
Chickpea (R)	82	25	35	-	-	-	-	-	-	-	0.8	0.8
Mungbean (R)	61	14	20	-	-	-	-	-	-	-	0.5	0.5
Blackgram (R)	61	14	25	-	-	-	-	-	-	-	0.7	0.7
Mustard (R)	82	25	8	0.50	-	20	30	10	-	-	0.7	0.7
Groundnut (R)	150	28	90	-	-	-	-	-	-	-	1.2	1.2
Sesame (R)	66	21	10	-	-	-	-	-	-	-	0.6	1.0
Onion (R)	195	45	6	-	1.00	20	-	-	-	-	4.0	-
Garlic (R)	195	45	90	-	1.00	20	-	-	-	-	3.2	-
Chilli (R)	180	42	0.5	0.50	1.00	25	-	-	-	-	0.6	1.0
Tomato (R)	151	42	0.1	0.50	1.50	80	40	-	-	-	6.2	-
Cabbage (IR)	185	42	0.1	0.50	1.50	100	40	20	-	-	9.7	-
Cauliflower (IR)	185	42	0.1	0.50	1.50	100	40	20	-	-	8.5	-
Sweetpotato (R)	155	30	1.5	0.50	-	-	-	-	-	-	9.0	-

(R) Rainfed * Relay crop. vp\chen-tab\tab-08

(IR) Irrigated ** Seed cotton + Usually farmers use only Urea, TSP & MP. But in Sulphur and Zinc deficient soils, some farmers use Gypsum and Zinc.

(L) Local *** Ash (M) Modern HYV

Note : Rice yield denotes unhusked rice Sources : Compiled from MPO, BRRI, BARI, BARC, and BJRI data.

TABLE 9
Present Croped Area by Land Type

Planning Unit : SW 5

CROP	IRRIGATED				NON-IRRIGATED				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	1039	1227	380	0	0	2,646	2,646
M Aus	97	152	0	0	13	64	0	0	249	78	327
B Aman	0	0	0	0	0	342	1901	649	0	2,892	2,892
L T Aman	44	270	49	0	83	214	41	0	363	338	702
M Aman	236	144	0	0	226	158	0	0	380	384	764
Jute	0	0	0	0	176	266	167	0	0	609	609
Sugarcane	14	2	0	0	184	69	0	0	16	253	269
Rabi											
L Boro	0	0	0	87	0	0	0	47	87	47	134
M Boro	153	239	366	37	0	0	0	0	795	0	795
M Wheat	108	148	110	0	38	203	172	10	366	422	788
Potato	1	5	1	0	20	2	24	0	7	46	54
Pulses	10	18	5	0	263	678	466	48	33	1,455	1,488
Oilseeds	12	21	12	0	112	325	263	27	45	726	771
Spices	6	6	0	0	28	67	20	0	12	115	127
Minor crops	14	37	6	0	30	97	25	0	57	152	208
Orchards	0	0	0	0	100	0	0	0	0	100	100
Totals	695	1,041	550	124	2,313	3,711	3,459	780	2,410	10,263	12,673
Total NCA	310	464	492	141	1,648	2,473	2,623	749	1,407	7,493	8,900
Average CI	224%	224%	112%	88%	140%	150%	132%	104%	171%	137%	142%

Planning Units : SW 10

CROP	IRRIGATED				NON-IRRIGATED				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	921	1092	577	0	0	2,590	2,590
M Aus	102	91	0	0	12	2	0	0	193	14	208
B Aman	0	0	0	0	0	277	1659	483	0	2,419	2,419
L T Aman	56	189	41	0	479	1529	235	0	286	2,242	2,528
M Aman	178	153	0	0	384	324	0	0	331	709	1,040
Jute	0	0	0	0	168	248	85	0	0	501	501
Sugarcane	14	7	0	0	80	45	0	0	21	125	146
Rabi											
L Boro	0	0	0	46	0	0	0	167	46	167	213
M Boro	100	191	350	59	0	0	0	0	701	0	701
M Wheat	105	93	46	0	19	44	12	3	245	78	323
Potato	4	5	4	0	63	2	155	0	13	221	234
Pulses	12	13	6	0	266	293	415	91	30	1,065	1,095
Oilseeds	26	76	38	0	236	409	408	97	140	1,150	1,289
Spices	4	7	0	0	12	24	0	0	11	36	47
Minor crops	10	68	8	0	34	118	26	0	86	178	264
Orchards	0	0	0	0	170	0	0	0	0	170	170
Totals	611	895	493	105	2,845	4,407	3,572	840	2,103	11,664	13,767
Total NCA	257	385	409	117	1,723	2,585	2,741	783	1,168	7,832	9,000
Average CI	238%	232%	121%	90%	165%	171%	130%	107%	180%	1.49%	153%

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TABLE 10

Irrigated Jute and B Aman changed to rainfed and total irrigated and rainfed areas adjusted to 1991 estimates

CROP GROSS MARGINS BY PLANNING UNIT (1991 Economic Values)

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SW5	IRRIGATED				NON-IRRIGATED				Totals		
CROP	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	4,935,990	6,365,430	1,244,027	0	0	12,545,446	12,545,446
M Aus	4,280,631	10,990,141	0	0	642,826	3,380,514	0	0	15,270,771	4,023,340	19,294,111
B Aman	0	0	0	0	0	9,863,880	34,610,347	11,438,624	0	55,912,851	55,912,851
L T Aman	2,136,730	21,306,968	1,100,097	0	4,382,970	12,287,853	1,491,769	0	24,543,795	18,162,592	42,706,387
M Aman	17,118,167	17,019,746	0	0	17,892,098	13,609,915	0	0	34,137,912	31,502,013	65,639,925
Jute	0	0	0	0	14,655,638	24,209,815	9,588,066	0	0	48,453,519	48,453,519
Sugarcane	2,789,428	553,565	0	0	31,159,690	12,811,272	0	0	3,342,992	43,970,962	47,313,954
Rabi											
L Boro	0	0	0	2,394,888	0	0	0	2,028,164	2,394,888	2,028,164	4,423,052
M Boro	11,405,910	29,019,211	12,600,679	1,307,553	0	0	0	0	54,333,353	0	54,333,353
M Wheat	4,581,776	10,321,258	2,166,701	0	989,176	5,714,692	3,055,092	163,997	17,069,735	9,922,957	26,992,692
Potato	87,753	955,492	71,421	0	1,743,942	162,391	1,436,024	0	1,114,666	3,342,357	4,457,023
Pulses	266,577	746,301	60,589	0	7,418,564	20,882,221	9,069,910	900,754	1,073,467	38,271,449	39,344,916
Oilseeds	273,636	784,213	130,005	0	2,800,954	8,884,662	4,537,419	446,264	1,187,853	16,669,299	17,857,153
Spices	1,062,644	1,514,046	0	0	5,102,363	13,418,218	2,585,792	0	2,576,690	21,106,373	23,683,063
Minor crops	1,595,145	7,021,429	343,587	0	2,545,482	9,101,674	1,447,461	0	8,960,160	13,094,617	22,054,778
Orchards	0	0	0	0	8,565,913	0	0	0	0	8,565,913	8,565,913
Totals	45,598,396	100,232,368	16,473,079	3,702,441	102,835,606	140,692,537	69,065,907	14,977,803	166,006,284	327,571,853	493,578,138
Total NCA	2,045	5,009	1,504	436	11,864	19,437	13,009	3,600	8,993	47,910	56,903
Tk/ha(NCA)	22,299	20,012	10,954	8,491	8,668	7,238	5,309	4,161	18,459	6,837	8,674

SW10	IRRIGATED				NON-IRRIGATED				Totals		
CROP	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	4,689,246	4,526,738	4,683,120	0	0	13,899,103	13,899,103
M Aus	6,129,457	4,230,641	0	0	536,929	66,916	0	0	10,360,099	603,845	10,963,944
B Aman	0	0	0	0	0	6,383,419	74,920,174	18,935,628	0	100,239,221	100,239,221
L T Aman	4,289,224	11,348,750	2,099,519	0	27,023,853	70,229,048	21,125,001	0	17,737,494	118,377,902	136,115,396
M Aman	22,918,228	15,350,561	0	0	36,227,703	24,884,645	0	0	38,268,789	61,112,348	99,381,137
Jute	0	0	0	0	15,027,250	18,054,719	12,049,430	0	0	45,131,399	45,131,399
Sugarcane	4,373,268	1,840,993	0	0	14,531,670	6,692,625	0	0	6,214,261	21,224,295	27,438,556
Rabi											
L Boro	0	0	0	0	0	0	36,020	15,181,408	0	15,217,428	15,217,428
M Boro	11,914,842	17,639,272	27,743,224	11,160,906	0	0	0	0	68,458,244	0	68,458,244
M Wheat	7,617,310	5,248,939	2,211,696	0	518,906	996,805	541,709	102,855	15,077,944	2,160,274	17,238,218
Potato	735,996	752,313	506,855	0	8,349,558	218,638	32,681,085	0	1,995,164	41,249,281	43,244,445
Pulses	431,294	373,097	142,350	0	7,256,935	6,512,900	18,062,475	3,446,517	946,742	35,278,827	36,225,569
Oilseeds	1,265,190	2,866,496	1,219,522	0	8,370,592	11,817,856	23,140,829	4,766,943	5,351,208	48,096,220	53,447,428
Spices	978,994	1,528,826	0	0	2,222,815	3,718,992	67,011	0	2,507,820	6,008,818	8,516,638
Minor crops	1,945,535	9,918,091	981,606	0	4,480,918	12,687,974	5,497,541	0	12,845,232	22,666,433	35,511,665
Orchards	0	0	0	0	22,383,149	0	0	0	0	22,383,149	22,383,149
Totals	62,599,340	71,097,979	34,904,773	11,160,906	151,619,525	166,791,274	192,804,395	42,433,351	179,762,997	553,648,545	733,411,542
Total NCA	2,709	3,160	2,870	1,946	13,286	16,233	33,732	8,371	10,685	71,621	82,306
Tk/ha(NCA)	23,109	22,501	12,161	5,736	11,412	10,275	5,716	5,069	16,824	7,730	8,911

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TABLE 11

Average Annual Crop Losses Due to Flooding at 1991 Economic Values

Planning Area : SW 5				Planning Area : SW 10		
Crop	1991 Value Tk. '000	Loss %	Loss Value Tk. '000	1991 Value Tk. '000	Loss %	Loss Value Tk. '000
Aus L	12545	3.04	381	13899	3.04	423
Aus M	19294	3.30	637	10964	3.30	362
Aman B	55913	6.25	3495	100239	6.25	6265
Aman TL	42706	1.32	564	136115	1.32	1797
Aman TM	65640	3.40	2232	99381	3.40	3379
Boro L	4423	0.91	40	15217	0.91	138
Boro M	54333	0.54	293	68458	0.54	370
Jute	48454	4.06	1967	45131	4.06	1832
Sugarcane	47314	0.25	118	27439	0.25	69
Total	350622	2.77	9727	516843	2.83	14635

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Appendix 2

Economics (Methodology)

APPENDIX 2

ECONOMICS

1 Introduction

1.1 Scope

This appendix sets out the basis for the financial and economic analysis undertaken as part of the Southwest Area Water Resources Management Project. It covers the prices, methods and assumptions made to arrive at the benefits and costs of the developments proposed for improved water resources management in the Southwest Area (SWA). The selection of the priority options and individual projects is covered in Part II of this Second Interim Report.

Studies at this stage are directed to the provision of a semi-detailed evaluation of the impacts of a range of water allocation, flood control and drainage (FCD) and irrigation interventions that are considered appropriate to improve resource management in SWA. To date the studies have been aimed at the screening of alternative development options. This is the first major stage in the selection of a number of projects that will be carried forward to feasibility studies during the final months of the project.

1.2 Development Proposals

The proposed development under the SWA regional plan are discussed in Part II. The proposals are confined in this Interim Report to the costs and benefits directly related to the three water management aspects of regional allocation, FCD and irrigation. These include the costs estimated as needed to mitigate adverse effects on the environment if they are considered necessary in addition to the components that are "built in" to the projects directly.

If full advantage of the FCD and other developments is to be taken there will be other costs associated with increasing the effectiveness of institutional support, credit, the provision of production inputs etc. However these would be generally applicable to development in SWA even if no water resource projects were implemented and have therefore not been included at this stage. They will be considered for the projects selected for feasibility studies.

1.3 Project Guidelines

The Flood Plan Coordination Organisation (FPCO) requires that Flood Action Plan (FAP) studies follow certain standard analysis methods to ensure that the various FAP proposals are directly comparable. The SWA studies follow the FAP Guidelines for Project Assessment issued in 1992.

2 Prices

2.1 Financial and Economic Prices

In accordance with FPCO's requirements 1991 prices have been used in all the study analyses. Financial prices have been converted to economic values using the conversion factors (CF) provided by FPCO in its Guidelines for Project Assessment noted earlier.

2.2 Capital and Operation and Maintenance Costs

Development costs were derived from a number of sources and where necessary inflated to 1991 prices.

Construction costs were based on unit rates supplied by BWDB O & M Circles in SWA and the Khulna Zone Highways Department. Unit rates from the five different sources within SWA showed no great divergence and average rates were used for all projects. The prevailing rate for embankment construction used by BWDB is based on manual labour with minimal, hand compaction. While it has been accepted that a large part of the work will continue to be labour intensive the standard of materials, fill procedures and compaction will have to be raised especially for the proposed works along major rivers. Some machine compaction will be needed and the unit rate of Tk 40/m^3 has been adopted to allow for this.

Irrigation development and equipment costs are based on prices supplied by BADC and a number of private sector equipment suppliers and contractors.

Operation and maintenance costs include the costs of diesel or electrical pumping as specified for individual schemes and an amount of 3% pa of the capital cost for earthworks and 2% pa for structures.

Economic values were calculated from financial costs using the composite CFs set out in Table A 2.1. The CFs take account of the different major cost elements in each construction and O & M works. The initial assessments covered in the report lack the detail required to closely distinguish between the cost components required for projects in different Planning Areas. The CFs have been further weighted therefore to reflect typical FC and D, irrigation type and energy sources. The weightings and resulting CFs applied in the study's initial screening of proposed developments are summarised in Table A 2.2. The analysis of individual projects applies to different CFs to the actual estimated works to be carried out. For LLPs and Tubewells the assumption is made that 25% are electric and 75% diesel powered in arriving at a composite CF. A 25% allowance for physical contingencies has been added to these preliminary designs and costings.

TABLE A 2.1

Capital and Operation and Maintenance Costs : Economic Conversion Factors

Items	Capital Costs		O & M Costs	
	Diesel	Electric	Diesel	Electric
Pumping				
Deep tubewells	0.83	0.81	0.67	1.45
Shallow tubewells	0.85	0.73	0.69	1.36
Low lift pumps	0.84	0.62	0.70	1.31
Floating pumps	0.68	na	0.70	na
Major pump stations	na	0.69	na	1.45
Distribution Systems				
Small scale (DTW, STW, LLP)	0.74		0.74	
Large scale	0.77		0.77	
Major drainage systems (1)	0.73		0.73	
Flood Control embankments (2)	0.71		0.71	

Source : Consultants estimates derived from 1992 FPCO Guidelines for Project Assessment

(1) 50% earthworks, 50% structures.
(2) 75% earthworks, 25% structures.

TABLE A 2.2

Derivation of Economic Conversion Factors for Development Projects in SWA (RAOM)

IRRIGATION DEVELOPMENT	Weighted	Small Barrages	Dist.by	DTW Diesel	DTW Elect	STW Diesel	STW Elect	LLP Diesel	LLP Elect	Large scale pumps Diesel	Large scale pumps Elect
Weighting		0.56	0.44	0.889	0.111	0.889	0.111	0.889	0.111	0.05	0.95
Area dev cost (per km²)	0.740										
GW pumps (per MCM/mo.)	0.829			0.83	0.81	0.85	0.73				
SW pumps (per MCM/mo.)	0.792							0.84	0.62	0.68	0.69
SW distribution (per km²)	0.764	0.76	0.77								
FLOOD PROTECTION CAPITAL COST	Weighted	FC Embank.	Drains	ENERGY COSTS			Weighted factor			0.731	
Weighting		0.19	0.81				Cost of diesel energy			0.630	
Rehabilitation	0.726	0.71	0.73				Cost of electric energy			1.540	
New	0.726	0.71	0.73				Weighting elec/diesel			0.111	

Source: Consultants estimates using FPCO, Guidelines for Project Assessment (1992) Conversion factors.

2.3 Commodity and Production Input Prices

2.3.1 Crops

The study analyses are based on 1991 crop prices collected regularly by the Department of Agricultural Marketing from 25 growers markets in SWA. Table A 2.3 lists the markets and the MPO Planning Areas and study's Planning Units to which they are relevant. The grower markets are the ones most widely used by farmers. The financial prices are for the 1991 harvest months for each crop. They are set out in Table A 2.4 which presents three price levels defined as follows:

- Average prices are the means of the figures derived for each PU based on growers market data.
- High prices are those in excess of one standard deviation above the mean price.
- Low prices are those below one standard deviation below the mean.

Table A2.4 also gives the economic values of crops and the FPCO (1992) CFs that were applied. There are also a number of crops that have either very limited distribution in SWA or for which few data were available. One value has been used throughout SWA in these instances. The crops and prices are set out below:

Crop	Financial Price Tk per 100 Kg	CF	Economic Value Tk per 100 Kg
Tomato	580	0.87	505
Cabbage	320	0.87	280
Tobacco	2250	0.87	1960
Seed Cotton	1930	0.87	1680
Straw:			
Wheat	30	0.87	26
Rice local	95	0.87	83
Rice Hyv	72	0.87	63
Jute sticks	255	0.87	222
Pulses	50	0.87	44

Source: Directorate of Agricultural Marketing

2.3.2 Crop Inputs

Labour, fertiliser and animal and mechanical draft power hire costs were collected directly from DAE and DAM staff throughout SWA. The prices used in the analyses are given in Table A 2.5.

TABLE A 2.3

Location of Growers Markets in SWA for which Regular Price Data are Available

MPO Planning Area	SWA Planning Units	Grower Market (District)
42	SW1	Gangni (Meherpur)
43	SW4	Jibannagar (Chuadanga)
44	SW3, 5, 6	Khankhanpur (Rajbari), Kanaipur (Faridpur), Lohagara (Narail)
45	SW 8	Jhikargacha (Jessore)
46	SW 8, 9	Jhikargacha (Jessore)
47	SW 9	Chuknagar (Khulna), Phultala (Khulna)
48	SW 10	Nowapara (Jessore)
49	SW 11, 12, 14	Patkelghata (Satkhira), Fakirhat (Bagerhat)
50	SC 3, 4	Takerhat (Madaripur)
51	SW 7	Shatpar (Gopalgonj)
52	SC 5, 7	Babuganj (Barisal), Nalchiti (Jhalakhati)
53	SW 13	Parerhat (Pirojpur)
54	SC 10, 11	Amtali (Barguna)
55	SC 8,9,12,13	Burhanuddin (Bhola), Kalaia, Boghabandar (Patuakhali)
56	SC 2, 6	Babuganj (Barisal)
57	SC 1	Bhartisar (Shariatpur), Takerhat (Madaripur)
58	SW 2	Garagonj (Jhenaidah), Nangalband (Magura), Khalishakhandi (Kushtia)

Source : Department of Agricultural Marketing

TABLE A 2.5

Financial and Economic Values of Selected Crop Inputs (1991 Prices)

Item	Unit	Financial Price Tk	Conversion Factor (1)	Economic Value Tk
Fertilizers:				
Urea	Kg	5.9	1.45	8.6
TSP		7.0	1.88	13.2
MP		5.6	2.02	11.3
ZnSO4		29.0	0.87	25.2
Gypsum		3.4	0.87	3.0
Manure		0.9	0.87	0.8
Labour:	man day			
Planning Unit				
SC 5 to 11, SC 13		50	0.75	38
SC 1, 3, SW 1, 2, 8		35	0.75	26
All other PU		40	0.75	30
Bullock draft (1)	day	45	0.87	39
Pesticide	Kg	510	0.87	444
Seed:	Kg			
HYV & Aus		11	0.88	9.7
HYV Aman		9	0.88	7.9
All other paddy		10	0.88	8.8
Wheat		12	1.29	15.5
Jute		24	1.06	25.4
Sugarcane		1	0.95	0.95
Tobacco		40	0.87	34.8
Vegetables		400	0.87	348
Onion		600	0.87	522
All other seeds		x 1.5 output price		x 1.5 output value

Source : Consultants field studies and FPCO Guidelines for Project Assessment 1992.

(1) Cost of bullock and plough hire only-does not include cost of ploughman.

2.3.3 Fish

Preliminary fish price and production cost data have been used in the present phase of the studies. The fish prices used are set out below:

Source	Financial Tk/kg	Economic Tk/kg
Capture	35.0	44.0
Culture	50.0	62.5
Shrimp: export	133.0	166.0
Local sales	20.0	25.0

Fish prices do vary within SWA and according to the species sold. The above prices were broadly typical in 1991 however. They will be revised for the feasibility studies.

2.3.4 Forest Products

A wide variety of fruit and fuel species are grown in SWA in the social forestry sector. Prices used in the study were obtained from consultants field studies and the Swiss Development Corporation - BARI report "Optimisation of Agroforestry Systems in Bangladesh at Household and National Levels" (September 1990).

Data on state forestry output prices and costs (Sundarbans) were obtained from the Department of Forestry. Details are given in Annex 3, Forestry.

3 Identification of Benefits and Penalties

3.1 General

The proposals for improved water resource management in SWA arise from a regional strategy for water distribution and use which takes into account water availability, and broad requirements for the agricultural sectors, navigation, urban areas and environmental considerations related to the possible changes in water regimes. The strategy is described in Chapter 7 and leads to the project outline development proposals in Chapter 8. The development programmes include projects for flood protection and drainage with irrigation components in most cases. The assessment of benefits therefore are confined to those arising from FCD and irrigation. These direct quantifiable benefits may be considered the minimum that can be expected. However they can be enhanced if improvements are made in other sectors : credit, production support services, institution strengthening for example. Such developments are not confined to FCD/I however and are not therefore included in the present analyses. The direct benefits fall into two categories:

(i) higher output arising from improved water regimes and land resource conditions, and

(ii) the reduction in agricultural and non-agricultural damage from floods that do not occur every year.

Penalties can also be expected from changes in resource conditions as will be noted in Section 3.2.2.

3.2 Production Benefits

3.2.1 Crops

The benefits considered in greatest detail are those expected from crop production which accounts for about three quarters of the value, net of direct costs, of total agricultural, forestry and fishery output in SWA. Three possible sources of benefit were considered; yield, cropping pattern and annual flood damage.

Yield

Under in-field conditions annual variations in water regimes, including flooding, are such that it is not possible to measure FCD benefits in terms of yield changes within each type of crop.

Cropping patterns

Each flood zone category; F0, F1 etc; is associated with a distinct cropping pattern. These relate to both annual cropping intensity and to the types of rice and other crops that are grown. Overall crop area data for SWA to illustrate this are given in Table A 2.6, for rainfed crops and Table A 2.7 for irrigated cultivation. In the kharif season there is an increase in the proportion of sugarcane and HYV rice and a decrease in the other major crops, jute and local rice varieties from the deeper flooded areas (F2, F3/4) to shallower areas (F0, F1). The changes that occur within the rice crop itself are illustrated below:

	F0	F1	F2	F3/4
		Percent		
Rainfed Rice:				
Local	83	91	100	100
HYV	17	9	0	0
Irrigated Rice:				
Local	11	51	100	0
HYV	89	49	0	0

Under rainfed conditions FCD projects will lose the boro rice crop that is grown in the F3/4 areas. The proportion of high value spices and vegetables - mainly sweet potatoes will rise. The wheat area will decrease as a result of the lower soil moisture regimes in F0 and F1 areas as shown in Table A2.6.

TABLE A2.6

Rainfed Cropping Patterns (percent)

	F0	F1	F2	F3/4
Kharif Rice:				
Local	72	85	96	100
HYV	15	8	0	0
Jute	9	6	4	0
Sugarcane	5	1	0	0
Rabi Rice:				
Local	0	0	1	29
HYV	1	0	0	0
Wheat	4	9	11	18
Pulses	42	49	49	33
Oilseeds	22	25	32	21
Spices	5	5	2	0
Other	26	12	5	0
Cropping intensity	140	148	157	119

Source: from MPO Data. For all SWA. (Figures rounded)

Irrigation, whether in conjunction with FCD works or not, leads to benefits from a higher cropping intensity in particular a major increase in boro rice production.

Table A2.7 clearly shows that when irrigated areas are within FCD deveopment, where F0 and F1 areas predominate, there is a major shift from local to HYV boro rice:

	F0	F1	F2	F3/4
		Percent		
Irrigated Rice:				
Local	0	5	2	43
HYV	100	95	98	57

Under irrigation in the less deeply flooded areas rabi cropping also exhibits higher proportions of wheat, spices and other high value crops such as vegetables and potatoes.

The changes in cropping patterns noted above for SWA as a whole arising from FCD and irrigation developments are found in each Planning Unit. The degree of the changes does vary from PU to PU according to the differences in cropping patterns that arise from other causes such as access to markets for specific crops. The study analyses have been based on the positions found in each individual PU leading first to the initial selection of areas in the RAOM and then to the specific project proposals presented in this report.

TABLE A2.7

Irrigated Cropping Patterns (percent)

	F0	F1	F2	F3/4
Kharif Rice:				
Local	10	50	100	0
HYV	84	49	0	0
Jute	0	0	0	0
Sugarcane	5	1	0	0
Rabi Rice:				
Local	0	3	2	43
HYV	61	55	82	57
Wheat	17	14	9	0
Pulses	3	6	4	0
Oilseeds	7	12	3	0
Spices	5	2	0	0
Other	8	8	1	0
Cropping intensity	211	223	117	92

Source: from MPO Data. For all SWA. (Figures rounded)

Unusual flood damage

Table A2.8 sets out the extent of damage to crops from unusual floods. Damage is expressed as the proportion of the total crop area and is the average reported during the 19 years, 1971 to 1989. In the study analyses the economic value of these crop losses, at 1991 prices, has been added to the benefit from changes in cropping patterns discussed above. The benefits do not accrue if irrigation is provided without FCD works.

TABLE A2.8

Karif Season Average Crop Losses due to Floods 1971-1989

Percent total crop area.

Planning Unit	Aus L	Aus M	Aman B	Aman TL	Aman TM	Jute	Sugarcane
SW1,2	2.43	3.07	4.32	2.13	2.13	0.84	0.53
SW4,5,8,9,10	3.04	3.3	6.25	1.32	3.4	4.06	0.25
SW11,12,13,14	3.02	2.21	4.73	0.23	0.24	1.86	0
SW3,6,7 SC1,2,3	3.74	5.06	7.68	23.16	15.85	2.35	3.54
SC4,5,6,7,11	2.49	0.43	5.01	0.95	3.25	1.45	0.27
SC8,9,10,12,13	1.63	2.7	0	0	0	0	0

Source: Derived from BBS data.

3.2.2 Fisheries

Previous studies (FAP 12/13) have confirmed that FCD works have a negative effect on capture fisheries. In practice culture fisheries programmes have not been pursued sufficiently to make up for the losses that culture fisheries suffer. The SWA has a diverse capture fisheries resource that includes production from flood plains, beels and baors as well as the numerous rivers and estuaries in its southern parts. In addition there is a developing culture shrimp sector in areas where brackish water is seasonally available, mainly PUs SW9 to 14. The water resource management plan recognises the importance of the shrimp industry to export earnings and development proposals take care not to adversely affect it. It is also acknowledged that the industry has generated social conflict between shrimp farmers, usually the more influential, and rice growers on whose land the shrimp are, seasonally, produced. Annex 2- Fisheries discusses these problems and the proposals made are directed towards enabling the socially weaker rice growers to become small scale shrimp farmers rather than rent out or seasonally lose share-cropped land to entrepreneurs who now typically cultivate shrimp.

The adverse effects of FCD on fin fisheries has been included in the assessment of SWA proposals using the loss estimates given in Table A2.9. The figures in Table A2.9 were applied for all PUs in SWA.

TABLE A2.9

Capture Fisheries Losses Resulting from FCD Development (1991 Prices)

Source of Loss	Loss Kg/Ha	Financial				Economic				
		income Tk/Kg	costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	income Tk/Kg	costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	G M Tk000/ Km²
Flood Plain:										
not flooded before	0	0	0	0	0	0	0	0	0	0
flooded before										
now dry	37	35	10	25	925	44	7	37	1356	136
still flooded	20	35	10	25	500	44	7	37	733	73
beels:										
remaining	150	35	10	25	3750	44	7	37	5498	550
lost	400	35	10	25	10000	44	7	37	14660	1466
rivers/khals	15	35	10	25	375	44	7	37	550	55

Sources: Consultants estimates and FAP 12/13 reports.

The values of culture, pond and baor, fisheries in each PU are given in Table A2.10 and A2.11 respectively. These are based on current reported yields and together with the figures given in Table A2.12 for shrimp-rice culture were used in RAOM to assess the value of present SWA production.

In the study analyses at this stage the following has been assumed:

- Flood Plain : F3/4 and F2 areas that are eliminated in FCD works are lost completely and F2 areas that remain suffer the partial loss quantified in Table A 2.9.

- Beels and Baors: The same proportion of beels and baors lie within each project area as in the PUs within which it is situated.

TABLE A2.10

Value of Culture Fisheries: Ponds (1991 Prices)

PU	Financial					Economic			
	Yield Kg/Ha	Value Tk/Kg	Costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	Income Tk/Kg	Costs Tk/Kg	G M Tk/Kg	G M Tk/Ha
SW 1	865	50	13	37	32005	62.5	9.23	53.27	46079
2	865	50	13	37	32005	62.5	9.23	53.27	46079
3	870	50	13	37	32190	62.5	9.23	53.27	46345
4	1925	50	15	37	67375	62.5	10.65	51.85	99811
5	1940	50	15	37	67900	62.5	10.65	51.85	100589
6	940	50	13	37	34780	62.5	9.23	53.27	50074
7	870	50	13	37	32190	62.5	9.23	53.27	46345
8	1890	50	15	35	66150	62.5	10.65	51.85	97997
9	1960	50	15	35	68600	62.5	10.65	51.85	101626
10	1840	50	15	35	64400	62.5	10.65	51.85	95404
11	1530	50	15	35	53550	62.5	10.65	51.85	79331
12	1560	50	15	35	54600	62.5	10.65	51.85	80886
13	1240	50	15	35	43400	62.5	10.65	51.85	64294
14	1530	50	15	35	53550	62.5	10.65	51.85	79331
SC 1	875	50	13	37	32375	62.5	9.23	53.27	46611
2	900	50	13	37	33300	62.5	9.23	53.27	47943
3	900	50	13	37	33300	62.5	9.23	53.27	47943
4	915	50	13	37	33855	62.5	9.23	53.27	48742
5	930	50	13	37	34410	62.5	9.23	53.27	49541
6	935	50	13	37	34595	62.5	9.23	53.27	49807
7	950	50	13	37	35150	62.5	9.23	53.27	50607
8	930	50	13	37	34410	62.5	9.23	53.27	49541
9	1160	50	15	35	40600	62.5	10.65	51.85	60146
10	1145	50	15	35	40075	62.5	10.65	51.85	59368
11	1030	50	15	35	36050	62.5	10.65	51.85	53406
12	1055	50	15	35	36925	62.5	10.65	51.85	54702
13	1160	50	15	35	40600	62.5	10.65	51.85	60146

Source: Consultants estimates based on Department of Fisheries Data

TABLE A2.11

Value of Culture Fisheries : Baors 1991 Prices

PU	Financial					Economic			
	Yield Kg/Ha	Value Tk/Kg	Costs Tk/Kg	G M Tk/Kg	G M Tk/Ha	Income Tk/Kg	Costs Tk/Kg	G M Tk/Kg	G M Tk/Ha
SW 1	195	50	12	38	7410	62.5	8.52	53.98	10526
2	255	50	12	38	9690	62.5	8.52	53.98	13765
3	195	50	12	38	7410	62.5	8.52	53.98	10526
4	295	50	12	38	11210	62.5	8.52	53.98	15924
5	300	50	12	38	11400	62.5	8.52	53.98	16194
6	205	50	12	38	7790	62.5	8.52	53.98	11066
7	200	50	12	38	7600	62.5	8.52	53.98	10796
8	280	50	12	38	10640	62.5	8.52	53.98	15114
9	300	50	12	38	11400	62.5	8.52	53.98	16194
10	290	50	12	38	11020	62.5	8.52	53.98	15654
11	195	50	12	38	7410	62.5	8.52	53.98	10526
12	240	50	12	38	9120	62.5	8.52	53.98	12955
13	205	50	12	38	7790	62.5	8.52	53.98	11066
14	190	50	12	38	7220	62.5	8.52	53.98	10256
SC 1	200	50	12	38	7600	62.5	8.52	53.98	10796
2	200	50	12	38	7600	62.5	8.52	53.98	10796
3	205	50	12	38	7790	62.5	8.52	53.98	11066
4	190	50	12	38	7220	62.5	8.52	53.98	10256
5	0	50			0	62.5		62.5	0
6	0	50			0	62.5		62.5	0
7	0	50			0	62.5		62.5	0
8	0	50			0	62.5		62.5	0
9	0	50			0	62.5		62.5	0
10	0	50			0	62.5		62.5	0
11	0	50			0	62.5		62.5	0
12	0	50			0	62.5		62.5	0
13	0	50			0	62.5		62.5	0

Source: Consultants estimates based on Department of Fisheries Data

TABLE A2.12

Value of Shrimp-Rice Culture (1991 prices)

	Yield main	Kg/Ha by prod.	Financial	Economic
			Tk/Ha	Tk/Ha
PU SW 11 SW 14				
Shrimp	304	0	15075	24860
Rice (1)	1900	3800	3060	3210
Total			18135	28070
PU SC 12				
Shrimp	304	0	13945	23960
Rice (1)	1900	3800	1660	1680
Total			15605	25640

Source: Consultants estimates

(1) Assumes that shrimp growers vacate in good time for the aman rice to be transplanted by mid August and that land is available for nursery beds before that time.

3.2.3 Forestry

The effect of SWA proposals on forestry have not yet been closely defined. However the present value of social and state forestry, the Sundarbans, were taken into account when deciding on a number of aspects of water management and regional allocation.

Social Forestry

Broadly SWA is divided into three social or homestead forestry areas. The differences, which are general at this stage, are given in Table A2.13.

TABLE A2.13

SWA Social Forestry Economic Value (1991 prices) (1)

Tree	G M Tk/Ha	Area A		Area B		Area C	
		%	Tk/Ha	%	Tk/Ha	%	Tk/Ha
Mango	56032	2	1121	2	1121	2	1121
Jackfruit	74264	2	1485	2	1485	2	1485
Coconut	96057	2	1921	30	28817	10	9606
Betelnut	184365	10	18437	10	18437	10	18437
Lemon	5090	2	102	2	102	2	102
Guava	85765	2	1715	2	1715	2	1715
Date	149420	30	44826	2	2988	20	29884
Fuel spp.	39323	40	15729	40	15729	47	18482
Bamboo:							
grove	46650	8	3732	8	3732	5	2333
field	83300	2	1666	2	1666	0	0
Total			90734		75792		83163

Source : Consultants estimates based on "Optimisation of Agroforestry Systems in Bangladesh at Household and National Levels" (1990); BARI, Swiss Development Corporation.

(1) Area A PU SW1 - 4,8 Part SW 5-7,9,10.
Area B PU SW 11,14: SC 8-13 Part SW 12,13: SC 5,7
Area C PU SW 7: SC 1-4,6 Part SW 12,10,13: SC 5,7

Sundarbans

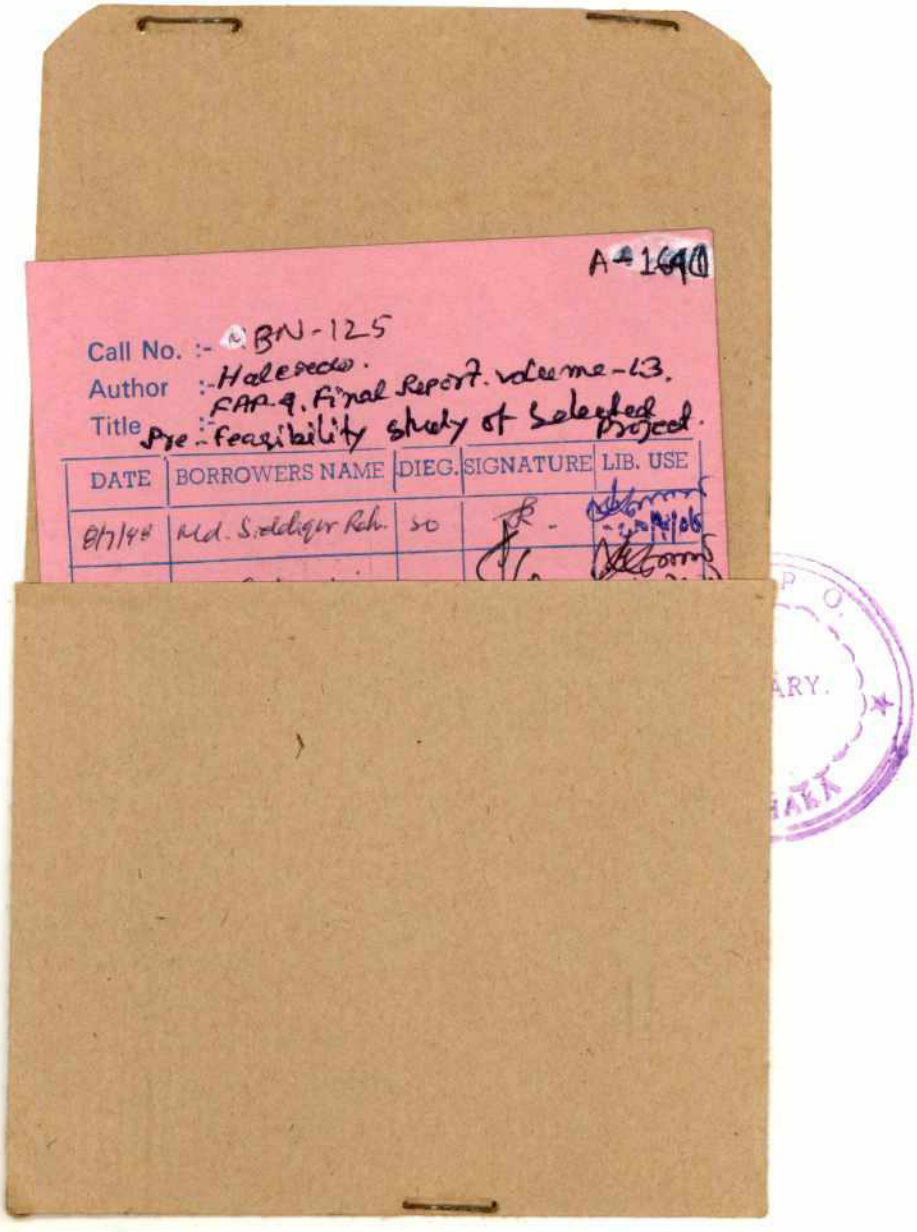
The value of the Sundarbans arises from a wide variety of resources. A preliminary estimate of the total value at 1991 economic prices is about Tk.4592 M/Year. This includes an imputed value of fish breeding as well as capture fisheries that amounts to 82% of the estimated total annual value. A breakdown of the value is set out in Table A2.14.

TABLE A2.14

Sundarbans Present Value at 1991 Prices (M Tk/Year)

Product	Financial			C F (Costs)	Economic		
	Gross Income	Costs	Net Income		Gross Income	Costs	Net Income
Sawlogs	300	23	277	0.74	300	17	283
Fuelwood	44	9	35	0.74	44	7	37
Pulpwood	70	30	40	0.74	70	22	48
Tr poles	27	4	23	0.72	27	3	24
Fronds:							0
Nypa	78		78		78		78
Phoenix	2		2		2		2
Honey	8		8		8		8
Wax	2		2		2		2
Shell	1		1		1		1
Grass	1		1		1		1
Fish	195	60	135		195		195
Fish breeding	3553		3553		3553		3553
Protection:							
Coastal	320		320		320		320
Wildlife	40		40		40		40
Total	4641	126	4515		4641	49	4592
Tk000/Km² total			1126				1145
less fish breeding			240				259

Source: Consultants estimates (Volume 7, Forestry)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