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

Flood Plan Coordination Organisation

JAMALPUR PRIORITY PROJECT STUDY

Caisse Francaise de Developpement
and
Commission of the European Communities

FAP 3.1

FINAL FEASIBILITY REPORT

MAIN REPORT

January 1993

Consortium

SOGREAH/ HALCROW/ LAHMEYER

in association with
Engineering & Planning Consultants Ltd.
AQUA Consultants and Associates Ltd.
and Service Civil International.

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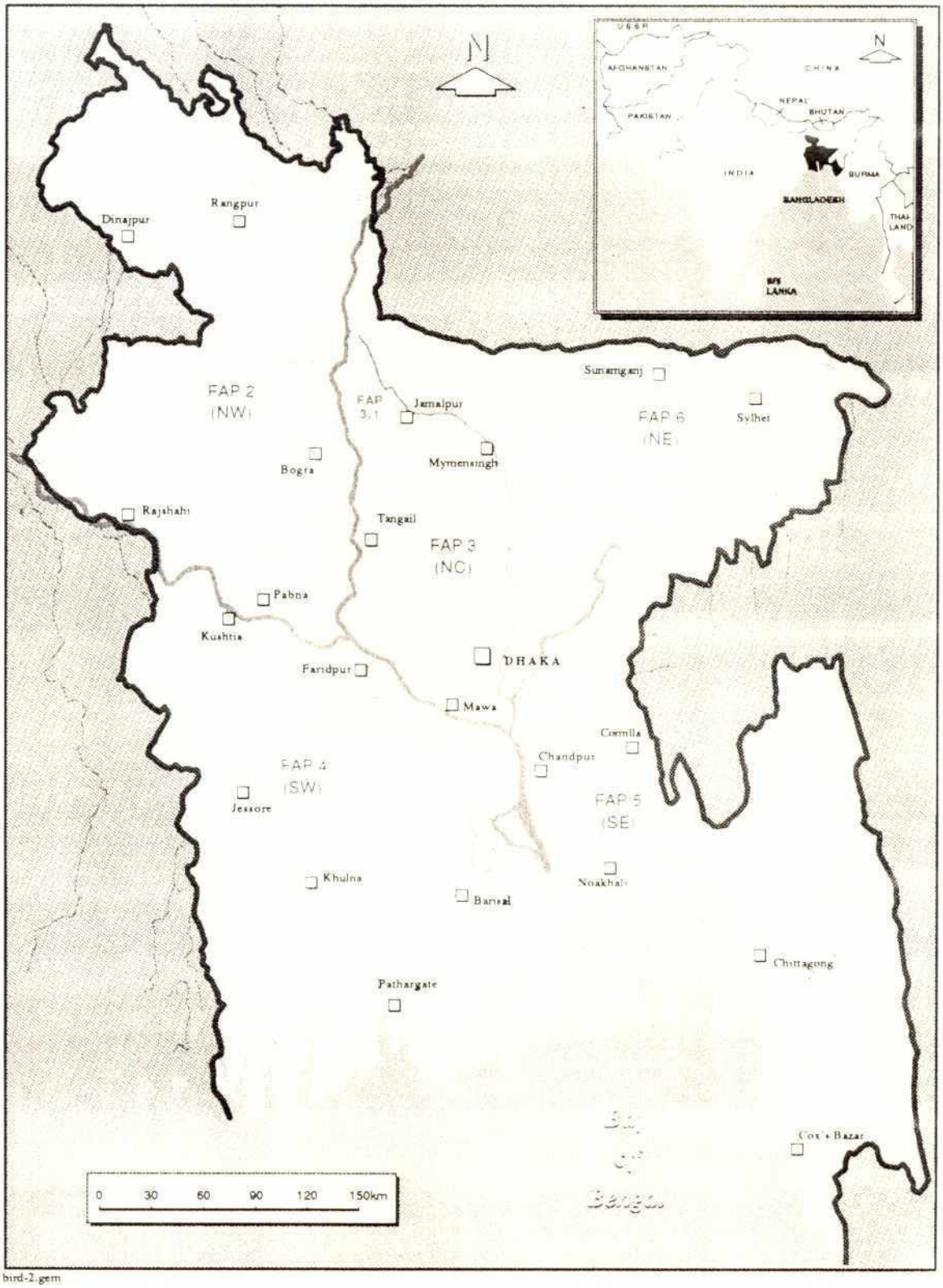
CONTENTS — Page No

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES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Tangail
Pabna
Kushtia
DHAKA
Faridpur
Mawa
Comilla
Chandpur
Jessore
Khulna
Barisal
Noakhali
Chittagong
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Pathargate
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FAP 3.1
FAP 6 (NE)
FAP 3 (NC)
FAP 4 (SW)
FAP 5 (SE)
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GLOSSARY

BADC	-	Bangladesh Agricultural Development Corporation
BWDB	-	Bangladesh Water Development Board
DEM	-	Digital Elevation Model
DOE	-	Department of the Environment
DSSTW	-	Deep Set Shallow Tube Well
DTW	-	Deep Tube Well
EIA	-	Environmental Impact Assessment
FAP	-	Flood Action Plan
FCD	-	Flood Control and Drainage
FCDI	-	Flood Control, Drainage and Irrigation
FFP	-	Full Flood Protection
GIS	-	Geographical Information System
GPA	-	Guidelines for Project Assesment (FPCO)
JPPS	-	Jamalpur Priority Project Study
LLP	-	Low Lift Pump
MCC	-	Mennonite Central Committee (an NGO)
MEF	-	Ministry of Environment and Forest
MOSTI	-	Manually Operated Shallow Tube Well for Irrigation
MPO	-	Master Plan Organization
NCR	-	North Central Region
NFP	-	No Flood Protection
NGO	-	Non Government Organisation
NWP	-	National Water Plan
PFP	-	Partial Flood Protection
PMO	-	Project Management Office
POE	-	Panel of Experts (of FPCO)
SCI	-	Service Civil International (an NGO)
STW	-	Shallow Tube Well
Sy	-	Specific yield
TM	-	Thematic Mapper
Upazila	-	Upgraded thana as defined by the Local Government Ordinance of 1982, now discontinued.
WHO	-	World Health Organisation

FOREWORD

Introduction

The disastrous 1987 and 1988 floods in Bangladesh raised considerable international interest in helping the country to find a long term solution to its flood problem. In June 1989, the Government of Bangladesh requested the World Bank to coordinate the preparation of a five-year Action Plan for Flood Control in Bangladesh. The role of the Bank in co-ordinating international efforts to assist Bangladesh in flood control was endorsed in the Communique of the G7 economic summit meeting held in Paris in July, 1989. The Flood Action Plan was discussed and endorsed by a meeting of donors held in London in December, 1989.

The Flood Action Plan (FAP) consists of Project-oriented studies in all the country's main regions, supporting activities to promote improved Project design and execution, and non-structural measures. The Action Plan attached high priority to flood control and drainage on the left bank of the Brahmaputra. A priority project in the Jamalpur area was identified in the Action Plan and confirmed for early implementation in the Reconnaissance study of the North Central Regional Study (NCRS). The Jamalpur Priority Project (JPP) is located on the left bank of the Jamuna River and is bounded by the Jamuna to the west, the Old Brahmaputra to the east and the Jamalpur-Jagannathganj Ghat railway line to the south.

This Feasibility Report of the Jamalpur Priority Project is financed by the Government of France and the Commission of European Communities (CEC), with France taking the lead. The study has been undertaken by a consortium comprising Sogreah Ingenieri (lead firm), Sir William Halcrow and Partners Ltd. and Lahmeyer International in association with Engineering and Planning Consultants Ltd., Aqua Consultants and Associates Ltd. and Service Civil International (SCI) of Bangladesh. Work commenced in 1991 and the draft Final Report was submitted on schedule in October 1992, following an extension in May 1992 to enable additional data collection and studies to be incorporated.

Study Programme

The Terms of Reference for this study are given in Appendices A, B, and C being:

A Terms of Reference for JPPS

B Terms of Reference for Extension of JPP studies

C Terms of Reference for Char Study

The original study commenced in August 1991 with a reporting programme as follows:

R1	February 1992	Inception Report
R2	March 1992	Preliminary Interim Report, Sub Regional Land and Water Development Plan
R3	April 1992	Interim Report, Selected Sub-Regional Land and Water Development Plan
R4	June 1992	Report of Surveys and Investigations
R5	June 1992	Feasibility Study of the Jamalpur Priority Project
R5(rev)	August 1992	Revised Feasibility Report

In June 1992 an agreement was reached to incorporate a study of the adjacent char and setback land within the Jamuna river. This lead to a further report:

September 1992 Char Study Report

Earlier in May 1992 it was agreed also to extend the duration of the Main Report to enable additional data collection and further hydrodynamic modelling. This lead to further reports as follows:

R6	October 1992	Draft Final Feasibility Report
R6	January 1993	Final Feasibility Report (i.e. this Report)

As may be observed from the above the scope and extent of the study has evolved as greater understanding of the needs of the area and the measures required to address these has been gained. It may be noted that Report R3, Interim Report on Selected Sub-Regional Land and Water Development Plan, presented in April 1992, was a key report in terms of establishing the types of mainland intervention to be considered at feasibility level. All subsequent work and the framing of this Final Report are based on the agreements arising from the discussions of Report R3.

Scope of this Report

This Report comprise 12 volumes, being:

- Executive Summary
- Main Report
- Annex 1 Groundwater
- Annex 2 Fisheries
- Annex 3 Environmental Impact Assessment
- Annex 4 Modelling
- Annex 5 Agriculture
- Annex 6 Social Impact Assessment
- Annex 7 Engineering
- Annex 8 Economics
- Annex 9 Char Study Report
- Drawings

Together these volumes describe the comparative studies of the two development Options selected for feasibility study in R3 (options A and B), together with the investigations and conclusions from the Char Study, and present overall recommendations for development within the study area. These recommendations together with an overview of the reasons behind them are presented in the Executive Summary. In this volume the Main Report, details are provided of each of the sectoral studies undertaken and the conclusions and recommendations arising from each.

1 PHYSICAL DESCRIPTION OF THE AREA

1.1 The Physical Environment

The total mainland Project Area, based on the 6 Thanas named in the T.O.R. (Madarganj, Melandaha, Islampur, Jamalpur, Sarishabari and Dewanganj) extends over 86,000 ha. In fact, 3 Thanas belonging to the North-East region (Phukhhari, Sariakandi and Kazipur), should also be considered as being part of the mainland Project Area since they belong to the same geographical unit. The original total mainland Project Area was therefore 96,000 ha. This was subsequently reduced to 92,242 ha as a result of movements in the Jamuna left bank and remeasurement of the mainland area.

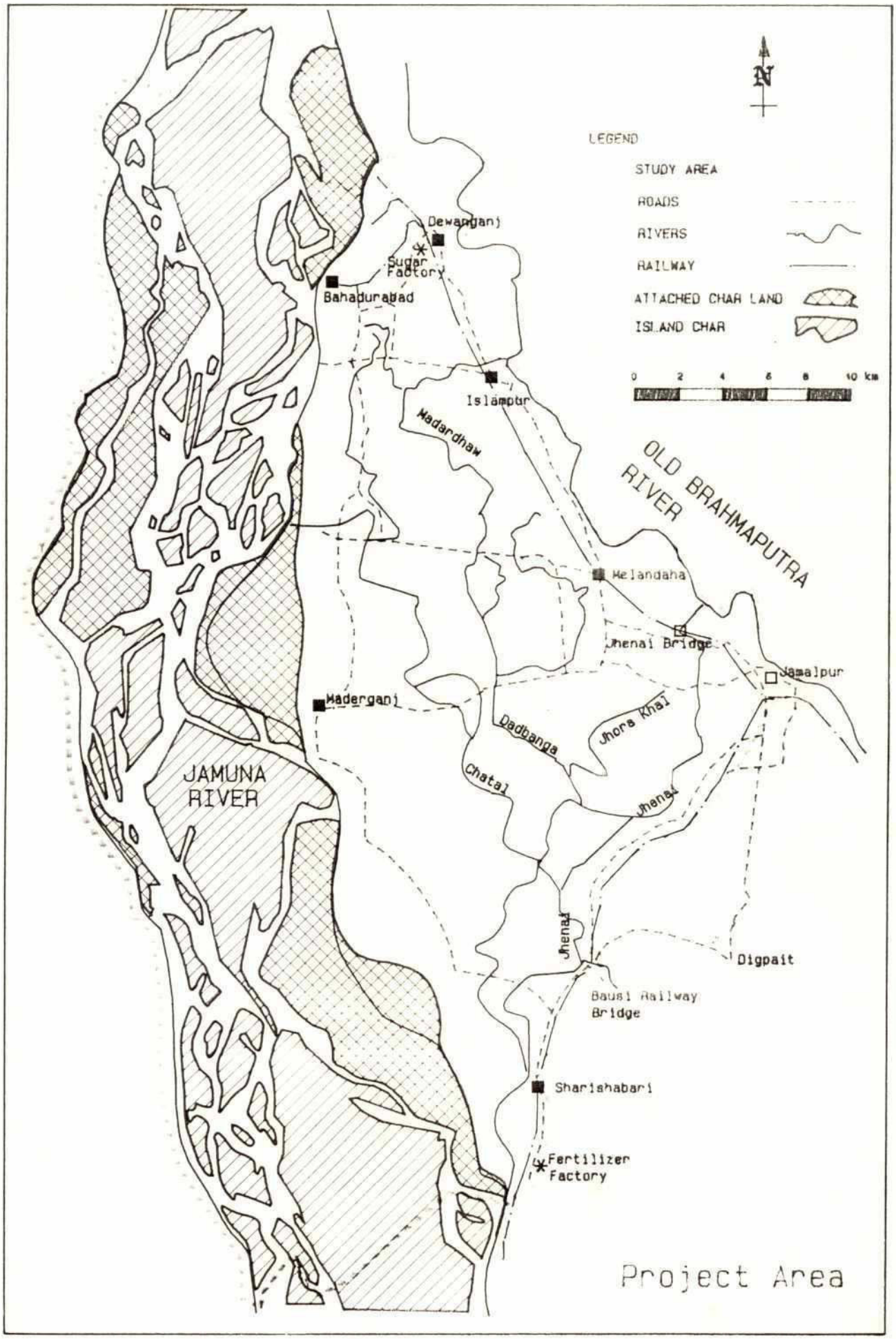
The inclusion of the Char land area within the scope of the studies has increased the total project area to 179,842 ha and 3 more Thanas are involved: Dhunat, Sonatala and Sughatta.

Two large rivers limit the mainland area. The Jamuna river on the west is a major water course and the Old Brahmaputra to the north-east is a distributary off it. Several secondary internal distributaries build up a network through the mainland area. They either originate from the Jamuna river the Chatal or from the Old Brahmaputra river as does the Jhenai. The network also functions as a drainage network whose main outlet is in the Jagannathganj Ghat area. The second significant outlet is through the Bausi bridge.

Regarding soils in the mainland area, some highly clayey areas exist here and there, in particular around Jamalpur where it is several metres thick. Otherwise, the soils are more silty and sandy, with a low organic content. They generally overlay thick sandy deposits forming an excellent aquifer. On Char land, the soils are mainly sandy.

Climate conditions are marked by a mean annual temperature of 25.3°C, varying from 18°C in January to 28°C for the six months of the year between April and September. The mean annual rainfall is 2240 mm, but 90% of it is concentrated in the six months from May to October. The annual evapotranspiration is 1290 mm, with a deficit in supply of 309 mm during the dry season.

The existing drainage system in the mainland project area is a natural system with the Chatal river and the Jhenai river as main drains. A minor river (Madardaha) flows from NE southward into the Jhenai river collecting a number of secondary and tertiary natural drains located in the western part of the project area. Water from floods and rainfall is drained through the above system which, during the dry post monsoon season, is cultivated as low land area, or, in some sections, remains with standing water. A number of depressions and waterlogged areas



Jamalpur Priority Project Study

are not connected to the natural drainage system at low water levels, and do not drain easily, if at all.

Flooding occurs every year, mostly caused by overbank spillage from the Jamuna, Old Brahmaputra and their distributaries. This regular flooding augmented by rainfall is generally mastered by the farmers. Its depth is the criterion which defines the various land types, conditioning a wide range of cropping patterns.

However, the occurrence of sudden floods, sometimes aggravated by high local rainfall and difficult drainage conditions may entail severe damage to the crops, particularly in early and late monsoon.

Under present circumstances, floods enter the mainland project area through major openings in the Jamuna embankment at Bahadurabad, Maderganj and at the head of Chatal. Along the Old Brahmaputra, major openings are located in the Jamalpur - Dewanganj railway embankment.

These flows during high floods wash away bridges on the east - west area roads. Many of the main bridges damaged during 1988 flood are still under reconstruction.

In the southern part of the project area, south of Maderganj, low land flooding and drainage conditions depend on the water level in Jamuna. This is well illustrated by the SPOT image which shows that at the end of November water logging is still persistent.

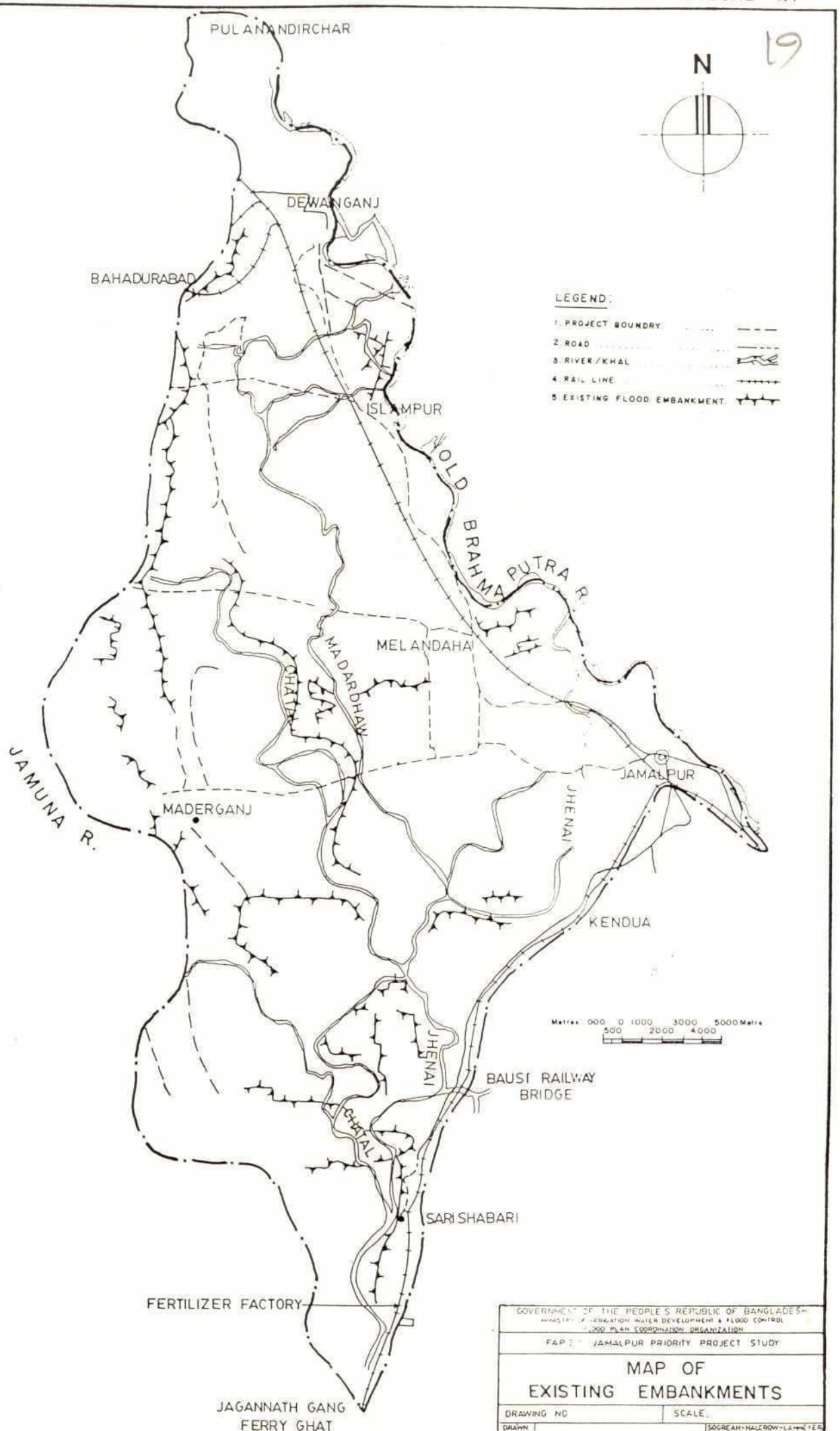
1.2 Existing Structures

1.2.1 Main Embankments (see Figure 1.1)

i) Role of existing embankments:

Embankments have been constructed in the mainland Jamalpur Project area with two distinct objectives:

- Embankments which have been constructed with the sole aim of protecting agricultural land against river floods. The main project embankments in this category are as follows:
  - the embankment along the left bank of the Jamuna from Bahadurabad to Jagannathganj;
  - the embankment along the left bank of the Chatal;
  - the embankment along the middle lower section of the Jhenai;



GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANIZATION

FAP 5 : JAMALPUR PRIORITY PROJECT STUDY

MAP OF EXISTING EMBANKMENTS

DRAWING NO	SCALE
DRAWN	
CHECK'D	
APPRV'D	
DATE	

SOGREAH-HALCROW-LAHMEYER WITH EPC & AQUA Project office House 80 Road 7, Block H Banani, Dhaka

- the embankments at the intake of the Chatal, on the Jamuna bank;

- Embankments which were constructed with the primary objective of providing a dry road network during the monsoon season and uninterrupted rail travel. Depending on their location, these embankments provide for partial flood protection to agricultural land. Major communication embankments, providing a certain level of flood protection along the project area boundaries are as follows:

  - the railway line from Jamalpur to Bahadurabad;

  - the road from Jamalpur to Dewanganj;

  - the railway from Jamalpur to Jagannathganj;

Many drainage culverts have been constructed along the embankment alignments, to allow water to flow freely from one side of the embankment to the other, thus limiting the flood protection obtained for adjacent agricultural land.

Within the project area a fairly dense road network, providing links between villages and access to isolated farms or groups of farms, has an effect on flood control. However this effect is limited by the cross drainage structures constructed under the embankments and by discontinuous alignments.

ii) Description of existing embankments:

From Bahadurabad to Jagannathganj Ghat, over a length of 58 Km, flood protection embankments of varying standards of design and construction have been constructed by the various local authorities. The construction materials are sandy to clayey soil. The crest width is 1.80 to 2.40 m. (6' to 8'). The overall design of the embankments is not adequate to provide flood protection and there are many gaps in the alignment. Near Bahadurabad and Madarganj, the embankments have been severely eroded and damaged, mainly during the 1988 flood.

There are minor flood protection embankments on the right bank of the Old Brahmaputra. The most efficient flood protection embankment, constructed to protect the town of Dewanganj from the Old Brahmaputra flooding and erosion, was severely damaged by the 1988 flood.

The main obstacle against floods from the Old Brahmaputra is provided by the railway embankment which runs more or less parallel to the river. However, it is susceptible to overtopping by

major floods in the Old Brahmaputra such as the 1988 flood which damaged it severely between Dewanganj and Bahadurabad. The number of cross-drainage structures between Jamalpur and Dewanganj Bazaar is 34. The largest crossing is at the Jhenai bridge with 4 spans.

The embankment of the road from Jamalpur to Islampur does not provide protection against floods from the Old Brahmaputra.

The elevated railway embankment along the southern side of the project area was severely overtopped west of Bausi Bridge in 1988, with serious breaches between Baira (KM 428) and Jagannathganj Ghat (KM 437) A total of 30 breaches have been recorded by the Railway Authorities. This was caused by flood water flowing out of the project area from NW to SE.

1.2.2 Railways

One railway connecting Jamalpur to Bahadurabad runs along the north-east limit of the area. A second railway runs along the southern limit of the area. This is a land border and not a main river. Both are equipped with culverts and bridges which make them probably transparent to water flows. They generally suffer only minor damage. Nevertheless, traffic was interrupted in 1988.

River bed scour is a problem which can threaten the safety of bridges. Below the bridge over the Jhenai river near Jamalpur, scour has been developing. During the dry season, stone protection can be observed at least along the downstream face of the large piers. In the case of Bausi bridge the flow is fairly well guided by the river banks.

1.2.3 Roads

Several roads, both major and minor have been built in the project area.

The Jamalpur-Madarganj road is fairly wide with a large number of culverts. Three bridges were destroyed during the 1988 flood and it is understood that the failure came from scour developed at the foot of the abutments. These bridges are presently being reconstructed.

The Jamalpur-Islampur-Dewanganj road is built on embankment-like levees. After Islampur, many secondary roads delineate cells, which appear to be hydraulically isolated. The same features can be observed along the reach Islampur-Jamalpur except in the vicinity of the Jhenai bridge where the landscape appears rather open. In the same area, some road bridges (at least two) are being rebuilt after their failure in 1988. They help crossing rivers of significant width.

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of the recharge calculations, recharge should not be regarded as a constraint in project terms.

Calculations based on observed well performance show that virtually the whole of the irrigation water requirement can be obtained from shallow (STW) or deep set shallow tubewells (DSSTW), which are the favoured option in terms of groundwater development in Bangladesh.

The impact of the project on groundwater quality through the use of fertilizers and pesticides cannot be estimated at present. The situation, including the use of agrochemicals and water analysis, needs to be monitored, as discussed in Annex 3.

The main conclusion of the ground water study are as follows:

- An aquifer system is recognizable in the project area, which is typical of the alluvial areas of Bangladesh.
- The hydrogeological conditions are amongst the most favourable in the country for tubewell development.
- There is no evidence of a groundwater quality problem with respect to irrigation.
- The proposed partial flood protection has little effect on ground water recharge, but full flood protection would reduce potential recharge by up to 20%.

1.4 River Morphology

1.4.1 Basic Documents

The LANDSAT maps covering a period of some twenty years have been used to assess the changes in the Jamuna river bed during this time over a distance of about 170 km in the project area and further downstream. The analysis provides information concerning the probable changes in the river bed and this information, which is summarised in Figure 1.2, can be used in relation to the planned development projects.

The map was drawn up from a mosaic of images prepared at a scale of 1:250 000. The dates of the LANDSAT images examined were as follows:

21/02/73; 10/01/76; 22/02/78; 21/02/80; 06/02/84; 08/11/84; 30/01/90; 08/03/92.

The images were taken during low water and show the low water river bed. Only the image of 08/11/84 shows the river bed at the end of the high-water period.

The satellite images provide a clear picture of the different channels, sand banks and cultivated areas.

1.4.2 Results

i) Widening of bed

An examination of the limits of the low-water bed provided some initial results.

The bed of the Jamuna river has widened over the years and the banks have retreated into the farm land.

A comparison of the area covered by the Jamuna river bed over a distance of 147.5 km for the years 1973 and 1992 provides the following figures:

1973	1250 km^2
1992	1645 km^2

This represents an increase of 395 km^2. The river bed has widened by 2.68 km in 20 years, in other words by 250 meters a year.

A comparison of the upstream and downstream areas reveals:

- 22% increase in the upstream area,
- 48% increase in the downstream area.

The reasons for this difference are twofold. On the one hand, in 1973 the upstream river bed was already wide, with many channels, unlike the downstream part, which was virtually straight and with only one channel before it reached the confluence with the Ganges. On the other hand, agricultural land was reclaimed in the upstream part of the river whereas in the downstream part the retreat of the banks resulted in the loss of farm land.

ii) Model of Limits and Widening of River Bed

An examination of the limits of the river bed reveals that the right bank has receded fairly uniformly and retained its linear characteristics. On the other hand, left bank changes are not as regular and are the result of localised erosion, particularly in the project area.

The braiding of the bed is linked to the solid load/water ratio. The number of channels and the width of the river bed increase as the proportion of sediment carried by the river increases.

It is thus understandable that the bed of a river of this type would have a widening phase corresponding to an increase in load or a phase involving a reduction in the number of channels in the event of a decrease in load. The analysis of the satellite images indicates that the river is in a widening phase. The question is whether or not this widening is reaching a limit.

It is not certain that the Jamuna river is reaching a point where widening will cease to take place. In fact, large islands are being formed in the middle of the bed, as can be observed in the area of the fertilizer factory. With the creation of these islands, the river bed takes up an increasingly large amount of space. Moreover, as the bed widens, the meanders become more accentuated, as can be seen in the project area and just upstream of the confluence with the Ganges. Cutting of the banks in these areas is more marked, though at the same time more localised.

An examination of the topographic features of the region reveals that the Jamuna river and the Ganges together form an immense detrital cone where they reach the ocean. Changes in the river on the cone resulting from changes in the river bed are characterised by the bed of the Old Brahmaputra. Such changes can take place during extraordinary floods and are not taken into account here.

The difference between the right bank and the left bank of the Jamuna is explained by the different types of flow towards the banks. In fact, on the right bank, the Jamuna has no outflowing branches to the Ganges. On the other hand, on the left bank, several effluents carry overspilling water toward the bed of the Old Brahmaputra and the Meghna river. Erosion develops at the beginning of these effluents and then progresses downstream, while remaining very aggressive. Local bank retreat is therefore very significant on the left bank of the river.

1.4.3 Conclusions

The analysis of the LANDSAT images reveals a widening of the Jamuna river bed along with the creation of large islands in the middle of the channel.

The alignment of the proposed embankment on the left bank of the Jamuna has a set back of about 500 m. under FAP 21/22, the problem of bank protection in the Jamuna has been examined. The weakest section of the bank in the project area is at Bahadurabad, near Ghilabari. FAP 21/22 has proposed to undertake a bank protection and river training project in this area which will secure the FAP 3.1

embankment. At detailed design stage it will be necessary to confirm the proposed embankment alignment on the basis of the final conclusions of FAP 21/22 and people participation.

2 AGRICULTURE

2.1 Introduction

The objective of the agricultural studies was to determine the factors which govern the present and potential agricultural development of the area.

The present agricultural situation has been defined on the basis of information collected during the field surveys and taken from the most recent of the past study reports.

Cultivated land in the mainland project area covers an area of 73,985 ha out of a gross area of 92,242 ha, i.e., 80% with, on average, nearly two crops being grown per year (Cropping intensity is about 191 on the whole Project area).

Rice is the principal crop and staple food and the production is enough for the present population.

A large proportion of the crops is dependent on rainfall but, at present, about 43% of the cultivated land has access to some form of irrigation in the dry season (November - April).

Cattle-rearing is of only limited importance in the study area in view of the lack of pasture land, but the majority of households have poultry.

The development possibilities within the context of proposed works, for which several alternatives were considered, have been analysed and the parameters necessary for the economic analysis of the project have been calculated.

2.2 The Agricultural Environment

2.2.1 Physiography

The project area lies within the Brahmaputra-Jamuna flood plain. There are three physiographic units, namely: active flood plain, young flood plain and old flood plain. They have been differentiated mainly on the basis of relative age, nature of deposits and characteristics of relief within the area. It is difficult to differentiate sharply each of these physiographic units and there are transitional areas, particularly between active and young flood plains. In a few areas the physiographic units are intermixed.

DISTRIBUTION OF LAND TYPES BY THANA - PRESENT SITUATION (WO) **Table 2.2.1**

	THANAS	Total gross area	ADJUSTED GROSS AREAS (a) F0	F1	F2	F3	PRESENT SITUATION (net areas) F0	F1	F2	F3	Total
	JAMALPUR	7837	3114	1184	2670	870	1374	1184	1800		4358
							32%	27%	41%		
	SHARISABARI	3054	1345	963	614	132	1081	963	482		2526
							43%	38%	19%		
inside	MELANDAHA	23320	7935	8810	4131	2444	5264	8810	2796	1109	17979
embankt							29%	49%	16%	6%	
	ISLAMPUR	11977	3038	4687	3473	779	1953	4687	2931	237	9808
							20%	48%	30%	2%	
	DEWANGANJ	3425	1428	655	1148	195	1149	655	1008	55	2867
							40%	23%	35%	2%	
	MADARGANJ	16192	5187	6573	3010	1422	3396	6573	2114	527	12610
							27%	52%	17%	4%	
	sub-total	65804	22046	22872	15045	5841	14217	22872	11131	1928	50148
							28%	46%	22%	4%	
	for the 6										
outside	above:	20062					486	1425	15933	1544	19388
embankt	for 3 other						2%	7%	82%	8%	
	thanas(*)	6376						448	2496	1505	4449
								10%	56%	34%	
	sub-total	26438					486	1873	18429	3049	23837
							2%	8%	77%	13%	
	TOTAL AREAS	92242					14703	24745	29560	4977	73985
							20%	33%	40%	7%	

(a) Refer to Annex 4, Modelling.
(b) FULCHARI, KAZIPUR and SARIAKANDI

2.2.2 Climate

The Jamalpur area is located between latitude 24° 40' and 25.15° north and between longitude 89° 30' and 90° east. The area shows fairly homogeneous climatic features.

The climate is dominated by the monsoon. The northeast monsoon, coming from the Siberian anticyclones, blows during the winter months, giving weather that is generally dry and cool: typical temperatures range between 13° C to 28° C from December to February, rainfall in this period amounts to 2% of the 2240 mm mean annual depth, and average wind speed is also at its lowest value. The availability of soil moisture during this period falls short of crop requirements.

The critical aspects of climate in relation to crops are:

- the occurrence and reliability of the pre-monsoon rains and the onset of the monsoon,
- the occurrence of storms that damage standing crops (boro and HYV aus rice),
- the reliability of the monsoon rains, and the rise, duration and recession of floods associated with the monsoon rains; and,
- the reliability, amount and distribution of the end-of-monsoon rains.

2.2.3 Flooding and Drainage

The most striking feature of the hydrology in the project area is the seasonal flooding and drainage. Only about 20% of the area is above normal flood level, located mostly along the north-east border of the project area. About 35% is land subject to shallow flooding, intermixed with highland and medium lowland in the central part of the area; about 40% of the area is moderately to deeply flooded, made up almost entirely of the area located in the western part of the project area. There are small areas of deeply and very deeply flooded land. In general, about 80% of the project area is seasonally flooded.

Drainage in general is slow. Apart from the Brahmaputra and Jamuna at the eastern and western boundaries of the project area respectively, the Chatal and Jhenai and their branches drain most of the floodwater into the Jamuna. Drainage during the peak monsoon season and also towards the end of the monsoon season becomes impeded if there is high rainfall over the project area or in the upper catchment areas.

RELATIONSHIP OF CROP SEASONS TO FLOODS AND IRRIGATION

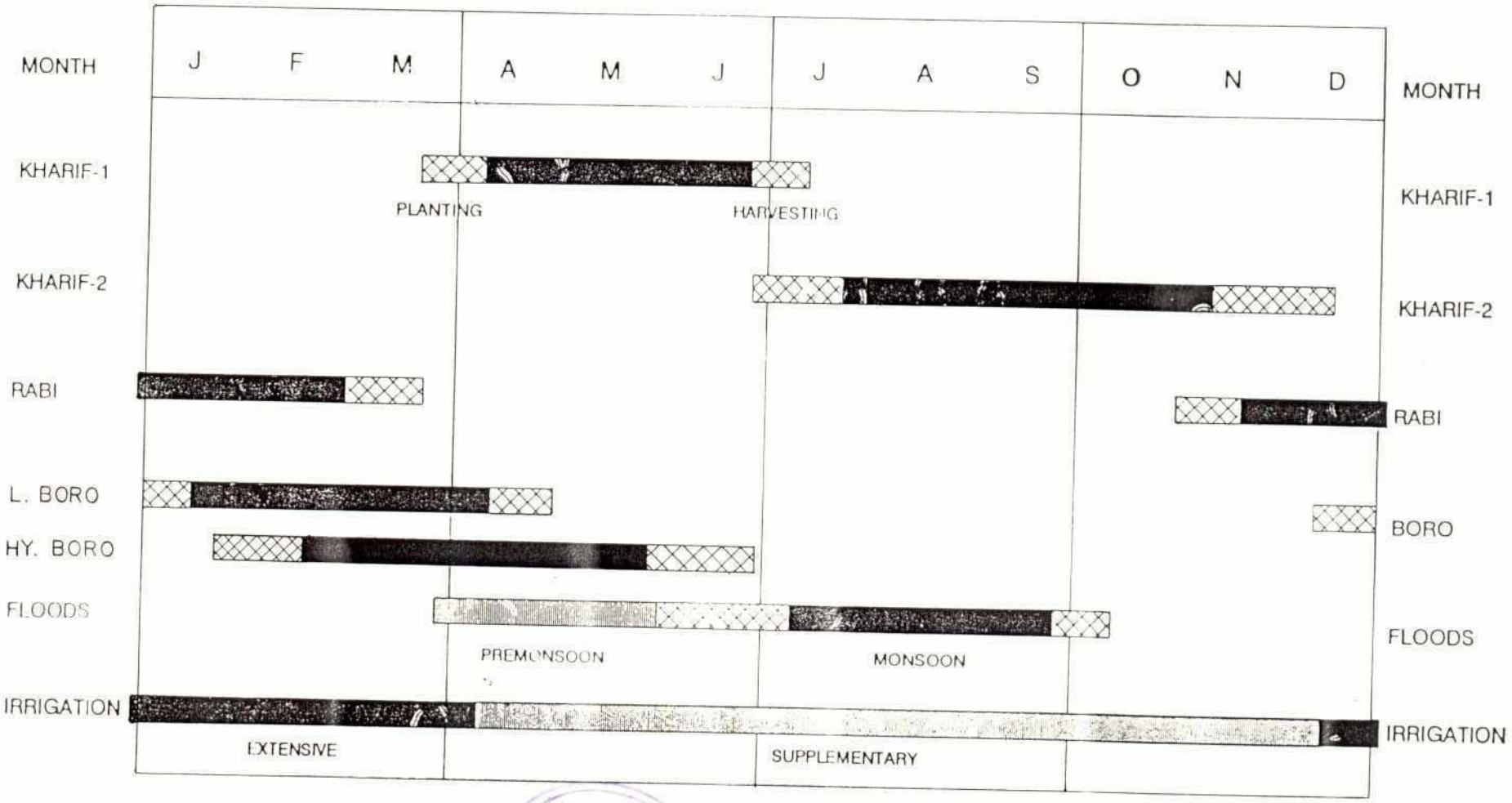


Figure 2.3.1

2.2.4 Land Types

By surveying and analysing soil association maps, topographic maps, flood depth maps and agronomic and climatic data, the soil scientists of SRDI have defined eleven land type classes. These are called SODAPS land types because they are part of the Soil Survey Data Processing System.

The land type classification followed in this report is updated from the SRDI documents and made compatible with the MPO (now WARPO) classification.

The distribution of the four land types, F0 to F3 (F4 group is insignificant) is shown in Table 2.2.1.

2.3 Present Situation of Agricultural Development

2.3.1 Cropping Seasons

The tropical monsoon climate favours production of a wide range of crops in the Jamalpur area. There are three distinct climatic seasons which are interrelated with three more or less distinct cropping seasons as listed below:

- a cool, dry winter season (rabi) covers the period from November to February. However crops are restricted to areas with adequate soil moisture or to irrigated areas. Rabi crops are sown in the winter and harvested in the spring or early summer, the principal rabi crop is boro, which is grown in poorly drained soil or where irrigation can be provided and where no flooding will normally occur before its harvest in May-June,

- the pre-monsoon season, or hot spring (kharif-I) runs from end of March to mid June

- the monsoon season or wet season (kharif-II) extends from mid-June through September

The crop environment during the kharif season is less favourable for high yields because of the uneven distribution of rainfall, variable flooding depths, low solar radiation and high temperatures and humidity. Kharif crops are grown in the spring or summer season and harvested in late summer or early winter. Rice is the predominant crop during the kharif season.

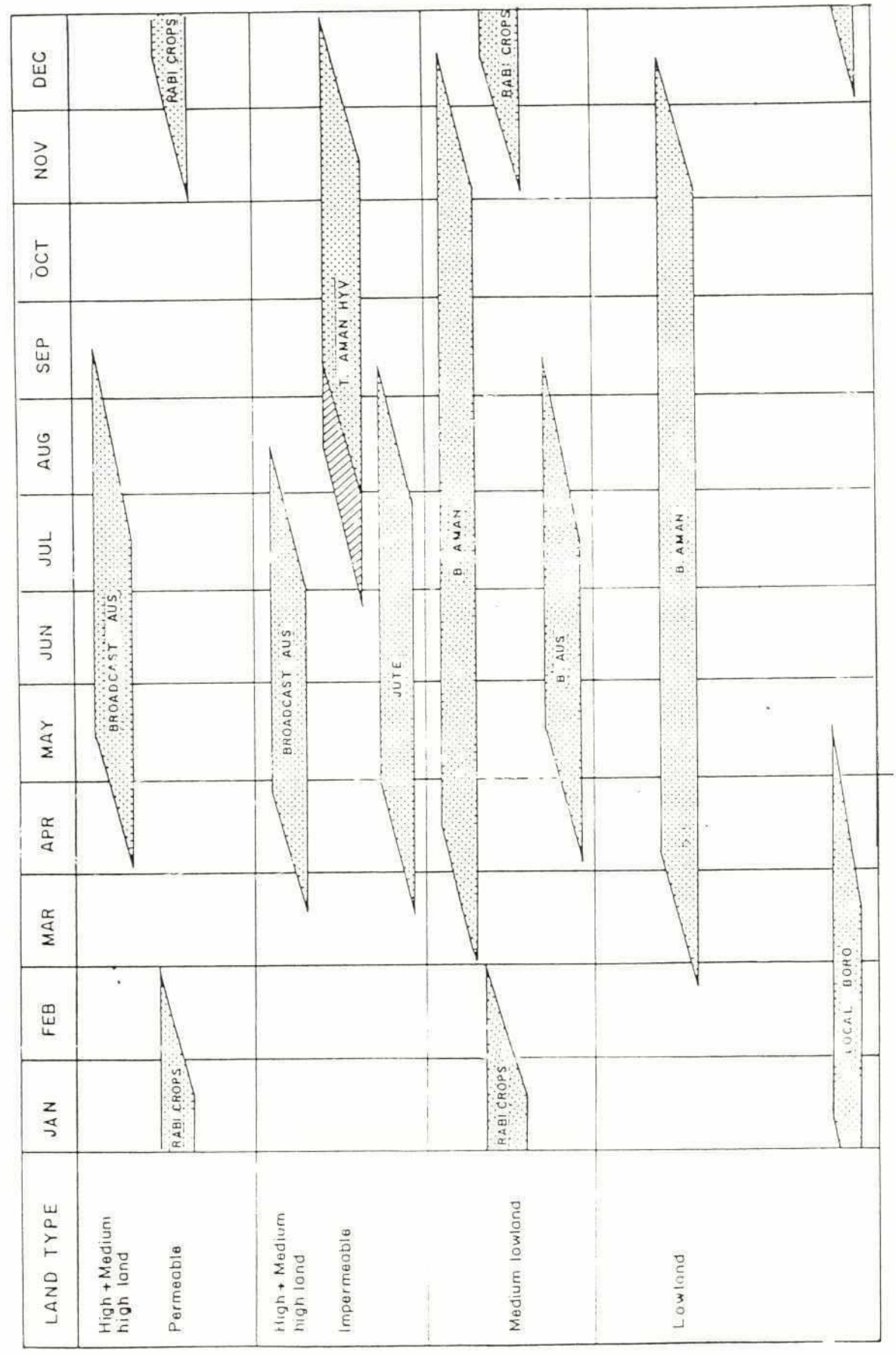
The depth and nature of flooding determine the crops that can be grown in a given area during the Kharif-II season.

Table 2.3.1 Main Cropping Patterns - Existing Situation

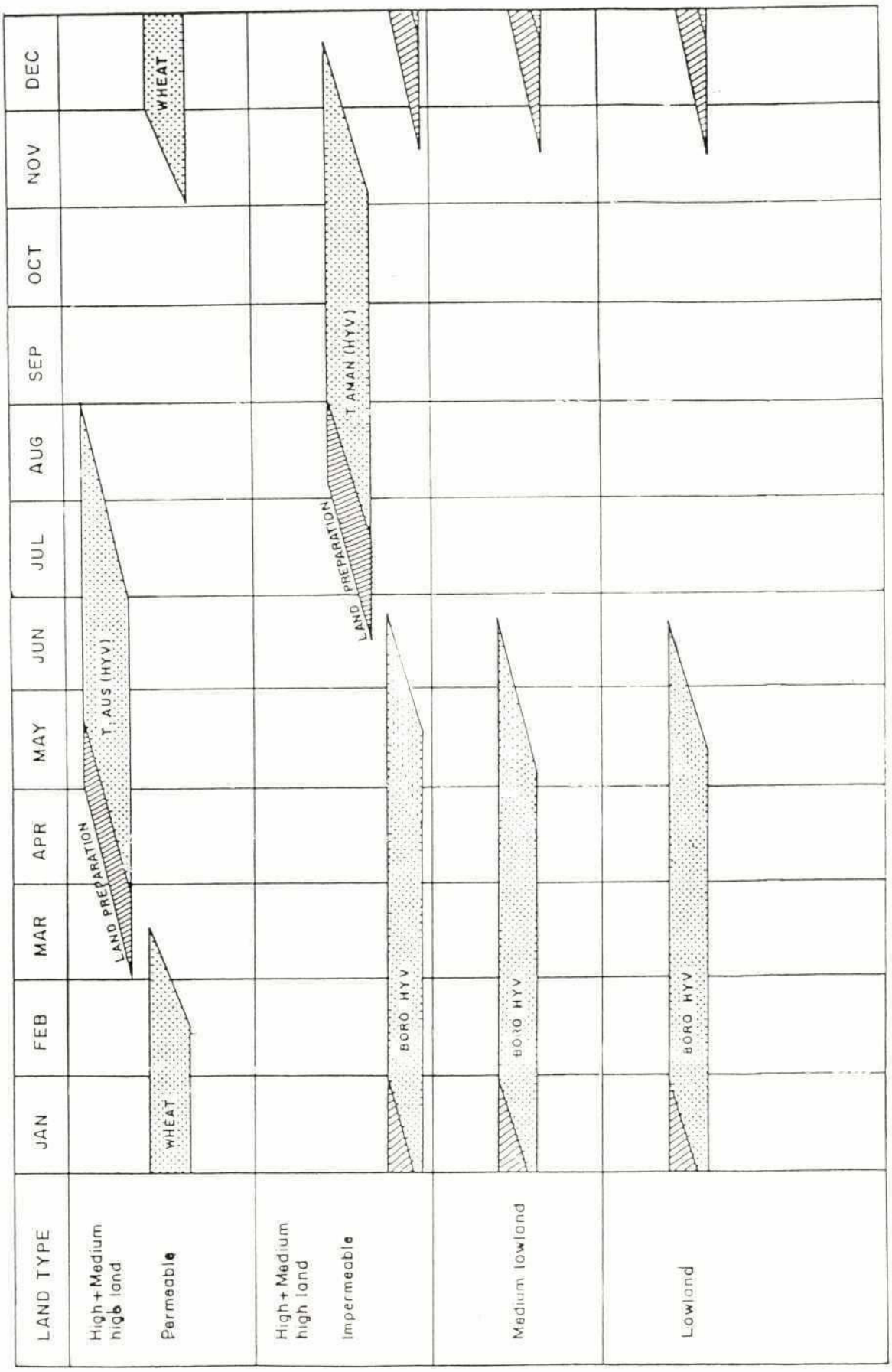
Crop. intensity	Main cropping patterns			PROJECT AREA F0 ha	F0 %	F1 ha	F1 %	F2 ha	F2 %	F3 ha	F3 %	TOTAL ha	TOTAL %
	GRASSLAND/FALLOW							1530	5.2	605	12.2	2135	2.9
S	SUGAR CANE	-		1777	12.1	378	1.5					2155	2.9
S	BORO	-						1842	6.2	1354	27.2	3196	4.3
S	MILLET			39	0.3	606	2.4	878	3.0	479	9.6	2002	2.7
S	GROUNDNUT			39	0.3	187	0.8	1007	3.4	479	9.6	1712	2.3
S	B.AMAN							805	2.7	656	13.2	1461	2.0
S	S.W. POTATO			39	0.3	187	0.8	1096	3.7	479	9.6	1801	2.4
D	AUS	-WHEAT		454	3.1	426	1.7	2381	8.1	102	2.0	3363	4.5
D	AUS	-PULSES		73	0.5	62	0.2	412	1.4	13	0.3	559	0.8
D	AUS	-MUSTARD		262	1.8	254	1.0	1557	5.3	68	1.4	2141	2.9
D	AUS	-POTATO		142	1.0	137	0.6	659	2.2	26	0.5	965	1.3
D	AUS	-EGG PLANT		41	0.3	39	0.2	208	0.7	13	0.3	302	0.4
D	AUS	-CHILLIES		22	0.1	28	0.1	193	0.7	13	0.3	256	0.3
D	AUS	-ONION		22	0.1	19	0.1	133	0.5	6	0.1	179	0.2
D	AUS	-AMAN		1205	8.2	1043	4.2	69	0.2			2317	3.1
D	JUTE	-WHEAT		235	1.6	209	0.8	1547	5.2	34	0.7	2026	2.7
D	JUTE	-PULSES		44	0.3	37	0.1	239	0.8	4	0.1	324	0.4
D	JUTE	-MUSTARD		192	1.3	179	0.7	976	3.3	23	0.5	1370	1.9
D	JUTE	-POTATO		98	0.7	93	0.4	414	1.4	9	0.2	614	0.8
D	JUTE	-EGG PLANT		34	0.2	30	0.1	134	0.5	4	0.1	202	0.3
D	JUTE	-CHILLIES		17	0.1	21	0.1	131	0.4	4	0.1	174	0.2
D	JUTE	-ONION		18	0.1	15	0.1	90	0.3	2	0.0	124	0.2
D	JUTE	-AMAN		1104	7.5	950	3.8	46	0.2			2100	2.8
D	T.AMAN	-BORO		4722	32.1	15243	61.6					19965	27.0
D	T.AMAN	-PULSES				599	2.4					599	0.8
D	AUS+AMAN	-PULSES						4243	14.4	298	6.0	4542	6.1
D	AUS+AMAN	-CHILLIES						2449	8.3	100	2.0	2549	3.4
D	AUS+AMAN	-ONIONS						788	2.7	39	0.8	828	1.1
D	D.W.T. AMAN	-BORO						5732	19.4	164	3.3	5896	8.0
T	JUTE	-T.AMAN	-WHEAT	371	2.5	430	1.7					801	1.1
T	JUTE	-T.AMAN	-PULSES	741	5.0	699	2.8					1439	1.9
T	JUTE	-T.AMAN	-CHILLIES	439	3.0	388	1.6					827	1.1
T	JUTE	-T.AMAN	-ONIONS	330	2.2	314	1.3					644	0.9
T	AUS	-T.AMAN	-WHEAT	377	2.6	384	1.6					761	1.0
T	AUS	-T.AMAN	-PULSES	722	4.9	707	2.9					1429	1.9
T	AUS	-T.AMAN	-CHILLIES	517	3.5	501	2.0					1018	1.4
T	AUS	-T.AMAN	-ONIONS	628	4.3	582	2.4					1210	1.6
				ha	%	ha	%	ha	%	ha	%	ha	%
			GRASSLAND/FALLOW					1530	5	605	12	2135	3
			SINGLE CROPPED	1895	13	1357	5	5628	19	3448	69	12328	17
			DOUBLE CROPPED	8684	59	19383	78	22402	76	924	19	51393	69
			TRIPLE CROPPED	4124	28	4005	16					8129	11
			TOTAL	14703	100	24745	100	29560	100	4977	100	73985	100
				20%:		33%:		40%:		7%:			
			CROP. INTENSITY	215		211		176		119		191	

Source : Consultant's computation based on SRDI soils & lands surveys carried out from 1985 to 1990.

RELATIONSHIP OF CROPPING PATTERN TO LAND TYPE
(WITHOUT IRRIGATION)



RELATIONSHIP OF CROPPING PATTERN TO LAND TYPE
(WITH IRRIGATION)



obtain (on the basis of 1991 prices, the net value of boro is 60% greater than that of wheat).

iv) Sugar Cane

Sugar cane is grown on permeable land, medium highland and highland (F1 and F0 land types). Canes are grown either for supplying Dewanganj sugar mill or for making gur (molasses) by bullock and power crushers.

v) Potatoes

Potatoes are an important vegetable crop in the project area, grown in the rabi season on medium lowland and medium highland. The cultivated areas vary from one year to the next between 1000 and 2000 ha. The average yields are low, around 8 t/ha, owing to the use of local varieties which are often preferred by consumers.

vi) Mustard

Mustard is extensively cltivated in the Project area (between 4,500 and 5,000 ha) as a major oil seed crop. Mustard is grown on low, medium low to high lands.

vii) Other Minor Crops

Pulses, vegetables and spices are also very common in the project area. There is a large demand for pulses in the country and a lot of vegetables and spices are cultivated in open fields and in vegetable gardens around dwellings.

2.3.3 Cropping Patterns

In view of the wide range of possible crops, and in view of the irrigation facilities available, farmers can make best use of the available land by growing two and occasionally three crops per year on the same field.

Since rice is the major crop, it tends to dominate the cropping pattern, especially since the rapid development of irrigation.

Depending on land type, soil permeability and irrigation possibilities, rice cropping may be single or double. Triple cropping which would be possible, only with short-term local varieties does not occur in the project area.

Non-rice crops are grown generally in rotation with rice, except for a few special crops adapted to the silty-sand, permeable soils of the medium

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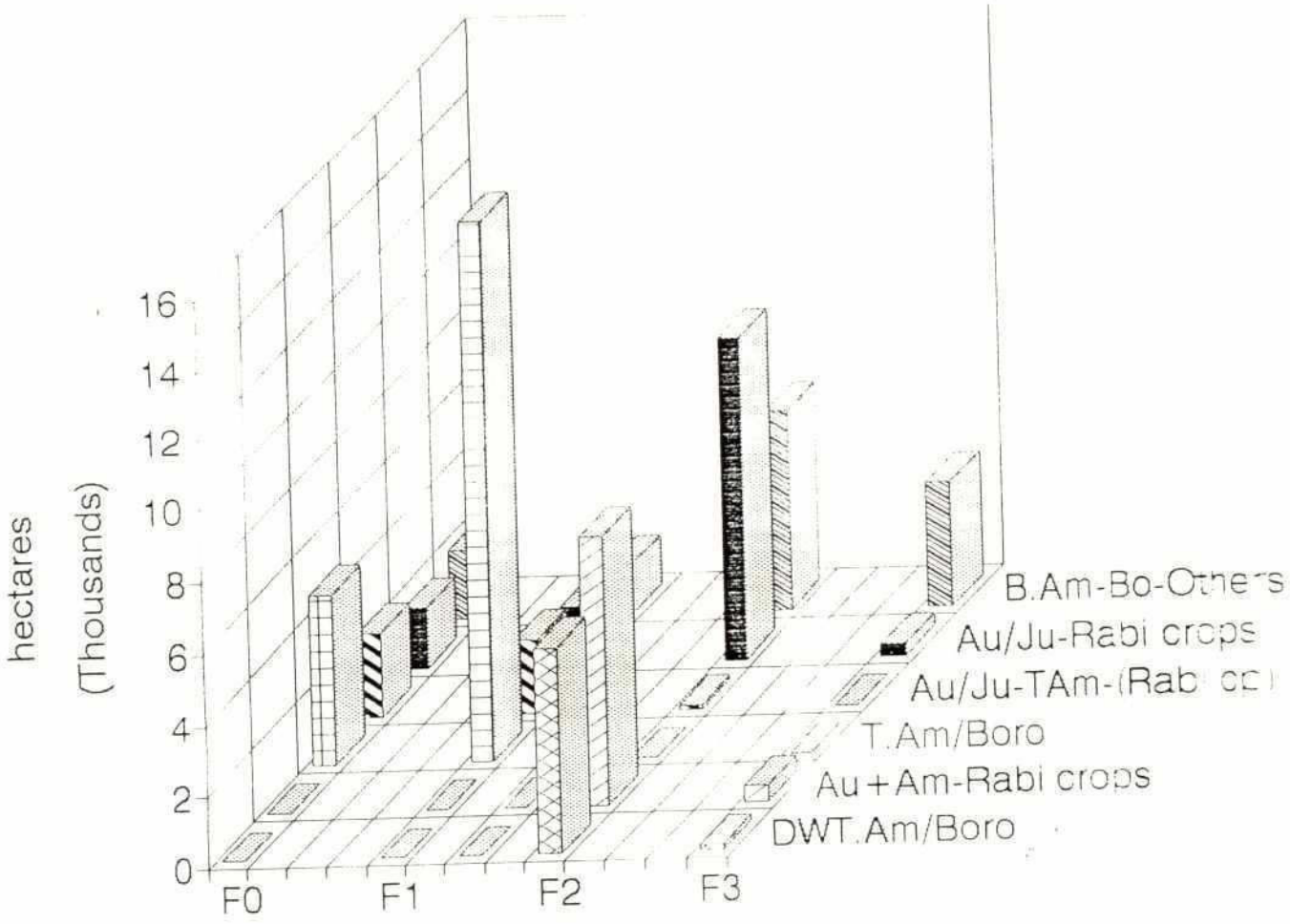
MAIN CROPPING PATTERNS
by land type in the project area



lowlands (groundnut, millet, sweet potato, which cover about 5500 ha or 7% of the NCA).

Cropping patterns by land types, including the main crops are shown for the project area in Table 2.3.1 and illustrated by Figure 2.2.4.

2.3.4 Inputs Use

The rapid dissemination of HYVs and the possibilities of obtaining irrigation equipment have also promoted an increasing use of fertilisers and pesticides over the past 15 years.

However, these inputs are for the most part reserved for irrigated crops and, overall, the quantities used are small.

i) Fertilisers

The fertilisers used by the farmers are mainly urea, TSP and MP and some zinc and sulphur. Urea accounts for up to 70% of the total quantity of fertiliser, TSP 20/25% and MP 3/5%. The recent privatisation of fertiliser distribution (March 1989) has given new impetus to their distribution. However, their cost remains excessively high for small farms who not have any cash in hand. Small farmers have difficult access to the purchase of fertiilizers in due times and in the right quantity, which adversely affects productivity.

Most of the farms apply fertilisers to HYV boro. All other rice and jute crops are also fertilised, but minor crops (millet, sweet potatoes, groundnuts) are hardly fertilised. Sugar cane is heavily fertilised.

ii) Pesticides

Most of the farmers are familiar with pesticides. Their application are currently limited, however, to HYVs. The major difficulty encountered in using pesticides is their selection appropriate to the crops affected and the diseases. Farmers are ignorant of the proper doses to be applied, resulting in ineffective use of the pesticides

In the rural markets pesticides, are not generally available, and it is necessary to go to the larger towns to procure them. Major pesticides are Furadan, Dithane, Dimecron, Diaziinon and Malathion.

iii) Irrigation

In the project area modern irrigation with deep tube wells (DTWs) and shallow tube wells (STWs) covers more than 90% of the total irrigated area, leaving only 5 to 6% to low lift pumps (LLPs) and manual irrigation done by hand tube wells, swing baskets and doons. Modern irrigation has been practised for only two decades.

Almost half (between 46% and 48%) of the cultivated areas in the thanas of Islampur, Madarganj, Melandaha and Jamalpur are irrigated. Irrigated agriculture account for 31000 ha (42%) of the total net cultivated area in the Project area (74,000 ha).

iv) Labour use

Agriculture in Bangladesh is still traditional where human labour and bullock power are widely used. Use of power tillers and tractors by common farmers is a rare phenomenon in the study area. Labour use is greater in the transplanting of aman and boro (HYV) and in weeding jute and boro (HYV). Besides family labour, manpower is hired whenever necessary. Hiring is done mainly in the transplanting and harvesting seasons.

v) Draught power

Animal power is the prevalent forms of draught power in agricultural operations.

2.3.5 Major Constraints for Agricultural Production

The most important factor limiting production in rainfed areas is the lack of control over water. Both moisture deficiency and excesses of rain contribute to instability in agricultural production. The main risks facing crops in the project area are:

- heavy pre-monsoon rains which affect aus/jute yields by damaging the young plants,
- early quick floods which damage not only aus, aman and jute but also the mature boro crop (May-June)
- total submersion of rice for more than 3 to 7 days (depending on the variety) which may occur in flood-prone areas, partially destroys the rice crop
- failure of early rains, delaying sowing of aus and jute, which in turn delays the transplanting of the aman crop

- failure of rain at the end of the monsoon period when aman is flowering affects it adversely.

Normal seasonal floods, which come in July and gradually recede in September, are regarded by the farmers as a blessing, depositing silt and recharging the water table. The depths of the floods vary from year to year. Occasionally high early floods and late floods from the Jamuna and the old Brahmaputra are damaging to crops in the flood plain.

Uncertainty linked with the risks of flooding limits the intensification of irrigated agriculture, which is only possible in areas that are protected against floods. High cropping intensities with improved technologies are only possible under irrigated agriculture if the land is not constrained by flooding depths.

Drainage difficulties, which prevent the rapid retreat of floods, restrict the availability of land for growing transplanted aman, which could be an attractive replacement for broadcast aman and mixed aus/aman crops.

2.3.6 Crop Damage

Damage to crops, livestock and agriculture generally occur at the beginning of the monsoon season, mainly affecting the newly transplanted Aman fields. The extent of damage is proportional to the severity of floods. T. Aman, B. Aman and HYV Boro are more subject to damages in the Project area.

As a conservative approach for the study, it has been assumed that yield losses as well as affected areas are both in the range of 25%, representing about 6% of global losses.

2.3.7 Livestock

As in other parts of the country, livestock is an integral part of the farming system in the project area, in spite of the fact that land is not available for grazing and scarcity of animal feed. The animals live almost entirely on the by-products of crops grown for human consumption.

Livestock is kept as a supporting activity to crop production and as a secondary source of income.

The most important types of livestock in the area are cattle, goats, chickens and ducks. Buffaloes, horses and sheep are rare.

According to the Agriculture and Livestock census of 1983/84, about 65% of all total households had cattle.

2.4 Potential Agricultural Development

2.4.1 Foreword

Land in the project area is already used intensively, as the cropping intensity is more than 200% except in areas along the Jamuna (Char lands), which are directly affected by the river's meandering and change of bed.

A large proportion of the land (F2 and F3 lands) is nevertheless subject to excessively deep submersion and risk of damage to be developed by using advanced technologies (irrigation, HYVs), which would require major capital investment, careful land preparation and a higher level of inputs.

Controlled flooding, with protection of agricultural lands from early floods and improved drainage, will provide opportunities for higher production levels per ha through controlled and shorter inundation periods faciliting better farming methods, higher resource investment in inputs, the use of HYVs and the extension of the growing period.

Newly improved varieties released by BARI, BRRI, BJRI have been introduced through the Agricultural Extension services. These varieties are adapted to the local growing conditions. Special emphasis has been laid on the improvement of crops such as rice, wheat, potatoes, oilseeds, sugar cane and vegetables.

2.4.2 Future Yields

Prediction of future yields is the most sensitive factor in the estimation of the agricultural benefits. Studying trends in crop yields is particularly complicated because it is necessary to assess the progress of new varieties, changes in input use, climate influence, and others factors such as pest attacks.

Moreover, yields obtained by research are potential one, which may not be achieved by all farmers owing to the particular conditions prevailing at present in the Project area (flooding, difficulties in drainage, inadequate supply of inputs).

For all these reasons, it has been considered here that the progress of productivity that could be ascribed to the Project implementation would exclusively proceed from the shifting from flood prone conditions to damage-free conditions and from the consequent changes in cropping patterns due to land type redistribution.

On the basis of assumptions made above on crop damages (para 2.3.6), two sets of average yields have been estimated for crops subject to flood damages.

With respect to the other crops, it has been assumed that a single yield level, corresponding to a single inputs level, is applicable in both the with [W] and without [WO] Project conditions. These yield levels were finally adopted after consultation and analysis of existing information and after observation of the results of field surveys.

Crop yields in the present and future situation as shown in Table 2.4.1.

Table 2.4.1 Crop Yields Estimates In The Present and Future Situations

Rice Crops	Damaged Land		Damage-free Land		Total	
	Area ha	Yield t/ha	Area ha	Yield t/ha	Area ha	Av. Yield t/ha
B.Aus			12325	1.20	12325	1.20
HYV Aus			2175	3.00	2175	3.00
B.Aman	365	1.13	1096	1.50	1461	1.41
DWT Aman	1474	1.13	4422	1.50	5896	1.41
Mix. Aus + Aman	1979	1.31	5938	1.75	7917	1.64
L.T. Aman	2192	1.65	11052	2.20	13244	2.11
HYV Aman	3289	2.81	16577	3.75	19866	3.59
L.Boro			3196	2.50	3196	2.50
HYV Boro	5284	3.38	20577	4.50	25861	4.27

Other Crops assumed to be unaffected by normal damage.

Crop	Av. Yield (t/ha)	Crop	Av. Yield (t/ha)
Wheat	2.00	Onions	3.50
Jute	1.70	Egg plant	5.00
Potato	8.00	Chilies	1.50
Mustard	0.80	Millet	0.80
Pulses	0.85	Groundnut	1.30
Sugar cane	45.00	Sweetpotato	6.50

2.4.3 Description of Alternatives Situations Studied

i) Without project (WO) situation

The assumptions made with regard to the increase in agricultural development were the following:

Table 2.4.2 Reference Situation (WO) - Areas and Production

Crops	Present situation Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk	Future situation Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk
L.Boro	3196	3.00	9588	60337	3196	3.10	9908	62351
HYV Boro	25862	4.50	116379	694084	27056	4.54	122858	732725
Boro	29058	4.34	125967	754422	30252	4.39	132766	795076
Mix. Aus+Aman	7917	1.40	11084	72011	7917	1.40	11084	72011
L. Aus	10082	1.50	15123	98179	5039	1.50	7558	49067
HYV Aus	4418	2.50	11045	68755	8615	2.52	21716	135182
Aus	18459	1.72	31710	238945	17613	1.98	34816	256260
L.T. Aman	12722	2.00	25444	165182	6362	2.00	12724	82604
HYV Aman	20389	3.20	65245	406149	27274	3.21	87670	545746
B. Aman	1461	1.50	2192	14227	1461	1.50	2264	14698
DWT. Aman	5896	1.25	7370	53934	5896	1.25	7370	53934
Aman	44427	2.38	105792	639492	44952	2.57	115570	696982
Total paddy	91943	2.87	263469	1632859	92816	3.05	283152	1748318
Wheat	6951	2.40	16682	146855	6729	2.59	17451	153621
Jute	10645	1.70	18097	213910	10296	1.80	18498	218656
Sugar cane	2155	45.00	96975	87568	2155	47.50	102365	92436
Potato	1579	8.00	12632	50339	1502	10.14	15224	60668
Mustard	3511	0.70	2458	29124	3369	0.77	2600	30810
Pulses	8892	0.65	5780	75022	8857	0.72	6418	83306
Vegetables	10860		19376	126469	10813		21408	137461
Millet	2002	0.80	1602	11147	2002	0.80	1602	11150
Groundnut	1712	1.30	2226	19363	1712	1.30	2226	19366
Sweet potato	1801	2.50	4503	15669	1801	2.50	4502	15667
Sub-t.other crops	50108			775465	49236			823139
TOTAL	142051			2408323	142052			2571457
Irrigated area	31132	42%			32138	43%		
Fallow/grassland	2135	3%			2135	3%		
Single cropping	12327	17%			12327	17%		
Double cropping	51393	69%			51391	69%		
Triple cropping	8129	11%			8130	11%		
Cropping intensity	191				191			

Source: Consultant's calculation; results of simulation.

Notes: Future situation is given for a full operational year.
It is recalled that in future situation, only 50% of areas are supposed to achieve target yields.
Gross value is calculated with economic prices.

Areas and Production - Option A

Crops	Future without project situation Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk	Future with project situation Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk
L.Boro	3196	2.50	7990	50282	2831	2.50	7078	44542
HYV Boro	27322	4.27	116595	695396	27782	4.27	118536	706972
B. Aus	12324	1.20	14790	97401	12324	1.20	14790	97401
HYV Aus	2175	3.00	6525	38935	2175	3.00	6525	38935
L.T. Aman	13244	2.11	27931	181328	14371	2.11	30256	196422
HYV Aman	19866	3.59	71414	444538	21557	3.59	77360	481551
B. Aman								
DWT. Aman	5896	1.41	8291	60677	4622	1.41	6500	47570
Mix. Aus+Aman	7917	1.64	12989	84391	7376	1.64	12103	78634
Total paddy	91940	2.90	266525	1652947	93038	2.94	273148	1692027
Wheat	6951	2.00	13902	122407	6796	2.00	13592	119678
Jute	10645	1.70	18096	213922	10669	1.70	18137	214407
Sugar cane	2155	45.00	96975	87568	2193	45.00	98685	89113
Potato	1579	8.00	12632	50339	1509	8.00	12072	48107
Mustard	3511	0.80	2809	33287	3352	0.80	2682	31782
Pulses	8892	0.85	7558	98103	8918	0.85	7580	98388
Vegetables	8311		20196	149491	8208		19986	148302
Millet	2002	0.80	1602	11150	2030	0.80	1624	11303
Groundnut	1712	1.30	2226	19366	1712	1.30	2226	19366
Sweet potato	1801	6.50	11706	30553	1801	6.50	11706	30553
Sub-t.other crops	47559			816185	47188			810998
TOTAL	139499			2469132	140226			2503025
Irrigated area	32592	44%			32908	45%		
Fallow/grassland	2135	3%			2135	3%		
Single cropping	12327	17%			11712	16%		
Double cropping	51393	69%			51403	69%		
Triple cropping	8129	11%			8570	12%		
Cropping intensity	191%				193%			

Source: Consultant's calculation; results of simulation.
Notes: Future situation is given for 2022
Gross value is calculated with economic prices.

Project Situation (Opt. B) - Distribution of Land Types by Thana

	THANAS	Total gross area	ADJUSTED GROSS AREAS (a) F0	F1	F2	F3	AGRICULTURAL SIMULATION (net areas) F0	F1	F2	F3	Total
inside embankt	JAMALPUR	7837	3114	1184	2670	870	2365	1316	679		4360
							54%	30%	16%		
	SHARISABARI	3054	1345	963	614	132	1327	889	310		2526
							53%	35%	12%		
	MELANDAHA	23320	7935	8810	4131	2444	10781	6424	774		17979
							60%	36%	4%		
	ISLAMPUR	11977	3038	4687	3473	779	5743	3669	396		9808
							59%	37%	4%		
	DEWANGANJ	3425	1428	655	1148	195	2246	567	52		2865
							78%	20%	2%		
	MADARGANJ	16192	5187	6573	3010	1422	4986	6015	1519	90	12610
							40%	48%	12%	1%	
	sub-total	65804	22046	22872	15045	5841	27448	18880	3730	90	50148
							55%	38%	7%	0%	
outside embankt	for the 6 above:	20062					486	1425	15933	1544	19388
							3%	7%	82%	8%	
	for 3 other thanas(b)	6376						448	2496	1505	4449
								10%	56%	34%	
	sub-total	26438					486	1873	18429	3049	23837
							2%	8%	77%	13%	
	TOTAL AREAS	92242					27934	20753	22159	3139	73985
							38%	28%	30%	4%	

(a) Refer to Annex 4, Modelling.
(b) FULCHARI, KAZIPUR and SARIAKANDI

Table 2.4.5

Areas and Production - Option B

Crops	Future without project situation				Future with project situation			
	Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk	Areas (ha)	Yield (t/ha)	Production (t)	Gross value MTk
L.Boro	3196	2.50	7990	50282	924	2.50	2310	14537
HYV Boro	27322	4.27	116595	695396	29833	4.45	132693	791408
B. Aus	12324	1.20	14790	97401	12837	1.20	15405	101451
HYV Aus	2175	3.00	6525	38935	2265	3.00	6796	40552
L.T. Aman	13244	2.11	27931	181328	12181	2.19	26712	173414
HYV Aman	19866	3.59	71414	444538	27752	3.74	103851	646452
B. Aman								
DWT. Aman	5896	1.41	8291	60677	3331	1.44	4787	35033
Mix. Aus+Aman	7917	1.64	12989	84391	6320	1.65	10441	67836
Total paddy	91940	2.90	266525	1652947	95443	3.17	302995	1870683
Wheat	6951	2.00	13902	122407	6884	2.00	13768	121227
Jute	10645	1.70	18096	213922	11205	1.70	19048	225176
Sugar cane	2155	45.00	96975	87568	2153	45.00	96885	87487
Potato	1579	8.00	12632	50339	1566	8.00	12528	49924
Mustard	3511	0.80	2809	33287	3466	0.80	2773	32860
Pulses	8892	0.85	7558	98103	7790	0.85	6622	85954
Vegetables	8311		20196	149491	7653		18830	138302
Millet	2002	0.80	1602	11150	1979	0.80	1583	11018
Groundnut	1712	1.30	2226	19366	1688	1.30	2194	19088
Sweet potato	1801	6.50	11706	30553	1775	6.50	11538	30114
Sub-t.other crops	47559			816185	46159			801149
TOTAL	139499			2469132	141602			2671832
Irrigated area	32592	44%			35056	48%		
Fallow/grassland	2135	3%			1953	3%		
Single cropping	12327	17%			9407	13%		
Double cropping	51393	69%			53926	73%		
Triple cropping	8129	11%			8115	11%		
Cropping intensity	191%				196%			

Source: Consultant's calculation; results of simulation.
Notes: Future situation is given for 2022
Gross value is calculated with economic prices.

- No modification in cropping intensity. It is already close to or above 200% in the main Thanas of the project area,

- No modification in cropping patterns, except for B. Aman which will progressively be replaced by HYV Boro (1,461 ha) during the whole period of the Project,

- No modification in the stock-breeding situation, which is of relatively little importance in the region's agricultural development (the value added of stock-breeding is only about 5% of the value added of agriculture as a whole).

The increase in areas of B. Aman, will enable HYV boro to be extended to about 27,300 ha (about 37% of the NCA).

Irrigated areas, which currently amount to 31200 ha will increase to 32,600 ha.

The change from B. Aman to HYV Boro will result in an increase in rice production of about 4,100 tonnes.

Table 2.4.2 shows the area and production of the main crop in the reference situations [WO], present and future situation.

ii) Option A

In this option, the planned works programme does not provide for any heavy control structures. Only drainage improvement measures will enable a reduction in the period of submersion, which affects mainly type F2 land.

Most of the major and minor natural depressions are located in MELANDAHA and ISLAMPUR Thana (32 000 ha) other minor water-bodies related to a deficient cross drainage along man-made obstacles can be considered as spread over all project's Thana (73,985 ha).

In quantitative terms, the following has been established:

- Grouped beels identified on the 4" to a mile map: 13 (total number of beels 47) with catchments in excess of 100 ha, say 200 ha.

- Individual small beels identified on the 4" to a mile map: 42, with catchments of about 20 ha each.

- Minor water bodies: 300, with a tentatively concerned catchment area of about 2 ha each.

Therefore, the total area concerned by the drainage improvements would be as follows:

Grouped beels	2,600
Individual beels	840
Minor water bodies	600
Total	4,040
	say, 4,000 ha

Drainage improvements alone, without flood control, will have an impact in terms of water depth duration at the end of monsoon season, mainly on account of the accelerated drainage of accumulated water during rainfall events.

For evaluation purpose, it has been assumed that about 75% of the land concerned by the drainage improvement, i.e. 3 000 ha, will be transferred from land type F2 to land type F1 in MELANDAHA and ISLAMPUR Thanas.

Modifications in the areas of the various cropping patterns in the area were obtained by considering the following hypotheses:

- Transfer 3,000 ha from F2 to F1 land type
- Identical crop distribution to that in the present situation
- Increase outside the drained areas on the same basis as for the without Project situation
- Decrease of 163 ha of NCA for land acquisition for drainage infrastructures.

The main results are the following:

- increase in the areas of rice (1,100 ha), with paddy production rising by up to 273,000 t,
- very slight increase in cropping intensity, which, for the project as a whole, will rise from 191% to 193% (203% for the Thana of Melandaha and 202% for the Thana of Islampur).
- stable situation for the other crops (slight decrease in Rabi crops, which will be replaced by HYV Aman and HYV Boro).

Table 2.4.3 shows the area and production of the main crops in the future [WO] and future [W] for Option A.

iii) Option B

In Option B, embankments with inlet and outlet structures are provided to control flooding from both the Jamuna and Old Brahmaputra as well as the same drainage measures as describes under Option A.

Changes on land types distribution have been studied for the six Thanas of the project area on the basis of the analysis of the result obtained from the simulations of the hydrodynamic model MIKE 11 for the project area. Result of the computations are shown in Tables 2.4.4 with the new distributions of land types per thana.

Changes in cropping pattern have been assessed in two areas:

- Outside the embankments (NCA of 23,837 ha less 422 ha for embankments and structures i.e. 23,415 ha) the evolution is the same as per the without Project situation i.e. slight increase of irrigated areas through a transfer from B. Aman to HYV Boro (about 890 ha),

- Inside the embankments (NCA of 50,145 ha less 163 ha for drainage structure i.e. 49,985 ha). The evolution of cultivated areas by cropping patterns has been defined according to following assumptions,

- No global change for areas for cropping patterns Aus/Jute - Rabi crops and Aus/Jute - T. Aman - Rabi crops, but now distributed according to the modified distribution of land types. The first patterns occurs mainly on permeable soils which are poorly suited for T. Paddy crops.

- Change in cropping patterns which include Aman (Aus/Jute - T. Aman, mixed Aus + Aman - Rabi crops, T. Aman - Rabi crops and DWT T. Aman - Boro) by applying their present percentages to the future land type distribution,

- Transfer from B. Aman to HYV Boro as for the without Project situation,

- Change in areas of cropping pattern T. Aman - HYV Boro now covering the remainder of available areas,

- Moreover five years after the completions of the works increase of HYV Aman by 10%.

In terms of areas per crop, the main results of these changes in cropping pattern are as follows for the whole project areas (73,400 ha of NCA).

- Increase of rice areas by 3,500 ha (from 91,940 ha to 95,450 ha) due to:
  - increase in areas of T. Aman by 6,800 ha;
  - decrease in areas of B. Aman, Mixed Aus - Aman and DWT Aman by about 4,200 ha;
  - limited changes of Aus and Boro areas (+900 ha) but notable increase of irrigated HYV Boro up to 30,000 ha i.e. 41% of NCA.

- Simultaneously the irrigated areas increased by about 2,500 ha i.e. about 48% of whole NCA (58% inside the embankment).

The main results excepted from this option, expressed in terms of areas and production are summarized in Table 2.4.5.

Rice production

The rice areas increase by 3,500 ha and the average yield increases from a present 2.85 t/ha up to 3.17 t/ha. The corresponding increase of production is 40,600 tons, achieved after 13 years taking into account the changes in cropping patterns the evolution of yields over 5 years in previous flood - prone areas and the increase in the share of HYVs varieties for Aman Rice (from 60% to 70%).

In comparison with the without project situation the increase of Rice production is 36,470 tons, 62.5% of which coming from the increase of Aman production, 27.5% coming from the increase of Boro, the Aus rice production remaining almost stable (decrease of 380 ha).

Other crops

With regards to other crops, there are very few changes in comparison with the without project situation except slight increase of 560 ha of Jute diminution of pulses areas (1,100 ha) and vegetables area (660 ha), the total area of other crops than rice remain stable (slight decrease of 3% in area).

Irrigated area

The irrigated areas will reach 35,000 ha (8% increase) after 13 years, corresponding to the increase of HYV Boro areas (2,500 ha).

Cropping intensity

Increase in cropping intensity which will rise to 196% for the whole Project. Inside the embankments the cropping intensity will reach 207% outside it will be stable remaining 172%.

The simulation results obtained for the whole Project area in terms of production, operating costs show that assuming that 290 days of work give a full annual employment, the Project area will have a labour supply of 70,680 man-year i.e. an increase of 2,880 man-year in comparison with the reference situation [WO].

3 FISHERIES

3.1 Introduction

The fisheries study quantifies the present fisheries situation in the study area, assesses the possible adverse effects of the project and describes mitigation proposals. Analysis of the present hydrological and biological system has identified three crucial effects on fisheries production. These are the timing and level of first floods into the area, changes in the extent and average depth of flooding and changes in the duration of flooding.

From both field survey data collected during the course of the study and existing FRSS data, present and recent past levels of fisheries catches have been calculated.

At the prefeasibility stage of the studies, using a coarse model, the likely effects on each of the different fishing systems of possible alternative land and water development options were considered. This led to calculations of the likely fisheries losses for each fishing system under the assumption that no mitigation measures are taken.

As a result of an economic comparison, a land and water development plan was selected (option B) which provides for flood control in the mainland project area and includes the construction of embankments and drainage infrastructure. A mitigation programme aiming at compensating the likely losses in fish catches, due to the project, has been included as an integral component of the project.

3.2 Fisheries Assessment Methodology

There are four fish production systems in the study area and the outputs of these have been assessed separately:

- Riverine fisheries, which are split between the main rivers at the extremities of the study area (the Jamuna and Old Brahmaputra) and the internal rivers within the study area. Fishing in these areas is an all year activity.

- Floodland fisheries, between the internal rivers down to individual paddy field level. This is a seasonal activity, predominately subsistence in nature.

- Beel fisheries, which are a seasonal professional activity.

- Culture fisheries in ponds which are often individually owned.

In most of the above systems the operators are different. They have been conventionally divided into three categories after FAO/UN 1962:

- Full-time fishermen
- Part-time fishermen
- Occasional fishermen

These represent three very different degrees of time involvement and commitment to fisheries activities and as a result have greatly differing fishing efficiencies.

The assessment has followed the prescribed FPCO GPA guidelines when applicable and has been organized on the basis of the Socio-economic pilot survey (done by the socio-economic team) and a fish production survey which were cross checked with FRSS data.

3.3 Present Understanding of the Fisheries Situation

3.3.1 The Fishermen

The Socioeconomic Pilot Survey has shown that, within a sample of 523 households resident in the project area, 313 (60%) are not involved in any fishing activity what so ever. The 40% of households who practice fishing to various degrees can be classified as follows:

- 0.6% of all households are full-time fishing households, this comprises 1.4% of all the fishing households.

- 6.7% of all households are part-time fishing households, this comprises 16.7% of all fishing households.

- 32.9% of all households carry out occasional fishing activities and these constitute 81.9% of all fishing households.

Due to the small number of full-time fishing households and the statistical dangers inherent in such small samples, it has been decided to aggregate the full-time and part-time fishermen when stratifying the data.

Table 3.1 gives the proportional split of the differing fishing household types effort between the three main fishing locations/systems.

Table 3.1 Percentage Distribution of Fishing Household Types Effort by Location/System

HH type	Beels	Floodland	Rivers
Occasional	47%	41%	12%
Part-time	55%	29%	16%
All	52%	33%	15%
Source: JPPS Field Survey Data 1991-1992			

In total, the fishing effort of the occasional fishermen represents 40% of the overall total fishing effort when all fishing grounds are aggregated. A gross average of the number of days spent yearly in each type of fishing ground was estimated.

These findings are summarized in Table 3.2, data being given in days. It should be noted that the figure for beels includes both permanent and non-permanent ones. The periods for the beel and river fishing seasons have been identified from the beel/river survey

Table 3.2 Fishing Household Mean Activity Rates by Fishing Location/System

	Beels	Floodland	Rivers
Fishing Days	107	75	133
Days in season	200	90	170
Source: JPPS Field Data Collection 1991-1992			

3.3.2 Fisheries Resources in the Study Area

In order to gain an initial insight and understanding of the relationship between different categories of fish species and their economic exploitation, a broad categorisation of fish species into three major types has been made as follows:

- Those fish having a high market value which are essentially a commercial resource. These include Hilsa (an anadromous riverine species which is unlikely to be effected by FCD interventions) and Carp (including "Major Carp" and Kalibous)

species. The latter depend on the floodplain for their growth and will undoubtedly be effected by FCD projects.

- Other fish species which have a market value and do not totally depend on potamodromous migration. That is they spawn and feed in inundated land, canals and depressions and undertake very little migration to the fringes of the main rivers. These are likely to be less affected by major river side embankments, but could be affected by internal drainage and water control.

- Miscellaneous fishes which include a wide variety of mixed small species.

3.3.3 Floodplain (Subsistence) Fisheries

i) Locations and Fishing Practices

The approximate area of floodland fisheries in the study area has been estimated, along with the volume of water contained within this area, calculated with the coarse model and the available hydrological and topographic data:

- Area Inundated = 63,965 ha.months (from May to October)

- Volume Inundated = 52,813 ha.m

The volume figure refers to existing semi-contained "compartments" created by the raised road embankments within the project area.

The maximum flood land fishery area is about 22,000 ha (in August) with an average area of 12,800 ha over the months June to September, inclusive.

ii) Production Estimates

The FRSS estimate of the average annual catch per household in the Jamalpur District for 1988/1989 was 12.05 kg. Using this figure and the number of households participating in flood plain subsistence fishing, the total floodland catch in JPPS area can be estimated at 935 tonnes, consisting mainly of miscellaneous small fish species. An alternative estimate can be made by multiplying the national average productivity of flood lands from FRSS data by the floodland area in the study area. The FRSS figure is reported to be 66 kg/ha and when multiplied by the average project flood lands area of 12,800 ha gives a figure of 845 tonnes. This gives good confirmation of the calculated figure of 935 tonnes. A rough value of about 900 tonnes has been

used for the economic simulations, to represent the present fisheries resource from the flood lands.

3.3.4 Beel Fisheries

i) Beel Location and Classification

Beels can be classified into those that are permanent and non-permanent ones. However, the network of interconnected beels and canals in the project area is so complex and dynamic that such a precise classification and assessment of these water bodies is difficult. They vary both seasonally and also from one year to the next, depending upon the nature of flooding which may originate from both river and local rainwater sources.

Data on beel locations were mapped from French SPOT satellite imagery for 27 February 1989 and 20 November 1990 (representing a dry season and wet season situation) and also by consultation of the lists of Government Jalmahals (government controlled water bodies that are leased for fisheries purposes). The latter represents nearly all major open water bodies in the study area.

The list of Jalmahals obtained from the Jamalpur District Administration shows a total of 89 beels in the study area with a total area of 1 780 ha. 64% of the 89 beels were over 20 acres in area. In contrast with these figures the field observations and the use of the SPOT satellite imagery showed a total beel area of 2 220 ha, with a different size distribution of the beels. The difference between the Jalmahal figure of 1 780 ha and 2 220 ha obtained from the SPOT imagery is likely to be caused by the following factors:

- not all beels or water bodies may be registered as "Jalmahals" by the Administration.
- the Administration records only the winter area of beels, at a date generally situated between two measurement times in December and January. This is not the minimum area which is normally around March/April time and relates more closely to the situation in the February/March 1989 SPOT image.

In order to obtain a figure for the total average beel area over the study area throughout the year it would appear best to use the Jalmahal data of 1,780 ha which is taken at a time between the maximum and minimum water levels. This figure also cross checks with the average between the February and November figures from the SPOT satellite imagery analysis. A breakdown of Beel areas by category is as shown in Table 3.3.

Table 3.3 Beel Areas (ha) in Project Area

Permanent Beels		Non Permanent Beels		Total	
No	Area (ha)	No	Area (ha)	No	Area (ha)
32	492	76	1288	108	1780

Source: JPPS calculations based upon SPOT Satellite Imagery Data of February 1989 and November 1990 cross-checked with District Jalmahal data.

Note: Area data are rounded

ii) Tentative Beel Production Estimates

The average total daily catch in the sample beels was found to be 1,836 kg/day over a sample area of 337 ha. Using the estimated figure for total beel area of 1,780 ha, the total production for these 3 months would thus be about 485 tonnes. This represents a yearly catch of 1 078 tonnes and is equivalent to a yield of 605 kg/ha.

Analysis of the data carried out in January 1992 using the ratio of the number of observed fishing days against the reported past figure of days actually spent fishing, gave an acceptable confidence interval value between the two sets of data. The initially computed value was therefore used for all future calculations. The equivalent yield figure given by the FRSS for the district of Mymensingh is 526 kg/ha as against a national average figure of 412 kg/ha.

The differences between the FRSS figure and study figure can be explained by:

- the FRSS data covers the whole of the Mymensingh area which is very different to the study area, particularly the fact that the study area lies in much closer proximity to two main river systems and many of the beels are inter-connected to these.

- the number, size and distribution density of beels in the project area is far greater than for the whole of the Mymensingh District.

A computed value of 1,100 tonnes (618 kg/ha) has thus been used for all calculations of beel fisheries annual production for the study area.

3.3.5 Riverine Fisheries

The study of fishing in the internal rivers of the project area (mainly the Jhenai and Chatal systems) used the density sliced SPOT imagery of February 1989 and November 1990 to ascertain the area of open water and seasonality of flow in the system. These rivers are not permanently linked with the main rivers or with their tributaries. Some reaches become dry during winter, transforming the rivers into intermittent static water bodies.

The yields estimated from the field data of November-December 1991 by extrapolation from the 3 day results, give a figure of 126 kg/ha. Based upon this, the total production would be 786 tonnes per year from the internal rivers. However, comparison with other data indicates that this could be an over-estimate.

By estimating the catch for the month of Agrahyan (15 October- 15 November) as representing 21% of the total yearly catch (this is estimated from the correlation between the fishing effort and the production observed during the rivers/beel survey, against the 78% of the days spent in fishing shown by results from the frame survey), the figure would be about 508 tonnes for the year. The equivalent figure from FRSS data is 533 tonnes. This was later confirmed by further field data collection work in January 1992 and the figure of 508 tonnes has been used for subsequent calculations and analysis.

The existing level of fish capture in the two main rivers bordering the project area has been estimated at 1445 tonnes according to the " Catch Statistics of Bangladesh, 1988-89, sixth report" to be published by DOF.

3.3.6 Cultured Fisheries

i) Fish Ponds

Ponds are traditionally divided into 3 categories: cultured, culturable and derelict. According to FRSS data the Project area has approximately 3000 ponds with the total area of 871 ha, these are categorised as 43% cultured, 29% culturable and 28% derelict.

The pond fisheries field survey work carried out for the study covered 114 ponds (93 cultured, 15 culturable and 6 derelict) and hence does not conform to the FRSS distribution nor to the same geographical area. However, the data that were obtained have given relevant information concerning the present flood risk to pond fisheries, allowing an assessment of the likely effects of flood control and drainage programmes on pond fisheries. This is summarised as shown in Table 3.4.

Table 3.4 Summary of Pond Classification and Flood Risk

Pond category	Cultured	Culturable	Derelict
Flooded every year	5%	80%	67%
Rarely flooded	58%	7%	0%
Never flooded	37%	13%	33%
Source: JPPS Field Data Collection 1991			

It is estimated that the project area covers about 50% of the area of Jamalpur District. Assuming an even distribution of ponds, the area and production of ponds in the JPPS area as per FRSS figures, can be estimated to be as follows:

- 185 ha of cultured ponds producing 311 tonnes
- 128 ha of culturable ponds producing 36 tonnes
- 122 ha of derelict ponds producing 61 tonnes

This gives a grand total of 408 tonnes of production from all pond types in the study area.

ii) Hatcheries, Nurseries

There are 3 hatcheries on the Project area. They are concentrated in Jamalpur area.

- GOB FSMF under control of DOF. Production is 25 kg spawn/year. Total area is 1.3 ha.
- Unnayan Sangha (NGO) Hatchery. Last year production was 62 kg of spawn on 0.34 ha area.
- One private hatchery on 0.2 ha area. Production is not known.

3.3.7 Fish Marketing, Prices and Production Cost

Fish from the study area appear to be marketed in three different ways: directly on site, at a landing point or sent directly to a market. The latter two ways are carried out either by the fishermen themselves or by middlemen. It is estimated, from a comparison of the species composition of catch and sales, that nearly all of the carp species are sold on markets while the figure for other fish species is about 70%

and 30% for the miscellaneous category. The balance is sold on site or at landing points. January 1992 prices are shown in Table 3.5.

Table 3.5 Fish Prices in January 1992

Habitat	Main Species Group	Price	
		Average (Tk/kg)	Range (Tk/kg)
River	Hilsa,catfish	40	25-65
Beel	Carp,catfish and miscellaneous	30	15-50
Floodplain	Miscellaneous	25	15-40
Pond	Major & exotic carps	35	25-45

Production costs were calculated for each type of habitat, as shown in Table 3.6.

Table 3.6 Production Cost per 1 kg of Fish

	Equipment (Tk/kg)	Labour (Tk/kg)
Rivers	6	2
Flood land	2	2
Beels	6	2
Ponds	14	6

Source: FAO/UN 1992 Fisheries guidelines - for river, C.E.

3.3.8 Future Fisheries Trends in the Study Area (WO)

For the assessment of the future without (WO) project situation there are two considerations that will be taken into account for the economic analysis:

- the production of capture fisheries should follow the national overall trend using the simplified total figure for all fisheries systems, excluding pond, of -1.5% per annum. This may well underestimate the comparative losses to floodland and beel fisheries when compared to the increases in the last six years, however it could well be the case that an upper threshold has

already been reached and a situation of over-fishing has already started.

- the production from culture fisheries will be taken to follow the recent trend observed at national level. For the purposes of the analysis it has been assumed that the number of ponds will not increase and that the rise in production will result only from the better management techniques being applied. Further it has been assumed, for this analysis, that the trend will continue for a 30 years at a rate of 4% per annum.

3.4 Fisheries Impact Analysis

The main factors affecting the productivity of fisheries in the floodland, beels and internal rivers would appear to be the average depth, duration and area inundated. At prefeasibility stage, a simplified empirical flood model was made which considers monthly stream levels and some notion of topography all set within the framework of the existing compartments of the area. Although of a questionable accuracy, the figures obtained were of sufficient validity to draw conclusions for each of the proposed development options. It would appear that in any case there is little option but to use this technique.

In the selected Option B - Controlled Flooding and Drainage improvement, the main impacts will be as a result of providing both controlled flooding of inflows to the area and increased drainage provision within it. It is predicted that this will produce major effects i.e a reduction in fish recruitment from the river (Effect 1), a reduction in fish habitat (Effect 2) and a reduction in carp size at capture (Effect 3) due to drought advance. These are illustrated in Figure 3.1.

For option A which provides for drainage improvement without controlled flooding, effect 3 would have to be considered.

A fisheries development programme that might be implemented in an attempt to reduce the negative impacts are proposed hereafter.

3.5 Fisheries Development Proposals

3.5.1 General Presentation

Option A has been kept for comparison purpose at feasibility level despite that option B has been already selected at pre-feasibility stage.

Therefore, this section of the report provide a description of the mitigation and management measures that are incorporated into the recommended land and water development plan and included in the economic analysis of the Project (Option B). Further work will be

carried out in the detailed design phase which will follow this feasibility phase.

The following three major areas have received consideration:

- The area concerning capture fisheries through the proposal of fisheries management, stocking measures and policies drawn up in the light of the selected development proposal. This includes appropriate design of hydraulic structures for controlled flooding, and provisions for water retention structures.

- The area concerning the very significant potentials in cultured fisheries

- The Institutional strengthening of existing management and extension system

The measure which perhaps offer the greatest potential for fish production under a controlled flooding situation is the intensification by aquaculture management of those contained areas which will not be so badly affected by reduced inflow. Whilst this is unlikely to directly replace the present fisheries system on flood plain or provide opportunities for many of the occasional fisherman, it does have the potential to produce significant increases in fisheries output. However, it will require resources in terms of training and management.

A replacement to mitigate FCD Project impacts would be to restock water bodies with fingerlings once an assessment of the existing production extension possibilities and a plan for development of new production units have been made and shown to be worthwhile. Water bodies suitable for restocking would need to be identified in terms of area and manageability along with consideration of simultaneous programmes of conservation and protection. This could include beels, ponds (perhaps re-excavated) and particularly new deep borrow pits for embankments that are near settlements. This will require close liaison with the implementation programme at both detailed design and construction stages. Great care will be needed to draw up an appropriate and sustainable fisheries programme with an emphasis on total participation by local people leading to them being totally self-managed and even owned.

3.5.2 Capture Fisheries

(i) Fisheries Management Programme

The objective of the fisheries management programme for capture fisheries will be to conserve and develop fish stocks and ultimately to reduce the adverse impact of the flood control and drainage project.

Under the guidance of the Riverine Fisheries Research Station at Chandpur and in coordination with the existing actors dealing with fisheries in the project area, the NGO's will support the DOF for the enforcement of the New Fisheries Management Policy as presented in para 5.4.2. The measures proposed under FAP 3.1 should be implemented with due consideration of this policy.

(ii) Main Rivers

Loss of catches in the main rivers results from reductions in the traditional nursing areas of migrator species.

A Riverine Fisheries Development Programme with multipurpose objectives is proposed:

- Maintaining of broodstock of major carps.
- Artificial breeding of carps and restocking of river pools.
- Coordination of fry collection from the river and stocking them in river pools.
- Nursing and releasing management on river pools.

A Riverine Fisheries Research Station with a fish hatchery has been established at Chandpur in 1985 under the Fisheries Research Institute. This Research Station is adequate for providing guidance to the proposed Riverine Fisheries Development Programme under FAP 3.1 Project. The implementation of this mitigation measure will be secured through an adequate institutional strengthening of the fisheries sector in the project area. (see para 3.5.5 hereafter)

(iii) Provision of Fish Sensitive Gated Structure

The opportunity of creating "fish passes" has been proposed.

This measure has to be taken into account for the detailed design of the hydraulic structures during the next stage of the project. Final conclusions of FAP 13 will also need to be taken into consideration.

(iv) Internal Rivers

Utilisation of the internal river beds with managed fisheries is one of the benefits which will be created by the Project. When the embankment and the Jhenai/Chatal outlet will be completed the internal southern rivers will become stagnant water like an "artificial oxbow lake". This gives an excellent opportunity for practising fishery management in this water body. Regulation of water level at 13.0 m (GTS) at the Chatal/Jhenai outlet structure means 666 ha of water surface instead of 233 ha (WO) in dry season (JPPS calculation Appendix D). Further water bodies can be developed in the river bed at the upper part of the project area with check structures which can create a further 100-150

ha of water area. A further positive impact could be obtained with fingerling stocking management.

Table 3.7 show the expected production from internal rivers.

Table 3.7 Fish Catch in Internal Rivers in Tonnes with Different Options

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	508	502	496	489	477	458	434	402	371	328
Option-B W-M	508	502	496	489	171	168	165	162	160	158
Option-B W	508	502	496	489	466	500	533	533	533	533

Method of Calculation:

WO: Use of national trend (about-1.5% per year decrease of catch)

W-M: 1993 - 1997 Use of national trend (-1.5%)

1998 - 2022 National trend on the remaining water surface area (JPPS model)

W: 1993 - 1997 Use of national trend (-1.5%)

1998 - 2010 The yearly catch reach 650 kg/ha (JPPS assumption) through stocking and management programme. Total Water surface calculated as 820 ha through different control and check structures.

2010 - 2022 Increase of fish production will reach biological saturation.

Note: WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

(v) Floodplains and Beels Management

Floodplains and beels can be treated as a single biological unit. According to the main findings from Mike-11 computer model the floodplain area will decrease to 54% of the WO situation.

A long term stocking programme is able to mitigate, and even to increase, the production of beels and connected floodplains as shown in Table 3.8.

Table 3.8 Fish Catching (tonnes) in Floodplain and Beels

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	2,002	1,978	1,953	1,929	1,880	1,806	1,709	1,585	1,463	1,292
Option-B W-M	2,002	1,966	1,929	1,893	979	936	881	817	756	680
Option-B W	2,002	1,966	1,929	1,893	1,657	1,710	1,800	1,835	1,835	1,835

Method of Calculation:

WO: Use of national trend (about-1.5% per year), without any development plan.

W-M: 1993 - 1997 Calculated with national trend on present area (about-1.5% per year).

1998 - 2022 National trend continued on beel area and 54% of present floodland area (10,200 ha).

W: 1993 - 1997 Decrease, using National trend and decrease of floodland area due to the embankment construction (JPPS assumption).

1998 Stocking and management programme will start on the present beel area and 10 200 ha floodplain area.

1998 - 2010 Fish production increasing due to stocking and management programme to the maximum of 650 kg/ha in beels and 66 kg/ha on floodplain.

2010 - 2022 The system will be saturated thus production will remain stable.

Note: WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

According to the new hydrological conditions, the re-excavation of some of the smallest beels would be very useful. Selection of these beels should be made during detailed design.

(vi) Compensation of Deprived Fisherman

A target group oriented approach to fisheries is required. This will focus on compensation measures for fisherman who will be affected by the project. The main component of the Fisheries development proposal which concerns this strata of the population is the restocking programme for internal rivers as described above. With the support of the NGO's stretches of the controlled water bodies in internal rivers will be allocated to groups of fishermen who will be able to perform their activity under new conditions.

3.5.3 Cultured Fisheries

(i) Fish Ponds

Fish pond farming will become one of the determining production factors in the fisheries sector during the implementation of the Project. The total pond area will be flood protected and suitable for semi intensive culture techniques. With a long term development programme, fish yields of 936 kg/ha could be increased to 4,000 kg/ha as shown in Table 3.9.

Table 3.9 Fish Production in Fish Ponds at Different Options

	1993	1994	1995	1996	1998	2001	2005	2010	2015	2022
WO	408	426	448	478	522	609	740	914	1,130	1,305
Option-B W-M	408	447	486	525	564	681	837	1,032	1,227	1,522
Option-B W	408	426	448	478	652	870	1,261	1,522	1,653	1,740

Method of Calculation:

WO: Production assumed to be increased from 938 kg/ha to 3,000 kg/ha until 2022.

W-M: Production assumed to be increased from 938 kg/ha to 3,500 kg/ha. The difference come from the flood control which convert all pond area into cultured pond.

W: Production assumed to be increased from 938 kg to 4,000 kg/ha. The difference will be obtained from the mitigation and extension service programme. (including fingerling supply).

Note: WO Without project
W-M Option B without mitigation measures
W Option B with mitigation measures

The techniques of intensification are simple and require low capital cost.

(ii) Borrow pits

For the construction of the embankments it is required to excavate about 9 million m^3 of soil. Part of the borrow pits can be converted to fish ponds. Assuming an area of 100 ha of fish ponds, an additional production of 400 tons of fish supply could be achieved annually.

To evaluate the exact production volume of the potential from borrow pits is premature at the present stage. It will be assessed during the detail design phase, when it will be possible, through public participation, to locate borrow pits to be converted into ponds and borrow pits to be reinstated as paddy fields.

(iii) Beels and Other Potentials

Other potential can be developed under the extension programmes for cultured fisheries.

At detailed design stage, on the basis of more in depth surveys, the following possibilities will be examinated:

- A big demand of fingerling will arise as the fisheries development plan is implemented. It can be expected that more farmers will establish mini hatcheries and will excavate new ponds for nursing fingerlings.

- integrated farming techniques should be looked into with due consideration of the domestic use of water bodies and health hazards.

- Seasonal beels and excavated beels could be used for hatcheries and nurseries.

3.5.4 Summary of Fish Yields

Table 3.10 provides a summary of expected production for the (WO) and (A) situations, the Project situation without mitigation measures (W-M) and the Project situation with mitigation measures (W).

Table 3.10 Fisheries Yields

Area	Present (Tonnes)	WO/A	Option B	
			W - M	W
Floodland	902	582	231	500
Beels	1,100	710	183	1,335
Riverine	508	328	105	533
Ponds	408	1,305	1,498	1,740
Main Rivers	1,445	932	932	932
TOTAL	4,363	3,857	2,949	5,040
Key: WO/A	Without Project or Option A			
W - M	Option B with mitigation measures			
W	Option B without mitigation measures			

3.5.5 Institutional Strengthening and NGO support

(i) Institutional arrangement and objectives

In order to secure the fisheries development proposals the institutional strongthening of the fishing sector through NGO's is recommended for the project area.

The approach to be followed should derive from the experience of the Mymensingh Aquaculture Extension Project (DANIDA programme)

Existing DOF staff should be kept at the present level. DOF staff will participate to the implementation of the works proposed under the project and carried out by NGO's. DOF staff will be deputed to the project, as proposed in Annex 7, for a multidisciplinary approach of project implementation. Furthermore, a specific Technical Assistance programme will be provided to the DOF and NGO's through the Project consulting staff.

The main objectives of the NGO support to be provided through capable and experienced NGO's are:

- to implement the proposed fingerling stocking management programme
- to participate in the identification, design and implementation of check structures and excavation of beels
- to support fisheries production programmes through a credit system
- to provide support services to the population through field training and extension programmes

Some facilities, if provided to the fishermen, would increase catch and thereby increase the income of the poor section of people who are engaged in this occupation. Provision of credit support for fishing boats and nets will make substantial improvement in increasing catches. NGO's have developed approaches to individual fishermen on easy terms for the purchase of inputs, fishing nets, boats.

3.5.6 Legislation Enforcement

The institutional strengthening programme should enable greater effectiveness in DOF action towards the enforcement of the existing legislation on fisheries i.e. The Fish Act, the Tank Improvement Act, the New Fisheries Management Policy (NFMP). The contents of this legislation are detailed in Annex 2 on Fisheries.

It is essential for the preservation of the resource and the development of the nation's fishery potential that laws promulgated to this end are enforced.

3.5.7 Summary of the Project Components

The following basic requirements should be implemented in order to achieve the production of 5040 tons of fish in the Project area in 2022.

- A Central Government Hatchery with training centre (Jamalpur FSMF)
- private mini hatcheries, NGO hatcheries
- 285 ha of nursery area
- an efficient support to the sector provided through NGOs

The renovation and extension of Jamalpur FSMF is necessary.

3.5.8 Implementation Schedule

A 2 phase programme is proposed:

- A first Phase which includes:
  - Renovation of Jamalpur FSMF. Start by end 1993 and construction completion by end of 1994.
  - Mobilisation and organisation of NGO support from 1994.
- A second Phase includes
  - Construction of check structures and excavation of beels (if any)between 1995 and 1997 on the basis of local participation
  - Stocking management of beels and floodplains from 1996
  - Stocking management of river beds as from 1997 after the actual completion of main structures
  - Stocking programme of main river and elaboration of artificial breeding of endangered species from 1997
  - Extension service for all water bodies from 1994
  - Training programmes from 1994.

3.5.9 Cost Estimates

i) Physical components:

• Rehabilitation of Jamalpur FSMF	TK 8.0 million
• Check Structures	TK 20.0 million
Total	TK 28.0 million

ii) NGO component for a 7 year support programme

• Investment cost	TK 1.5 million
• Staff	TK 13.6 million
• running cost	TK 15.9 million
Total	TK 31.0 million

Total programme: TK 59.0 million

The required Technical Assisstance has been included in the cost for the engineering and TA arrangement proposed in the chapter on Engineering.

could change as a result of project interventions, particularly as a result of induced impacts.

The realisation that the flooding problem in these areas, which is more severe than in the mainland, could be made worse due to the combined effects of FAP 3.1 development proposal and other possible interventions, including the construction of Jamuna Bridge, has prompted CCCE to support a subsidiary study aimed to investigate the existing social and environmental situation in the reach of the Jamuna river adjacent to FAP 3.1. Based on the findings of the study, which was carried out in close cooperation with Service Civil International (SCI), a comprehensive flood proofing programme for adjacent unprotected land has been formulated and presented in Annex 9 of this report.

4.2 Methodology

4.2.1 General

As outlined in the FPCO Guidelines for Project Assessment, SIA involves the six following steps:

- Identification of the social groups to be affected.
- Description of the bases of their livelihood.
- Estimation of the project impact on their livelihood.
- Estimation of the overall impact of the project on income distribution in the project area.
- Assessment of the likely changes in the general quality of life of people.
- Estimation of the capital and recurrent costs of any mitigation measures.

To meet the requirement of the Guidelines, the social study has been divided into three different components including, a household census, a socio-economic survey and a local participation element.

4.2.2 Household Census and Socio-Economic Surveys

The household census, which was primarily designed to provide a reliable stratified sampling frame of households, was conducted on 19 randomly selected villages and more than 5,000 households were enumerated. From the census results, an estimate of the population of the project area was given and the main social groups were identified and numbered.

From the census list, 482 households were randomly selected and have been interviewed as part of the socioeconomic survey. During the survey, information pertaining to the occupation and employment patterns, sources of income, value of subsistence production and income was obtained. Based on these data, the bases of livelihood of each social group have been ascertained, average household incomes have been computed and the equity of income distribution has been analyzed.

4.2.3 Impact Assessment

To measure the changes in the evolution of household incomes and those in the overall distribution of incomes which are solely due to the project, only the factors which are likely to be different under a "with" and a "without" situation have been considered, irrespective of all the other determinants of household incomes which will not be directly affected by the project.

Due to the nature of Option B, flood damage, cropping patterns, fisheries resources and employment opportunities for Farm and Non-Farm Labour are likely to be different and their effect on household incomes needs to be determined. Based on the forecasted changes in these four variables, household incomes and related distribution have been computed ceteris paribus (all other variables held constant) in the "with" and "without" project scenario and the impact of the project on incomes has been assessed.

4.2.4 People Participation

Because one of the key factors to ensure the sustainability of a development project is linked with the involvement and participation of local population in the project planning, implementation and maintenance, emphasis has been placed on eliciting the respondents views on the possible development options; what they believe to be needed and their perceptions of the effects on their livelihood.

Through group discussion and more formal interviews, a wide range of local people has been consulted, including farmers, fishermen, and Char land inhabitants. In addition, opinions of local administration representatives, of NGOs involved in the project area and of public representatives have been solicited and comments and ideas have been gathered.

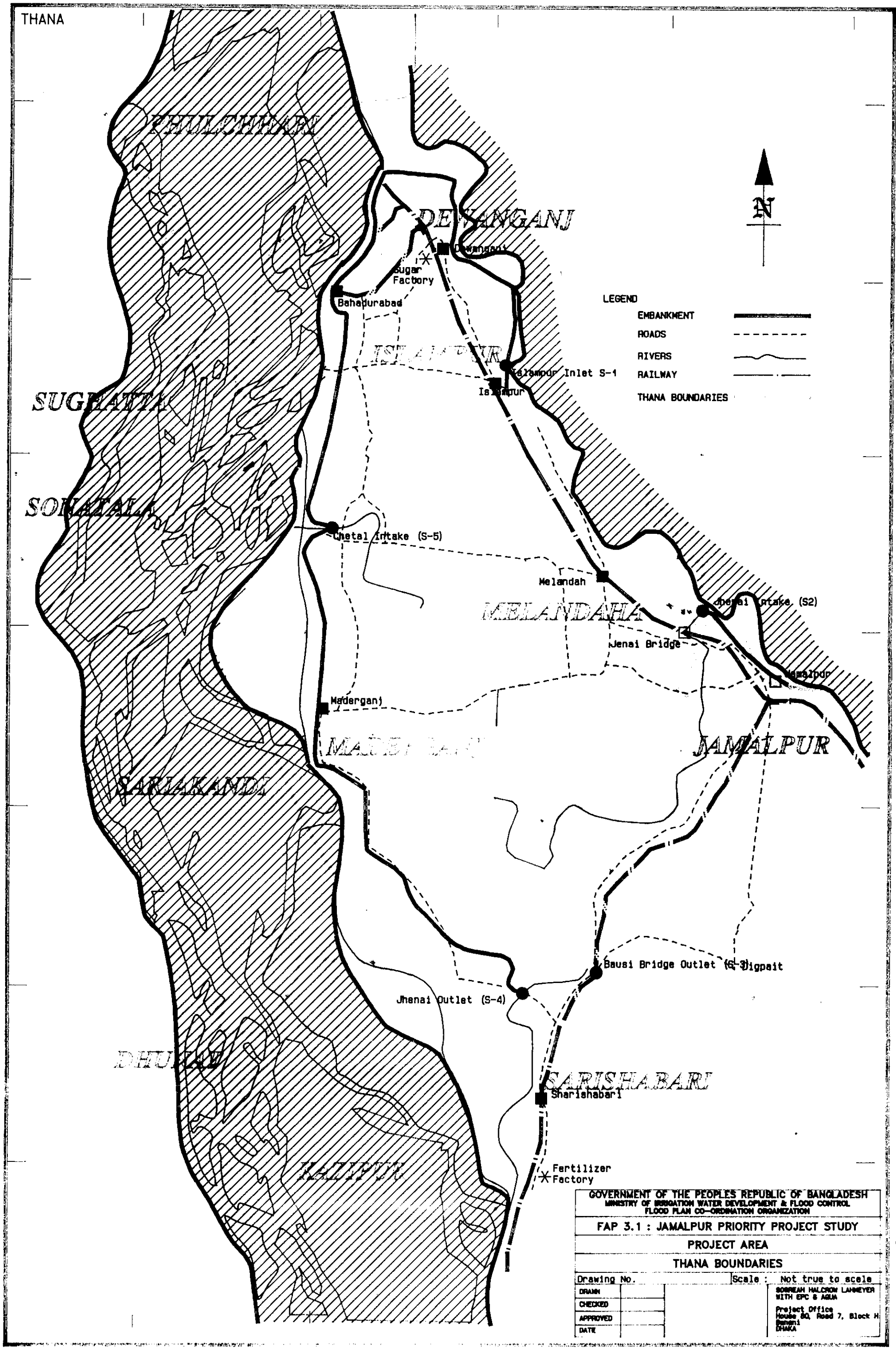
The existing institutional settings in the project area have also been identified with the ultimate objective being to assess how a comprehensive and effective framework for local participation in project design, implementation and maintenance could be worked out. However, considering the prevailing social inequity, power structure and

institutional set up of rural Bangladesh, local participation remains an idealistic concept with little tangible significance. In an exploitative environment, where the patron-client relationships are dominant, how can the poorest strata of the population raise their voices with an open and free mind to those on whom they depend for their survival? In this respect, the present governmental agencies charged with development activities need to adjust their approaches to integrate, to a greater extent, the population which is usually not concerned by development activities. In this respect, the mobilisation of NGOs to pursue awareness raising, community development and income generating programmes is foreseen as a component of major significance to build up self-reliance among the marginalised populations and to uplift their living conditions. Regardless of the development scenario chosen, the involvement of NGOs is, for the time being, one of the most practical answers to local participation and emancipation of the rural poor leading to sustainable development.

4.3 Socio-Economic Surveys

4.3.1 Project Area and Population Estimates

The study area is spread over twelve Thanas (see Figure 4.1) and has a gross area of around 180,000 ha, which includes 20,800 ha of river channels as at 8 March 1992. With the construction of the proposed embankment under option B, the study area can be split between protected land (65,800 ha) and unprotected land (93,237 ha) which includes both Set-Back Land and Attached Chars on both banks of the Jamuna and Island Chars. As shown in Table 4.1, the total population of both areas is 1.23 million of which 51% are in the protected area. However the Socio-Economic studies mostly relate to the FAP 3.1 implementation area which excludes the set-back and attached land on the right bank. Hence the Socio-Economic study area is 134,759 ha containing a population of 1,058,496 people.


THANA
PALCHHARI
DEWANGANJ
Dewanganj
Sugar Factory
Bahadurabad
ISLAMPUR
Islampur
Jalalpur Inlet S-1
SUGRATTAL
SONATALA
Chetal Intake (S-5)
Melandah
MELANDAHA
Jenai Intake (S2)
Jenai Bridge
Jamalpur
Madergani
MADERGANJ
JAMALPUR
SARIAKANDI
Bausi Bridge Outlet (S-3)
Digpait
Jhenai Outlet (S-4)
DHUNAT
SARISHABARI
Sharishabari
Fertilizer Factory
N
LEGEND
EMBANKMENT
ROADS
RIVERS
RAILWAY
THANA BOUNDARIES
GOVERNMENT OF THE PEOPLES REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION
FAP 3.1 : JAMALPUR PRIORITY PROJECT STUDY
PROJECT AREA
THANA BOUNDARIES
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WITH EPC & AGUA
Project Office
House 80, Road 7, Block H
Banani
DHAKA

Figure 4.1

Table 4.1 Land Area and Population in the Study Area

	Protected	Unprotected Land (Total)			Total
		Island Chars	Attached-Set-Back	Total	
Area (ha)	65,804	38,744	54,493	*93,237	*159,037
Population	631,023	118,060	484,533	612,603	1,233,626
No of Households	123,247	19,327	95,008	114,335	237,582
Density	959	305	889	646	776

Source: estimates from FAP 3.1 Household Census (Protected Land) and from Char Land Study (Unprotected Land). Land areas taken from classified Landsat imagery of 8 March 1992.

* Does not include 20,801 ha of main river channel water areas as at 8 March 1992.

Note: The Socio-Economic studies in Annex 6 exclude the attached and set-back land on the right bank (see Char land study, Annex 9) giving a study area of 134,759 ha with a population of 1,058,496.

4.3.2 Social Stratification and Land Distribution

The ownership of agricultural land is the main determinant for the economic position of a household and the social structure of rural Bangladesh can be explained to a large extend by its agrarian structure and the related patron-client social organization. As shown in Table 4.2, agriculture land is very unevenly distributed in the proposed protected land. About half of the households in the project area have no land at all while some 37% have less than one hectare to sustain their livelihood. Because most of these households have expenditures greater than their incomes, they are caught in a process where they gradually have to deplete their fixed assets to finance their deficits. Eventually, when the amount of debt becomes large, this process will end by the mortgage and sale of their agricultural land. If the present tendencies of concentration of land ownership continue, an ever increasing amount of land will be owned by a small number of surplus households while the majority of households will become totally landless. As a result, a growing number of destitute households will fall outside the patron-client network since they have no possessions and no assets to offer. Unless appropriate measures are taken so as to develop their livelihood through specific income generation and education programmes, an increasing number of people will leave the area in search of a livelihood in the slums of the rapidly growing cities of the country.

Table 4.2 Land Distribution and Social Stratification

Land Distribution (in acres)	Landless 0-0.05	Marginal 0.06-0.5	Small 0.51-2.50	Medium 2.51-7.50	Large > 7.50	All
No of Households	61,747	17,378	29,333	12,571	2,218	123,247
% of Households	50.1%	14.1%	23.8%	10.2%	1.8%	100.0%
Household Size	4.49	4.83	5.43	7.10	9.53	5.12
Population	277,415	83,935	159,277	89,255	21,142	631,023

Source: estimates from FAP 3.1 Household Census (Protected Land)

In addition to the impact of the land concentration process, a purely demographic factor will contribute to further increase the number of landless households in the project area. Landless and marginal land owning households have higher birth rates (5.2% and 4.3%) as compared to other strata (between 2% and 3%) and their population is increasing at a much faster rate (3.1%) than the average (2.1%).

4.3.3 Employment Patterns

In the Project Area, the Civilian Labour Force (CLF) has been estimated at around 230,000 persons of whom 22% are fully employed while 48% are not employed throughout the year. Nearly 30% of the labour force (60,000 persons) are either unemployed or do not look for jobs although they would be ready to work if opportunities were available.

As shown in Table 4.3, activity and employment status vary significantly among land strata and follow a reverse trend. With the increase of the size of the landownership and of the related farm incomes, the participation rates (refined activity rates) decrease because these households do not need to mobilize their children and female members to support their livelihood. In case of landless and marginal landowners, participation rates are higher but most of them are underemployed or unemployed. This indicates that employment opportunities for the landless labour force are not sufficient to meet their demand.

Table 4.3 Activity Status and Employment Patterns

(population figures in thousands)

Employment Patterns	Total	%	LL	MA	SF	MF	LF
Civilian Labour Force	230.5	100.0%	111.6	29.0	53.3	31.1	5.5
Employed	51.6	22.4%	11.5%	8.4%	28.9%	54.6%	69.6%
Underemployed	112.1	48.6%	57.0%	61.7%	45.3%	18.6%	13.7%
Unemployed	4.6	2.0%	1.0%	1.9%	2.1%	4.1%	9.8%
No Looking for Job	62.2	27.0%	30.5%	28.0%	23.7%	22.7%	6.9%
Refined Activity Rate	51.5%		59.3%	50.7%	46.3%	44.1%	33.3%

4.3.4 Occupational Patterns

As shown in Table 4.4, the distribution of employed and underemployed labour force by main occupation shows that Agriculture Daily Labour and Farming are dominant. The importance of Agriculture Daily Labour is very high in the case of the landless labour force (75%) and decreases gradually with increasing land ownership. Farming is the main occupation of around 73% of small, medium and large landowners but only 4% of the landless labour force is engaged in farming as a primary activity.

Table 4.4 Distribution of Employed and Underemployed Labour Force by Primary Occupation (figures in thousands)

Main Activity of CLF	Total	%	LL	MA	SF	MF	LF
Total	163.7	100.0%	76.5	20.3	39.5	22.8	4.6
Farming	59.8	36.5%	4.3%	34.7%	74.5%	73.2%	72.9%
Business/Trade	5.9	3.6%	1.8%	5.3%	5.7%	4.2%	4.7%
Services	8.6	5.3%	1.8%	2.7%	5.0%	16.9%	20.0%
Daily Labour (Farming)	71.1	43.4%	75.3%	45.3%	9.2%	2.8%	0.0%
Daily Labour (Non-Farm)	6.0	3.7%	5.7%	4.0%	2.1%	0.0%	0.0%
Transport	1.6	1.0%	1.4%	1.3%	0.7%	0.0%	0.0%
Others	10.6	6.5%	9.7%	6.7%	2.8%	2.8%	2.4%
Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)							

4.3.5 Bases of Livelihood

If the distribution of the population by main occupation gives an idea of the main sources of household incomes, it does not provide a full picture of the structure of the household incomes. To have a precise idea of the bases of the household livelihood, the different income generating and subsistence production activities in which the household members are engaged need to be identified.

In the project area, the proportion of households involved in agro-forestry (79%), farming (60%), agriculture daily labour (57%), Livestock/Poultry production (52%), non-agriculture land exploitation (39%) appears to be very significant. Around 30% of the households are engaged in subsistence fisheries while only 7% can be classified as professional fishing households although most of them are fishing on a part-time basis. On average one household is engaged in approximately 3 different activities, this figure being higher in the case of large landowners (5%) and lower for the landless (2.1%).

4.3.6 Definition of Household Incomes

Household income, which refers "to material return in cash or in kind earned by the household members in exchange for goods and services" can be estimated from two different perspectives. The first approach, known as the "source method", intends to estimate rural incomes using production accounts of the households. The aim is to measure how much was earned (in cash or in kind) by the household members during the reference year by summing the income obtained from each activities in which the members were involved. However, since rural households do not keep records of their activities, it is difficult to estimate income accurately for activities conducted on self employed basis. In addition, subsistence production activities which are undertaken for home consumption are not usually considered as income and there is a tendency to underreport these activities. In the context of the study, the subsistence production activities which have been considered and valued include:

- Agro-Forestry, i.e. production of banana, wood, fuel, coconut, fruits, betel nut, date, palm an bamboo,
- Non-Agriculture Land exploitation i.e. production derived from grass land, fallow land and kitchen garden,
- Open water Fisheries (river, khals, flood lands, beels),
- Livestock i.e. production of eggs, meat and milk.

The incomes earned from these activities were valued by recalling information from the household heads. Because this method suffers from the usual problem of faulty memory and leads to under-reporting of costs and under-reporting of incomes, the estimates of average incomes obtained are usually biased downward and the importance of subsistence production incomes could be under-estimated.

In an attempt to balance these imperfections incomes were also estimated from a second method which measures the level of incomes from the household expenditures. As expected, the estimates of the average incomes obtained from expenditures data are slightly higher. In order to consolidate the results derived from these two approaches adjustments have been made by including the residual differences under the "other sources" head of the income structure.

4.3.7 Household Income by Land Strata

The average amount of gross income per household in the project area is slightly above Tk 20,000 per year. The main sources of income are farming (40%), agriculture labour (22%). Non-agriculture labour appears to be a minor sources of income (less than 4%) while the importance of

subsistence production activities such as agro-forestry (5%), livestock (3%) and fisheries (2%) is not very high though probably biased downward for the reasons explained above (4.3.6).

Significant variations have been found between strata as shown in Table 4.5. Landless households earned an average of slightly more than Tk 14,000 per year whereas large landowners have an average income of more than Tk 85,000 per year. The structure of income sources is also correlated to the size of landownership. The contribution of farming activities to household income rapidly expands as land ownership increases from a mere 7% in case of landless up to 50% and more for small, medium and large landowners. The importance of agriculture labour sources follow a reverse trend, contributing some 50% to the landless households annual income. The importance of all other activities including agro-forestry, livestock production, homestead cultivation and fish culture except in open water fisheries increases with the size of landownership. Although farming is the dominant source of income for larger landowners, these households have a relatively more diversified livelihood than the smaller ones which enables them, among other reasons, to sustain a more stable living.

Table 4.5 Annual Household Income By Land Strata (in Tk/household)

Sources of Income	ALL		LL	MA	SF	MF	LF
Farming	8,326	40.9%	7.3%	32.5%	52.4%	64.6%	62.1%
Daily Labour (Farm)	4,484	22.0%	49.4%	26.1%	5.7%	1.1%	0.0%
Other Labour/Employment	1,956	9.6%	7.6%	10.2%	8.5%	18.4%	14.7%
Agro-forestry	934	4.6%	2.8%	4.0%	5.4%	5.5%	8.3%
Business/Cottage/Trade	739	3.6%	3.4%	3.2%	5.0%	2.0%	5.6%
Daily Labour (Non-Farm)	677	3.3%	5.8%	6.4%	2.6%	0.0%	0.0%
Livestock/Poultry	575	2.8%	1.7%	3.2%	3.6%	3.6%	2.7%
Fisheries	407	2.0%	3.0%	2.9%	2.3%	0.3%	0.0%
Non-Farming Resources	276	1.4%	0.8%	1.6%	1.5%	1.3%	3.4%
Fish Culture	57	0.3%	0.1%	0.0%	0.1%	0.6%	1.5%
Other Sources	1,938	9.5%	18.1%	9.9%	12.9%	2.8%	2.3%
Household Income	20,368	100%	14,329	16,187	21,277	42,357	85,280
Average Household Size	5.12		4.49	4.83	5.43	7.10	9.53
Income Per Capita	3,978		3,189	3,351	3,918	5,966	8,949

Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)

4.3.8 Household Income By Occupation

Farming households operate an average of 0.6 ha of land but significant variations among strata have been noted. Landless farming households, have an average holding of 0.2 ha whereas Medium and Large farmers operate 1.8 ha and 3.2 ha respectively. About 20% of farming households have access to part of their operated land through sharecropping arrangements. This percentage reaches 100% in case of landless, 50% for marginal farmers, 20% for small farmers and 2% for medium farmers.

As shown in Table 4.6, the average annual income of farming household is close to Tk 25,000, out of which nearly 60% is derived from farming activities. Agriculture and non agriculture labour sources account for slightly over 10% while the remaining 30% come from other sources. Behind this average pattern significant variations among land strata are observed both in the level of income and in its structure. While the upper farming households strata earned the majority of their living from farming activities, smaller landowners and landless farming households have to search for additional sources of incomes to sustain their livelihood.

Table 4.6 Household Income by Occupation and Income of Women-Headed Households (in Tk/household)

Sources of Income	Day Labour (Farm)	Day Labour (Non-Farm)	Farming	Prof. Fishing	Women Headed
Farming	6.0%	2.6%	56.6%	24.3%	33.1%
Fishing	2.7%	0.4%	2.4%	65.1%	0.0%
Agriculture Labour	55.3%	0.9%	7.2%	4.1%	1.4%
Non-Agriculture Labour	8.8%	95.3%	3.1%	1.5%	4.9%
Other	27.3%	0.8%	30.8%	4.9%	60.5%
Average Household Income	14,072	14,492	24,019	16,654	10,190
%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)

Among the different professional groups likely to be affected by the project, farming households will probably end up better off. Average annual household incomes of daily labour (farm and non-farm) are already 40% lower than those of farmers, while the income of professional fishermen is between that of farmers and that of labourers, due to their greater participation in farming activities (24% of their income derives from farming). The situation of women Headed households is far more critical than any other households. With an income of only Tk 10,000 per year these marginalized households are 30% below even the average standard of landless households. From the

above information it appears that to achieve sustainable development priority should be given to raise income of the lowest strata of the rural structure through appropriate targeted income generating poverty alleviation schemes.

4.3.9 Income Distribution

The distribution of income in the different professional groups considered highlights the fact that most of the daily labour and professional households are concentrated in the lower income groups while the situation is more balanced in case of farming households. As shown in Table 4.7, the worst situation is found in case of women headed households with more than 80% of them living with less than Tk 10,000 per year.

Table 4.7 Distribution of Household Income for Different Professional Groups and for Women Headed Households

Income Classes	Day Labour (Farm)	Day Labour (Non-Farm)	Farming	Prof. Fishing	Women Headed
< 10000	33.2%	36.4%	22.4%	20.0%	83.3%
10001 - 20000	49.7%	54.5%	29.3%	60.0%	10.0%
20001 - 30000	12.6%	9.1%	17.0%	16.7%	3.3%
30001 - 40000	2.5%	0.0%	14.9%	3.3%	2.3%
40001 - 50000	2.0%	0.0%	8.5%	0.0%	1.1%
+ 50,000	0.0%	0.0%	7.9%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)					

4.3.10 Distribution of Incomes by Land Strata

The pattern of the income distribution by land strata shown in Table 4.8 underlines a strong correlation between the level of income and the size of the landownership. Around 85% of the landless and 75% of the marginal households are earning less than Tk 20,000 per year whereas this proportion is below 20% in case of medium landowners and nil in case of the largest ones. As a whole, nearly 70% of the households (around 80,000 households) are concentrated in the lowest income classes and, as such, can be regarded as highly vulnerable because they are likely to be deficit households. For the landowners falling within this category this would normally mean that they are already engaged in a gloomy process of dispossession which could ultimately end by the sale of fixed assets, including land. As a result, landlessness in the project area is likely to increase in the future.

This surplus number of landless households will have to search for employment opportunities either on farm or off farm leading to a fiercer competition among the poor in the rural labour market. The all-important question is whether or not employment opportunities will increase at the same pace as the landlessness process, so as to absorb the growing surplus of labour force. Given the present pace of economic development in the project area, this is most unlikely and a more realistic scenario is that out-migration to urban areas will be taken up by a significant number of the deprived households.

Here again, in order to achieve sustainable development, priority should be given to raising the incomes of the lowest strata of the rural population through appropriate targeted income generation and poverty alleviation schemes.

Table 4.8 Distribution of Household Income in each Land Strata

Income Classes	Landless	Marginal	Small	Medium	Large	All
< 10000	32.5%	24.8%	11.4%	2.2%	0.0%	22.7%
10001 - 20000	52.0%	49.2%	46.6%	17.8%	0.0%	45.9%
20001 - 30000	10.7%	20.6%	21.0%	26.6%	2.3%	16.0%
30001 - 40000	2.2%	3.2%	16.2%	22.2%	9.1%	7.8%
40001 - 50000	2.2%	2.0%	3.8%	16.6%	10.1%	4.2%
+ 50,000	0.4%	0.2%	1.0%	14.6%	78.5%	3.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)						

4.3.11 Land/Income Relationship

In the project area, the income of each household is strongly correlated to the amount of agricultural land owned. The result of the regression analysis indicates that there is a linear relationship between the two variables:

$$Y = a X + b$$

where,

Y = Annual Household Income (in Tk/HH)
X = Amount of Agricultural Land owned (In Ha/HH)
a = 14,169 (significant with 99.9 % confidence)
b = 15,861 (significant with 99.9 % confidence)

This analysis highlights that the key determinant to the income of the household, and thus to its livelihood, is land ownership. Any reduction in the amount of land owned by each household has an adverse effect on its income and on the sustainability of its livelihood.

4.4 Social Impact Assessment

4.4.1 Sustainable Development

The basic philosophy behind this SIA exercise is the concept of sustainable development as opposed to a narrow mitigatory approach to disbenefits. As explained earlier, sustainable development cannot be achieved until and unless the poorest strata of the rural communities, including destitute, homesteadless and landless households, women headed households, and marginal landowners are involved in the economic development process.

In assessing the social implications of the project (Option B), the focus has been placed on measuring the impacts of the project on households incomes; on identifying whether or not the project is likely to contribute to raising incomes, especially of the poor, and on whether or not the equity issue has been addressed.

4.4.2 Social Benefits

The social benefits induced under option B would be of two types:

- Short-run benefits: They are linked to the construction phase and will provide direct incremental socio-economic benefit to the large population of labourers. The effects are additional employment therefore increase of incomes and better scope for higher consumptions, improved diet and reduction of dependency.

- Longer-run benefits: They are linked to the developmental consequences of the project. They are generated gradually as a result of the projet investment and operation with the construction of the embankment, one of the major benefits is the prevention of flood damage in the protected land, including protection of human lives, livestock, household assets, infrastructure and standing crops which would contribute to increase the security of livelihood. Other benefits included effects on agricultural production and productivity household incomes, saving, investment and consumption patterns that can generate multiplier effects in other sectors of rural economy (trade, transport.....). This will also result in improving the non-agriculture sectors such as higher scope for employment in maintenance of structure and trade which will positively affect the poverty alleviation.

With the construction of the embankment, one of the major benefits is the prevention of flood damage in the protected land, including protection of human lives, livestock, household assets, infrastructure and standing crops which would contribute to increase the security of livelihood.

Another positive social impact is that the poorest households which used to borrow money, sell fixed assets, mortgage and/or sell land to recover from flood damage would become less vulnerable since the risk of loss of livelihood as a result of floods will be much reduced. Eventually, the landlessness and pauperization process could be reduced.

4.4.3 Social Disbenefits

The following potential social disbenefits may be associated with the proposed project:

- loss of agricultural and/or homestead land due to land acquisition for embankment construction
- loss and/or reduction of livelihood due to alteration of open water fisheries resources
- increase flood risk in unprotected areas (Char land and Set-Back land)

The reduction of open water fisheries resources will adversely affect the livelihood of flood plain professional fishermen through a direct loss of cash income, but this effect will be mitigated by the promotion of fisheries in the protected area. Subsistence fishing households will be affected through a reduction of their nutritional status since they will loose a significant part of their animal protein intake.

Land acquisition will affect a significant number of households, thereby reducing their agricultural income and increasing their socio economic vulnerability. For the households living on the existing embankment, the loss of their homes as a result of the construction of a new embankment could be a major negative impact. For this reason a resettlement programme, linked to the multi-purpose use of embankment, is envisaged and will be further developed at the detailed design stage of the embankments.

The increased flood risk in unprotected areas is an issue of major significance which has to be taken into consideration when assessing the social implications of Option B. This question is addressed in the Char study (Annex 9) where mitigation measures in the form of flood proofing are proposed.

4.4.4 Impacts on Household Incomes

Impacts on household incomes have been measured by comparing the forecast incomes of different social groups in the future without project [WO] and with project Option B [B] situations. The results of this comparison are shown in Table 4.9. As explained above in the methodology, these projections have been made based on the expected changes in cropping patterns (given the agricultural studies reported in Annex 5), in the increased volume of farm labour employment and non-farm labour employment (for O&M).

87

Table 4.9 Income Impact Assessment (in Tk/HH)

Impacts on Income	Reference	[WO]	[B]	Increment
1- Household Income				
Farming Household	24,019	24,012	26,856	11.8%
Day Labour (Farm)	14,072	14,040	14,982	6.7%
Daily Labour (Non-Farm)	14,492	14,486	17,064	17.8%
Professional Fishermen	16,654	15,253	19,171	25.7%
Women Headed Household	10,190	10,205	10,913	6.9%
2- HH Income By Land Strata				
- Mean Stratum Income				
Landless	14,329	14,290	15,096	5.6%
Marginal Landowners	16,187	16,153	17,429	7.9%
Small Landowners	21,277	21,266	23,374	9.9%
Medium Landowners	42,357	42,478	47,846	12.6%
Large Landowners	85,280	85,542	96,022	12.3%
All Households	20,368	20,361	22,291	9.5%
- Share of each Stratum				
Landless	35.2%	35.1%	34.0%	-3.1%
Marginal Landowners	11.2%	11.2%	11.1%	-0.9%
Small Landowners	24.8%	24.8%	25.1%	1.2%
Medium Landowners	21.2%	21.3%	22.0%	3.3%
Large Landowners	7.5%	7.6%	7.8%	2.6%
All Households	100.0%	100.0%	100.0%	
3- Equity Gap				
Gini Coefficient (*)	0.227	0.228	0.243	6.6%

Source: estimates from FAP 3.1 Socio-Economic Survey (Protected Land)

Note: Increment refers to the increase provided by Option B in comparison to the WO situation.

(*) This is a concentration index which intends to indicate the degree of inequality in the distribution of a given variables (such as income) among different group an increase in the coefficient means that a smaller share of the total income is obtained by the lowest income groups while the shares of the highest groups have increased. In other words, it means that the level of income concentration is higher and that the social prices of income distribution has become more inequitable.

In the context of the study, the impact of the different options on the income distribution among land ownership groups could be ascertained and thus, their relative shares have been measured. Therefore in the study, the Gini coefficient provides an index of the income concentration among different landownership groups. An increase in the Gini coefficient means that the shares of the biggest landowners has increased while those of the landless and marginal landowners have decreased.

Because the [B] situation is based on and improvement of the total agricultural and fisheries productivity in the project embanked area, the incremental income influence of [B] compared to [WO] is significant (+9.5%). The projections shown in Table 4.9 are only valid to assess the incremental impact of one scenario over the other one and should not be regarded as a plausible estimate of the future evolution of rural incomes.

This being said, a significantly increased amount of recurrent unskilled labour cost in O&M work (Tk 15 million per year) created by the project will give additional employment opportunities for non-farm daily labour. The average income of households from this occupational group would rise by 17.8% provided that the number of households engaged in this activity is constant, which is not likely. Other sections of the labour force, especially from underemployed farm labour would probably take a share of these incremental job opportunities created by the project. As a result both farm labour and non-farm labour are expected to provide additional incomes.

Farming households are expected to be better off (+11.8%) due to an increase in their farm incomes. However, this pattern is not uniform in each land holding strata. The amount of incremental farm benefits is proportional with the size of landownership and large farmers are the first gainers in both absolute and relative terms. This seems to be a direct consequence of the existing share cropping system which does not allow for a fair remuneration of the tenant farmer own labour. The return to the sharecroppers own labour is usually below the labour market price, which indicates that the sharecropping system is one of the major tools used for the exploitation of the rural poor.

Professional fishermen are expected to be better off as a result of the fisheries mitigation programme. Their annual household incomes would increase by some Tk 4000 in case of [B] as compared with the [WO] situation. In the future [WO] situation, for which no specific fisheries programme has been assumed, the income of this professional group is expected to decrease as compared to the existing situation, as a result of the general declining trends in open water fisheries resources in Bangladesh.

4.4.5 The Equity Issue

The projected changes in the average income of each land holding strata, shown in Table 4.9, show that, under Option B, the lower classes are not expected to benefit from the project to the same extent as the higher classes. Although the average income is higher in all strata, the incremental income in the [B] situation is higher in the case of large landowners (+12.3%) than in the case of landless, marginal and small landowners (+7.0% on average). As a result, the share of landless households and marginal landowners in the total income would

decrease, whereas the share of large landowning households would increase. This would contribute to increasing the equity gap somewhat as shown by the value of the income concentration index (Gini Coefficient) which is likely to raise from 0.228 (WO) to 0.243 (W). Despite the fact that it will provide an additional income to the households, Option B does not intend to address the issues of increased landlessness or the widening equity gap.

4.4.6 Likelihood of Social Conflicts

As a result of the project implementation, four categories of people would be likely to be adversely affected if no mitigation is provided:

- Those who are going to lose land in the land acquisition process
- Those presently sheltered on the existing embankment who are going to be displaced
- Those living in unprotected land (Char land & Set-Back land) who are going to be subject to an increasing flood risk
- Those who are going to loose part of their protein intake (subsistence or occasional fishing households) due to the reduction of open water fisheries resources

The likelihood of conflicting situations between direct beneficiaries (farmers) and the disbeneficiaries identified above depends on how far the project will be able to involve these groups of people through specific targeted programmes aimed at providing them with appropriate compensating measures and to involve them in project activities in a positive manner. If these groups have the feeling that they are not left out and that their concerns have been heard by development planners and properly dealt with, they will be more likely to accept the project proposals. Unless this is done, the emergence of social conflicts, which could go as far as cutting the embankment, cannot be ruled out.

4.4.7 Local Participation and Public Opinion

i) Public Representatives

The role of the Union Parishads in coping with the natural disasters such as flooding is limited by the level of material assistance that they receive from government resources. Because the level of this assistance is usually insufficient to enable a quick recovery after disasters, the Union Parishads have a tendency to prefer strategies which are likely to minimize damage. Most of the Chairmen interviewed have indicated a clear preference for Option B because it offers the maximum guarantee of protection against both early and peak floods.

In addition to protecting human lives, livestock, standing crops and infrastructure, Option B is expected to contribute to raising agricultural productivity and to improve overland communications. The increase in employment opportunities has been quoted as a very important positive impact of this option as compared to the Option A.

All of the interviewed Chairmen expect that the majority of the population would benefit from the project if Option B is implemented. They do not foresee any major disbenefits and the likely fisheries decline is perceived by them as a minor issue in comparison to the flood control benefits.

ii) NGOs

Option B has enjoyed a broad acceptance among the interviewed executives of NGOs, because it appears to offer the best guarantee to secure human lives, standing crops and infrastructure. The major negative impact quoted is the likely reduction in open water fisheries due to the limited quantity of flood waters which would be allowed into the project area. The livelihood of professional fishermen is expected to be seriously altered and the nutritional standard of the poorest households, which are usually very much dependent upon fish for their animal protein intake, will be badly affected.

Even if all the households benefit from the protection against flood hazards, the incremental agricultural benefits will be directed mainly to the landowners with limited benefit for the landless households. This will only increase further the equity gap between those who have access to the land and those who do not.

One NGO (SCI) has raised its concern over the possible adverse effects that Option B could produce for the people living on the Char land. The main issue is that if embankments are erected along the Jamuna, the water level might significantly rise in the river thus increasing the possibility of Char land being inundated.

Within the scope of the Charland study (presented in Annex 9) the incremental flood risk linked to the proposed option B of the Jamalpur Project has been investigated. The results obtained from FAP 25 simulations indicate that the combined effects of Jamuna Bridge, the existing right bank embankment and FAP 3.1 could lead to a significant in average of peak flood levels in the southern part of the study area (0.5 to 0.7 m)

Another NGO (Action Aid) newly based in Gothail Bazaar (in the North West part of the project area) has started a nutritional

survey and they have already identified deficiencies in iodine and Vitamin A as a result of too little diversification in food intake.

iii) People's Views

Farmers identified flooding as a very acute problem. They feel that with full protection, they will undoubtedly be able to increase crop production. With option B, they foresee that 90% of the people in the Project Area will be benefitted.

Fishermen held that direct losses to flood plain fisheries are bound to occur as a result of controlled flooding or full flood protection. This situation, according to them, may be counterbalanced by stocking catfish and carp in the water bodies in collaboration with the DOF. Their choice between Options A and B was hesitant in a few cases but they favour both, probably indicating that any intervention was considered by them as better than none.

The Char inhabitants feel that their hardship will become more acute in the case of Option B, because their lands will not be available for cultivation so early in the cropping calendar or due to increased flood risk.

4.4.8 Summary of the Social Impact Assessment

Option B is expected to minimize flood damage to crops, livestock, household assets and public infrastructure and thus would contribute to create a more secure environment with better road communication and transport facilities. This general improvement in the area would have a positive impact on economic development as a whole and on the agricultural sector in particular. The socio-economic benefits of Option B are expected to be derived from the reduction of livelihood vulnerability to flooding, from the likely rise in farm incomes and from the induced increase in farm and off-farm employment opportunities.

However, the negative impacts of this option have to be underlined. Unprotected land (Char land & Set-Back land), where the flooding problem is already worse than in the mainland, would be subject to an increased flood risk. Subsistence fishing households would loose a valuable sources of animal protein. The issue of people being displaced as a result of the embankment construction is another sensitive impact which would have to be considered. Unless carefully dealt with, in the manner proposed in other parts of this report, these negative impacts could affect the overall social feasibility of the project.

4.5 Social Considerations in Project Design and Implementation

4.5.1 Introduction

To achieve the ultimate objective of sustainable development, the project has to carefully consider direct benefits to the population as a whole and not restrict itself to the relatively privileged strata of the rural society.

To pursue this goal, specific targeted programmes should be included in the project design so as to address the equity issue and the negative social impacts which might otherwise be induced by the project. This approach has to ensure the active participation of all the population, with specific attention to those households who are likely to be worse off (those in unprotected land, subsistence fishing households, displacees) and those who are not likely to benefit directly from the project (destitute households, women headed households).

For unprotected land, a flood proofing and development project has been proposed and is outlined in Annex 9. With respect to households living on the embankment, a resettlement and housing programme has been recommended. An improvement in income of professional fishing households will be achieved through proper management of the remaining water bodies (beels and internal rivers) which could be stocked with valuable commercial fish species. In order to address the need for sustainable development, a specific social support and income generating scheme targeted to rural poor has been recommended.

Based on the above social considerations, the following measures are envisaged:

- A resettlement programme for displacees, destitute and homesteadless
- Flood proofing and a development project in the unprotected land
- Social support for the non direct beneficiaries of the project through income generating activities.
- Raising of public awareness and motivation through the development of an effective local participation system aimed at improving the communication between the beneficiaries, the non-beneficiaries, and the project planners and implementers.

4.5.2 Resettlement of Displacees and Homesteadless Households

The project should provide for a specific support programme for homesteadless households living on the existing embankment, who are to be displaced as a result of the construction of the new embankment.

The land acquisition procedures recommended by FAP 15 will need to be considered. However the following three categories of people will require special attention:

- Those who lose all their land including their homestead
- Those who lose only their homestead but not all their agricultural land
- Those who have no land and who reside on the existing embankment with no legal right to do so

An estimate of the number of homesteadless households affected by the embankment by Thana is:

Sarishabari	675
Madarganj	3090
Islampur	1768
Dewanganj	493
	6010

This estimate will need to be updated with the help of the local authorities and NGOs during the detailed design phase.

Compensation is to be made for those who will lose land and an additional support programme is considered necessary for the homesteadless.

A housing programme proposed for those living on the unprotected land (Char study, Annex-9) could be undertaken outside the project to provide flood-proofed housing. In areas of high population concentrations the embankment will need to be provided with a berm on the land side for new settlement and the institutional arrangements for BWDB to give the right of occupation on the berms will need to be addressed. Extra costs in connection with resettlements are included in the quantity and cost of the embankment.

4.5.3 Flood proofing

The unprotected land falling outside of the main project area which should be considered for a flood proofing programme has been estimated in the Char Study (Annex 9). Some 602 000 people would benefit from the proposed programme. It includes a pilot phase and a Main phase over an 8 years period. The pilot phase should proceed in parallel to detailed design and early implementation of the mainland development.

4.5.4 Local Participation for Non-Direct Beneficiaries in Protected Land

The vulnerability of those who will not benefit directly is serious in all aspects of life. Many are economically weak, physically weak, less educated, have little bargaining power, are victims of patron-client relationships, receive fewer facilities for health and nutrition and experience great difficulty in obtaining credit.

A strategy to reduce the foreseen social inequity is presently being implemented by most of the NGOs, to some extent by the BRDB rural development section and by Grameen Bank in financial terms.

Within the framework of the project, a support programme needs to be provided to involve 6000 mainland households in the following activities.

- Income Generating Activities (credit facilities)
- Social Services (health, education, sanitation)
- Awareness Raising (training, group formation)

Three NGOs could be supported for 5 years to implement this rural development programme, one in Islampur - Dewanganj, one in Jamalpur - Melandaha and one in Sarishabari - Madarganj.

Including the investment, staff, social services, credit and consumables an amount of Tk 2.675 million /NGO /year is estimated to be needed for this.

The total requirement : 2.675 X 3 X 5 = Tk 40.125 million

The cost of this programme has not been included in the project costs.

BRDB has a good track record in this field and could support these interventions. The deployment of their services has yet to be fully utilised and at present, under RD 12 financed by CIDA, there is provision for extension.

4.5.5 Public Awareness and Local participation

An institutional framework and local participation in the planning, design, implementation, operation and maintenance of the investment is considered essential. Consideration of the opinions of the affected people in a balanced way and the harmonious involvement of different social groups is a requirement for successful project.

The following issues will need to be addressed during the preparation of the detailed design work programme and cost estimate:

- Identification and mapping of the land required for permanent and temporary expropriation
- The mechanism for land compensation assessment and payment
- The resettlement of displacees.

The implementation of the above task needs the direct involvement of the following organisations:

- the Land Settlement office
- the Local Parishad
- the Engineering Department
- the local NGOs

The operation and maintenance of the project will require institutional arrangements and structures which will be supported by local committees and NGOs.

The project should develop the capabilities of Government, Semi-Government and Non-Government officials so that a significant amount of the project running cost will be self-managed and self-sustaining. This requires local administration officials and community representatives to be motivated and to identify with the project aims and objectives. To achieve this the following goals should be achieved:

- To develop better two-way communication between the FAP planners and local communities and individuals.
- To improve the dissemination of information through media support.
- To develop community commitment to participation in the proper implementation of the development work.
- To instigate a community-based approach to address the marginalised population in order to draw them into in the development process.
- To develop an information network for heightening awareness and motivation of people in the implementation of FAP work.

The administrative set up required to achieve the above objectives needs appropriate arrangements which can be taken up by an NGO specialised in such communication work. planners.

This specialized NGO could best operate in 3 "Centres" located close to the proposed embankment, one in the northern part (Islampur), one in the middle part (Madarganj) and one in the southern end (Sarishabari). The financial support required for this will need to be phased from the beginning of the detailed design phase for a period of three years.

The cost of establishing one information centre has been prepared in consultation with an NGO which has already developed a similar system for improved communication.

Total Cost for three years (inc coordination) : Tk 11 million

The cost of the local participation process has been included in the cost estimate for engineering cost and Technical Assistance programme.

5 ENVIRONMENT

5.1 Introduction

5.1.1 Aims and Objectives

The initial aim of the Environmental Impact Assessment (EIA) component of the FAP 3.1 Jamalpur Priority Project Study (JPPS) was to identify the likely relative impacts of a wide range of development options for the immediate study area. This analysis included consideration of a without project situation and resulted in two of the options being selected for more detailed study. The major impacts of these were identified and the negative ones quantified where possible, and if relevant valued. This allowed environmental considerations to be taken into account when modifying the options to draw up an intervention strategy for the area.

At pre-feasibility stage this required the comparative impacts of alternative project Options A to D to be ranked against each other and also the without project situation. This analysis and its results were given in the JPPS Interim Report (R3) of April 1992. At feasibility stage the major impacts identified at pre-feasibility level have been assessed for the selected Option B and where possible quantified. Due to the time and resource constraints given to the environmental component of the study, this concentrated upon negative impacts, identifying those that could be avoided or minimised by taking appropriate steps to provide alternative livelihoods and resource use for those people adversely effected by the proposed intervention. Mitigation possibilities for the most serious negative impacts have been identified and investigated, including the production of cost estimates where appropriate. This work included an assessment as to if the negative impacts were so great as to question the viability of the proposed intervention in its planned form and if it could be modified to avoid these problems. Attention has also been given to maximising benefits by ensuring that the proposed interventions are appropriate to the conditions in the study area.

The detailed design phase will need to include close liaison and interaction between the design team and supporting study specialists to ensure that the environmental issues are tackled as an intrinsic part of the planning and design process.

5.1.2 Scope of the Environmental Studies

The scope of environmental studies covers consideration of both the natural and human issues, their interaction and how this changes as a result of project interventions, particularly as a result of induced impacts. A basic philosophy behind such studies is the notion of environmentally sound and sustainable development with a proviso that no person is to be worse off as a result of the project intervention. Thus all major negative impacts are to be mitigated and the cost included in the project

economic analysis. These steps are to be incorporated into a sustainable environmental management plan for the project. It must however be appreciated that within the context of the very high population densities and intensity of resource use in the study area this is very difficult id not impossible to achieve.

5.1.3 Definition of the Project Area

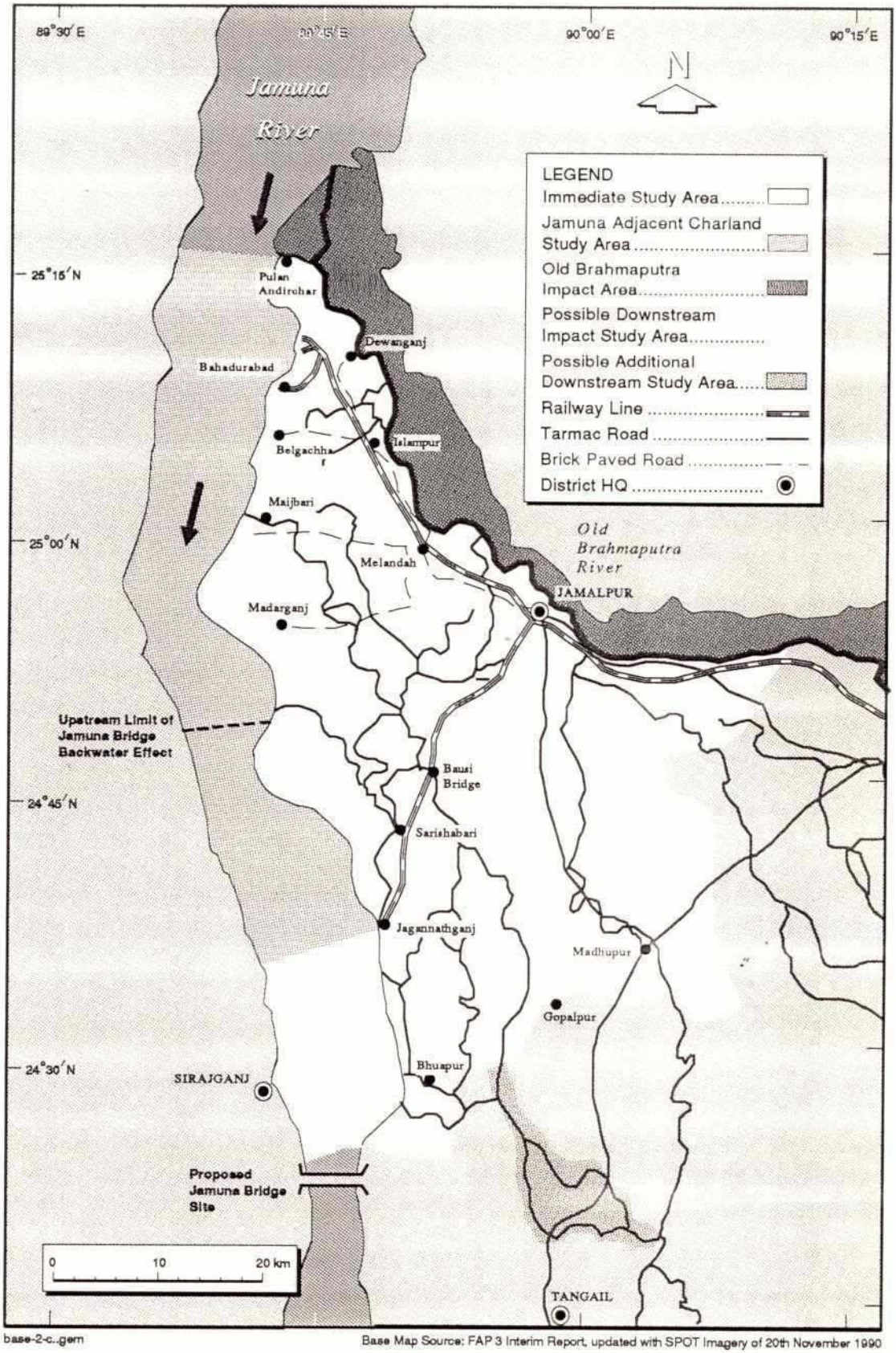
The initial project study area was defined as being between the main left bank of the Jamuna river and the railway lines between Bahadurabad Ghat, Jamalpur and Jagannathganj Ghat. This was subsequently extended eastwards to the right bank of the Old Brahmaputra to fully include the four nucleated settlements of Jamalpur, Melandah, Islampur and Dewanganj. In addition the environmental impact analysis was to include consideration of external impacts. This covers any induced impacts in the adjacent Char lands and both mainland and Char land areas downstream of the project area. However as a result of preliminary investigations and comments received on earlier reports, work was concentrated on the adjacent Char land area rather than the downstream mainland area where the negative impacts are likely to be comparatively far less severe, and if sensitively managed then beneficial. The downstream Char land area is to be tackled by the FAP 3.2 study, the philosophy being that local people will assume, perhaps incorrectly, that he dis-benefits of intervention should be apportioned to close by interventions. Thus each study area will tackle all externalities from both upstream and downstream interventions. All these external impact study areas are shown in Figure 5.1. A special study was carried out on the adjacent Char lands which has provided the data for impact analysis in the area. This area has now been incorporated into the project planning process and is attached as Annex 9 to this report. Consideration has also been given to possible upstream constraints to development from other potential development proposals, particularly in the North West Regional Study area (FAP 2).

5.1.4 Environmental Procedures and Guidelines

The procedures for Environmental Impact Assessment for the Flood Action Plan (FAP) have been drafted by FAP 16 subsequently to the drawing up of the original Terms of Reference for the JPPS. The FAP 16 draft Guidelines were in a state of constant revision, the edition of August 1991 and a verbal briefing from the Panel of Experts having been used as the basis for the revised work programme for the JPPS environmental studies contained in the revised Inception Report and also for the extension period work. The latest edition of the Guidelines comprises an Appendix to the GPA, a set of FAP Guidelines (dated October 1992) and approved by FPCO and the DoE along with Volume 1 of an EIA Manual dated March 1992.

Figure 5.1

FAP 3.1 Regional Context



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Base Map Source: FAP 3 Interim Report, updated with SPOT Imagery of 20th November 1990

The principles behind the Guidelines generally follow the provisions of World Bank Operational Directive 4.01 of October 1991, which clearly state the criteria for deciding upon an EIA, what it should comprise and what else is necessary before the World Bank will consider funding a project. Under World Bank criteria any project involving flood control or drainage, resettlement, river basin development, or large scale irrigation falls in the highest Category A class requiring mandatory EIA.

Unfortunately none of these guideline documents were in place when the Terms of Reference for FAP 3.1 were drawn up. The perception of environment was considered in narrow terms as mainly comprising ecology (specifically water quality), flora and fauna with little concern for the human interaction in the resource system. In addition the study period did not include a full yearly cycle. This resulted in the environmental component being seriously under-resourced to carry out a credible EIA under the FAP Guidelines. As a result an extension period to the study was agreed with some additional staff resources. This has allowed further data collection over the last wet season (although it was abnormally dry) which has gone some way to addressing this shortfall. Even so there is still a problem with the assessment of natural environment issues due to the lack of even medium term baseline data for Bangladesh as a whole and the study area in particular. An on-going programme is required to continue data collection and embark upon baseline studies for specific issues, especially health and nutrition. Another major constraint is the lack of adequate hydrological modelling output data, particularly in mapped format, which shows the extent, depth, duration and timing of flooding for a range of flow conditions in a with and without project situation. Until this is made available then it will not be possible to do a full, internationally credible EIA.

This Feasibility Study EIA work, which is reported in full in Annex 3 (Environment) has thus aimed to identify the major environmental issues and deal with these in sufficient detail to allow balanced decisions to be made with adequate if not ideal data coverage. The draft (and recently approved) FAP EIA Guidelines (part of the FPCO GPA) are a theoretical ideal and have to cover a range of different situations, from large area regional pre-feasibility studies to small area project detailed feasibility studies like FAP 3.1. They have been used for the basis of the work but have been adapted to be more appropriate to their first use on a detailed sub-regional study and within the resources allowed.

5.1.5 Interface with Other Disciplines

The environmental component of the study has relied upon the outputs of other disciplines in the FAP 3.1 Study for impact analysis work. This has included Surface Water Hydrology, River Morphology, Groundwater Hydrology, Land and Soil Resources, Sociology and Socio-Economics, Agriculture and Agricultural Economics and Fisheries. In addition the

findings of the following FAP and related studies have been directly used:

- The FAP 3.1 Char Study Report (Annex 9)
- Work carried out for the FAP 16 Resource Inventory of Chars in the Brahmaputra and Jamuna River System.
- FAP 25 Flood Modelling and Management Study
- The Jamuna Multi-Purpose Bridge Environmental Impact Assessment work.

The FAP 3.1 environmental work has thus concentrated on the following five major areas of data collection:

- water quality
- soil chemistry
- flora and fauna
- human health, including nutrition and particularly waterborne diseases
- archaeology and cultural sites

5.1.6 Public Participation

An intrinsic part of all development planning work should be public participation by concerned and effected parties. The nature of this can vary greatly however, from simple consultation to ensure acceptability of a pre-conceived idea through to the grass-roots total involvement of people on the ground in formulating policy and implementing the strategy themselves. The institutional frameworks required for these are very different. Guidelines for Participatory Development for the FAP are in the process of being finalised and incorporated into an Annex to the GPA. In the absence of these and in response to comments made on the original Inception Report, FAP 3.1 has taken the initiative and attempted to involve local people in the project planning process at the grass roots level. This has been done as part of the detailed household questionnaire data gathering exercise for both the mainland and Char land studies, by household case study work and structured group discussions. In addition, the views of NGOs in the study areas have been obtained and in the case of the Char land study a local NGO was actively used in partnership with the Consultant to carry out the work. The views of local administrators and officials as were also canvassed. This work has allowed an assessment to be made of a wide range of people's perceptions, expectations and priorities as to flooding issues and associated subjects (erosion for instance), along with the level of commitment they are prepared to give to FAP 3.1. In addition the Char lands study opened out this work to cover all aspects of livelihood, not just flooding issues, in a "needs-led" approach to drawing up a

development strategy for the area. This whole process is seen as vital if a sound sustainable strategy that addresses local people's requirements is to be sought. A major obstacle to this is the lack of an information and community awareness regarding the philosophy and aims of the FAP and how this relates to their individual household situations.

5.2 Environmental Profile of the Study Area

An initial broad environmental profile of the study area was prepared and included in the JPPS Interim Planning Report (R2) of March 1992. This was written after a preliminary site reconnaissance and aimed to retrospectively cover what was felt to be a gap caused by the telescoping of the Regional Study (FAP 3) project selection process and the pre-feasibility stage leading to formulation of a range of policy options.

The study has now been revised, bearing in mind the POE comments on the earlier reports, and updated as more information has been collected. The major primary and secondary data collection included:

- collection of a sets of dry and wet season water quality samples in an attempt to provide some sort of baseline data. These have been analyzed in a laboratory for both chemical and organic content but agro-chemical analysis could not be carried out as the facilities were beyond the budget of the study and not easily accessible.

- collection and a review of the existing soil chemistry data and mapping for the main study area with an assessment of likely trends as a result of flood control and improved drainage

- a baseline inventory of fauna and flora in the study area with the aim of establishing the basis for assessing the likely effects of any possible habitat change as a result of project interventions. This has highlighted the present important use of medicinal plants and the low level of remaining wildlife in the area.

- a review and verification of existing data on the present state of human health in the area. This has indicated that there are serious problems with waterborne disease in the study area with a large number of deaths from diarrhoeal diseases and a high number of malaria cases. There is also an outbreak of Kala-azar (Leishmaniasis) and goitre is a very serious problem in some highly concentrated areas. The biggest problem is prediction of likely future trends in disease patterns as a result of flood control and drainage interventions, particularly the expansion of irrigation resulting in all year standing water in places where previously there was none and the curtailment of the movement of river

flood water through the area reducing the present flushing effect. This requires the outputs of the hydrological modelling for the with and without project situation and also the results of FAP 16's national studies on waterborne diseases.

- a preliminary survey of waterborne navigation in the area considering the main routes, both perennial and seasonal, the types and sizes of craft using these and the loads they are carrying along with route distribution, length, frequency and trends in all these factors.

- collection of data on possible archaeological and other sites of historical and cultural interest. This has included reviewing the settlement history of the area which has determined present settlement patterns and has had a considerable influence on the nature of present day resource use.

In addition, a considerable amount of new data was acquired during the project study and has proved invaluable in resources assessment and analysis. This includes dry season time series Landsat satellite imagery of the area for 8 occasions over the last 19 years and two during flood times, one on the peak flood day of 18 August 1987. This has been invaluable for river morphology studies, specifically erosion and accretion and also for the Char lands which are so dynamic. This has been done in collaboration with FAP 19 (GIS) and has included interactive image processing to analyze land age and utilisation as well as main bank erosion and accretion. The most recent image acquired is a Thematic Mapper (TM) one dated 8 March 1992 and has been used for report illustrative base map production as it shows significant recent changes since the last, admittedly better resolution, SPOT image of 20 November 1990. The project has also acquired some time series digital SPOT imagery for December 1988 and December 1990 which, when combined with the Landsat TM data of November 1988, existing FPCO SPOT of February 1989 and the recently received FPCO SPOT data of the wet season and dry seasons of 1990 has given some valuable data on flooding and drainage patterns. However to fully realise the potential of this data would require time and resources to carry out digital image analysis with access to large format hard copy facility.

The biggest and most serious constraint to impact analysis work for the study still remains the poorly developed hydraulic modelling of both the main rivers and the internal flooding and drainage system of the area. The biggest problem stems from the lack of recent and suitably accurate topographic data of the area which seriously limits the usefulness of the hydraulic modelling. The existing topographic data is derived from 1963 air photography with a 1m contour interval. It is now considered to be of very limited use, particularly over the 75% of the study area which was heavily inundated in both 1987 and 1988 and especially for the western part of the area which is very dynamic being subject to major

ISSUES	P	LP	NOW	WO	A	B	MP	MC
THE NATURAL ENVIRONMENT								
Hydrology								
Surface								
Flooding Damage to Land	*	*	0	-5 *	-4	+4		
Drainage Problems	*	*	0	-4	-2	+4		
Groundwater Availability								
Irrigation			0	0	0	0		
Domestic Water Supply			0	0	0	0		
Erosion								
Jamuna	*	*	0	-4	-4	-2		
Within Project Area			0	-2	-2	+2		
Sedimentation								
Jamuna			0	-2	-2	-2		
Within Project Area			0	-2	-2	+2		
Clogging/Smothering		*	0	-2	-2	+2		
Soil Fertility			0	0	0	-2		
Freshwater Ecology								
Water Quality								
Domestic Water Quality	*F		0	-2	+2	+2		
Agriculture Water Quality			0	+2	+2	+3		
Land Resources								
Soil								
Quality/Chemistry			0	0	0	-1		
Erosion			0	-2	-2	+2		
Ecology								
Flora			0	-2	-2	-3		
Fauna			0	-3	-3	-4	NW	
Seismic Activity (*1)								

Figure 5.2
Sheet 2 of 3

THE HUMAN ENVIRONMENT	P	LP	NOW	WO	A	B	MP	MC
Economic Livelihoods								
Risk	*	*	0	-5 *	+2	+4		
Settlement		*	0	-4	+2	+4		
Land Tenure								
Scarcity		*	0	-2	-2	-2		
Land Values			0	+2	+2	+5		
Common Resource Rights	*							
Fish			0	-2	-2	-4	VD	
Fuelwood			0	-4	-4	-4	PO	
Grazing			0	-2	-2	-2		
Fodder			0	-2	-2	-4		
Agricultural Output	*F	*F	0	+2	+3	+5		
Fishing ("Professional")			0	-1	-1	-4	PO	
Forestry and Fuelwood			0	-2	-2	-2		
Livestock			0	-2	+2	-1		
Wage Paid Employment	*F	*	0	+2	+2	+4		
Industry			0	+2	+2	+4		
Drinking Water Availability	*F		0	0	0	0		
Human Health	*							
Waterborne Diseases	*							
Diarrhoea	*		0	?	?	?		
Cholera			0	?	?	?		
Insect Borne Diseases								
Malaria	*		0	-2	-2	-3		
Japanese Encephalititis			0	+2	+2	+2		
Filariasis			0	+2	+2	+2		
Drinking Water Quality	*		0	-2	+2	+1		
Sanitation	*		0	-2	+2	+3		
Nutrition	*		0	-1	+1	-4	VD	CO
Mental Health	*		0	-2	+3	+4		

Figure 5.2
Sheet 3 of 3

	P	LP	NOW	WO	A	B	MP	MC
Access and Transport Infrastructure								
Waterborne								
Jamuna	*LF		0	-2	-2	-2		
Within Project Area			0	-2	-2	-4		
Railway			0	-1	-1	+5		
Road	*		0	-4	-2	+4		
Archaeology and Cultural Sites			0	0	0	0		
DOWNSTREAM IMPACTS	P	LP	NOW	WO	A	B	MP	MC
Main Jamuna	*	*	0	-3PF	-3PF	-5PF*	PO	CO
Old Brahmaputra Left Bank			0	-2PF	-2PF	?		
Old Brahmaputra Downstream			0	-2PF	-2PF	?		
Downstream of Bausi Bridge			0	-2PF	-2PF	+2		

LEGEND

RANKING OF IMPACT

-5 Severe Irreversible Negative Impact
-4 Highly Negative Impact
-3 Significant Negative Impact
-2 Moderate Negative Impact
-1 Slight Negative Impact
0 Present Baseline Situation and No Change
+1 Slight Positive Impact
+2 Moderate Positive Impact
+3 Significant Positive Impact
+4 Very Significant Positive Impact
+5 Highly Significant Positive Impact

VD = Mitigation Very Difficult
PO = Mitigation Possible
NW = Mitigation Not Worthwhile
CO = Mitigation Costly
PC = Mitigation Prohibitively Costly

ABBREVIATIONS/HEADINGS

P = "Expert" Priority Issues
LP = Local Peoples Priorities
NOW = Present Situation
WO = Without Project Situation
A = Option A
B = Option B
MP = Mitigation Possible?
MC = Mitigation Costly?

(+1) = A Constraint not an Impact
* = Major Issues

F = In Times of Flood
LF = In Low Flows
PF = In Peak Floods
? = Insufficient Data to Assess

erosion and accretion from the Jamuna river, as demonstrated by the time series analysis of digital Landsat data. Only when the long awaited Finnmap data is made available, and then converted into Digital Elevation Model (DEM) format, can it be combined with the hydraulic simulation model to give a much better indication of the extent, depth and timing of flooding. Even then, the usefulness will depend on the contour interval and accuracy of the DEM, reputed to be derived from field spot heighting and 0.5m contours. For hydraulic modelling work of the Jamuna river, FAP 25 are in the process of working through the development of a range of embanking scenarios under different flood flow conditions. At present their work has given preliminary results of a simulation of the present situation and also one with the FAP 3.1 Jamuna left embankment in place under peak flood conditions such as 1988. This has been used as the basis for assessing the increased flood risk to unprotected land, however a considerable amount of work is required to extend the simulation to other flow conditions and also to interface it with awaited topographic data to give mapped indications of induced changes in flood extents, depths, durations and timings so that appropriate mitigation planning can be carried out. From the 18 August 1987 Landsat image it is apparent that there is likely to be a serious induced flooding problem on the left bank of the Old Brahmaputra river under FAP 3.1 embanked conditions. At present suitable hydraulic modelling of this is not being carried out. This would seem to warrant a special study as proposed by FAP 3 as a matter of urgency.

5.3 Development Proposals and Impact Assessment Methodology

5.3.1 Development Options and Strategies

The JPPS Interim Planing Report (R2) outlined the four development options that were considered for the area. These covered a wide range of intervention possibilities from non-structural flood proofing measures through varying degrees of controlled flooding to the complete exclusion of all river water by polderisation. The following Interim Report (R3) contained a preliminary Environmental Impact Analysis which included a comparative subjective matrix between all four options and also a without project situation. The aim was to provide sufficient information for an Option or strategy to be selected for feasibility study.

As a result of the POE reactions to the JPPS Interim Planning Report (R2), the conclusion of the summary of R3 raised the issue of a possible multiple development strategy rather than a discrete Option being selected. The presently recommended FAP 3.1 Flood Action Plan is based upon Option B (variation B5), controlled flooding for the maximum area of mainland which can be protected, with a parallel programme of Option A (an integrated flood proofing programme) being adopted for the land which can not be protected, including all the adjacent Char lands to the Brahmaputra right embankment. The specific nature of the flood proofing programme will be refined by detailed consultations with the

beneficiaries during the detailed design stage. It is envisaged that it will cover a range of possibilities and scales from individual house and homestead raising through to the provision of communal refuges, the size, spacing and locations to be decided with very close consultation with local people. In addition the multipurpose use of embankments will be a major element, both in terms of temporary refuge but also as permanent flood proofed homestead sites, particularly for erosion displacees, homestead-less and landless households. This is discussed in detail in Annex 9, the Char Study, with proposals being given in Section 4.

5.3.2 Impact Assessment Matrix

The comparative impact assessment matrix has now been updated and modified to look at just Option B and Option A in comparison to a without project situation. The matrix is shown in Figure 5.2, adding a column indicating local peoples perceptions and priorities in addition to the existing one indicating those issues considered to be important from a purely detached "expert" technical viewpoint. This was added in response to POE comments on R3.

It should be emphasised that local people on the mainland understand and have experience of the short term benefits of FCD construction projects. These include the opportunities for wage paid employment amongst lower strata people, along with security from flooding of agricultural land for land owners and also wage paid labourers. Few people, even those who stand to lose in the medium and longer term, (fishermen and boat operators for instance), appear to have any idea of how FCD programmes are likely to effect them in the longer term. Whilst this is understandable in that many people are forced to live on a hand to mouth basis and only the short term matters, it is a factor which must be treated with caution. There is a basic lack of understanding and concern of these longer term issues (nutritional effects of the decline in fish intake for instance) coupled with the ingrained response that any funding that is coming into the area must be good for everybody. This points to the need for a concerted community awareness and information programme for the area which shows both the positive and negative sides of intervention. Individual households would then be able to assess their specific situation and make rational decisions as to how best to take advantage of the benefits that the project has to offer. It is encouraging that there appears to be general support for the project from within the mainland study area but care must be taken not to raise peoples expectations unrealistically.

The situation in the adjacent Char lands appears to be far more complex. Under the Option B scenario for the mainland only, there is likely to be serious objections from those outside it from two related perspectives:

- why is the mainland being flood protected when more serious flooding problems lie in the land which will remain unprotected?

- if the mainland is protected then there will be increased flood risks to the unprotected areas which already have a higher flood risk.

The proposal for Option B thus appears to be unpopular with many Char land dwellers. They seem to feel that cental government not only does not take any notice of their position, but is also prepared to jeopardise their livelihoods in favour of agricultural production on the mainland. Opinions have been expressed that Char land people will be prepared to deliberately breach embankments if they perceive that they are making flooding for them even worse than before. As a result a parallel intervention based around an integrated flood proofing is being proposed for all of the adjacent unprotectable land. This intervention is considered to be justifiable in its own right, irrespective of any mainland intervention, but would at the same time mitigate for the increased flood risk to homesteads created by the mainland controlled flooding intervention. Extreme care will be needed to reassure the Char land dwellers that their interests are being taken note of and acted upon.

The matrix (Figure 5.2) lists all the likely natural and human environmental impact issues and gives a separate indication of four major external impacts. Care has been taken to avoid repeating or double counting particular issues by being very specific as to the nature of the impact being considered. For example, groundwater availability for domestic water supply is listed under the natural environment and domestic water quality is under freshwater ecology, whilst general drinking water availability is under human impacts along with overall drinking water quality. This reflects the differing sources for domestic water supply and also consideration of how this changes in peak flood conditions.

The matrix is in effect a ranking of impacts, assuming no mitigation programmes, based upon a steady state baseline position as of now. Scores are allocated in the range +5 for positive impacts to -5 for negative ones, -5 being a severe negative impact which is likely to be irreversible.

Quantification of the major impacts has been carried out where possible, especially for the most important issues and particularly those that are negative and will require significant targeted mitigation measures. This has been done on an issue by issue basis, the FAP 3.1 Char Study having collected the relevant data for unprotected lands and Annex 2 of this report being the fisheries impact assessment and mitigation requirements.

Valuation of impacts is fraught with problems, it is difficult to quantify many of the losses let alone place a value against them. The use of simplistic market cash valuation often omits to consider the real cost of impacts in needing to provide sustainable replacement livelihoods. The key issue is alternative replacement resource availability and use with the aim that no person should be worse off than they were before the project.

For the unprotected lands (this includes, unprotected main land known as Set-Back land as well as Attached and Island Char land), the mitigation costs attributable to the mainland project are those of attempting to restore the people to, at worst, the level of flood risk they were experiencing in a pre-project situation. Assuming that the flood proofing programme is being carried out in its own right, irrespective of the mainland controlled flooding intervention, then the negative impact costs attributable to the mainland will be the incremental costs of additional flood proofing homesteads above the extra flood risk created by the confinement effects. This averages 0.3m over the area and is about 10% of the total flood proofing programme costs. Data to estimate the quantities and costs of such a strategy have been collected as part of the FAP 3.1 and FAP 16 Char land studies and are given in detail in Annex 9. Summary costs are given in Section 5.4.2 below.

The fisheries assessment has indicated the value of lost fisheries for the two project option, in terms of current market prices. In addition an estimate has been made as to the increased area of rice cultivation required to produce an equivalent cash value of crop. However this does not address the real issues of replacement of livelihood loss for professional fisherman or even more difficult, the nutritional loss of directly caught and consumed fish by occasional fishing households. The proposed fisheries mitigation programme, aimed primarily at providing replacement livelihoods for existing professional fisherman but with a targeted programme for presently occasional and particularly landless fishermen, includes the following components:

- management of the main river fisheries and remaining flood lands in the left bank Set-Back land
- stocking and management of the internal rivers
- beel and adjacent floodland fisheries stocking and management
- renovation, stocking and management of ponds and beels

The recently carried out nutritional reconnaissance survey needs to be expanded in the next phase of the study (the TOR for this are given in Annex 3, Appendix D) to look at targeted replacement protein production possibilities with cost estimates for doing this.

The next stage in the impact assessment procedure is to look at the detailed impacts for the selected Option or strategy emphasising their spatial and social variability across the study area. This would divide the area into six major areas based upon the modified agro-ecological zones ("land systems" in effect) of high, medium and low land for the protected land plus the Island Char lands, Attached Char lands and unprotected main land (Set-Back land) between the existing and proposed embankments. It will not be possible to do this until the hydraulic modelling is refined considerably to give mapped outputs for the extent, depth, duration and timing of with and without project situations under a wide range of flood conditions. This is a very urgent priority if a credible EIA that will stand up to international scrutiny is required.

5.4 Principal Impacts

5.4.1 General

The principle negative impacts of Option A (flood proofing) are nil and even the minor ones are negligible when compared to the without project situation. However its main draw-back is that it fails to secure agricultural land from flooding and as such does not address what many people consider to be the principle issue with regard to flooding in the study area. In summary it is felt to have insufficient positive impacts to justify it on the mainland where Option B is a practical possibility, particularly in the eyes of local people.

The principle negative impacts of Option B are shown in the matrix (Figure 5.2) and include some very severe ones. All issues with a rank of -3 and greater are discussed below in order of decreasing severity. Comments are also made as to mitigation possibilities and the likely costs involved in attempting these.

5.4.2 Increased Flood Risk to all Unprotected Land

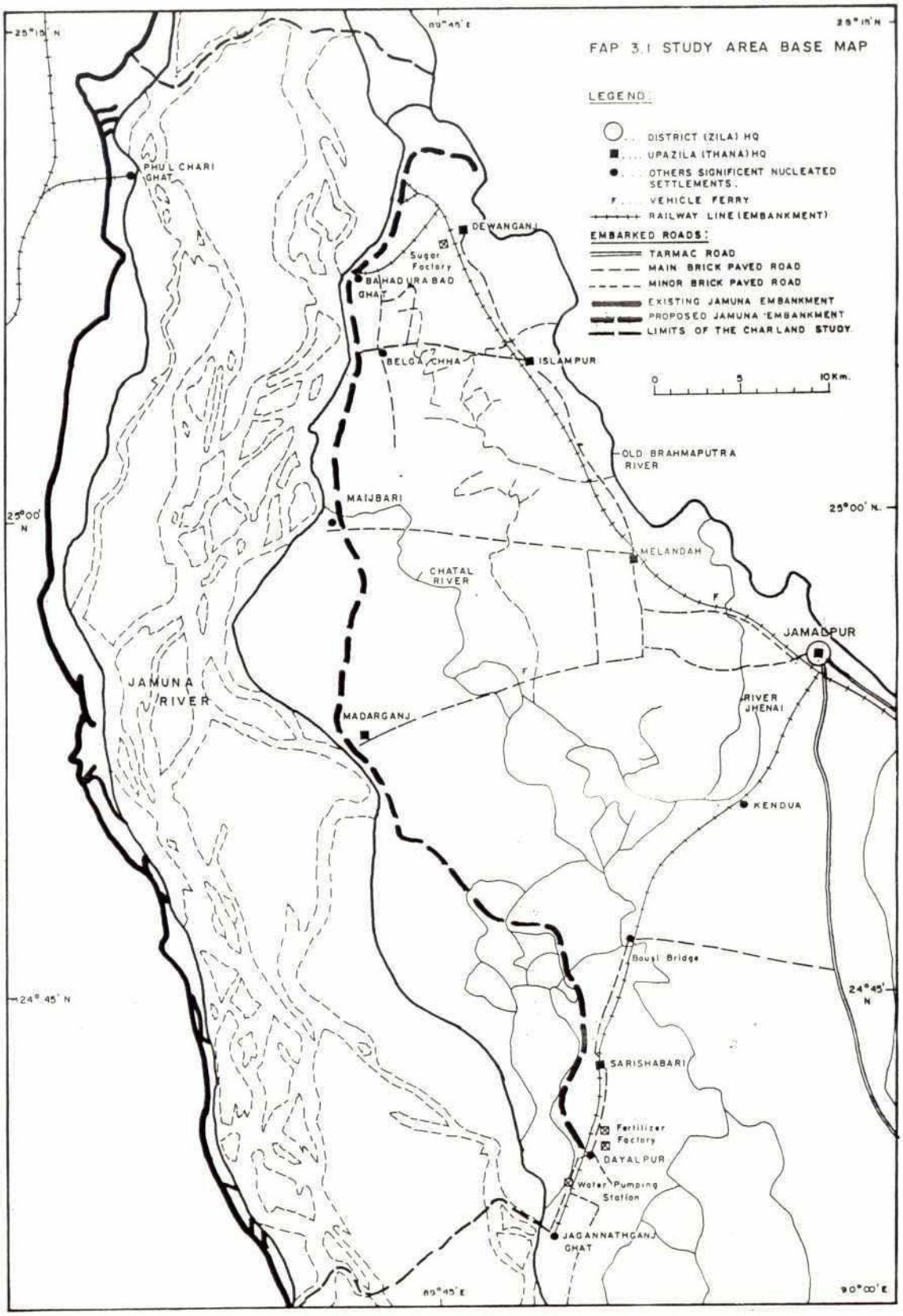
The most recent published results of the hydrological modelling supporting study FAP 25 (Ref: Table 9.1, Figures 7.6a and 7.6b of their Main Report of June 1992) indicate that under a peak flood condition similar to 1988, with the present embankments and the FAP embankments in place, the flood levels in the confined area between the existing and proposed embankment are likely to rise. The figure at Bahadurabad at the northern end of the project area is only 0.07 m, however the figure at Sirajganj is estimated to be 0.54 m. Dividing this proportionally to the length of the river gives a figure of 0.49 m at the southern end of the project area and hence a mean increased figure of 0.29 over the whole area. A significant additional influence is likely to be the proposed Jamuna Multipurpose Bridge, the approach roads for which are already under construction. Discussion with members of the impact assessment team indicate that as a result of hydrological modelling work (using the same model as FAP 25) they expect, in

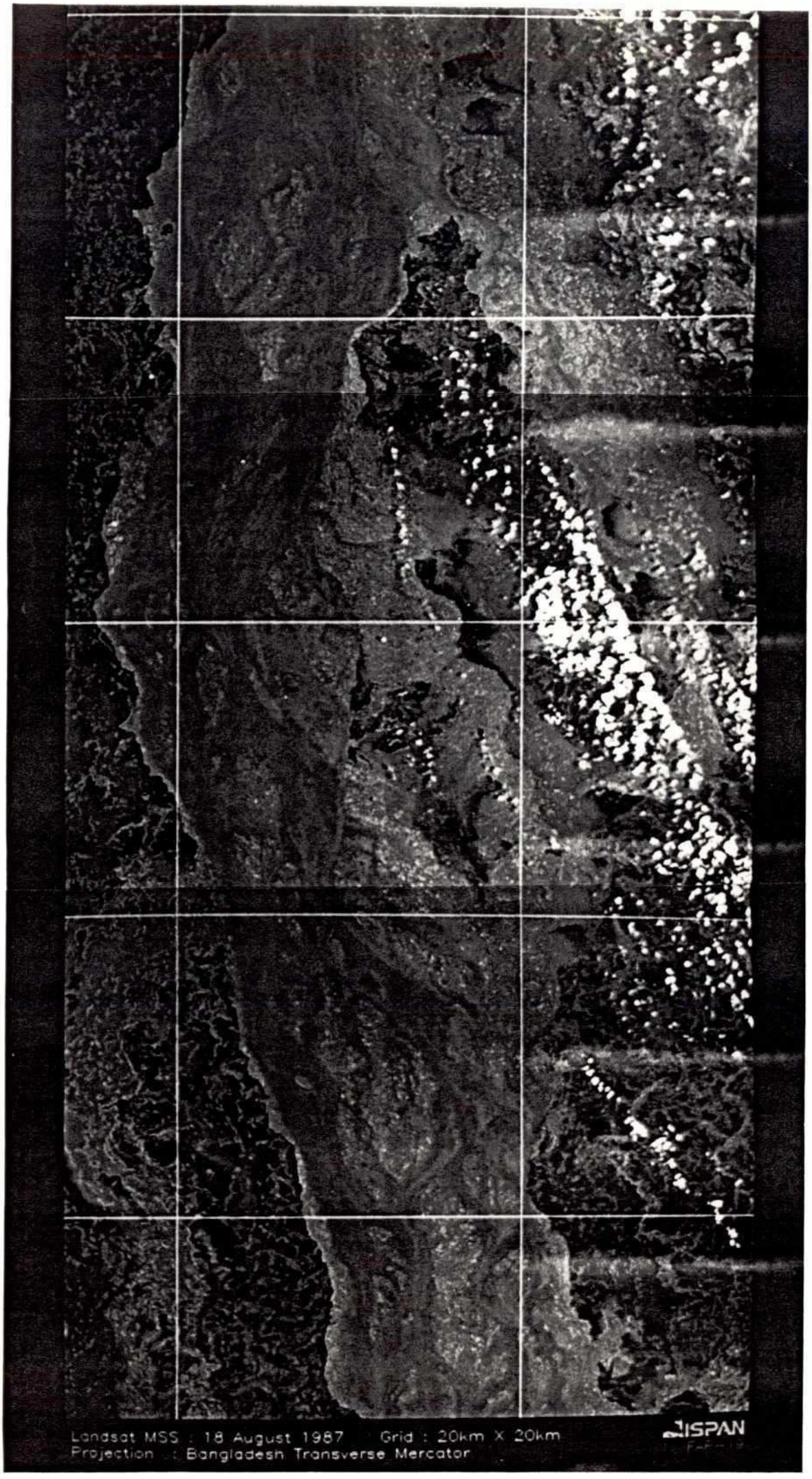
similar peak flood conditions, a rise of 0.5 m at the bridge stretching back upstream for some 50 km (see Figure 5.1). This would mean an additional rise of 0.25 m at the southern end of the study area totalling 0.74 m. The figure adjacent to Madarganj where the Bridge impact is said to be nil would be 0.21 m. In addition there is reportedly (from FAP 18) a datum difference of 0.2 m from the left bank to the east bank. At present this has been discounted from consideration, but care will need to be exercised with this, especially when dealing with data sources with differing datums at the flood proofing detailed design stage.

Considerable further modelling work is required to give the changed situation for other flow conditions. Of particular concern is the need to identify times when in the past specific Char land areas did not flood but will do so in the embanked situation. Ideally the model needs to be interfaced with the DEM data to give mapped extents, depths, durations and timings of flooding. However it has recently been learnt that the Char land mapping programme was removed from the FAP 18 programme. In the next phase of the study considerable work will need to be carried out on deriving flood risk mapping for the unprotectable area. This will need to consider alternative techniques, including time sequence flood period remote sensing, possibly from radar imagery. Only when this is done can accurate assessment of both homestead flooding and agricultural land inundation patterns be made. The changed flooding patterns of agricultural land in the unprotected area may have more significant effects on household economic livelihoods than homestead flooding because it is impossible to directly mitigate for it whereas homesteads can be flood proofed. Diversification of economic activity at risk due to flooding, through targeted income generation programmes, would seem to offer the most appropriate way of tackling this problem and this has been proposed in the FAP 3.1 Char Study (see Annex 9).

From the FAP 3.1 and FAP 16 Char studies it is estimated that 602 000 people live in what will become unprotected land with an increased homestead flood risk if only the mainland intervention were to be implemented. This is compared to 631 000 who will be within the mainland area protected by controlled flooding.The flood proofing programme for the people in the unprotected land has been drawn up as part of the FAP 3.1 Char land study. This is estimated to cost TK 1396 million (US$ 34.9 million), with the proposed pilot phase being TK 127 million. This is equivalent to TK2140 per head of population in the Char land when compared to TK 2212 for the mainland intervention. However it must be remembered that the mainland controlled flooding programme is designed to protect agricultural land unlike the flood proofing programme.

Logically the costs of flood proofing the Char lands to mitigate for the increased flooding effect should be apportioned to those projects which caused the impacts. In the case of FAP 3.1 the cost of its apportioned





Peak Annual Flood Day at Bahadurabad Ghat – 18th August 1987

part of the mitigation programme for unprotected land should be offset against the agricultural benefits attributable to controlled flooding. The total cost of the flood proofing programme is estimated to be Tk 1396 million ($US34.9m) compared to a mainland intervention cost of Tk 1431 million ($US35.8m). The apportionment of the incremental flood proofing costs attributable to FAP 3.1 has been calculated as Tk 31.2m ($US0.78m) when taking into account the fixed costs of the programme.

In summary this means that without a flood proofing programme in the unprotectable land, those people already living with the greatest flood risk (although many actually state that erosion is an even bigger problem) are likely to have this increased still further in order to protect agricultural land on the mainland from which it is estimated increased agricultural production can be realised to economically justify the investment. The whole basis of the project intervention of protecting the land with the least flood risk and increasing the risk to that land which already has the highest risk is likely to be a very difficult and contentious issue. Bearing in mind that the basis on which many donor nations are investing in the FAP is a humanitarian one then this would appear to be a serious contradiction. Of particular concern must be the "set-back" part of the mainland (i.e. on the "wet" side of the main Jamuna embankment) which would not expect to flood in a present normal year and where there are high population densities including many erosion displacees and other homestead-less and landless households. This highlights the necessity of carrying out the parallel flood proofing programme in the unprotectable land. The following analysis and costing of dis-benefits using mitigation costs assumes that this is going to happen.

It must be further emphasised that this assumes the flood proofing programme will be implemented irrespective of the mainland intervention. Many people would argue that this is the type of targeted programme that the FAP should be doing as a priority. The social benefits of this are likely to be high but difficult to quantify let alone calculate in financial terms.

The issue of increased flood risk to the left bank of the Old Brahmaputra would appear to be a serious one, judging by the flood peak Landsat image (see Figure 5.3). There is at present no output data from hydrological modelling nor a resource and population study of the area which would be needed to quantify impacts in this area. This needs to be commissioned as a matter of urgency and will probably need to extend for some way downstream of Jamalpur town.

5.4.3 Losses to Fisheries

The present fisheries system in the mainland study area and the methodology for calculating losses under each option are given in Annex 2 of this report. They are shown in summary form in Table 3.3.1. For

Option A the immediate post project floodplain fisheries losses without mitigation are in the order of 8% marginal and would seem acceptable. For Option B the equivalent figure is near 75% and would be very significant. However one of the difficult issues is prediction of the likely without project situation as the fisheries trends in the mainland study area over the last 6 years are very different from the national figures, particularly when these are dis-aggregated by fishing habitats and catch systems. The conclusion has been to use the overall national trend figure of -1.5% per annum for all fishing systems with the exception of pond production which is predicted to rise from its present low level by 4% per annum. These figures were initially predicted for 6 years after the construction period of the project but have now been refined and also considered the possibilities for mitigation. Mitigation of the fish resources of the area requires to address both the needs of professional fishing households and also the likely nutritional implications, particularly to occasional fishing households who catch "common good" fish for direct consumption.

The mitigation centres around a fisheries management and stocking programme for the area bearing in mind the different hydraulic regime that is likely to be in place as a result of controlled flooding. It is likely to be far more successful in mitigating the effects for professional fishermen, although specialist targeted programmes of riverine production aimed at occasional and landless groups would broaden this. Overall it is thought that if well managed the area could produce more commercial fish for sale than it does at present and in a without project situation. The capital costs of this programme will be in the order of Tk 28 million and require a major institutional commitment to the running costs, mainly in terms of the provision of skilled technical staff.

5.4.4 Permanent Disruption to Waterborne Navigation

There is likely to be a significant curtailment of waterborne navigation on the internal rivers in the study area. Whilst this is likely to cause serious livelihood loss to boatmen and associated activities (boat building, labour for unloading etc) it must be pointed out that this is already in significant decline due to the recent low flows in the Jhenai and Chatal systems during the dry season. This has been particularly acute in the last two years, probably linked to the construction of the embankment at the mouth of the Chatal which has stopped all flow and also the silting of the intake of the Old Brahmaputra and the Jhenai which has caused very low dry season flows and reduced the Jhenai to unconnected stretches of standing water. There is presently trade in goods during the wet season, certainly up until December to Bausi Bridge. In terms of mitigation, a replacement network of road links is required with transfer facilities to the main river navigation which should remain unaffected. This may entail extending the road embankments on the "wet" side of the main embankment across the "set-back" land. Provision of a replacement transport network could be achieved as part

of the upgrading of the existing water management system that uses the existing road embankments. It is important that these improvements take into consideration the need to make the roads wide enough for commercial lorry traffic and also sugar cane tractors and trailers to pass.

Consideration for providing a navigation lock has been made, including designs and costings, however a policy decision has to be made as to if this is thought to be worthwhile, bearing in mind the fact that navigation is already in such decline. There are special issues linked to the carrying of the output from the fertilizer factory and the transport of finished pottery which commented upon in Section 2.4.13 of Annex 3. These will become increasing problems irrespective of any project intervention.

5.4.5 Decline in Flora and Fauna

Although the matrix ranking figures for flora and fauna decline in the area are high this is a result of a severe decline in habitat irrespective of a project intervention. The wildlife situation is already very poor and changed habitats, particularly the draining of beels, will make this still worse although the relative position when compared to a without project situation is not that great. The flora position is a little different in that there is still some reasonable diversity of habitat linked to the availability of water and their appears to be quite significant use of plants for medicinal uses. These have been inventoried to assess their usefulness and importance and how the supply of these is likely to be effected and if sufficient alternative sources will exist after project construction. The mapped output of the hydraulic modelling to determine the effect on habitats is required before this can be carried out. The estimated situation with flora is that there are likely to be greater losses than fauna as a result of project intervention, but the without project situation is not so bad, hence the end situation will not be so severe.

5.4.6 Nutritional Consequences

The nutritional consequences of the implementation of Option B have been commented upon in Section 2.4.12 of Annex 3 and also the Fisheries Annex 2. In addition there is the issue of how pulse production and availability in the area is likely to change as irrigated rice cultivation is extended. It appears that these two factors could be highly significant and the reconnaissance nutritional study has identified the need for a follow up detailed study linked to the methodology being carried out by the FAP 16 Special Study. The nature of the issue is the degree to which various different groups of households depend upon fish intake for both animal and total protein intake, the nature of its source (directly caught and consumed, bought in markets and at what cost) and how this is likely to change as a result of implementation of Option B. Whilst the fisheries mitigation programme may provide some of these sources,

other alternatives need to be identified that will provide economic and affordable replacement protein at the household level. The resources need to be made available during the Detail Design phase of the study to follow this up. This will allow an assessment of the degree of dependency upon common good fisheries resources and allow mitigation programmes of alternative protein provision to be investigated.

5.4.7 Possible Increase in Specific Waterborne Diseases

As with the nutritional issues there is insufficient knowledge as to the implications of project implementation on the likelihood of waterborne disease. Special studies are under way at FAP 16 to look at these, but until they report some conclusions there is little that can be sensibly said backed by statistical data. However summary data from the Jamalpur District Surgeon for 1991 indicate that there are already serious problems with waterborne diseases, particularly diarrhoeal ones and also malaria and an outbreak of Kala-azar at Maderganj. The confirmed malaria cases seem to be concentrated in the larger towns (414 cases in Dewanganj) and may be linked to mosquito habitats in all year standing water in urban ponds and tanks. There may however also be an urban bias in the reporting of cases. There has been significant evidence (Ref: WHO/Tiffen and WHO/Birley) that the expansion of irrigated agriculture which results in all year standing water in areas where previously it seasonally dried out can lead to the promotion of mosquito habitats, particularly in drains. In addition the curtailment of surface flooding can mean that there is an increase in stagnant water which was previously flowing and had creating a flushing effect. This increase in stagnant water could significantly promote the risk of waterborne diseases, particularly diarrhoea (which it appears includes Cholera but there are insufficient laboratory facilities to isolate it from diarrhoeal diseases) that are already a major problem in the area and a major cause of death. The most effective mitigation measure is the provision of all-year round safe drinking water and sanitation facilities, accompanied by a major health education programme. This would seem a priority for the area irrespective of any FCD intervention. This is also the case with the provision of iodised salt to tackle the presently very serious problem of goitre.

5.4.8 Decline in Fuelwood and Fodder Availability

There are already significant problems with the present supply of fodder and fuelwood in the study area. This will only get worse in a without project situation as the agricultural system intensifies. This process will be accelerated under Option B as common "free-good" fodder and fuel resources decline still further. There is a direct link between these issues in that there is widespread use of animal dung and also rice straw as fuel, the major use of wood being normally confined to large scale burning for pottery and brick firing. Some replacement provision of fuelwood could be carried out by the development of community

forestry as part of a strategy of multi-purpose use of embankments. However great care will need to be taken in selecting appropriate local species that have the maximum utility (including shade and perhaps fruit production) and will not significantly damage the embankment. This will require a commitment by the implementing authority to this type of programme within a framework of integrated environmental management. More detailed studies will be required in the immediate post construction phase.

The present shortage and poor quality of draught animals in the study area is cited as a constraint to the development of irrigated agriculture. However the intensification of resource use will only make the situation more difficult. There is already evidence in the northern part of the study area that small power tillers are being adopted by larger farmers and those with the necessary resources. Whilst in employment opportunity, energy and sustainability terms this my beg some questions, it would seem a rational and inevitable solution to the problem at household level if it can initially be supported in terms of spare parts and skills. The prevalence of small engines for both irrigation and boat power in the project area would seem to indicate that this can be made sustainable.

5.4.9 Soil Fertility Issues

Study of existing detailed SRDI data for the area has indicated that soil fertility issues are not considered to be a major issue in the area at the moment nor in the immediate future. There is no salinity problem (in fact there is a lack of salt in drinking water supplies which may be the link in the serious incidence of goitre in the area) and a review of the extensive archive of soil chemistry data has turned up no major problems although care may need to be taken with high levels of iron in deep tubewell water. This can be managed out of the system with suitable watering scheduling. However POE comments on a previous report (R2) raised the issue so it is being addressed in the Environmental Annex even though it scored a rating of only -2 on the matrix. The fear is that the spread of continuous mono-cropping is likely to deplete soil fertility in the medium term. This can be tacked by the use of large quantities of both artificial and organic fertilizers. However supplies of organic fertilizer are limited and declining as the use of draught animals becomes less attractive and more use is made of animal dung for fuel as fuel wood supplies dwindle. However in environmental terms the use of large quantities of fertilizer is considered undesirable in that it is likely to cause water quality problems associated with high nitrate levels. There is a chance that the high levels of rainfall may wash much of this out of the area but this depends upon the effectiveness of the drainage system, particularly in a controlled flooding situation. In addition there are apparently uncertain economic issues with regard to artificial fertilizer use, despite the existence of a production plant within the study area. Fears have been expressed that the extensive expansion of irrigation may cause waterlogging of soils in

the dry season when previously they dried out. This could lead to anaerobic conditions which may change the chemical condition of the soil. This, along with the previously mentioned high soluble iron content in the groundwater, particularly from deep tubewells, point to the need for a baseline and longer term soil monitoring requirement for the area in addition to an initial assessment once the hydraulic modelling gives some idea of the water flow conditions in the with project situation.

5.5 Conclusions, Recommendations and Future Work Programme

5.5.1 Conclusions

The major conclusion of previous JPPS reports was that Option A has very few negative impacts but also far fewer positive ones than Option B, particularly those associated with the protection of agricultural land from high normal floods. The stated desires of local people in the mainland project area (both those occupying land and those who do not), are for the construction of embankments. However care has to be exercised in considering this, as local people's perceptions are very much formed by a short time horizon, due to the precarious nature of many household's security. They tend to undervalue the significance of the longer term and indirect negative impacts, for example the nutritional consequences of loss of fisheries.

Option B carried out in isolation for the mainland and without any mitigation, is likely to have some serious negative impacts. The most significant of these is the resulting increase in flood risk to unprotected lands in the Jamuna and also possibly the Old Brahmaputra. There are major welfare and equity issues here, in that those people who already have the most vulnerable livelihoods due to both flooding and erosion are likely to have this made even worse in order to protect the agricultural land of better off people who presently have a significantly lower flood risk. Now that the numbers of people are known it would seem to very seriously question the basic philosophy of the intervention as originally proposed. Some 602 000 people are likely to have their flood situation made worse for the sake of controlling the flooding of 631 000 people.

In order to address this issue, it is now proposed to take up a complementary programme of flood proofing in the adjacent unprotectable area. This is regarded as an intervention in its own right and would entail a major programme of various degrees of homestead raising, communal refuge provision and multi-purpose use of embankments aimed at securing the lives and homestead assets of residents. This would allow more rapid post flood recovery to take place.

There are complexities in apportioning the mean increased flood risk of 0.3m in a peak flood situation between FAP 3.1 and other existing and proposed projects. However it would seem likely that local people will

perceive, wrongly, that FAP 3.1 is the primary cause of this. The aim of the flood proofing programme would be to raise homesteads and provide flood refuges above the 1988 peak flood level plus the additional height required as a result of the confinement effects due to embanking. The incremental height raising needed will be only some 10% of the required total height and even this should be apportioned between other interventions, both present and past which have and will contribute to this. As a result the apportioned flood proofing costs attributable to the FAP 3.1 land protection intervention are likely to be relatively low at TK 31 200 000 or some 3% of the total mainland project costs.

The social impact assessment indicates that there could be benefits to landless people on the mainland, principally in wage paid employment during construction, operation and maintenance and perhaps some agricultural labour as a result of intensification. However the experience of the FAP 12 studies indicates that the latter could be very limited, as there is such oversupply of labour from within households owning land that they are unlikely to hire in much extra labour.

The whole question of risk levels and sustainability of the recommended option from social, economic, environmental, political and even narrow engineering standpoints is difficult to assess at present. It requires, inter alia, confirmation of the institutional framework for project implementation, including the nature of project funding (central to this is if it will all be grant aid funded or a recoverable loan), which should be established at the outset, ideally with sustainability in mind, before this can be done.

If the decision is taken to implement the Controlled Flooding Option B5 on the mainland area then there should be no alternative but to incorporate a parallel programme of flood proofing in the unprotected lands, very preferably combined with an income diversification support programme.

However, irrespective of decisions made for the development of the mainland, there is a clear need from both social and humanitarian standpoints to improve conditions for those people living in the unprotectable areas. The proposed interventions, given in Annex 9, outline a portfolio of measures to address many of their needs, including making fullest use of the mainland embankments as potential locations of both temporary refuge and permanent settlement.

The costs of the total flood proofing programme are comparable to those of the mainland intervention on a per person basis. These are estimated to be TK 1 396 million or $US 34.9m (TK 2140 per head) for the flood proofing programme and TK 1 431 million or $US35.8m (TK 2212 per head) for the mainland intervention.

The loss of fisheries resources is also significant and mitigation of this appears to be possible for the small proportion of professional fisherman but not so easy for occasional fisherman who directly consume the fish they catch on an informal basis. The real issue is the provision of a sustainable programme of affordable protein replacement provision. More detailed nutritional surveys are required to obtain data on the present situation and draw up a suitable mitigation programme.

There are lesser issues with regard to the decline of waterborne navigation and these should be mitigated for as part of an improved road network that is likely to occur, ideally as a component of internal water management planning. The situation with regard to water borne diseases is presently unclear and a major national study is underway to tackle an understanding of these issues. This is presently being handled by FAP 16. There is a lack of data on possible changes in soil fertility as a result of all year mono-cultivation and a baseline and monitoring programme is required in the mainland area.

There still remain uncertainties due to the lack of defined overall aims and strategy for national environmental management, how these interface with the Flood Action Plan and how they are to be applied to the first sub-regional study area at Jamalpur. Guidance is required as to national, regional and sub-regional priorities and policies and how these relate to the presently embryonic ideas for national environmental policy. From the comments on the draft version of this report some policy direction can be inferred, however this needs rationalising into a coherent strategy. The role and concept of integrated rural development within the previously envisaged narrow perception of flood control needs to be resolved, particularly the role and capability of the BWDB to undertake non-engineering programmes with a social component. Central to this is the likely nature of the institutional structure for implementation of the Flood Action Plan and the degree and nature of active public participation that is to involved in it. FAP 3.1 have proposed that a Project Management Office (PMO) be set up under the BWDB. This would need to have an environmental management and planning cell with multi-disciplinary staff either taken on directly or seconded in from different organisations. This is further expanded in Annex 7 but is believed to be a necessary and welcome move in widening the scope of FAP interventions in comparison to FCDI work that has gone on previously in Bangladesh. The aim is to promote interventions that address those issues that in the past have proved troublesome and undermined their chances of success.

5.5.2 Recommendations

From an environmental perspective, whilst the recommended intervention, Option B5, addresses many of the important infrastructural development needs of the mainland area it excludes those people who have arguably a much greater need for flood protection. The mainland

component is justified economically on the basis of the primarily agricultural benefits derived from it, whereas the parallel flood proofing programme, considered necessary on both social and humanitarian grounds from observation and a needs led assessment, is far less amenable to economic analysis. The framework and methodology for assessment of the value of benefits derived from the flood proofing measures is far less advanced than is the case for projects which directly produce increases in agricultural output. From discussions held during the FAP 3.1 study it appears that more work is needed in order to fully address the requirements for project assessment techniques as well as an overall framework for defining policy and investment criteria for such unprotectable areas.

In consideration of narrower natural environmental issues there is a basic lack of data, with the result that many of these can not be considered in a sound technical manner in the EIA work for the JPPS and the FAP programme in general. These require long term national monitoring programmes (the short term and episodic nature of FAP 3.1 is a totally inappropriate vehicle for such work) and need to address the following issues:

- National water quality monitoring including surface water, groundwater, industrial pollution (both rural and urban), agro-chemicals, including nitrate problems of fertilizer use along with herbicides and pesticides, particularly under conditions of all year round cultivation and dry season irrigated agriculture.

- The nutritional implications of present fish consumption and how this is likely to change under FCD interventions, considering production (species diversity change) and consumption patterns. This also needs to consider alternative affordable sources of protein intake, particularly for marginalised households.

- A baseline data collection exercise to monitor likely soil chemistry changes as a result of all year mono-cropping and dry season irrigated agriculture.

- A study and monitoring programme of the likely effects of all year standing water (due to irrigation) on the incidence and nature of waterborne disease, particularly diarrhoea, Kala-azar and malaria.

Many of these programmes would be best carried out by a reinforced and assisted national Department of the Environment, but this needs to be part of a conscious policy not just a one off, ad-hoc arrangement for FAP 3.1.

In the absence of this, then adequate full time environmental staffing must be made available on a permanent basis as part of the Detailed Design and following work programme.

Specific recommendations for the JPPS environmental component are outlined in the following section on the future work programme.

5.5.3 Future Work Programme

As part of the detailed design phase of the proposed project, it is felt that there needs to be a significant amount of resources given to the non-engineering issues to ensure that environmental and social factors are considered adequately during engineering design. This includes the institutional structure for project implementation and the degree of public participation. A crucial issue is land acquisition policy and procedures. A copy of the draft of the TOR for the supporting studies of the detailed design phase are included as Appendix D in Annex 3 of this report. This will require significant skilled staff inputs, both generalists and specialists, from Bangladesh and outside it.

The specific environmental items that need to be addressed include:

- A full, internationally credible EIA under World Bank Operational Directive 4.01 and the newly released and approved FAP Environmental Guidelines. To this end it will be useful to improve the hydrology modelling of both the internal project area network and the main rivers (both the Jamuna and Old Brahmaputra), incorporating output from Digital Elevation Models (DEM's) that allows mapping to be produced that shows time series extents, depths, durations and timings of floods under a full range of with and without project situations. This would allow a suitable data collection programme for detailed ecological assessment to be drawn up. In addition it would then be possible to do more detailed impact analysis that allows a comparative assessment of spatial and social variation of impacts and development needs among the six or even eight sub-areas with in both the mainland and unprotectable land implementation areas.

- Baseline monitoring data of water quality will need to be continued along with the planning of an evaluation and monitoring programme for the whole project.

- The detailed nutrition and health baseline studies need to be instigated.

- More detailed assessment work can be carried out on ecology as a result of the hydraulic modelling results.

- Fisheries considerations in the detailed design of drainage networks will need to be addressed along with the details of the fisheries mitigation and management programme.

- Environmental considerations for design, particularly construction impacts, land acquisition policy and procedures including compensation.

In addition the following issues with wider environmental considerations need to be addressed and followed up:

- the institutional framework for the implementation of the project, including construction, management, operation and maintenance.

- liaison with local people to form a participation strategy to obtain detailed planning data. This is particularly crucial to any flood proofing work which will need a large component of social planning, including group formation.

In order to comply with the requirements of the latest FAP Environmental Impact Assessment Guidelines there would need to be a full 12 month period of data collection on the natural environment. For the human environment the 1991 BBS data for the area would need to be made available to fully address the issues of spatial and social differentiation of both the positive and negative impacts. However the most important requirement is the need for mapped outputs for the hydrological modelling which show the with and without project conditions under a range of different flow conditions. This would need to be a pre-requisite for commencing a full EIA and requires FAP 25 and FAP 18 to have completed the relevant parts of their work at least 6 months before the FAP 3.1 EIA could be completed. Of particular concern is the recently learnt fat that the mapping work for the Char land area was removed from the FAP 18 programme. This needs to be resolved and if necessary alternative techniques, such as time series remote sensing data, be investigated.

5.6 References

(a full environmental bibliography is included in Annex 3):

FPCO	Guidelines for Project Assessment, July 1991 and May 1992
ISPAN	Guidelines for Environmental Impact Assessment, Latest Edition May 1992
ISPAN	Manual for Environmental Impact Assessment, Volume 1, March 1992
Kruger/BCEOM	FAP 25, Flood Modelling and Management, Flood Hydrology Study, Main Report, June 1992
Sogreah/Halcrow Lahmeyer	Jamalpur Priority Project Study -Revised Inception Report (R1), February 1992 -Interim Planning Report (R2), March 1992 -Interim Report (R3), April 1992 -Interim Feasibility Report (R5): -Main Report June 1992, Revised September 1992. Annex 2 Fisheries, June 1992 Annex 3 Environmental Impact Assessment, July 1992 -Char Study Report, September 1992
WHO/Birley M	PEEM Guidelines Series 2 "Guidelines for Forecasting the Vector-Borne Disease Implications of Water Resources Development", WHO,Geneva, 1991
WHO/Tiffen M	PEEM Guidelines Series 1 "Incorporation of Health Safeguards into Irrigation Projects.." WHO, Geneva, 1991
World Bank	Operational Directive 4.01 on Environmental Assessment, 3rd October 1991, World Bank, Washington, USA

6 MODELLING

6.1 Construction of the Model

The mathematical model of the Jamalpur Priority Project Study area has been operational since January 1992 and is based on the MIKE-11 software of the SWMC. It uses information from their General Model of the major rivers of Bangladesh, together with the data from the similar Coarse Pilot Model constructed by the North Central Regional Study (FAP-3).

The initial model, constructed using only available data, was not accurate enough and further topographical and hydrological data were therefore required to improve its precision. These were collected during the extension period of the study i.e.

- topographical cross-sections and longitudinal profiles of the principal rivers and embankments within the area,
- hydrological surveys (seven gauge measuring points and four discharge measuring points) during the 1992 monsoon period,
- the Finmap topographical survey was not available in time and so the old map dating from 1960 (scale 4 inches to a mile) was used to obtain the elevation-area curves for the various cells.

The new reference model was entirely reconstructed by introducing the new data and validated by means of hydrological measurements during the 1992 monsoon.

6.2 Aim and Limitations of the Model

The ultimate aim of modelling, according to the terms of reference, is to model the effect of different development options, in terms of water elevation and discharges in the hydrographic network, flow rates through structures to be studied at preliminary design level and water management procedures. During the course of the study, the aim was to see how these would change the flooding conditions in the floodplain, in terms of water levels, duration and period, in order to convert these results into land types based on depths of flooding for the "with" and "without" Projects scenarios.

This latter exercise proved disappointing due to the basic philosophy of the model and, in this respect, it is worth recalling the following points:

- The mathematical model based on the MIKE-11 software is of the looped type, with topography being represented schematically. The pronounced micro-relief in the area and local development works carried out by farmers, which strongly affect the real

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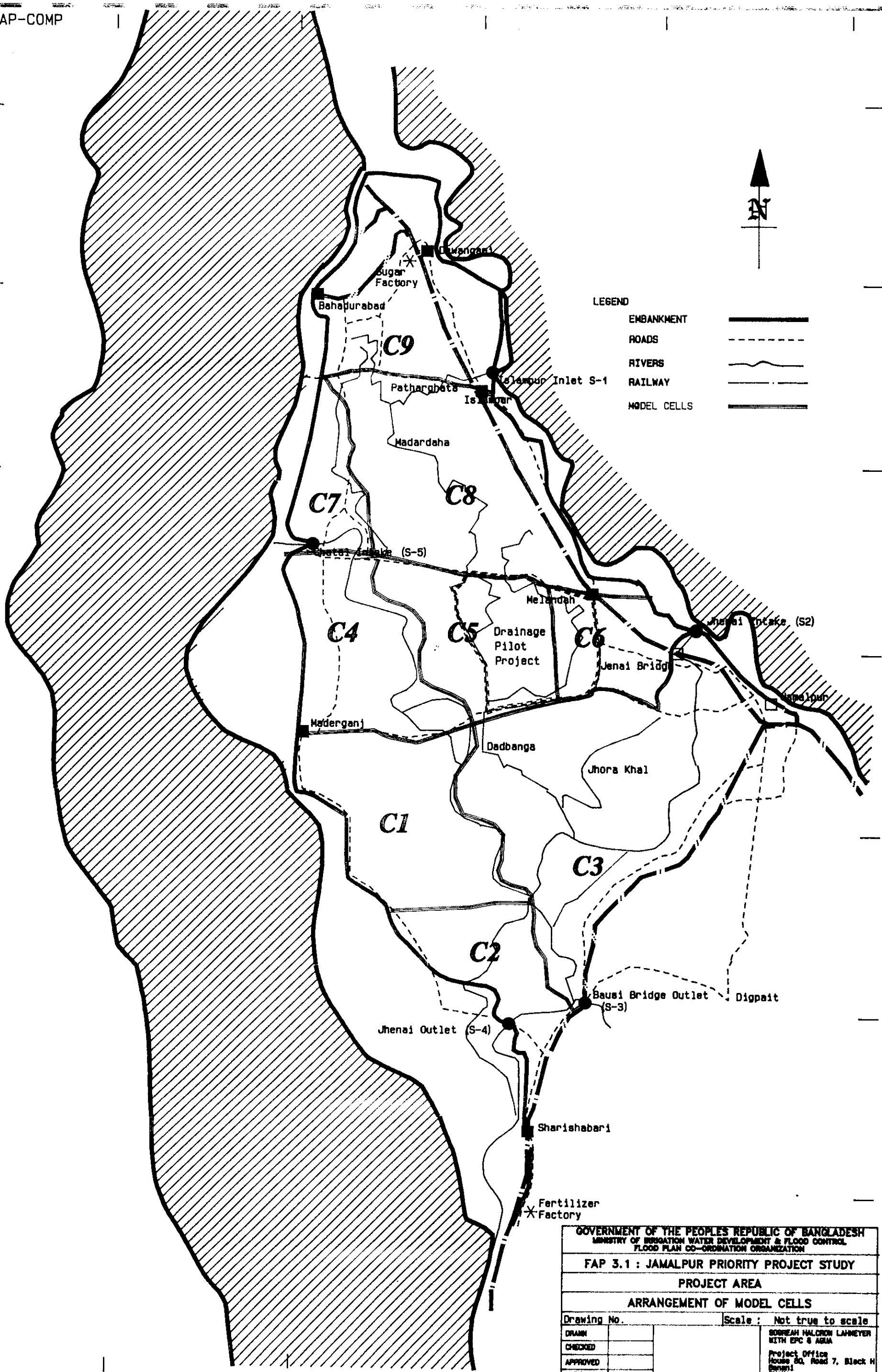


GOVERNMENT OF THE PEOPLES REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION

FAP 3.1 : JAMALPUR PRIORITY PROJECT STUDY

PROJECT AREA

ARRANGEMENT OF MODEL CELLS

Drawing No. | Scale : Not true to scale

DRAWN			SOGREAH HALCROW LAHMEYER WITH EPC & AGUA
CHECKED			
APPROVED			Project Office House 80, Road 7, Block H Banani DHAKA
DATE			

Figure 6.1

classification of land types, cannot be taken into account with a sufficient level of detail by this model,

- The data available for validating the model vary from one year to another, in particular with respect to the breaches in existing embankments along the Jamuna,

- It is not possible to make a direct comparison between the distribution of actual agricultural land types and those calculated by the model from elevation-area curves. Indeed, the former are net cultivated areas, while the latter are gross areas.

Because of these different factors, it is essential to interpret the simulation results with caution, as far as calculating modifications in land type distribution is concerned. A special methodology was used, which considers the model results as only relative (and not absolute) values.

6.3 Validation of Reference Model

The reference model was validated mainly by using hydrological data from 1992. Unfortunately, the 1992 monsoon was particularly dry and the maximum water levels reached were about one metre lower than usual. The few data available for 1991 were also used. The maximum discrepancies between calculated and observed water levels were of the order of 20 cm, which is satisfactory in view of the accuracy of the topographical data and method of exploiting the model in relative terms.

6.4 Scenarios Modelled

The following scenarios were considered on the basis of the reference model.

Option A Flood Proofing and Drainage Improvement

Actually, Option A was not simulated. It is indeed impossible to carry out realistic simulations using a reference model that gives overall water storage values within the cells.

The accelerated drainage under option A involves the local improvement of drainage conditions, which cannot be represented at the level of accuracy of the model.

Realistic modelling of option A would require much more accurate knowledge of the topography than that adopted in the reference model, and in particular, knowledge of the topography of each depression and its outlet, which is impossible to achieve without exorbitant computation facilities that are quite out of keeping with the scope of the present study.

Option B Flood Control and Drainage Improvement

Option B aims at assessing the feasibility of flood control within the project area. More specially, the simulation principle is to admit floods into the project area during a fixed period and to secure a continuous receding flood level within the project area after the closure of the flood intakes. At Bausi bridge a maximum discharge of 50 m^3/sec has been assumed towards the area south of the project area as per FAP-3 boundary condition. The schematic diagram showing the river model for Option B is shown in Figure 6.1.

Option B (Modified)

This option aims at assessing the effect of back flow from Jamuna in absence of Chatal/Jhenai drainage outlet structure. The schematic diagram showing the river model for Option B is shown in Figure 6.2.

Option B (First phase of embankment construction)

With this option, it is possible to assess the effect of a first phase of works in constructing the embankment along the Jamuna between the northern extremely and Maderganj. The schematic diagram showing the river model for Option B is shown in Figure 6.2.

6.5 Land Type Distribution

6.5.1 Definition of Land Types

Crop statistics and cropping distribution have been based on the flood phases, as such, the present situation regarding flood and drainage in the project area can be assessed from land classification related to the flood depth. Flood phases are categorised as follows:

•	F0	Flood depth of	<0.3 m
•	F1	Flood depth of	0.3 m - 0.9 m
•	F2	Flood depth of	0.9 m - 1.8 m
•	F3	Flood depth of	>1.8 m for less than nine month
•	F4	Flood depth of	>1.8 m for more than nine month

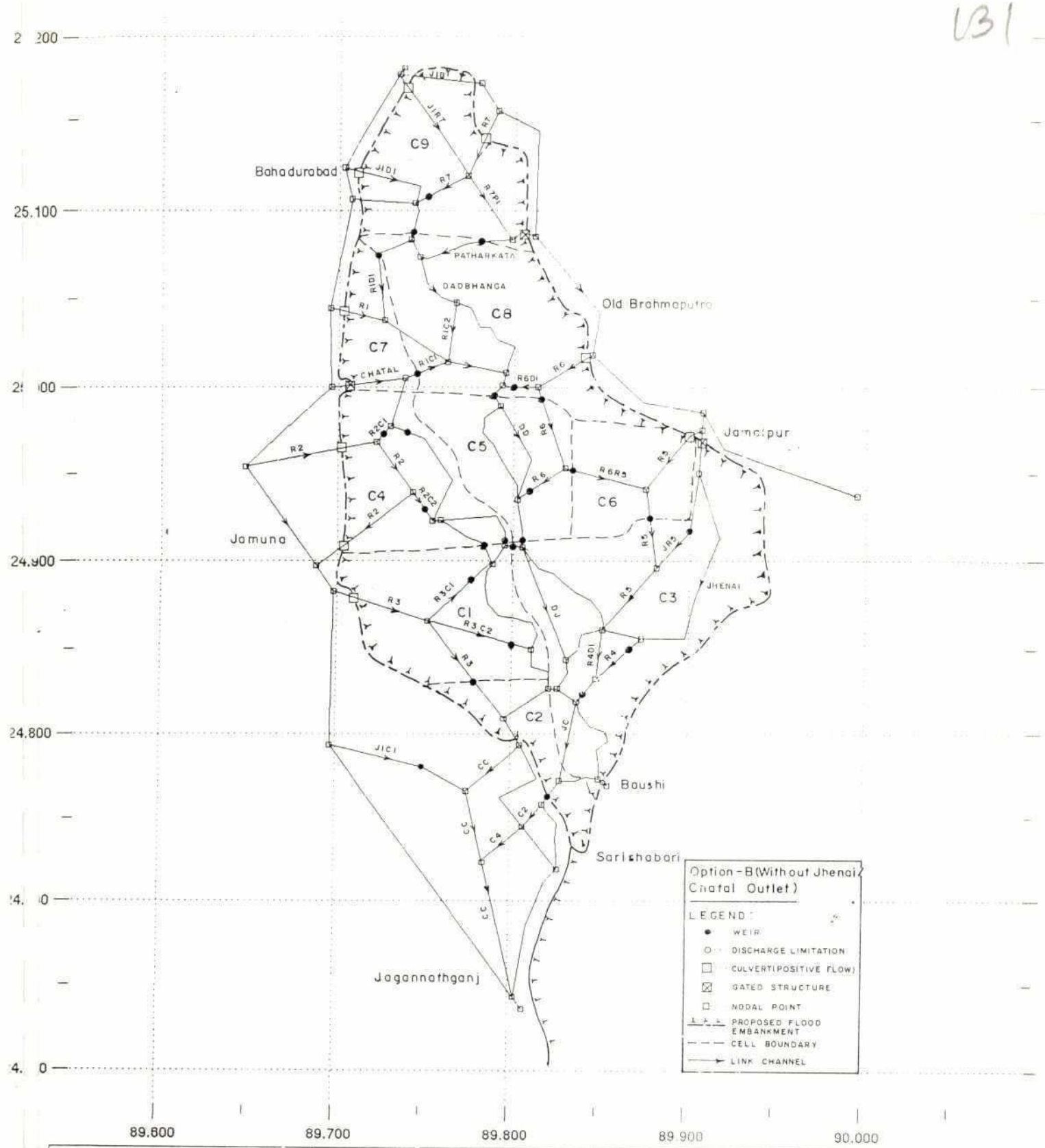
6.5.2 Land Types Identified in the Field

The land type areas identified by field investigations and measured on the 1:50,000 maps produced by SRDI are representative of the crops traditionally grown in the regions considered.

In addition to the official definition based on water levels, this distribution takes into account the following factors:

Figure 6.2

V31



S W M C	RIVER SETUP MODEL SCHEMATIC PLAN JAMALPUR PRIORITY PROJECT STUDY (FAP 3.1) BANANI, DHAKA
	MIKE 11 Dwg no.:

- the pronounced micro-relief throughout the study area

- the ability of farmers to erect bunds, taking advantage of the micro-relief to carry out localised protection works and thus be in a position to cultivate F0 crops on F1 land, for example.

The figures represent net areas of cultivated land. They do not include inhabited or wooded areas, tracks, embankments, areas of deep water, etc.

6.5.3 Land Types Calculated by the Model

Interpretation of the results, of the model is based on analysis of the area-elevation curves for each model cell. These curves are derived from a topographical map dating from 1960, to the scale of 4" to the mile. In contrast to the land types identified in the field, they therefore cannot provide details on the micro-relief and localised works carried out by the farmers.

In addition, the area-elevation curve cannot correctly represent beel areas situated at relatively high levels.

Indeed, the beels are classified as F2, F3 or F4 according to their depth, but if they are at a relatively high altitude, they will be represented by the area-elevation curve as F0 or F1.

In order to test the sensitivity of the land type distribution to variations in water levels, the land type distribution according to assumed water level within the model cells were calculated using the definition of the different land types.

It can be seen from Table 6.1 that, in the range of normal flooding for each cell, a 10 cm variation in water level causes significant changes in the allocation of land areas to each of the classes F0 to F4.

The distribution of land types is consequently highly sensitive to variations in water levels and this shows that the results of the hydraulic model, irrespective of its accuracy, must be taken as relative values, so as partly to eliminate systematic distortions.

Table 6.1 Percentage Variation of Land Classification Areas resulting from a 10 cm change in Flood Depth

Model Cell	Land Classes			
	F0	F1	F2	F3 + F4
C1	5	1	2	2
C2	3	2	3	2
C3	4	1	1	2
C4	6	1	5	1
C5	4	1	2	1
C6	4	0.5	2	1
C7	1	1	1	2
C8	4	0.5	2	1
C9	3	0.5	2	1

Note: This table shows absolute values (%) which may represent plus or minus variations in land classification.

6.5.4 Comparison of Land distribution Identified in the Field and calculated by the Model

In order to make a comparison, they must be referred to the same gross area. This transformation is not identical for all land types. The difference between net cultivated area and total gross area must be distributed primarily:

- over the F0, in which are located all the inhabited areas and tracks (mainly in areas not subject to flooding)
- over the F2, F3 and F4, which include uncultivated areas of unconfined water (beels).

In order to carry out this transformation, the following coefficients were adopted:

- 50% of the difference between gross and net areas is added to the net areas classified as F0
- the remaining 50% is shared equally between F2 and F3/F4.

Table 6.2 gives the corrected percentages of gross areas according to this transformation criterion, for each thana.

Table 6.2 Land Classification (% Gross Area) by Thana

Thana				
	F0	F1	F2	F3 + F4
Jamalpur	40	15	34	11
Sarishabari	44	32	20	4
Melandaha	34	38	18	10
Islampur	25	39	29	7
Dewanganj	42	19	34	6
Madarganj	32	41	19	9
TOTAL AREA	34	23	23	9

6.6 Simulation Procedure

6.6.1 Methodology

In order to assess the effect of the project options on land type distribution, one year has been selected in which the model gives a similar land type distribution to that shown in Table 6.2. This year, which has been selected following simulation of several years simulated, is termed the reference year. The selection criterion adopted for the reference year is the standard deviation between the cultivated area values transformed into gross areas and the values calculated by the model.

The available years from which the reference year can be selected are those for which boundary conditions are available for the without-project and with-project situations. FAP 25 provides these conditions for with and without the FAP embankments-Jamuna bridge combined projects. It should be noted that the with Project simulations were made for the situation with embankments and bridge on the Jamuna. The data with embankments and without a bridge are not yet available from FAP-25.

The simulation results for the various project options have been compared in relative terms to the simulated reference situation. A reverse transformation to that used in obtaining gross areas from net areas was performed to transform the gross areas calculated by the model into net cultivated areas that can be used in the agricultural calculations.

6.6.2 Choice of Reference Year

The years simulated by the without project model, following validation, and the corresponding peak flood return periods established by FAP-25 in terms of maximum water levels, are shown in Table 6.3.

Table 6.3 Water level Return Periods

Year	Return Period at Bahadurabad
1977	4.1
1980	6.4
1987	1.5
1988	59.5
1989	1.2
1990	1.02
1991	5.0
1992	1.0

The distribution of land types throughout the area within the embankments was calculated for each simulation and for inundation times of 3 and 10 days. The results were then compared with the corrected agricultural data.

1977, with a maximum submersion time of 10 days, is the year with the smallest standard deviation. Accordingly 1977 has been chosen as the reference year. It corresponds to a flood peak return period of about 1 in 5.

6.7 Results and Interpretation of Various Simulations

6.7.1 Calculation of new Land Type Distribution for Option B

The new distribution of land types corrected with respect to the net agricultural area is given in the table hereafter.

To confirm the distribution obtained, the years 1980 (10 days), 1987 (2 days) and 1988 (10 days), with standard deviations again close to the minimum, were also simulated. The values obtained for the net cultivated areas are also shown in the Table 6.4.

Table 6.4 Model Results - Land Classification

Year	Flood duration (days)	F0 (%)	F1 (%)	F2 (%)	F3 (%)
1977	10	55	38	7	0
1980	10	58	31	10	1
1987	3	52	36	12	1
1988	10	63	30	8	0

Table 6.4 shows that the differences from one year to another, in the case of the closest years to the agricultural distribution actually observed, are not very far from one another, confirming that 1977 is a good choice of reference year.

6.7.2 Usefulness of the Jhenai/Chatal Outlet

Analysis of the simulation results in terms of water levels immediately upstream of the Jhenai/Chatal Outlet structure site, with and without the structure, shows that the difference is relatively slight (of the order of 10%) for the reference year.

This phenomenon can be explained by the fact that inflow into the area as a result of rainfall is sufficient to fill the low-lying part of the area at a speed almost equivalent to that of the rise in the Jamuna.

In contrast, in an exceptional year such as 1988, the difference reaches one metre. In these circumstances the outlet structure would have been enough to prevent the catastrophic flooding within the embanked area.

6.7.3 Sizing and Managements of Hydraulic Structures

i) Sizing of Structures

Bearing in mind that the selected option is a controlled flooding option, the preliminary size of the inlet structures was fixed on the basis of the flows entering the area in the without project situation, so that rivers downstream these structures can flow at full bank level. Discussion adnd justification of this is included in Annex 7 on Engineering.

It was then confirmed with the model that the flows introduced were sufficiant to ensure adequate water levels in the cells, particularly during the month of June.

The sizes of the outlet structures i.e. Jhenai/Chatal outlet and Bausi Bridge outlet, were fixed on the following basis:

- Jhenai/Chatal outlet: assessment of the averages flow leaving the area in the without project situation.

- Bausi Bridge outlet: restriction of the flow to 50 m^3/s as per assessment made by FAP 3.

Subsequently simulations were tun to test the size of the structures with respect to the resulting maximum head loss through the Jhenai/Chatal outlet during monsoon and the incremental head loss for reduced/increased discharge capacities at this outlet structure.

Two sets of simulations were carried out:

- One set concerning the reduction of ventages at Jhenai/Chatal outlet with a restricted discharge at Bausi Bridge (50 m^3/s)

- One set concerning the reduction of ventages at Jhenai/Chatal outlet without flow restriction at Bausi Bridge.

The results of the simulations show that :

- From a financial and social point of view, the proposed size of Jhenai/Chatal outlet, 25 vents for a nominal discharge of 400 m^3/s under 25 cm head.

- The restriction of the discharge of Bausi Bridge would aggravate the general flooding situation within the JPPS project area. This is on the assumption that there is no downstream influence on the discharge at Bausi Bridge outlet and therefore that the base water level controlling the drainage of the project area is more favourable in the Jhenai river.

It will be then necessary at detailed design stage to re-assess the impact of the development of PU 2 on the JPPS. The JPPS model should be extended in order to integrate the topography of the Jhenai river downstream of Bausi Bridge and subsequent feasibility studies of FAP 3 for PU 2 should aim at limiting any discharge restriction at Bausi Bridge (accurate assessment of Jhenai full bank capacity, construction of embankment to contain higher discharges etc.)

ii) Management of Structures

The with-project simulations show that once the Jamuna in flows and levels are controlled by the embankments, maximum levels within the project area are reached in August and September, due to the influence of rainfall. The type of management applied to all the larger structures, which are open only during June, will not therefore interfere with the maximum flooding levels which defines the land type distribution. Under these circumstances, management of all the structures can remain fairly flexible, depending on local requirements, as long as the project area is protected against the high water levels in the Jamuna.

As far as the three large inflow structures and minor flushing structures are concerned, there are two criteria to follow:

- A sufficient flow must be introduced in June to meet the requirements of agriculture, fisheries, navigation and other environmental aspects and a sufficient level of water must be maintained in the internal rivers.

- Inflows must be restricted when external levels in the Jamuna and Old Brahmaputra are high, and when accumulated rainwater within embankments entails high flood levels. In the event of sudden floods, these structures must be closed.

These management criteria, and in particular the upstream and downstream set levels, will have to be finalised for each of the structures in the detailed design study phase, according to the actual location and final setting of the structures. They must be set out in the scheme's management manual.

6.7.4 Partial Embanking of the Jamuna

Simulation with the partial embankment along the Jamuna between the extreme northern end of the project area and Maderganj shows that the relative improvement in terms of flooded area is of the order of 30% to 35% of the improvement obtained between the reference situation and option B.

The flooded areas for the reference year under the three situations are as follows:

- Without project : 50 640 ha
- Option B : 33 840 ha
- Partial embankment : 44 800 ha

7 ENGINEERING

7.1 Physical Features and Present Situation

The general pattern of the topography of the project area is V shaped from east to west with Madardhaw river (or Dadbanga khal) as central, north to south drainage axis. A general gradient from north to south from elevations of 19.8 m to 13.7 m can be observed. The natural drainage of the area is complex. It was assessed from the study of air photographs and the existing 4" to 1 mile topographical maps, and from site visits (see Figure 7.1). The Madardhaw river, Chatal river and the Jhenai river form the main drainage network of the project area and are fed by numbers of secondary drains which are actually meandering former river beds. At field level, the present drainage pattern is governed by existing bunds around paddy fields and by embankments for roads and flood protection. At field level there are no drainage channels as such and excess water is drained from each paddy field to the next before reach the drains, when base water levels in low-lying areas permit it. The highly uneven topography related to depressions (beels) and former river bank levels adds to the complexity of the present drainage pattern and shows that drainage improvements in the project area will rely more on local structural measures than on structural measures at project level.

Embankments have been constructed in the project area either for providing a dry communication network (roads and railways) or for providing flood protection to agricultural land during the monsoon season (see Figure 7.2).

The main embankments are the railway line from Jamalpur to Bahadurabad, the railway line from Jamalpur to Jagannathganj and the breached flood protection embankment along the Jamuna river from Bahadurabad to Jagannathganj. Other major embankments for roads between eastern and western parts and for internal river flood protection can be found within the project area. In 1988 all embankments were either breached or overtopped, thus highlighting the weakness of the embankment system during major flood events.

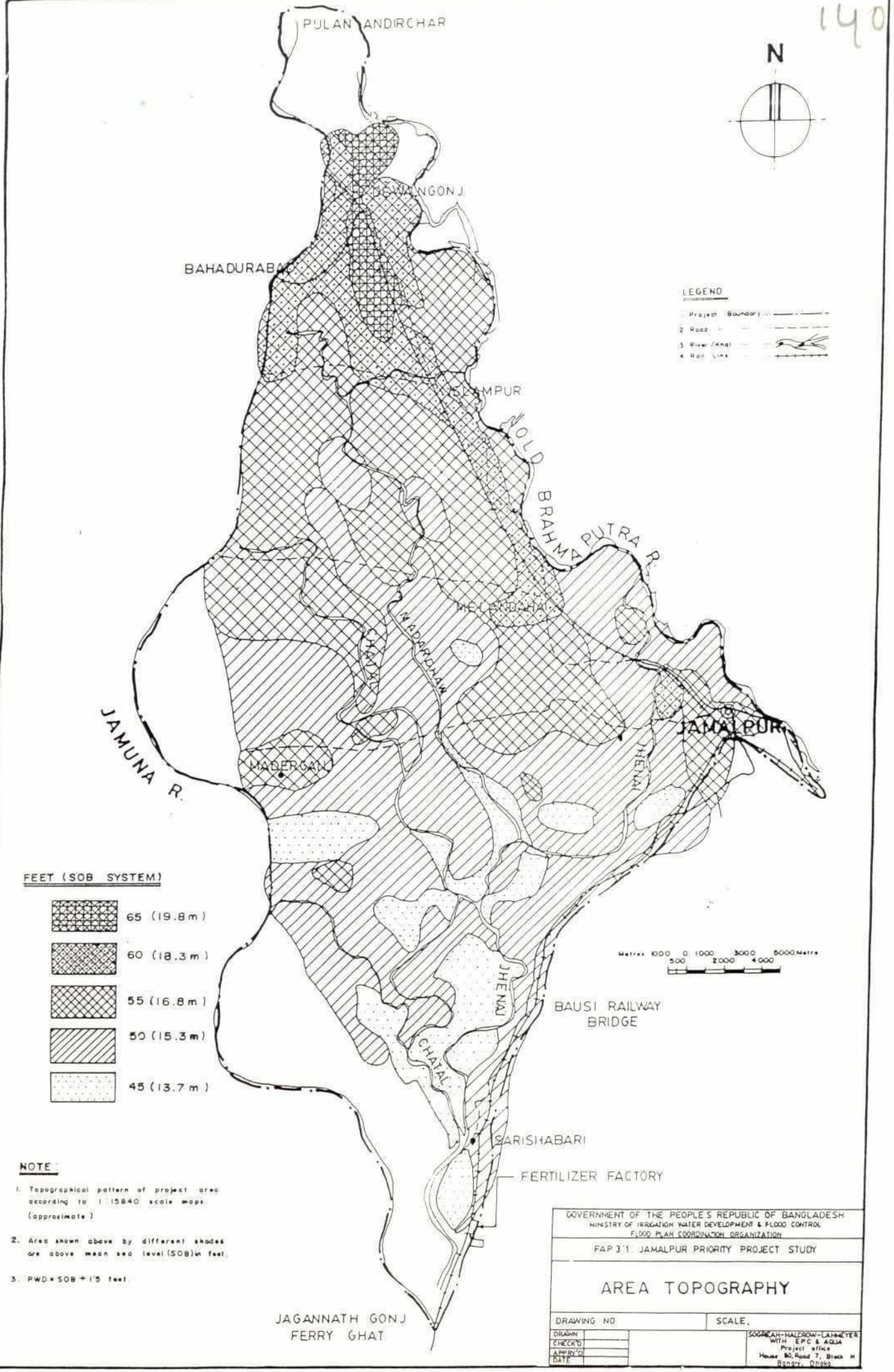
7.2 Possible Development Options for the Study Area

7.2.1 Introduction

The land and water development options, considered at the Interim Report stage, were as follows:

Option A: Flood proofing and drainage improvements (NCRS Scenario I).

FIGURE 7.1



NOTE:

1. Topographical pattern of project area according to 1:15840 scale maps. (approximate)
2. Area shown above by different shades are above mean sea level (SOB) in feet.
3. PWD = SOB + 1·5 feet.

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANIZATION

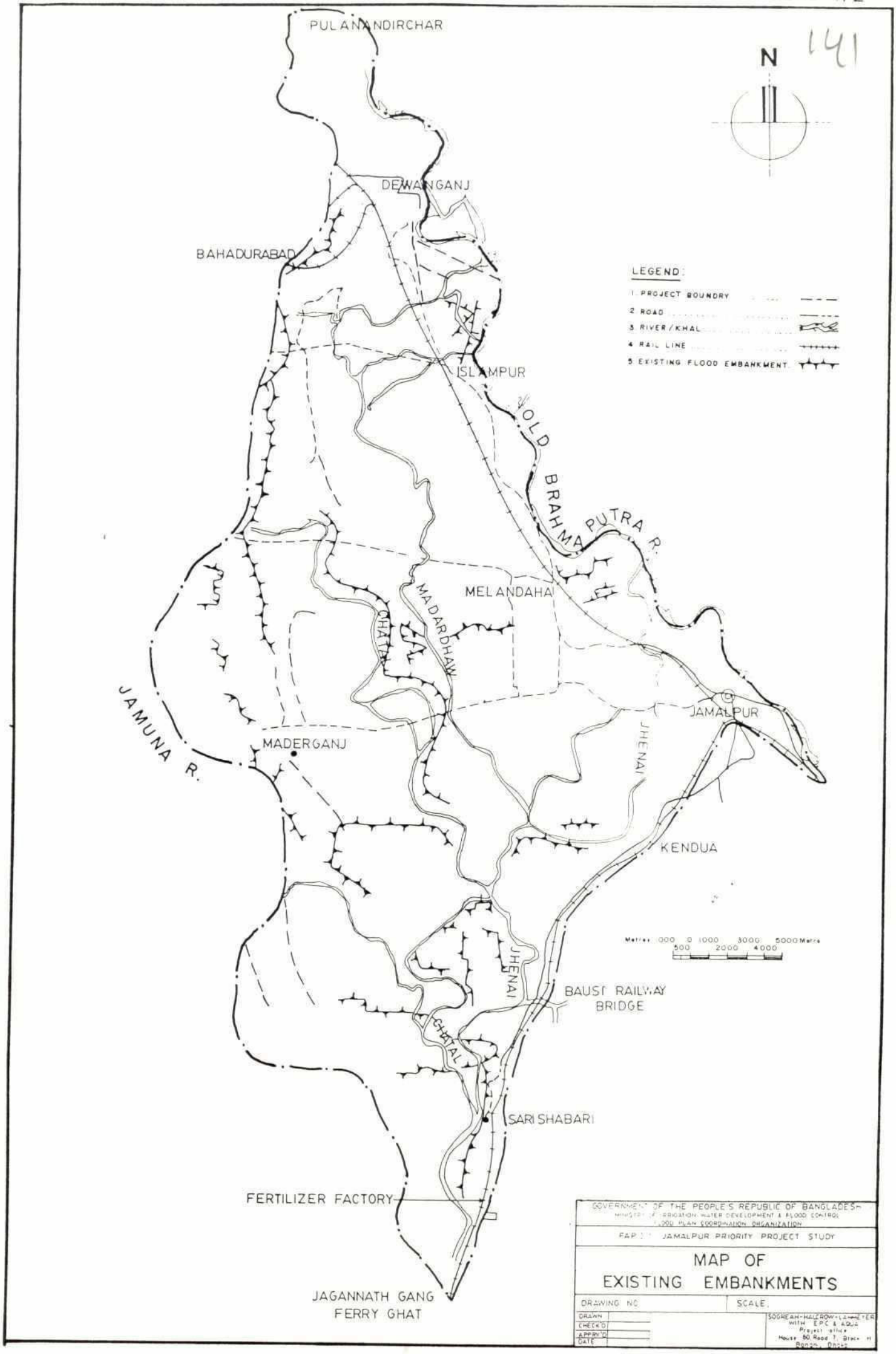
FAP 3·1 JAMALPUR PRIORITY PROJECT STUDY

AREA TOPOGRAPHY

DRAWING NO	SCALE.
DRAWN	
CHECK'D	
APPRY'D	
DATE	

SOGREAH-HALCROW-LAHMEYER WITH EPC & AQUA
Project office
House 80, Road 7, Block H
Banani, Dhaka

FIGURE 7.2


PULANANDIRCHAR
N
DEWANGANJ
BAHADURABAD
LEGEND:
1 PROJECT BOUNDRY
2 ROAD
3 RIVER / KHAL
4 RAIL LINE
5 EXISTING FLOOD EMBANKMENT
ISLAMPUR
OLD BRAHMA PUTRA R.
MELANDAHA
MADARDHAW
CHATAL
JAMUNA R.
JAMALPUR
MADERGANJ
JHENAI
KENDUA
Metres 500 0 1000 2000 3000 4000 5000 Metres
JHENAI
BAUST RAILWAY BRIDGE
CHATAL
SARISHABARI
FERTILIZER FACTORY
JAGANNATH GANG FERRY GHAT
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANIZATION
FAP 1 : JAMALPUR PRIORITY PROJECT STUDY
MAP OF EXISTING EMBANKMENTS
DRAWING NO.
SCALE.
DRAWN
CHECK'D
APPRV'D
DATE
SOGHEAN-HALCROW-LAHMEYER WITH EPC & AQUA
Project office
House 80, Road 7, Block H
Banani, Dhaka

Option B: Controlled flooding for the whole areas; intakes on major streams crossing the boundary; full boundary embankments; drainage improvements and flood proofing on char land within the project area (NCRS Scenario III).

Option C: Project divided by extended Chatal left embankment; north and east to have controlled flooding; control structures on the Jhenai; flood proofing for the remaining area and drainage improvement (NCRS Scenarios II/III).

Option D: Full scale polder with flushing sluices and drainage regulators only; Jamuna embankment of geotextile and other protection; improved drainage (NCRS Scenario II).

Options B and C may also include some form of compartmentalisation.

7.2.2 Option A (See Figure 7.3)

i) Objectives

The objectives which are in line with the initial findings of FAP 23 are:

- to define modifications which may be made to project designs, such as embankments, to provide refuge areas during extreme floods;

- to define small scale structural measures that can be undertaken by local people, with the ultimate objective of reducing flood losses in the project area,

- to improve drainage conditions so that water level in the paddy fields can be controlled efficiently (removal of excess water due to river flooding and rainfall) taking into account the specific requirements of fisheries activities.

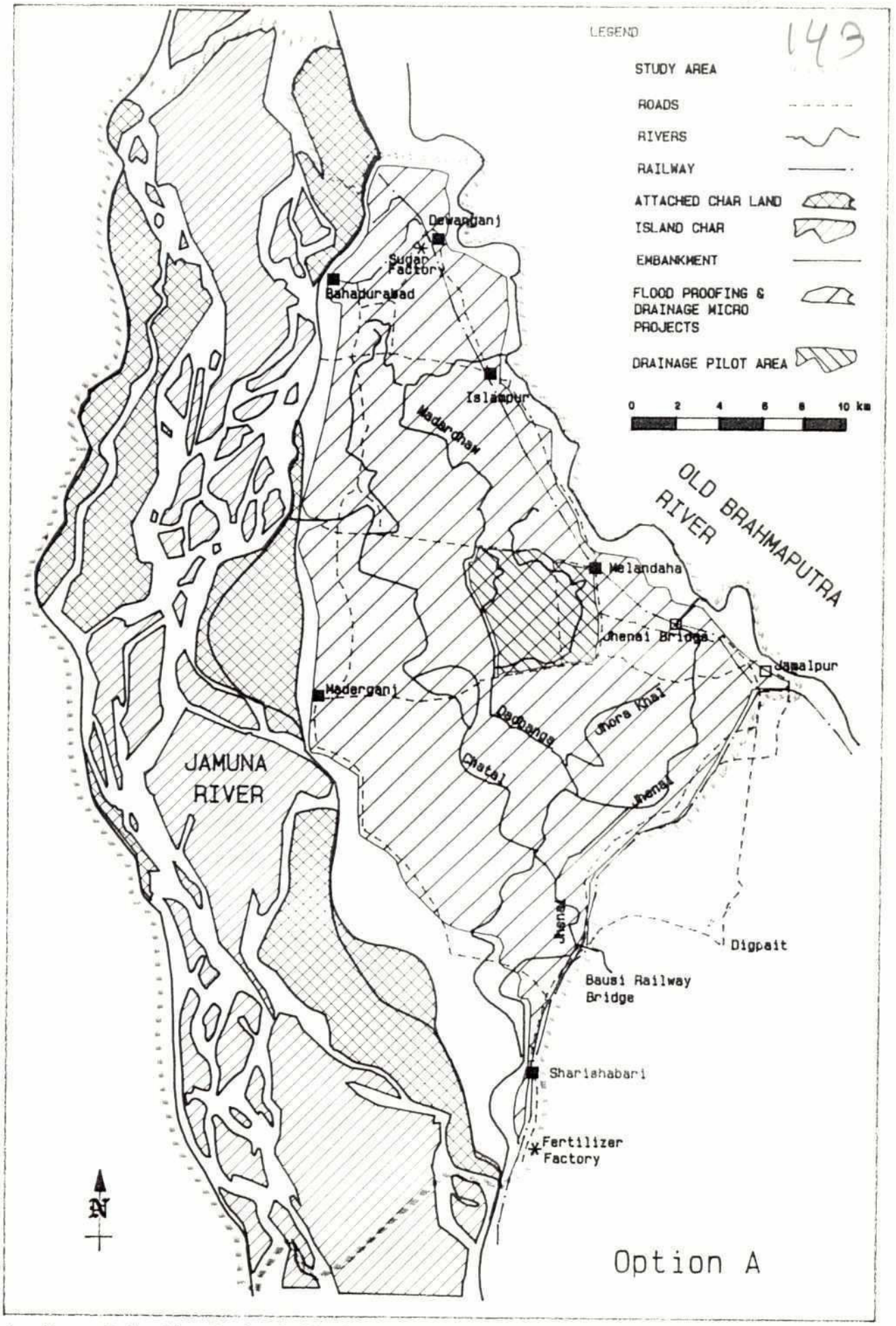
ii) Components

The components for Flood Proofing are:

- refuge areas providing safe places and basic life support during extreme floods, and community infrastructure to improve the population's living conditions,

- flood proofing of households which will be raised above extreme flood levels taking into account the impacts of the Jamuna confinement and other projects which will modify the natural water depth in the river,

Figure 7.3



Jamalpur Priority Project Study

The components for Drainage Improvement are:

- improved channels for the drainage of depressions and waterlogged areas;
- excavated channels and new control structures to achieve an accelerated release of excess water and the control of water levels when water should be retained and water bodies preserved

7.2.3 Option B (See figure 7.4 and 7.5)

i) Objectives

The objectives of Option B are as follows:

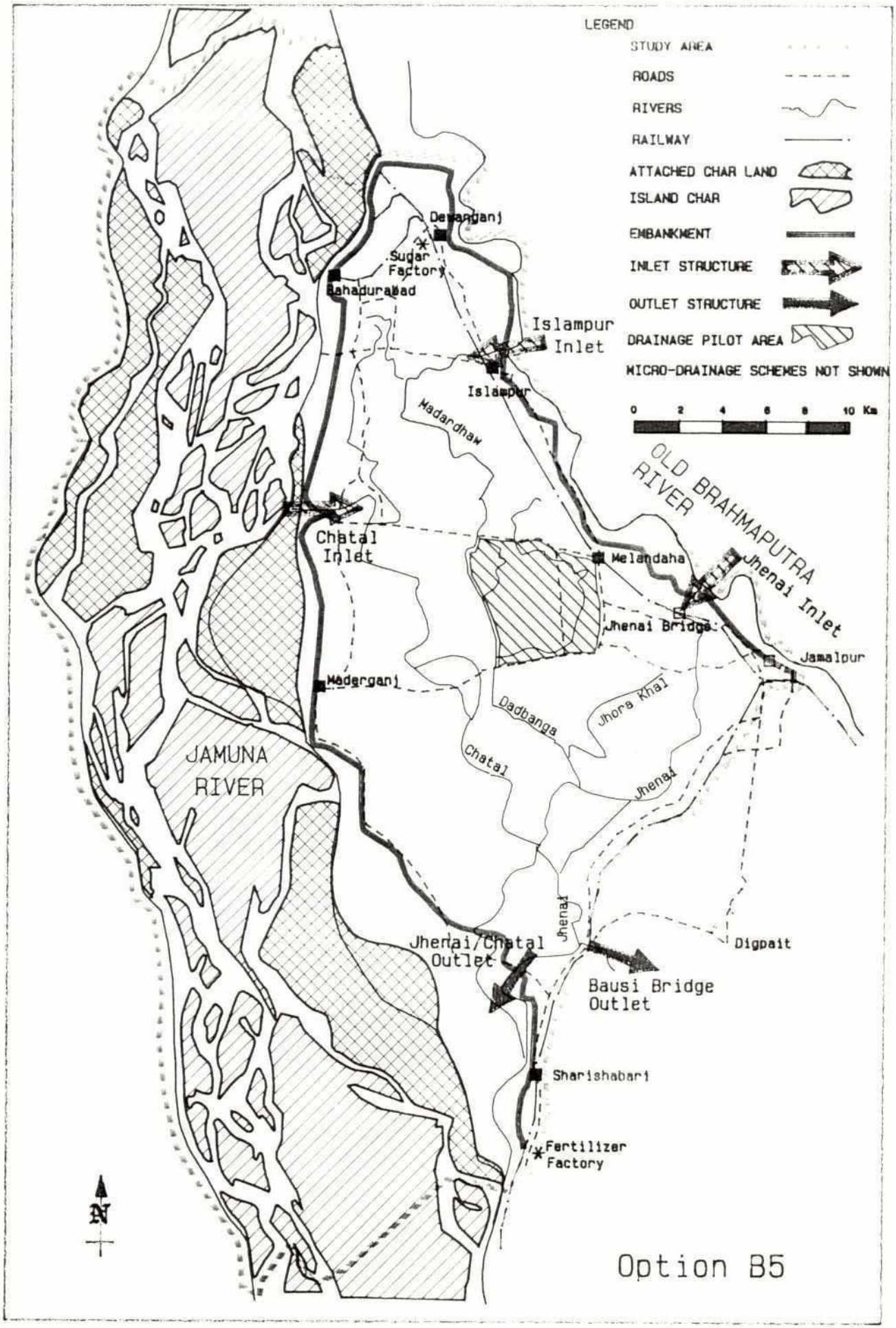
- to admit only controlled flows to the project area thus preventing early floods, peak floods and subsequent excessive rise of water levels during inundation;
- to protect railways and towns against floods;
- to improve drainage conditions so that water levels in paddy fields can be controlled efficiently (removal of excess water due to rainfall and when inundation recedes);
- to mitigate, as much as possible, by water management the adverse impact on fisheries.

ii) Components

The components of this Option are the following:

- flood proofing as in Option A for land outside the embankments
- an embankment along the Jamuna river (embankment 1);
- an embankment along the old Brahmaputra river on the eastern side of the railway (embankment 2);
- an embankment along the east bank of the Chatal river on the western side of the railway, downstream of Bausi Bridge (embankment 4a);
- two control structures to admit floods on the Old Brahmaputra river, a major one at Jamalpur for the Jhenai intake (S2) and a smaller structure at Islampur (S1);
- a major control structure at the Chatal inlet from the Jamuna (S5);

Figure 7.4



Jamalpur Priority Project Study

- a major control structures to release water from the project area; at Sarishabari (Jhenai/Chatal outlet - S4)

- minor control structures (flushing sluices) in relation to local topography in order to admit controlled floods and to drain excess water;

- channel and drainage improvements as per Option A.

7.2.4 Option C

i) Objectives

The objectives for Option C are the following:

- for the western part of the area, objectives are similar to those of Option A,

- for the eastern part of the area, objectives are similar to those of Option B.

This Option derives from the following facts:

- the set back for the flood protection embankment along the Jamuna river, although located in accordance with the 20 year criterion of FAP 3, would not be completely safe in the long term;

- fishing in the area west of the Chatal embankment would be virtually unaffected.

ii) Components

The components for this Option are the following:

- an embankment along the left bank of the Chatal river with extension parallel to the Jamuna to Bahadurabad and to Bausi bridge to the south, dividing the Chatal from the Jhenai;

- a new channel for Chatal at loop approximately 8km upstream of Bausi Bridge;

- an embankment along the old Brahmaputra river on the eastern side of the railway;

- an embankment along the Jhenai river on the western side of the railway downstream of Bausi bridge;

- improvement of embankments around two higher areas west of the Chatal, one around Madarganj and the other to the south east;

- two control structures on the old Brahmaputra river to admit floods, a major one at the Jhenai intake and a smaller structure at Islampur;

- two major structures to release water from the project area, one at Bausi bridge, one on the Jhenai;

- minor control structures (flushing sluices) in relation to local topography in order to admit controlled floods and to drain excess water;

- channel and drainage improvements as per Option A;

- flood proofing measures as per Option A except in the protected area.

7.2.5 Option D

i) Objectives

The objective for Option D is:

- Full flood protection of the project area.

ii) Components

The components of this Option are the following:

- flood embankments as in Option B;

- improved channels and drainage as in Option A;

- major gated inlet structures on the Chatal and Jhenai and a smaller gated structure at Islampur;

- major outlet structures on the Jhenai/Chatal; a simple weir at Bausi Bridge and a controlled structure near Sarishabari;

- controlled minor cross-drainage structures where necessary along boundary embankments;

- flushing sluices where necessary;

- flood proofing measures as in Option B.

7.3 Selection of Options for the Feasibility Study Proper

At the Interim Report (R3) stage, the option for the full flood protection of the area, Option D, was discarded from further discussion on account of the severe disbenefits which would be created by the exclusion of all river flood water from the project area. The main negative impacts which led to this decision were:

- the complete stop to the recruitment of fish species from the rivers and subsequent impact on the nutrition of landless people;
- the impossibility of taking into account the population's wishes regarding the need for controlled flooding of agricultural land;

At the Interim Report (R3) stage, the other three options, A, B and C, were considered for economic comparison and for the evaluation of their respective expected impacts.

The economic comparison has shown that Option C, partial flood control, for the eastern part of the project area was unattractive due to a low EIRR. The main reason for this result is that Option C provides for infrastructure to protect land which, under the "without project situation" is only marginally affected by the floods in comparison to the rest of the project area, with investment costs per ha of embanked area about 30% higher than investment costs per ha of embanked area for Option B.

Option A and B showed good results.

In terms of impacts and in terms of benefits, the findings concerning these two options were not fully conclusive. The main preliminary result of the Interim Report (R3) study on Options A and B were as follows:

i) Option A: flood proofing and drainage improvement

- it tackles the issues of immediate loss of human life and assets from flooding and allows quick post flood response to economic disruption;
- it provides for a certain increase in agricultural production through drainage improvement;
- it does not affect fish production, the livelihood and an important nutritional source of the landless and the poor;
- it fails to protect the existing cultivated area and therefore does not respond to the expectation of most of the local population;

- it does not provide any economic confidence to the farmers who are reluctant to face the future following major flood events.

ii) Option B: flood control and drainage improvement

- it secures a continuous increase in agricultural production;
- it allows a phased approach to implementation, with the possibility of pilot trials, allowing the assessment of impacts over small areas to be used for further expansion, especially for flood proofing and fisheries;
- it responds to the population expectation, provided that it is implemented on the basis of a "bottom-up" approach.

It was therefore accepted by FPCO and the donors that, Options A and B, being the more promising options in economical, sociological, environmental and technical terms, should be selected for further analysis at feasibility level, treating trhe flood proofing programme as a separate Project not included in Option B economic analysis (except for the mitigation costs due to confinement of the Jamuna.

7.4 Description of Components of the Selected Options

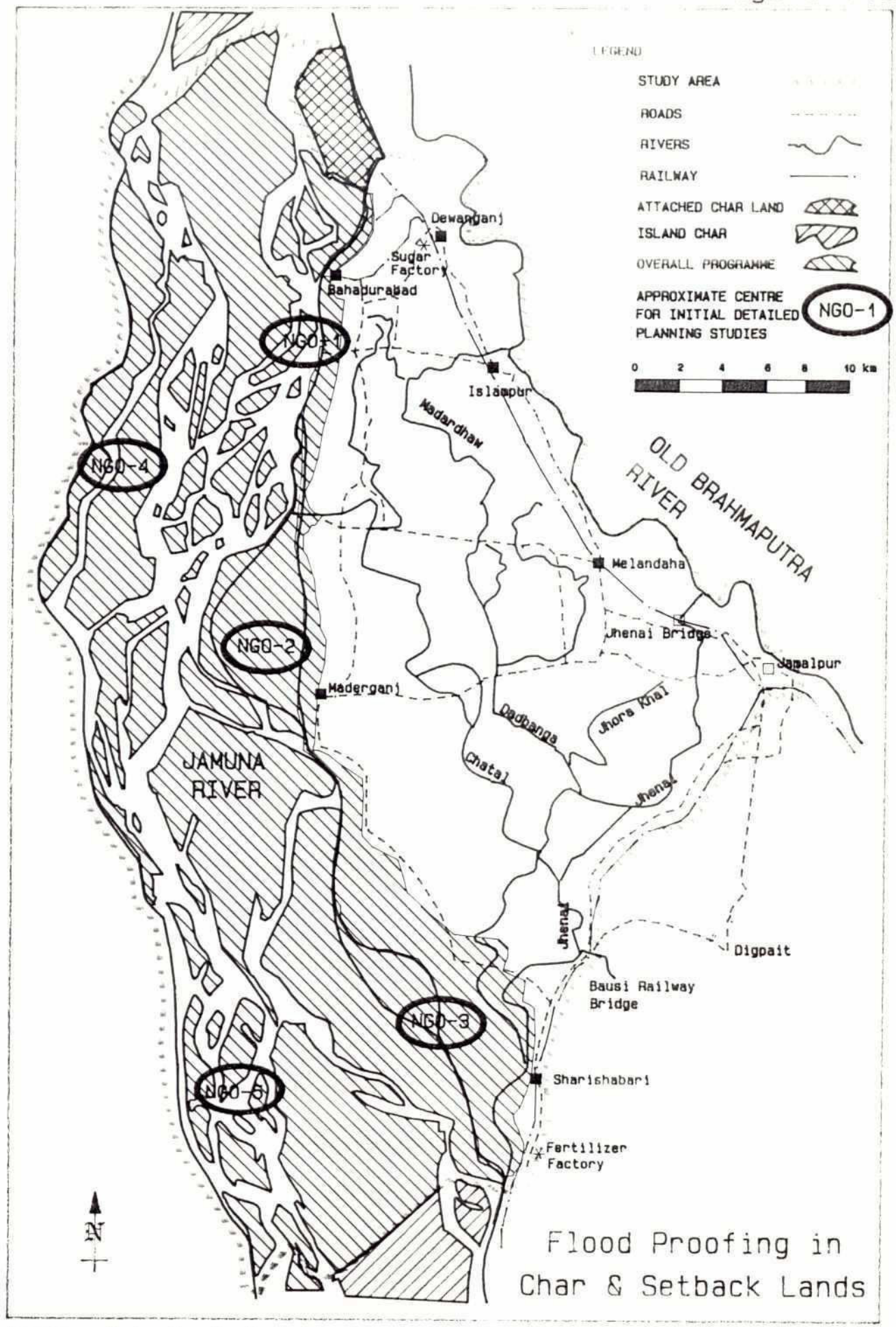
7.4.1 Flood Proofing Measures (Options A)

With the expected rise in river water levels due to existing embankments (right bank, Bhuapur), Jamuna Bridge construction and the future FAP development proposals, the entire population living in island chars, attached chars and set back land would be subject to an increase flood risk.

As a result, mitigation measures have to be provided with the ultimate objective of eliminating incremental damages caused by increased flooding. However, it is not easy to identify the impact of FAP 3.1 development proposal separately from Jamuna Bridge, other FAPs and existing embankment. A tentative proposal for allocating the appropriate share of these incremental damages to FAP 3.1 is proposed at the end of this section.

From a socio-economic point of view, the development to be made under FAP 3.1 would contribute to generating incremental economic and social benefits in the protected land. The living conditions of the Char and Set-back land inhabitants would at best remain the same as before and the equity gap between the population of the unprotected land and of the protected land would further increase.

Figure 7.5



Jamalpur Priority Project Study

Therefore, the proposed approach, as established during the Char Study (Annex 9), calls for designing a comprehensive flood proofing programme with the following objectives:

- to save human lives
- to protect houses and households amenities (water supply and sanitation system)
- to protect livestock and poultry
- to protect and develop community infrastructures
- to support the diversification and strengthening of economic livelihood through agriculture production programs and income generation schemes

To meet these objectives, the project has five components:

- Minor Structural Flood Proofing
- Community Infrastructure Development
- NGO Support
- Institutional Support
- Technical Assistance

7.4.2 Detailed Features of Flood Proofing Project Components

i) Minor Structural Flood Proofing

Minor structural flood proofing consists of strategies adopted on individual household basis.

The findings of the study have shown that housing units in Char land are usually temporary facilities because they have to be frequently shifted due to flooding and erosion. The perceptions of Char land people indicate a strong demand for improved and more permanent settlement. This underlines the need for a housing program aiming at:

- providing flood proofed housing facilities to the most vulnerable sections of the population such as the homeless, the landless and the marginal landowners (below 0.1 ha). It is estimated that around 50% of the households could be eligible under this program. The project will support the

construction of "flood free" houses by providing building materials

- providing earth filling to raise houses of the remaining 50% of the population

ii) Community Infrastructure Development

The project would provide financial support to investment in community infrastructure development in the project area. In this respect, 400 micro-projects will be financed throughout the project area (1 micro-project for 250 to 300 households). In order to be eligible under this component an infrastructure micro project should be designed so as to:

- develop the community resource base to provide additional and/or improved livelihood opportunities.
- cost less than Tk 1 million and be completed in less than 1 year
- be implemented through NGOs or relevant government agencies with appropriate technical capabilities

The following activities would be eligible for funding under the micro-project component:

- multi-purposes flood shelters which can also be used as schools, grain stores and community welfare centres.
- refuge areas (elevated earthen platforms)
- drinking water supply and sanitation
- minor scale irrigation/drainage facilities
- development of small roads/dykes

iii) NGO Support

The main objectives of the NGO support, to be provided through experienced NGOs, are:

- to support agriculture production programmes and income generating activities through a credit system.
- to identify, design, and implement minor structural flood proofing components (housing program)

- to participate in the identification, design and implementation of infrastructure micro projects.

- to provide social support services to the population through group formation, community development, education, health and training programmes

iv) Institutional Support

This component will support project implementation and some institutional improvements for the government organization in charge of implementing the project as required to attain sustainable development. Due to the nature of the project programme, no single ministry seems to be appropriate to be in charge of the project implementation. It is recommended that an independent body, the Charland Development Board (CDB), be established. The CDB would act as a coordinating and policy making body and would be responsible for ensuring the enforcement of its decisions by the respective central line ministries.

However, because the establishment of a new authority could take time it is recommended that this project be implemented through the institutional framework to be set up under the FAP 3.1 mainland project. A Deputy Director in charge of the project will be appointed by the Project Management Office (PMO) to be established for the FAP 3.1 main project.

v) Technical Assistance

The main objective of the technical assistance (TA) under the mainland project is to assist in the project implementation and to prepare a comprehensive master plan for the development of Char land. For this purpose, the TA will carry out specific studies and will make a full use of all the information collected by the other FAP studies as well as of the experience gained from the implementation of the first phase of the project.

vi) Project Phasing

The flood proofing projects concerns a large area both in terms of surface area (about 1,140,000 people). Because the flood proofing experiences are rather limited in scale and because the nature of the project implies a bottom-up design approach, it is proposed to implement it in two phases.

- A pilot phase of three years, during which the proposed solutions will be tested and during which the methodological approach for full implementation will be worked out. This

pilot phase will represent about 5% of the total Flood Proofing programme.

- A main phase which last 5 years, or more, depending on the initial findings of the pilot phase, during which the identified full programme will be implemented.

vii) Flood Proofing Costs

The estimated base cost of the flood proofing project, as shown in Table 7.1 is Tk 1460.6 million (US $ 22 million) excluding physical and price contingencies. The cost of the pilot phase is about Tk 128.0 million while the cost of the main phase is about Tk 1332.6 million. The NGO support, which is also expected to contribute significantly to improving the socio-economic status of the population, accounts for 34% of the project base cost. Technical Assistance accounts for 3% of the pilot Project Base cost.

Table 7.1 Estimated Costs for Flood Proofing
Summary of Flood Proofing Cost Estimates
Expressed in 1991 Taka

	Unit Rate (Tk)	Total No. of HH	Total Cost (MTK)	Mitigation Rate (Tk)	Mitigation Cost (MTK)	Pilot Scheme	
						No. of HH	Cost (MTK)
Minor Structural Flood Proofing							
Vulnerable Housing							
- Building materials	10,000	57,000	570.0	0	0.0	2,500	25.0
- Earth filling	3,300	57,000	188.1	330	18.8	2,500	8.3
Other Housing							
- Earth filling	5,700	57,000	324.9	570	32.5	2,500	14.3
Total		114,000	1083.0		51.3	5,000	47.5
Loans for building materials at	30%		171.0	0.0%	0.0	30.0%	7.5
Net Project Payment			912.0		51.3		40.0
Total			1,083.0		51.3		47.5
Community Infrastructure							
Weighted Cost of Micro Projects	500,000	400.0	200.0	27,500	11.0	50	25.0
NGO Support			152.1	0.0%	0.0		44.6
Technical Assistance			25.5	0.0%	0.0		10.9
Grand Total			1,460.6		62.3		128.0
Less loans			(171.0)		0.0		(7.5)
Net Total			1,289.6		62.3		120.5
Attribute share to Jamilpur Project (FAP 3.1)				50.0%	31.2		

viii) Benefits and Justification

The major benefits of the flood proofing project would be the reduction of livelihood loss due to flood damages for the concerned households

In addition, the population is expected to benefit from the agriculture production programs and income generation activities to be supported by NGOs. Household incomes are likely to rise and the sources of economic livelihood are expected to be more diversified and thereby less subject to flood risk.

Moreover, a wide range of social benefits for the poorest households which are not immediately measurable, are likely to be generated by the project:

- the reduction of flood impact on their livelihood
- the improvement of their nutritional standards and health status
- a raised awareness and self-reliance and an improved level of education of the poorest strata of the population of the project area

7.5 Drainage improvement (Options A and B)

Waterlogging is a major problem cited by the farmers in the project area requiring accelerated surface water drainage by local measures in the following areas:

- major natural depressions with central beels or group of beels;
- minor natural depressions which remain waterlogged late into the post monsoon season;
- minor water bodies created by man made obstacles (eg roads) with deficient cross drainage.

As regards the main drainage system i.e. Chatal, Jhenai and Madardhaw rivers, it appears that training works are not required. As assessed from site investigations and the operation of the model they are deep enough to convey excess water, and their drainage limitations result from backwater effects caused by high flood water levels in the Jamuna.

The physical requirements for drainage improvement are related to micro-topography and, in the absence of detailed topographical surveys and detailed field enquiries, an estimate of the quantity of work required has been based on:

- analysis of the 4" to 1 mile 1963 maps for the major depressions and individual beels (total number 97);

- reasonable assumptions for minor water bodies not visible on the previous document (total number 300).

A sample area, shown in Figure 7.6, has been examined in detail in order to illustrate the proposed works.

Typical arrangements will be as follows:

- for major depressions: channel excavation, gated control structures to regulate minimum water level in beels;

- for minor depressions and other water bodies : channel excavation and culverts.

Provision for the rehabilitation of cross drainage structures on existing main road embankments were considered (90 structures). To address the problems of local participation in the drainage improvement and to refine the design process, it is recommended that a pilot drainage project should be selected and surveyed during the detailed design phase.

The total capital cost for the drainage component is Tk 41.2 million.

7.6 Flood Protection Embankments (Option B)

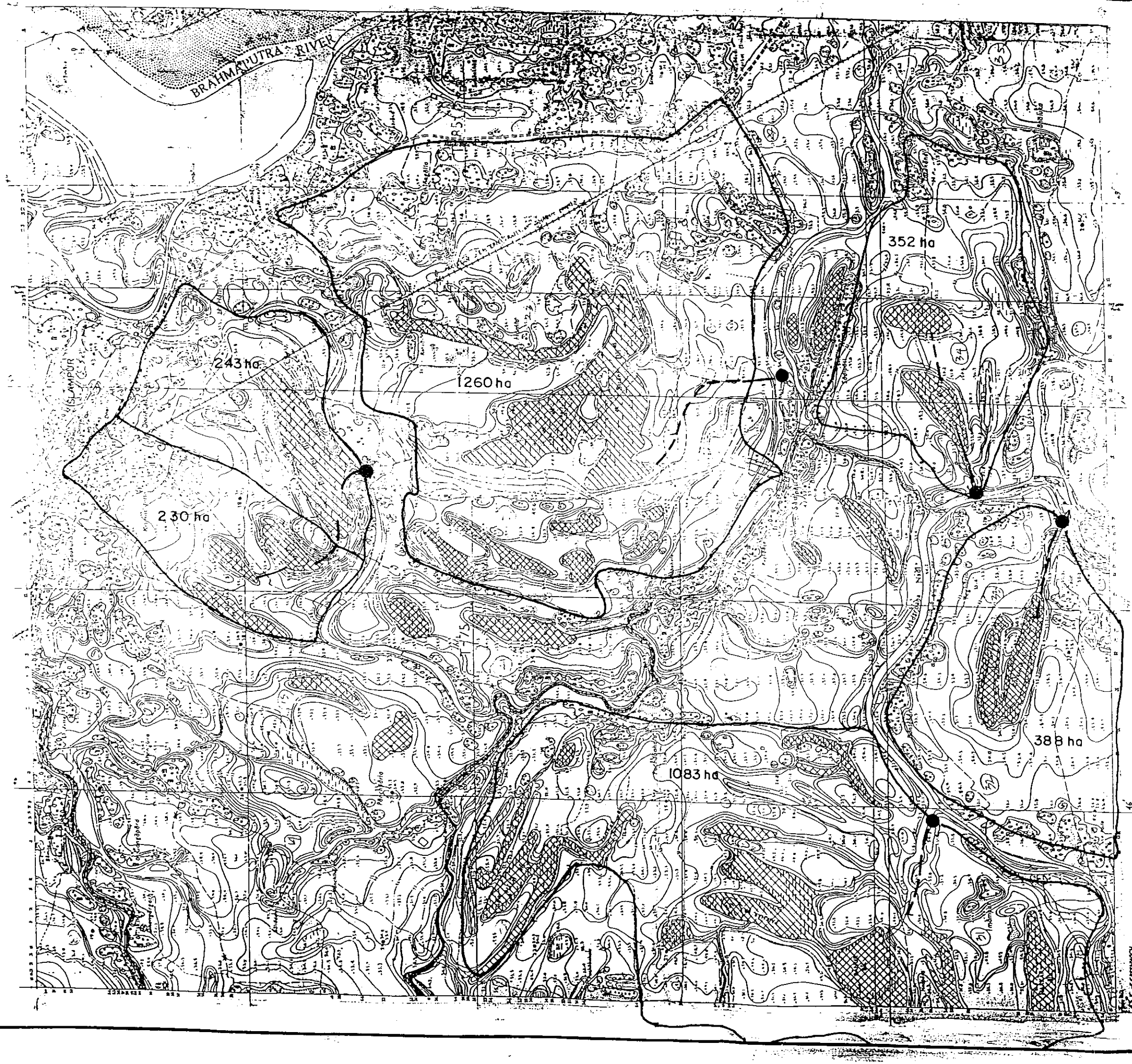
7.6.1 Embankment Alignments

Severe flooding of the Jamalpur area in the recent years indicates a need for flood protection. Option B includes embankments with intake structures for controlled flooding and drainage outlet structures along the boundaries of the Jamalpur area to achieve a sustained development of the regional economy, to prevent loss of life and property, and to reduce damage to railways and roads.

For Option B the following main protection embankments have been considered:

- embankment 1: along the left bank of the Jamuna River at the western boundary of the area between Dewanganj/Bahadurabad in the north and Sarishabari in the south with a length of 73,859 m,

- embankment 2: along the right bank of the Old Brahmaputra at the eastern boundary of the area between Dewanganj in the north and Jamalpur in the south, with a length of 43,170 m,



N

LEGEND:

- CONTROL STRUCTURE . . ●
- DRAINAGE CHANNEL . . – – – –
- BEELS AND OTHER WATER BODIES . . . .
- CATCHMENT AREA . . . 243 ha

SCALE

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION

FAP 3.1: JAMALPUR PRIORITY PROJECT STUDY

TYPICAL POSSIBLE DRAINAGE ARRANGEMENT

DRAWING NO. | SCALE :-

DRAWN
CHECKED
APPRVD
DATE

SOGREAH-HALCROW-LAHMEYER
WITH EPC AQUA
Project office
House 80, Road 7, Block 'H'
Banani, Dhaka

- embankment 3: on the southern boundary along the railway line between Jamalpur and Sarishabari with a length of 27,239 m,

- embankment 4a: along the left bank of Chatal River from Sarishabari to Jagannathganj Ghat/Dayalpur Fertilizer Factory with a length of 8,240 m

- embankment 4b: along the railway line from Sarishabari to the Dayalpur Fertilizer Factory with a length of 8,240 m.

Alternative heights of embankments were considered in connection with flood protection level i.e. 1 to 100, 1 to 50 and 1 to 20 years return periods. The designation of the alternatives was respectively B5, B4, B3 and B5 was found to be the alternative proving the best return in economic terms.

The selected Option B5 contains embankment 1, embankment 2 and embankment 4a, considering that the area south of JPP (PU2) will be protected against flooding by embankments simultaneously with the protection of JPP. Embankment 4a will connect the Jamuna embankment with any embankment of PU2 area.

If protection embankments of PU2 south of the project area are not constructed in due time then embankments 3 and 4b would have to be considered in order to protect the project area against flooding from the south. In this respect it will be necessary to assess in detail with FINMAP topographic maps, further analysis of flood water levels determined by FAP 25 and further modelling, the exact extent of the embankments required in to ensure adequate protection for the FAP 3.1 area in the absence of the assumed developments within the PU2 area.

The siting of the flood protection embankments is planned to protect a maximum percentage of the population, agricultural land, villages, railway lines and major access roads from destructive floods. Nevertheless, the alignment will make use of existing embankment alignments at the banks of the rivers, access roads and the railway lines in order to reduce problems related to land acquisition.

The selection of the alignments for the protection embankments was based on an interpretation of the latest spot image satellite maps of the area which show clearly existing embankments and access roads and the actual river channels. The alignments selected by the study of the maps were verified by a detailed field inspection.

The location of the embankment alignments is shown in Figure 7.2 and on Drawing 4.

Numerous embankments constructed by various agencies exist on the proposed Old Brahmaputra and Jamuna embankment alignments. These

existing embankments were inspected and evaluated in detail to determine their adequacy for incorporation into the proposed embankments. Because of their poor quality and their actual condition the existing embankments are not adequate to be used as an integrated part of the new protection embankments. None of them which are located on the alignment of the proposed protection embankments can be used without reconstruction. Therefore, it is recommended to excavate the existing embankments and to reuse the material in the construction of the new protection embankments. If new embankments (embankments 3 and 4b) along the railway embankment between Jamalpur and Dayalpur are required, the new embankments will be located at the southern toe of the existing railway embankment in order not to interrupt the railway traffic during construction. The railway embankment will provide support to the new embankments.

7.6.2 Embankment Foundation

i) Foundation Conditions

An extensive field and laboratory investigation programme was carried out during the FAP 3.1 study and reported in the Geotechnical Investigation and Topographic Survey Report (R4).

The foundation conditions in the project area are governed by holocene river and flood plain deposits which overlie the pleistocene clay formation of the Madhupur Block. The foundation of the embankment alignments will be predominantly fine grained alluvial soils. The clay formation forms the foundation only at a few isolated areas like the area between Jamalpur and Jhenai River and the area around and north of Bahadurabad.

Considering the ever changing erosion and deposition regime of the river in the area, the alluvial deposits of the flood plain are relatively complex. It is, therefore, difficult to classify foundation materials into distinct and identifiable units. There are some transitional zones but mostly the changes are relatively abrupt representing changes in sediment load of the stream or interruptions in depositional process. The foundation conditions vary from place to place.

ii) Foundation Design Parameters

The geotechnical foundation design parameters of the alluvial material can be summarized as follows: the alluvial soils are poorly graded silty fine sand to sandy silt. There is an indication from the boreholes that in general coarsening of grain sizes appears with depth from silty material (ML to CL) to silty sand (SM) and poorly graded or single sized fine sand (SP).

The distribution of plasticity values for the foundation soils indicates a material of intermediate plasticity.

Standard Penetration Tests and in situ density tests show that the alluvial soils have low in situ density with a relative density far below 85 % (liquefaction potential) down to a depth of about 10 m.

The Madhupur clay is a soft to stiff silty clay with intermediate to high plasticity. There are some lenses of weathered ferruginous fine gravel-sized nodules and mica-rich fine to medium sand.

iii) Groundwater

The groundwater table in the project area is generally shallow, even in the dry season, and is in the range between 1 and 4.5 m below surface. The level depends upon the ground elevation and the level of neighbouring rivers.

The permeability of the foundation soil has been determined in boreholes by constant head tests. The coefficient of permeability is on an average between 10^{-6} to 10^{-7} m/s. The permeability of the sandy soil (SM-SP) increases to 10^{-5} m/s and of clayey soil decreases to less than 10^{-8} m/s.

The groundwater quality in the project area is totally devoid of industrial pollutants, is not critical in the context of embankment construction and is not likely to have any deleterious effects on reinforced concrete used in hydraulic structures or on piled foundations.

7.6.3 Construction Materials

For economic reasons it is envisaged that construction materials for the embankments will be taken from borrow areas which are located close to the embankment alignments. After exploitation of the 2 to 3 m deep borrow areas they will be reclaimed to be used as paddy fields or fish ponds in order not to loose the land for production.

In general, the construction material to be taken from the alluvial deposits in the likely borrow areas is a silty sand to sandy silt (ML to MI material) with relatively constant index properties. Below a depth of about 2 m the construction material changes into sandy material (SP). In areas with Madhuru clay, the construction material is a clayey silt with an average clay content between 6 to 20 %.

7.6.4 Embankment Design

Taking into account the expected properties of the construction materials found close to the embankment as well as the foundation conditions, the embankment design incorporates adequate side slopes and crest width

to provide sufficient stability against both normal and extreme loading by high water level on the river and country sides of the embankment, seepage water forces, seismic loading and possible traffic on the crest.

The protection embankments on the different alignments have been designed as homogeneous embankments using sandy to silty sandy alluvial material from nearby borrow areas. According to the predominantly available sandy-silty construction materials, which governs the choice of embankment side slopes, the upstream (river side) slope is to be inclined at a slope 1v:3h and the downstream (country side) at a slope of slope 1v:2h. No special sealing of the embankments will be required since the purpose of the embankments will not be storage of water but protection against flooding over relatively short periods. Therefore homogeneous embankments have been designed.

The design flood level is 1/100 years return period, which is equal to the 1988 flood level plus 0.40 m. For the Jamuna embankment and the Sarishabari/Fertilizer Factory embankment. For the Old Brahmaputra embankment, the design flood is 1/50 years return period. A normal, yearly average flood level of about 1.50 m below the 1988 flood level was considered in the design. The design tailwater due to controlled flooding was assumed to be 1 m above foundation level.

The crest level is determined by the freeboard above the maximum design flood level. For the embankments along the Jamuna River with expected large wave run-up due to a large fetch a freeboard of 1.50 m was chosen. For the embankments along the Old Brahmaputra River and along the southern railway line - if needed - a freeboard of 1.10 m was chosen.

The height of the embankments varies from place to place along the alignments in accordance with the foundation elevation, the design flood level and the selected freeboard as described above. The heights of the embankments along the alignments can be seen in the Drawings 16.2 to 16.6 which show the crest level of the embankment, the foundation level, the 88 flood level and the level of existing embankments. The average height of the embankments is substantially less than was assumed in the Interim Report for preliminary costing.

The proposed embankment along the Old Brahmaputra has an average height of 3.50 m with a minimum height of 0.95 m near to Islampur and a maximum height of 6.80 m at the Jhenai River crossing. The average height of the embankment along the Jamuna is 4.90 m with a minimum height of 2.50 m north of Diwanganj and a maximum height of 7.50 m south of Madarganj. The embankment along the southern railway line, if needed, will have an average height of 3.70 m with a minimum height of 2.60 m and a maximum height of 4.85 m.

Two different embankment designs are proposed to be used according to the required height of the embankments:

i) Embankment Alternative 1 (see Drawing 16.8 in separate volume)

Alternative 1 embankments have been designed for situations where the difference between the foundation level and the 100 year flood level is less than 4.00 m. These embankments will therefore have a height of less than 5.10 m where the freeboard is 1.10 m or of less than 5.50 m where the freeboard is 1.50m. Regular yearly inundation during the monsoon season will usually be less than 2 m above the upstream (river side) embankment toe. About 87 % of the embankment length will be constructed according to alternative 1 design.

For the Alternative 1 embankments the upstream (river side) and downstream (country side) slope will be protected only by turfing. Neither a key trench at the upstream toe to extend the seepage path beneath the embankment and to provide protection against scouring nor a drainage layer at the downstream toe will be provided.

ii) Embankment Alternative 2 (see Drawing 16.9/16.10 in separate volume)

Alternative 2 embankments will be constructed where the difference between the foundation level and the design flood level is more than 4.00 m. These embankments will be higher than 5.10 m where the freeboard is 1.10 m and of more than 5.50 m where the freeboard is 1.50 m. It is estimated that only be approximately 13 % of the embankment length will be constructed according to alternative 2 design.

For alternative 2 type embankment only the downstream (country side) slope is turfed. The upstream (river side) slope is to be protected by a 15 cm thick layer of interlocking concrete blocks. The blocks will be placed on top of a filter layer in order to prevent erosion and scouring beneath the blocks and to avoid washing out of embankment fill material during the draw down of flood water on the upstream (river side) face of the embankment. Because of the lack of natural filter material in the vicinity of the embankment alignments, a geotextile filter is to be installed. The geotextile will be anchored into the embankment fill.

At the upstream (river side) embankment toe a key trench with a depth of half the embankment height is to be excavated and backfilled with compacted fill material. The purpose of the key trench is to provide a protection against scouring at the toe and to extend the seepage path beneath the embankment. The key trench material will be surrounded by a geotextile anchored into the embankment. The geotextile will prevent erosion of the key trench fill material in case of scouring at the embankment toe. In case of scouring beneath the key trench the

sausage like key trench fill with geotextile would be displaced as a whole into the scoured hole and would help reduce further scouring.

A drainage layer under the downstream (country side) toe of the embankment will be installed in order to guarantee controlled drainage when seepage through the embankment occurs in the yearly flood season. Missing granular drainage material has been substituted by a geodrain (highly permeable geogrid with geotextile filter on both sides). A horizontal length of the geodrain of at least half of the embankment height is required in accordance with stability calculations. To allow free drainage of the geodrain, it is covered by a brick layer with openings (weep holes).

For the Jamuna and Sarishabari/Fertilizer Factory embankments, the crest of both embankment alternatives will have standard width of 7 m. A 3.5 m wide sand-gravel maintenance track is foreseen and considered in the cost estimates. For the Old Brahmaputra embankment, the crest width is 4.5 m with a 3.5 m sand-gravel maintenance track. Any further upgrading to public road is not included in the cost estimates.

7.6.5 Quantities and cost estimate

A detailed quantity estimate was done based on the actual ground levels along the alignments and the resulting individual embankment heights. The total fill volume was estimated to be about 9 million m^3 for recommended Option. The total costs for this option are estimated to be about Tk 472.7 million, based on individual unit prices (1991 price level) for the different construction materials within the embankment and crest track.

7.7 Hydraulic Structures (Option B)

Two types of hydraulic structures have to be constructed under the project.

- Major hydraulic structures to control large discharges on main rivers at the boundaries of the project area (see drawing 6 to 14 in separate volume)

- Minor hydraulic structures along the embankments to maintain and control the present flood pattern and drainage pattern at the boundaries of the project area (see drawing 5 in separate volume). 55 flushing structures, with 2 m^3/sec nominal discharge have been proposed (see drawing 15 in separate volume).

Major hydraulic structures are as follows:

- S1 Islampur Inlet . . . . . 15 m^3/sec
- S2 Jhenai Inlet . . . . . 115 m^3/sec
- S3 Bausi Bridge outlet . . . . . 50 m^3/sec
- S4 Jhenai/Chatal outlet . . . . . 400 m^3/sec
- S5 Chatal Inlet . . . . . 130 m^3/sec

The quoted nominal discharges under 0.25 m head, actual discharges depending on actual operating heads.

The sizes of the inlet structures have been fixed on order to match the bed capacity of the channels located downstream these structures. The sizes were then checked with the hydraulic model and with consideration of the operating conditions in May/June.

Bausi Bridge discharge has been fixed in order to be consistant with the NCR study findings and recommendations.

The size of the Jhenai/Chatal outlet has been justified through model simulations and the evaluation of the maximum head loss at the structure location and subsequent flooding of the area within the embankment (See Annex 4 on Modelling).

The Jhenai/Chatal outlet will include a navigation lock. Fish passes will be provided at the inlet structures.

Foundation conditions at the sites of the hydraulic structures were assessed on the basis of the Geotechnical survey. All major hydraulic structures are proposed to be founded on friction piles 15 m deep. All major hydraulic structures are located on straight channels reaches to reduce scour problems. Siltation may require regular dredging of these channels once the project is operational.

The total costs for the major hydraulic structures of Option B5 without the S3 structure will be about Tk 292.4 million. The minor flushing structures will cost a further Tk 34.7 million, approximately.

7.8 Recommendations for Detailed Design for Embankments

The geotechnical investigations already completed for the assessment of the foundation conditions and construction material borrow areas along the proposed embankment alignments and at the locations of the hydraulic structures are considered adequate to produce the detailed design. Therefore, supplementary geotechnical investigations for the detailed design can be limited to boreholes, in situ testing and laboratory soil testing on samples from the boreholes for embankments 3 and 4b parallel to the railway Jamalpur to Sarishabari, if these embankments are required. In case of special foundation methods for the hydraulic structures additional geotechnical investigations may become necessary.

If during the detailed design phase a relocation of embankment alignments and/or hydraulic structures is required, additional borings and soil testing will become necessary at the new locations. In this case also new topographic survey would also be required for these locations.

The detailed design of the embankments will require detailed cross-sections of the embankment with reassessment of slope protection, key trench and drainage layer requirements for the various locations along the alignments, especially at river crossings and in connection with hydraulic structures.

A detailed quantity and cost estimate will be necessary based on the finally adopted detailed design of the embankments.

7.9 Recommendations for Detailed Design for Structures

The sizing of the Jhenai/Chatal outlet will be refined with the hydraulic model. The JPPS model should be extended in order to incorporate the Jhenai river downstream the Bausi bridge outlet and the restricted discharge of 50 m^3/s at Bausi Bridge should be confirmed under the feasibility study of PU 2 of the NCR study. One finding of the JPP feasibility study is that the size of Bausi Bridge should be maximized in order to achieve maximal drainage conditions for the project area within the embankments.

The hydraulic design requirements of each of the inlet structures needs to be reviewed in the light of more accurate field level data downstream, an appreciation of specific water management requirements and more detailed consideration of hydraulic conditions favourable to fish movement.

Similar considerations should be given to the design of the flushing sluices, for which precise locations and individual sizings have not been fixed yet.

7.10 Compartmentalisation

The basic concept of compartmentalisation, in engineering terms, is to delineate areas, called compartments, which are bounded by physical features, such as roads, embankments or other physical barriers. Hydraulic structures are provided to control water entering and draining from each compartment. Compartments may be considered as water management units.

The concept has yet to be developed and tested and a special pilot project (FAP 20) has been initiated to this end. FAP 20 was supposed to provide guidelines to FAP 3.1. They were not available at the time of preparation of this feasibility study.

The consideration of the compartmentalisation concept in FAP 3.1 has concentrated on application in the project area. At present, the paddy field is the basic compartment which is the basic water management unit being used by farmers. Water management at paddy field level aims at controlling flows admitted to the fields and passed to the drain (or other fields) in order to maintain the water level required for a given development stage of the crop.

Considering a group of paddy fields, limited by road or other embankments, a new level of compartmentalisation could be obtained. Peripheral control of flows could be achieved at existing culverts and bridges where control structures could be constructed.

The water management procedures for such a compartment should take into account basic aspects and objectives:

- To integrate the management of the volume of water admitted to the compartment from river and the volume of water from unforeseeable rainstorms;

- To increase the water depth in the compartment so that the flooding process from compartment to compartment can be attenuated;

- To satisfy farmer's basic requirements with respect to water levels in their fields and with respect to accelerated drainage;

- To integrate the operation of numbers of control structure in an orderly and centralised manner.

Based on the above considerations and in view of the concern expressed by FPCO in their comments on the previous reports about the possible divergence of approach to compartmentalisation between FAP 3.1 and FAP 20 and the statement therein that "compartmentalisation should not be considered as essential", the strategy for JPPS must be very carefully considered indeed.

FAP 20's production of "tentative guidelines" is expected for the end of 1992 but this is too late for FAP 3.1 to carry out a detailed feasibility study of compartmentalisation of the area before the completion date for JPPS.

It is pointed out in the FAP 20 Inception Report that the "bottom-up" approach, fundamental to compartmentalisation, needs to be flexible and requires a long time for development.

The above observations point very strongly to the adoption of a staged introduction of compartmentalisation to the FAP 3.1 area. At this stage consideration could be given to providing minor water control structures,

improving road and other embankments and cross-drainage structures along the existing main compartment boundaries.

Compartmentalisation measures to be considered under this Study are therefore:

- improved drainage with due consideration of fishing activities in beel areas
- improved compartment boundaries;
- improved cross-drainage structures at compartment boundaries;
- retention of water in the river beds to increase fish production.

The next stage would follow if it is established that improved water management at a wider scale is technically feasible and economically viable and when definitive guidelines became available from FAP 20.

7.11 Operation and maintenance (O&M)

O&M of the FCDI project under the Flood Action Plan is covered by FAP 13, which provides guidance to all new projects under the Flood Action Plan.

BWDB has the ownership of all FCDI projects and is responsible of their O&M. There is an old plan to transfer O&M activities to LGEB, but it has not been implemented so far. Projects examined under FAP 13 have major O&M problems.

It appears that the main FCDI O&M problems result from conflicting interests among the concerned population (some people gain and others lose) and this is hardly taken into account in project planning, design and implementation. The main conflicts are related to decisions about the operation of control structures, to the difficult integration of the needs of farmers and fisherman and to the change of established flow patterns inside and outside project areas, after the construction of the infrastructure (with resulting "public cuts").

Institutional performance is poor due to a lack of any effective organisations which would be in a position to arbitrate between conflicting interests with public participation and due to a lack of skilled personnel. Lack of funds is a major constraint on O&M activities. In effect, with the exception of irrigation charges, BWDB is not entitled to raise revenue directly.

To achieve the long term sustainability of the project, the infrastructure need to be operated and maintained in a way which will maximise the

benefits for all the social groups concerned, which requires the combined efforts of local officials, NGO's and the local population.

As a result of this assessment the GOB should determine the overall policy to be applied. The O&M phase of a project presents three contrasting major alternative possibilities for organisational institutions:

- the present practice with BWDB assuming all major O&M responsibility and expenditure.
- the creation of a specific "Project Authority" which will assume a multidisciplinary role in the O&M of the project.
- the passing of the O&M responsibilities to local Authorities and Users Associations.

Under present policies, it is recommended that BWDB should assume responsibility for O&M with specific arrangements to mitigate the outlined short-comings which are due to the fact that BWDB's main skills are in engineering. To introduce a suitable multidisciplinary role of the Project O/M organisation, taking into account the existing organisation of the Government sectors, it is necessary that all relevant Ministries - Ministry of Fisheries and Livestock, Ministry of Agriculture - depute to the Project O&M (under BWDB and hence the Ministry of Irrigation, Water Development and Flood Control) organisation the staff required for an integrated multidisciplinary O&M organisation. Administratively and financially, these deputed staff would remain under the direct responsibility of their own Ministries.

To introduce the local participation into the O&M process, - participation of Local Authorities and of the beneficiaries - the public participation proposed at design stage should be further built into the operation and maintenance stage. Structure committees and embankment committees should be set up and should bear responsibilities for O&M activities under the supervision of the Project O&M organisation.

A tentative annual budget for O&M has been worked out. It represents about 4% of the total project capital cost.

7.12 Implementation

7.12.1 General

The recommended development for JPP is complex and, because these recommendations have been made in advance of the preparation of positive guidelines by the other relevant FAP studies, the implementation programme must take into account the necessity of proving some of these solutions and of getting them accepted by the people most concerned. For this reason a phased development with pilot projects

implemented as early as possible in the programme, is strongly recommended.

7.12.2 Programme

With the detailed design phase due to start early in 1993, the first year of project implementation would be 1994, although it should be possible to start work on pilot flood proofing project and Fisheries project at the end of the 1993 monsoon, since extensive design work is not required.

Two development phases are recommended possibly overlapping to a certain degree:

i) Phase 1

In the first year of Phase 1, i.e. the end of January 1994 at the earliest, construction would start on the section of the Jamuna embankment from Bahadurabad to the Chatal inlet and the embankments to protect Dewanganj, Islampur and Jamalpur. The drainage pilot project should be completed during 1994 and the pilot flood proofing project and the fisheries project should be initiated.

Immediately after the 1994 monsoon, the full programme of drainage improvements would start based on the initial findings of the drainage pilot area, divided into contracts for beel drainage, improvement of drainage channels and construction of drainage structures. Construction of the Jamuna embankment between the Chatal inlet and Madarganj would commence, also the construction of flushing sluices in completed sections of embankments, and all inlet and outlet structures. The flood proofing project and the fisheries project should proceed beyond the end of 1994.

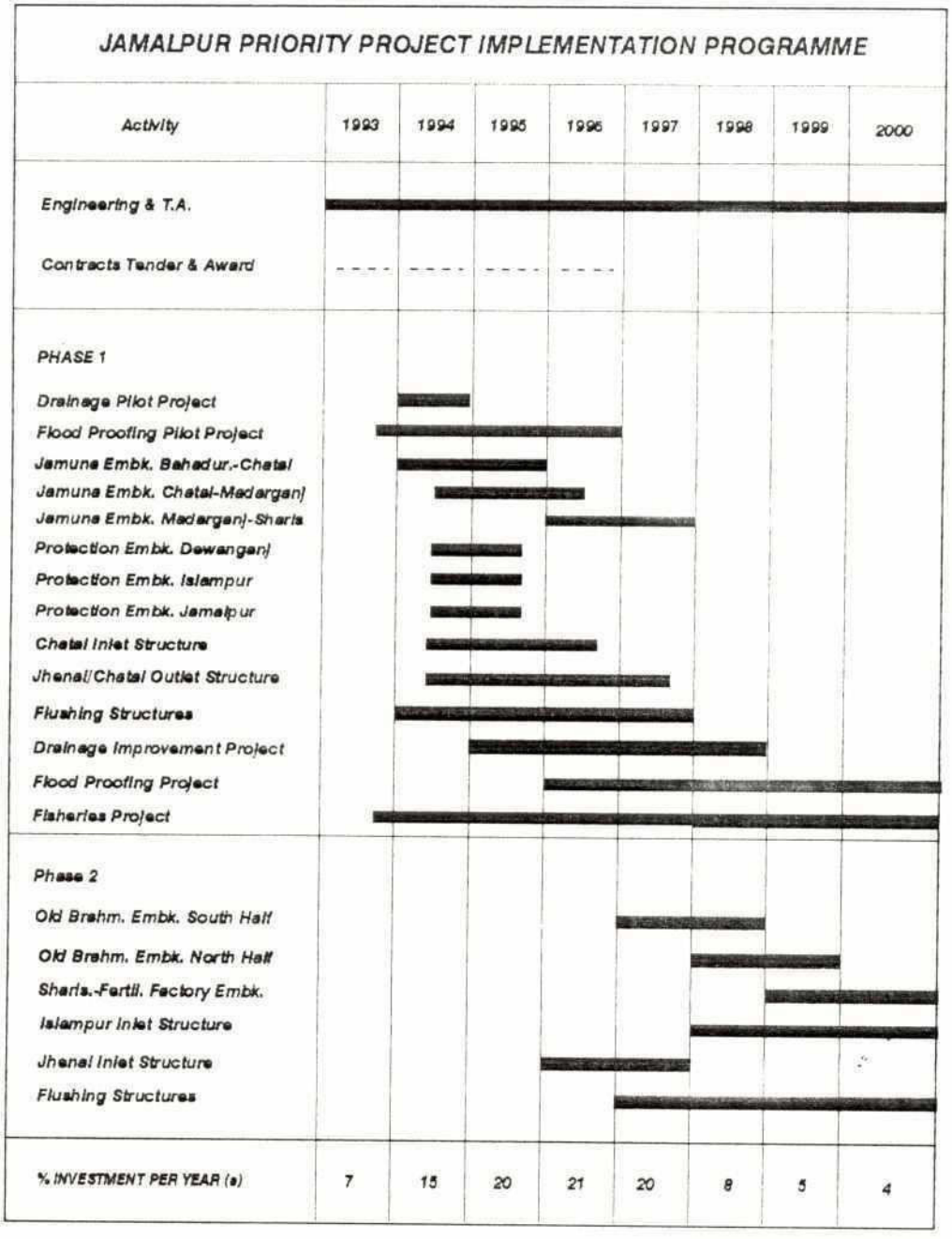
ii) Phase 2

This phase would involve the construction of the old Brahmaputra embankment from Dewanganj to Jamalpur and the embankment from Sarishabari to the Fertilizer factory. The southern part of the Old Brahmaputra embankment and the enclosure of the Jhenai inlet should be completed by the time that the Jamuna embankment is completed so that the main inflows into the project area are controlled.

An outline programme for these works is given in Figure 7.7

Figure 7.7

JAMALPUR PRIORITY PROJECT IMPLEMENTATION PROGRAMME



7.12.3 Institutional Arrangements (See Figures 7.8 & 7.9)

It is consultants opinion in the context of Bangladesh and following discussions with FPCO and other bodies, that the future of projects for the time being will have to be through traditional implementation agencies such as the BWDB.

As a result the only changes should be made for FAP 3.1 should be improvements of the present system rather than the introduction of major new implementation bodies or "Project Authorities", which would compete with the existing ones for scarce, suitably qualified, human resources.

However, it is recommended that an element of the "Project Authority" idea should be adopted within the existing framework of the BWDB so as to introduce the multidisciplinary factors into the project. To this end it is recommended that a Project Steering Committee should be formed to sit quarterly to review and monitor the project progress and to take decisions on policy and financial matters.

For the actual implementation of the project a Project Management Organisation should be formed under a Project Management Officer drawn from BWDB. This organisation should be supported and assisted by a consultancy which would be responsible for the technical design, research and construction supervision.

7.12.4 Engineering and Technical Assistance

For the detailed design stage and the preparation of tender document of option B 100 manmonths of foreign experts and 220 man-months of national experts will be required. During works extention, a total of 120 man-months of foreign experts and 500 man-months of national experts will be required.

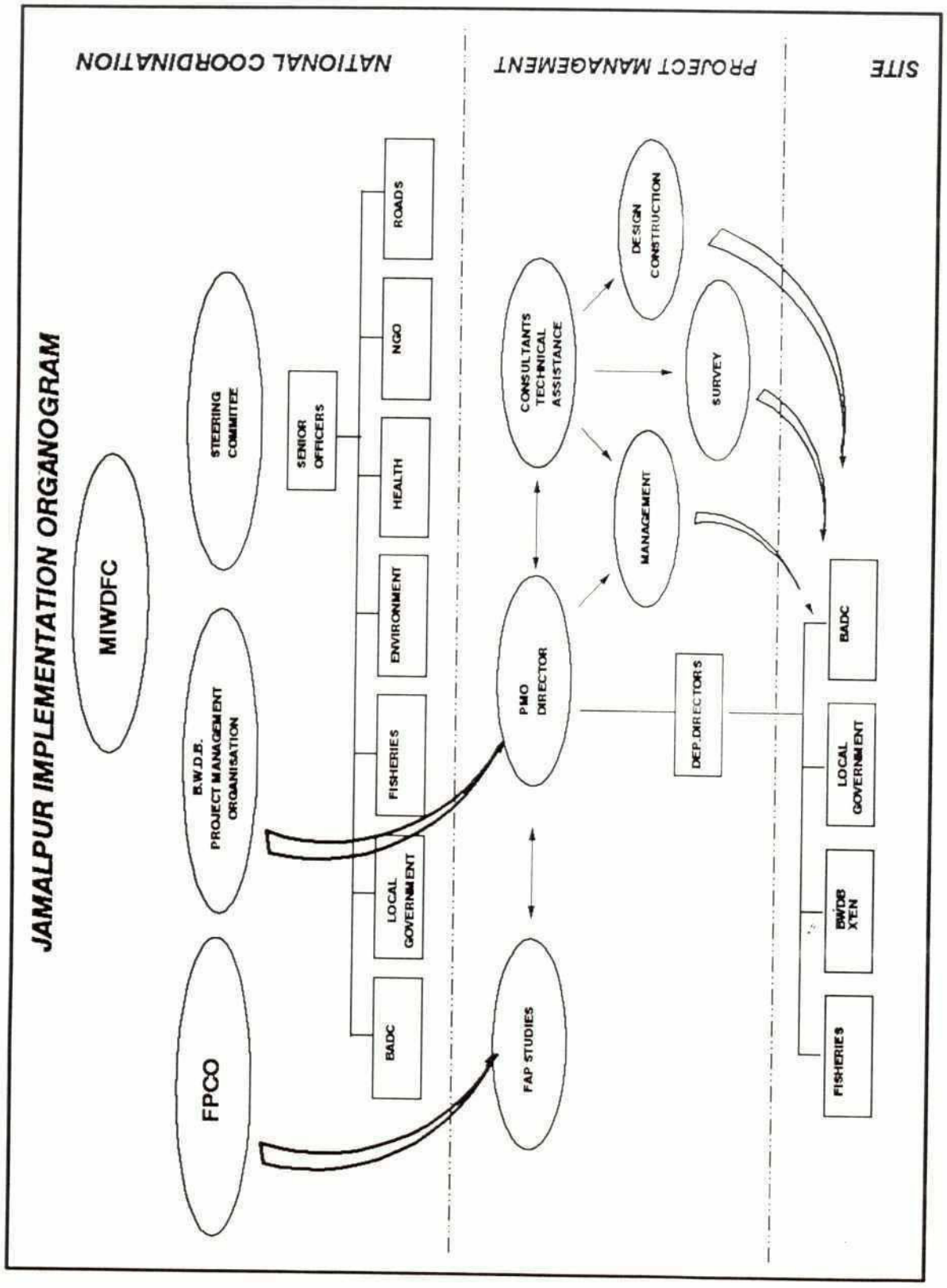
The cost estimate for Engineering cost, technical assisstance and surveys is Tk 230 Million, including Tk 11 million for the public participation process. Regarding the flood proofing programme, a total cost for technical assistance of Tk 25.5 million has been calculated, including Tk 10.9 million for the pilot phase.

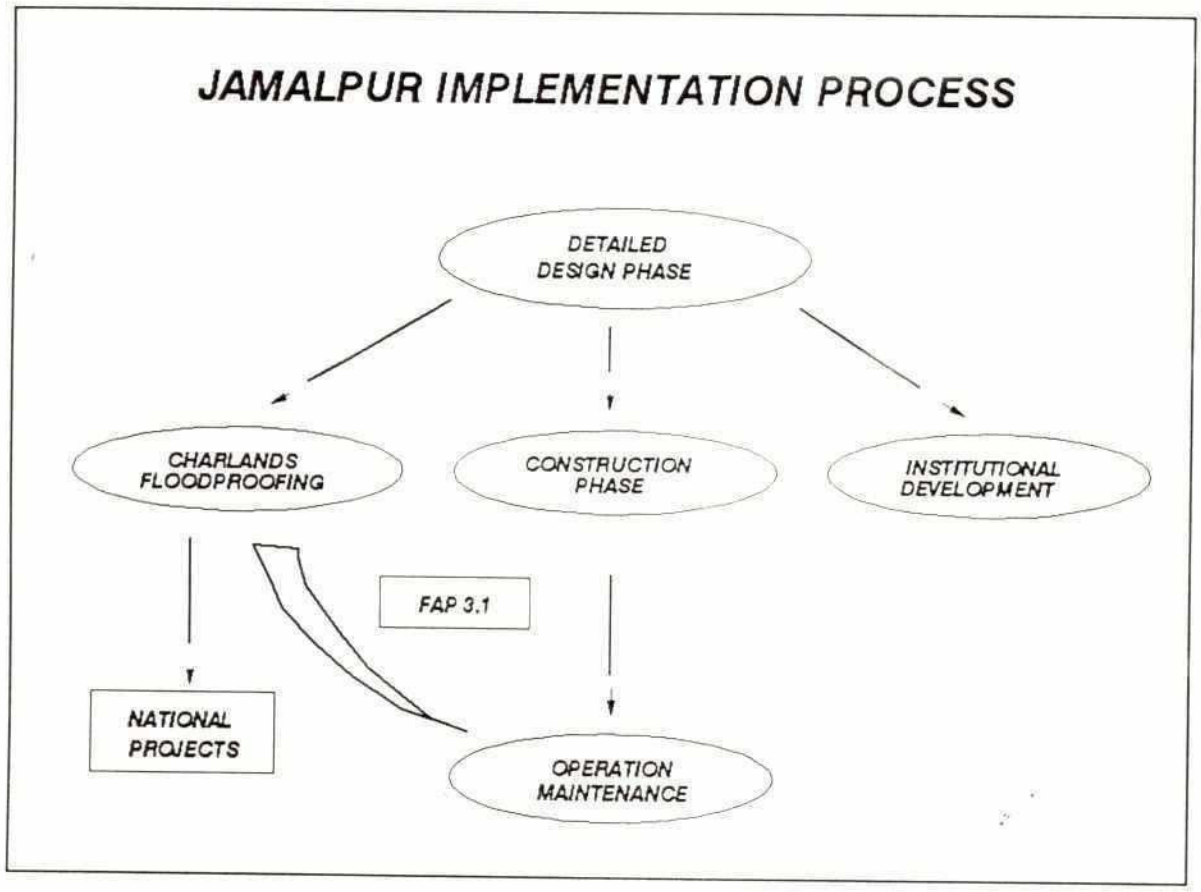
7.13 Summary of Quantities and Cost Estimates

The summary of Cost Estimates for the recommended developments is given in Table 7.2 below.

The summary of cost estimates for Options A and B5 are given in Table 7.3 below. For the economic analysis of option B5, mitigation costs on

FIGURE-7.8


JAMALPUR IMPLEMENTATION ORGANOGRAM
NATIONAL COORDINATION
PROJECT MANAGEMENT
SITE
MIWDFC
FPCO
STEERING COMMITTEE
B.W.D.B. PROJECT MANAGEMENT ORGANISATION
FAP STUDIES
SENIOR OFFICERS
BADC
LOCAL GOVERNMENT
FISHERIES
ENVIRONMENT
HEALTH
NGO
ROADS
PMO DIRECTOR
DEP.DIRECTORS
CONSULTANTS TECHNICAL ASSISTANCE
MANAGEMENT
DESIGN CONSTRUCTION
SURVEY
BADC
LOCAL GOVERNMENT
BWDB XEN
FISHERIES


JAMALPUR IMPLEMENTATION PROCESS
DETAILED DESIGN PHASE
CHARLANDS FLOODPROOFING
CONSTRUCTION PHASE
INSTITUTIONAL DEVELOPMENT
FAP 3.1
NATIONAL PROJECTS
OPERATION MAINTENANCE

account of increased water level in the Jamuna river have to be added to B5 costs, i.e. Tk 31.2 million.

Cost Estimates are based on BWDB rates adjusted to 1991 level, as per GPA.

It has been assessed that rates for construction works for FCD project contracted according to local bidding procedures are in line with the rates derived from the application of GPA.

Nevertheless, based on recent experience of construction works contracted according to international bidding procedures, it is possible that construction costs will be higher than those derived from the application of the GPA.

An analysis of 1992 rates of recent international tenders shows that a global variation of the project capital cost could be +28%. (See Annex 7 for details)

Table 7.2 Summary of Cost Estimates Recommended Developments Expressed in 1991 Taka (Financial)

	Mainland Option B5	Char and Setback Land Pilot Phase	Total Initial Investment	Char and Setback Land Main Phase	Overall Investment
Drainage Improvements	41,223,000	-	41,223,000	-	41,223,000
Flood Proofing					
Community Infrastructure	-	25,000,000	25,000,000	175,000,000	200,000,000
Minor Structural Flood Proofing	-	47,500,000	47,500,000	1,035,500,000	1,083,000,000
Sub-total	-	72,500,000	72,500,000	1,210,500,000	1,283,000,000
Embankments (Base Case)	472,756,000	-	472,756,000	-	472,756,000
Hydraulic Structures	327,053,000	-	327,053,000	-	327,053,000
Fisheries Programme	59,000,000	-	59,000,000	-	59,000,000
Land Acquisition	114,660,000	-	114,660,000	-	114,660,000
Total Capital Costs	1,014,692,000	72,500,000	1,087,192,000	1,332,625,000	2,419,817,000
Less loans	-	(7,500,000)	(7,500,000)	(163,500,000)	(171,000,000)
Net Capital Costs	1,014,692,000	65,000,000	1,079,692,000	1,169,125,000	2,248,817,000)
Physical Contingencies @15%	152,204,000	incl above	152,204,000	incl above	152,204,000
Engineering & Tech. Assistan	219,000,000	10,875,000	229,875,000	14,625,000	244,500,000
NGO Support Programmes	10,191,000	44,570,000	54,761,000	107,500,000	162,261,000
Estimated Grand Total (including loans)	1,396,087,000	127,945,000	1,524,032,000	1,454,750,000	2,978,782,000

Table 7.3 Summary of Cost Estimates Development Options A and B5 Expressed in 1991 Taka (Financial)

	Option A	Option B5
Drainage Improvements		
Earthworks	6,239,000	6,239,000
New Structures	24,984,000	24,984,000
Rehabilitation of Structures	10,000,000	10,000,000
Sub-total	41,223,000	41,223,000
Flood Proofing		
House Improvements for 28,800 H/H	273,600,000	-
Less loans repaid on 30% materials	(43,200,000)	-
Community Infrastructure Micro-Projects, 100 No.	50,000,000	-
Sub-total	280,400,000	-
Embankments (Base Case)		
Jamuna	-	365,326,000
Old Brahmaputra (incl. town protection)	-	86,519,000
Jamalpur - Sarishabari Rlwy	-	-
Sarishabari - Fert. Factory *	-	20,911,000
Sub-total	-	472,756,000
Hydraulic Structures		
Islampur Inlet	-	22,157,000
Jhenai Inlet	-	54,597,000
Chatal Inlet	-	51,335,000
Jhenai/Chatal Outlet	-	164,314,000
Flushing Sluices, 55No.	-	34,650,000
Sub-total	-	327,053,000
Fisheries Programme - Capital works		
Rehabilitation of Jamalpur FSMF	-	8,000,000
Check Structures	-	20,000,000
Fisheries Programme - NGO support		
Establishment costs	-	1,500,000
Staff Costs	-	13,600,000
Running costs for 7 years	-	15,900,000
Sub-total	-	59,000,000
Land Acquisition	31,948,000	114,660,000
Total Capital Costs	**396,771,000**	**1,014,692,000**
Less loans	(43,200,000)	-
Net Capital Costs	353,571,000	1,014,692,000
Physical Contingencies @ 15%	59,516,000	152,204,000
Engineering and Technical Assistan	42,300,000	219,000,000
NGO Support for Public Participation	10,191,000	10,191,000
Estimated Grand Total (including loans)	**508,778,000**	**1,396,087,000**

8 ECONOMICS

8.1 Introduction

Agricultural development is a major priority in the national objectives of Bangladesh. In this respect, the North Central Region, and more specifically the Jamalpur area, present physical potentials as well as basic infrastructures, making a favourable framework for further agricultural development.

However, this current development of agricultural activities has now met some limitations with the occurrence of uncontrolled flooding and deficient drainage situation.

The investments which are foreseen in this Jamalpur Priority Project, will allow a better water control to be achieved and will improve the security of agricultural activities within the areas protected by the embankments.

The Jamalpur Project unit extends over a total area of 92,242 ha (gross area), corresponding to a net area of 73,985 ha.

8.2 Methodology

The methodology adopted here for the assessment of Project profitability is in conformity with the "GUIDELINES FOR PROJECT ASSESSMENT", May 1992, issued by FPCO, abbreviated as GPA.

The basis of this economic evaluation was the construction of a model simulating the expected evolution of agricultural activities (and fisheries) over a 30-year period. The cash-flow resulting from the difference between benefits and costs for the recommended development option was then compared with the cash-flow of a reference situation defined as a "without project situation" (or: WO). Finally, the economic indicators were calculated on the differential cash-flow and a sensitivity analysis was carried out.

Two major Options were examined and evaluated:

- Option A, with implementation of flood proofing measures and drainage improvements, but without any major structures or embankments.

- Option B, providing for the construction of embankments and major hydraulic structures to control flooding, together with drainage improvements as in option A.

The areas taken into consideration in each option are as follows:

Designation	Gross Areas (ha)	Net Areas (ha)		
		WO	A1	B5
Inside future embankment		-	163	163
• land acquisition	65,804	50,148	49,985	49,985
• cultivated area				
Outside future embankment		-	-	422
• land acquisition	26,438	23,837	23,837	23,415
• cultivated area				
Total Project Area	92,242	73,985	73,985	73,985

8.3 Without Project Situation

The reference situation, quoted as "WO" in the "GUIDELINES", corresponds to the forecast evolution of the Project area with the assumption that no measures of flood control and drainage are taken over the 30-year period which is considered in this study.

Even if no public investments are made in the Project area, the farmers may make private investments and some external incentives (in particular from NGOs) may benefit the region. Field visits make obvious that private investments are currently being made for the purchase of farm equipment such as power tillers or the digging of tube wells.

Therefore, it has been assumed in the reference situation, that the irrigated area will continue to increase with a progressive substitution of high yielding varieties to local ones. This evolution will result in a regular progress of production, and hence of economic results, for the reference situation.

8.4 Development Option A1

In this Option, the planned works programme does not provide for any heavy control structures. This programme only includes:

- flood-proofing measures over the Mainland Project area,
- drainage improvement.

Figure 8.4.1

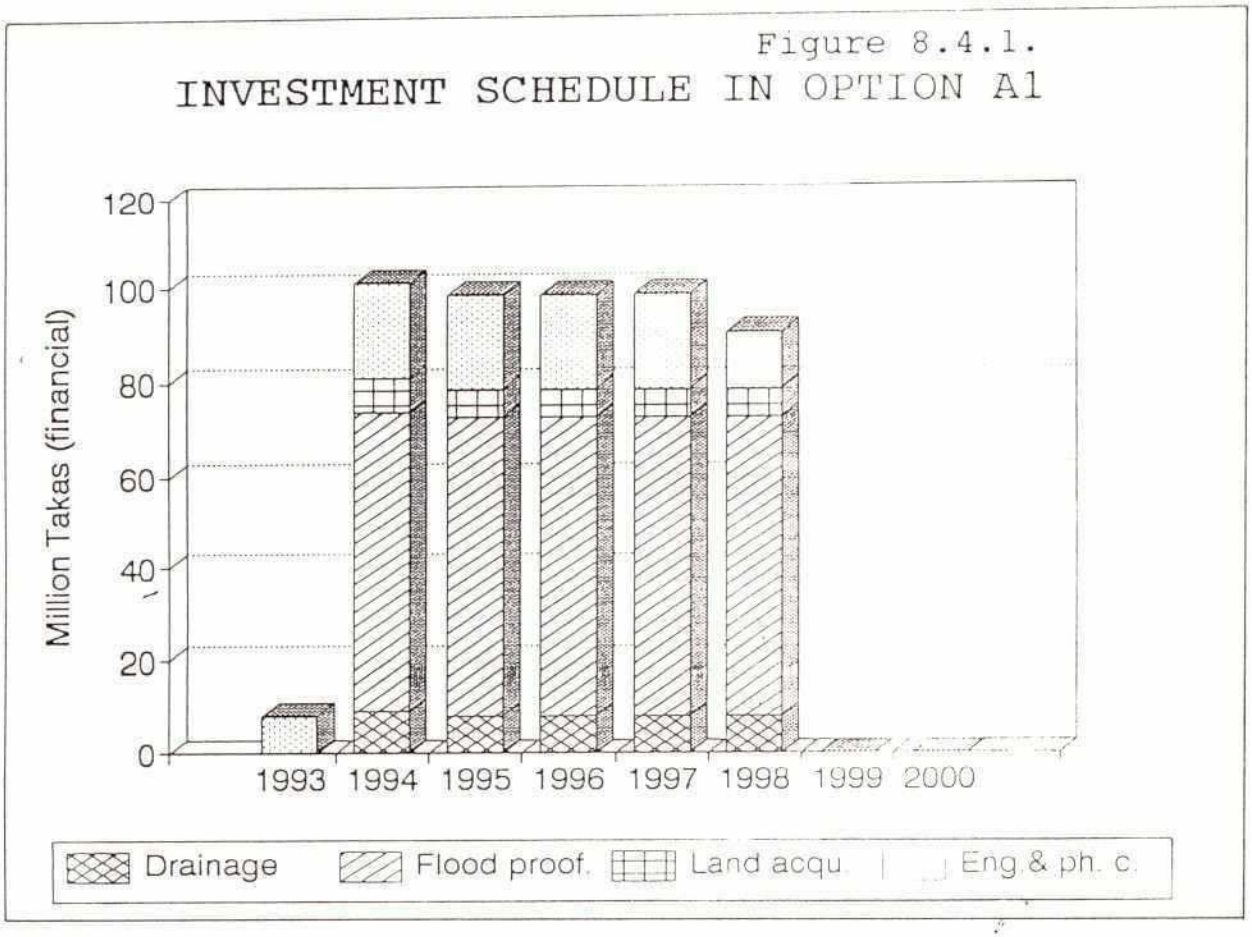


Figure 8.4.1.
INVESTMENT SCHEDULE IN OPTION A1
Million Takas (financial)
120
100
80
60
40
20
0
1993
1994
1995
1996
1997
1998
1999
2000
Drainage
Flood proof.
Land acqu.
Eng.& ph. c.

Land types distribution will be modified in drained area through a slight increase of land areas with low flood risk and a parallel diminution of areas with high flood risk.

In Option A1, a slight intensification of rice cultivation may be expected, particularly through a shifting from B. Aman to HYV Boro, thanks to a reduction of the submergence period and through higher use of inputs and improved management practices. Supplementary benefits will come from the reduction of flood damages on the livestock etc and assets of 28,800 concerned households, owed to the consequences of the flood proofing programme. An option A0, with drainage improvement only has been analysed.

8.5 Development Option B5

In this Option, which is recommended, the planned programme of works includes: flooding control, drainage improvement, fisheries development. A maximum protection against floods is achieved through the construction of embankments and structures for the control of flooding. In addition, half the incremental costs of the parallel flood proofing programme in the Jamuna are attributed to option B5, arising from the increased water levels caused by the confinement of the river by the right and left embankments.

It is expected that the flood control will bear positive effects on agricultural benefits, by way of:

- cultivation of risk free transplanted Aman in all the areas, with HYV instead of local varieties,
- increased irrigation practice in risk free area, allowing in particular extension of Boro,
- reduction of damages on HYV Boro and T. Aman,
- increased fish farming in risk free area, through specific support.

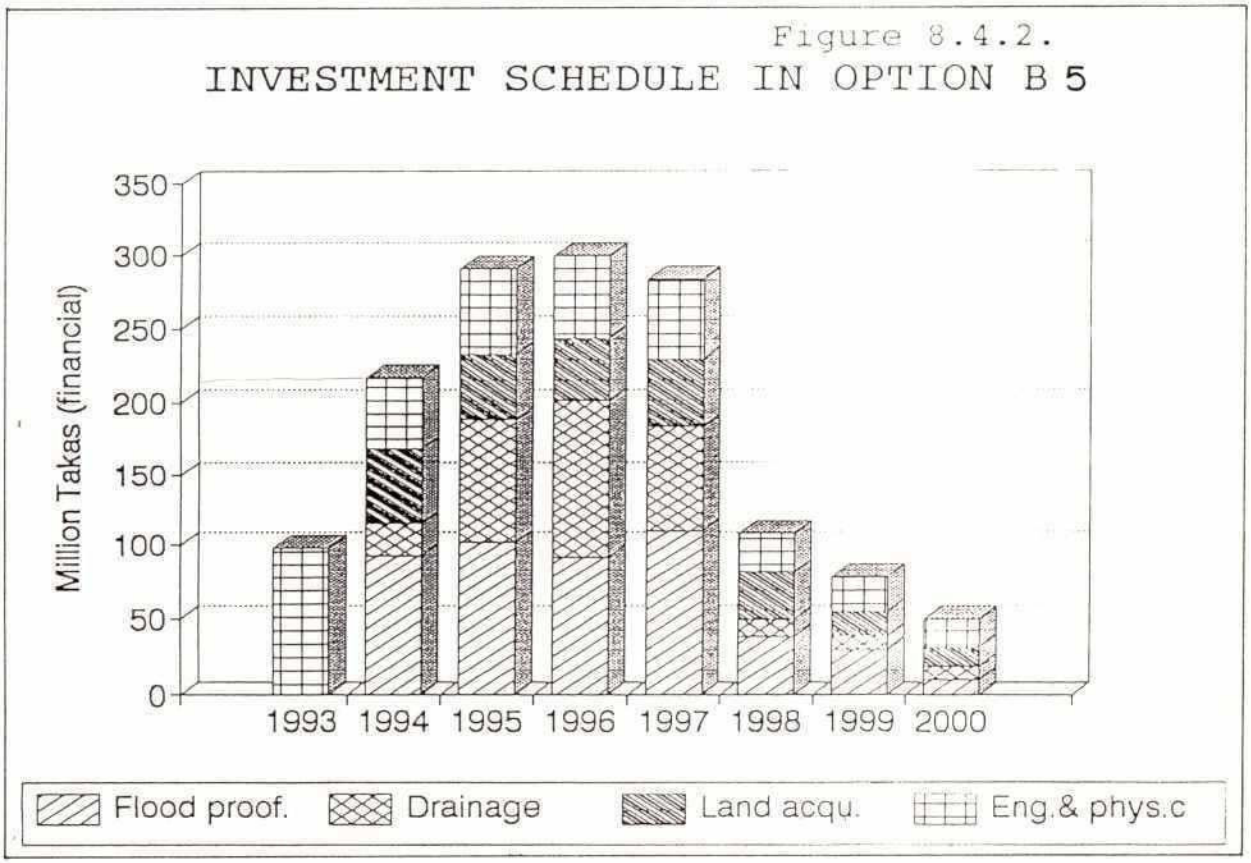
In quantitative terms, the modification of land type distribution within the embankments allows an increase of 9,239 ha of land types F0 and F1.

The modification of crop distribution linked to the evolution of land types has been assumed over 7 years, with 1 year delay with respect to the starting date of the works. The reaching of new yield levels (corresponding to damage-free conditions) is supposed to be achieved in 5 years following the shifting to new cropping patterns.

Figure 8.4.2

Figure 8.4.2.

INVESTMENT SCHEDULE IN OPTION B 5



Annex 8 - vi

100
210
280
300
280
170
100
80
45
1395

8.6 Project Benefits

Direct benefits correspond to agricultural and fish-farming products, while indirect benefits are due to a possible reduction in agricultural and non agricultural damage.

In order to make an assessment of the economic benefits of the JPPs, it has been necessary to calculate the difference between the damage expected in the (W) and (WO) cases.

The data collected for each thana allowed a damage frequency curve to be drawn up and the mathematical expectation of annual flood damage to be calculated. The damages which can be saved by providing protection against 100 year return period floods is Tk 68.75 million per year (non agricultural damages and exceptional agricultural damages).

These damages are supposed to steadily increase in option A1, whereas they will be progressively reduced in the protected areas of option B5. In parallel, yield levels now only achieved in damage-free conditions, will generalize over the newly protected lands.

Little benefit can be expected from a raise in cropping intensities which are already very high in the Project area (191%). This ratio will remain stable with a slight increase up to (196%) in option B5.

8.7 Project Area

8.7.1 Investment Costs

The investment costs for both Options are summarized in the following table (in financial costs). They include the cost of land acquisition required by the execution of proposed development works.

In terms of areas, the land acquisition will concern a total of 585 ha to which 30 ha should be added (at no cost) for flood proofing requirements in Option A1.

Summary of Investment Costs - (MTk financial value)		
Item	Option A1	Option B5
Flood Proofing	323.6	31.2 (**)
Fisheries	-	59.0
Drainage	41.2	41.2
Flushing Sluices	-	34.7
Major Structures	-	292.4
Embankments	-	472.7
Land Acquisition	31.9	114.7
Sub Total	396.7	1045.9
Phys Cont (15%)	59.5	156.9
Eng & TA (*)	39.7	230.0
TOTAL	495.9	1432.7
(*) including local participation process on the 3 first years. (**) incremental cost to provide for the confinement of Jamuna.		

According to the above table, the average development cost would be 15,502 Tk per hectare (gross area) in Option B5, if the whole area is considered, or 28,662 Tk/ha for the protected area.

In the case of Option A1, the investments are limited to the flood proofing programme, and to drainage improvement. The total of investments amounts to 495.9 MTK i.e. 5,376 Tk/ha gross area.

8.7.2 Implementation Schedule

In terms of area protected under the Project, the proposed implementation programme implies a progressive build up that has to be taken into account for the calculation of the Project benefits in this economic analysis.

It is foreseen that the whole programme of works could be realized within a period of 7 years and that by the end of 2000, 100% of the Project area will be ready for production.

The prospective schedule for both options is illustrated in the attached Figures 8.4.1 and 8.4.2.

8.7.3 Operation and Maintenance Costs

As a result of the O/M cost analysis carried out in Annex 7 on Engineering a global 4% of the base costs for O/M has been taken into account.

8.7.4 Production Costs

Production costs include agricultural inputs (fertilizers, pesticides, seeds), labour, animal haulage and irrigation cost, when applicable, and fisheries production costs.

Seasonal credit requirements have been estimated, in accordance with GPA, at 80% of annual cash costs, with a loan period of six months and interests at 16% per year. Cash cost have been assumed to be equivalent to total production costs excluding family labour.

Finally, irrigation costs were also calculated and added to crop production costs.

8.7.5 Economic Value of Investment Costs

All types of investments listed above are expressed in financial terms. Their economic value has been calculated, in conformity with the GPA, May 1992.

With regard to the cost of land acquisition, the economic value has been estimated as equal to the value of the production foregone.

The total value of investments in economic terms, amounts to:

- 366.2 MTK for option A1
- 1043.5 MTK for option B5

8.8 Project Evaluation

8.8.1 Summarized Results

The results of the economic simulations which were carried out for the reference situation (WO), Option A1 and Option B5 are summarized below:

			Without Project	Option A1	Option B5
Assumptions	Investment components		1461 ha increase of irrigated area	1777 ha increase of irrigated area	3925 ha increase of irrigated area
			-	Flood proofing	Incremental Flood proofing
			-	Drainage improvement	Drainage improvement
			-	-	Fisheries
			-	-	125 km embankment
			-	-	4 major hydraulic structures
	Investment costs at financial prices (MTK)		-	496	1433
	Crop (ha) (a)	Single Double Triple	12,327 51,393 8,129	11712 51403 8570	9407 53926 8115
	Cropping intensity		191	193	196
Economic results at full operation (at economic prices)	Production costs (MTK) (a)		1557	1575	1626
	O/M costs (MTK) (a)		-	10.8	27.6
	Exceptional Damages (MTK) (a)		162.0	151	25.1
	Gross value (a)	Fishing (MTK)	138	138	181
		Agriculture (MTK) (b)	2566	2601	2771
	Cash flow (MTK/Year)		948	965	1224
	Value added/ha (TK/ha)		24,605	25,017	27,123
	EIRR (%)		-	0.19	14.04
	NPV (10^6 TK)		-	-170.2	+135.6
Agricultural employment (Number of man/years)			67,831	68,661	70,681

(a) Annual value for a full operational year. (b) Includes livestock

It is first recalled that in the reference scenario [WO], some progress may be expected in the total crop production and therefore in the value added per man-day. This is due to the increasing proportion of HYV crops, linked to an increase of 1461 ha of irrigated area. However, in

the absence of investment in infrastructures, the average cropping intensity will remain stable at 191%.

Under development option A1, which contains only flood proofing and drainage improvement measures, the expected benefits can only come from:

- a reduction of non-agricultural damage due to an improved protection of dwellings and assets (thus, a better efficiency of agricultural inputs) and a reduction in livestock losses,

- intensification of agricultural production on better drained land.

In Option B5, heavy investments are made in terms of infrastructures. These investments are almost triple than those for Option A1 in financial terms (1432.7 instead of 495.9 x 10^6 Tk). They result in a change of land types distribution, allowing a shift to more profitable cropping patterns and thus leading to a significant improvement of all economic parameters.

8.8.2 Sensitivity Analysis

Owing to the level of uncertainty affecting the values of Project components and most particularly their future evolution, an analysis has been carried out on the sensitivity of major economic indicators with regard to possible variations of:

- Capital costs
  - consideration of possible price variations.

- Operation and maintenance costs

- Value of agricultural production
  - effect of alternative conversion factor for rice
  - effect of yields variation
  - effect of external factors of macro-economic nature

- Reduction of flood damages

- Delays in Project implementation

- Delays in achieving yield's increase.

The results of the sensitivity analysis are summarized in the next table.

SUMMARY OF SENSITIVITY ANALYSIS		
Parameter tested	EIRR	NPV 10^6 Tk
BASE	14.0	135.6
INVESTMENT		
Variations in unit rates		
+15% Capital costs	12.8	56.9
-15% Capital costs	15.5	214.2
OPERATION/MAINTENANCE		
+15%	13.7	115.3
-15%	14.3	155.9
AGRICULTURAL PRODUCTION		
Variation of gross margin		
+10%	14.8	186.5
-10%	13.3	84.7
"Macro-economic" factors		
+20%	16.3	298
-20%	11.6	-26.8
FISHERIES		
+15%	14.2	149.3
-15%	13.8	121.9
DAMAGE		
Reduction of damages	13.3	85.3
RICE CONVERSION FACTOR		
0.65 (export parity)	10.9	
1.11 (import parity)	17.7	
Implementation (2 years delays)	12.7	50
Delay in achieving YIELDS (3 years delays)	13.3	86.9

As it appears from the above table, the economic results which are obtained for the base case formerly described as Option B show a global EIRR of 14%.

It should not forgotten that this profitability is calculated on the increment cash-flow between reference and Project situations, and that in the particular case of Jamalpur area, the agricultural sector has already achieved impressing productivity levels in terms of yields and in terms of cropping intensity. A significant proportion of the Project area is now irrigated in the dry season and cropped with HYV varieties. Therefore, the progress margin that could proceed from new investments is limited.

The sensitivity analysis also shows that most of the possible variations have relatively limited effects on the economic indicators, excepted to a certain extent when testing the possible variations of agricultural gross margin. This variation demonstrates the advantages of giving priority to investments in agricultural research and to the spreading the use of HYV seeds.

However, the highest sensitivity of economic indicators is observed with respect to variations of capital costs or delalyed implementation. These factors may be easily controlled, provided that the Project execution be strictly supervised and that effective competition is assured between tenderers at each Project stage.

8.8.3 Multi-criteria Analysis

Decisions for implementing Jamalpur Priority Project cannot be taken on the sole examination of expected financial and economic outcomes, which may be subject to unavoidable variations, owing to multiple uncertainties on determining factors. This point has been stressed above in the sensitivity analysis.

Besides the strict economic point of view, there are other quantitative outcomes that may be expected from the Project implementation. They principally reside in a substantial increase of rice production (40,600 tons above the present production level) and agricultural employment (3250 more man-years). The expected increase of fish production is also interesting in terms of protein supply.

However, other aspects of more quantitative nature should be taken into consideration: they chiefly result from the flood proofing programme and from indirect social impacts of the Project. These were analyzed in depth in Annex 3, Environment, through an impact assessment matrix.

The major points that should be taken into account in the final Project assessment are summarized in the next table. As explained in Annex 3, qualitative data were ranked according to a subjective ranking scale,

from -5 up to +5. Under all respects, the Project situation shows substantial improvements.

The following Table presents the results of the multi-criteria analysis, drawing on information from this Annex, in the case of Economic, Quantitative and Financial data, and from Annex 3 (Environment) in the case of Qualitative data.

Multi-Criteria Analysis - Summary of Project Results

		PROJECT		
Data type	Variable/Measure/Units	WO	A	B
1.ECONOMIC				
	EIRR %	-	0.19	14.04
	NPV (Tk x 10^6)	-	-170.2	135.6
2.QUANTITATIVE				
	Rice production increase(ton)	4109	10738	40577
	Employment increase(man-year)	403	1234	3250
	Fisheries production increase(ton)	-506	-506	667
3.QUALITATIVE	Hydrology			
	Surface			
	Flooding Damage to Land	-5	-5	+4
	Drainage problems	-4	-2	+4
	Erosion			
	Jamuna	-4	-4	-2
	Within Project area	-2	-2	+2
	Sedimentation			
	Jamuna	-2	-2	-2
	Within Project area	-2	-2	+2
	Clogging/Smotherring	-2	-2	+2
	Soil Fertility	0	0	-2
	Freshwater Ecology			
	Water Quality			
	Domestic Water Quality	-2	+2	+2
	Agriculture Water Quality	+2	+2	+3
	Land Resources			
	Soil			
	Quality/Chemistry	0	0	-1
	Erosion	-2	-2	+2
	Ecology			
	Flora	-2	-2	-3
	Fauna	-3	-3	-4
	Economic Livelihoods			
	Risk	-5	+2	+4
	Settlement	-4	+2	+4
	Land Tenure			
	Scarcity	-2	-2	-2
	Land Values	+2	+2	-3

	Common Resource Rights			
	Fish	-2	-2	-3
	Fuelwood	-4	-4	-4
	Grazing	-2	-2	-2
	Fodder	-2	-2	-4
	Agricultural Output	+2	+3	+5
	Fishing ("Professional")	-1	-1	+3
	Forestry and Fuelwood	-2	-2	-2
	Livestock	-2	+2	-1
	Wage Paid Employment	+2	+2	+4
	Industry	+2	+2	+4
	Drinking Water Availability	0	0	0
	Insect Borne Diseases			
	Malaria/Kala-azar	-2	-2	-3
	Japanese Encephalititis	+2	+2	+2
	Filariasis	+2	+2	+2
	Drinking Water Quality	-2	+2	+1
	Sanitation	-2	+2	+2
	Nutrition	-1	+1	-2
	Mental Health	-2	+3	+4
	Access and Transport Infrastructure			
	Waterborne			
	Jamuna	-2	-2	-2
	Within Project area	-2	-2	-2
	Railway	-1	-1	+5
	Road	-4	-2	+4
4.FINANCIAL				
	Investment costs (MTK)	0	396.7	1432.7
	O/M costs (MTK/year)	0	14.6	37.3
	Agricultural value added (TK/day)	101.0	101.3	160.1
	Agricultural value added (W/WO)	0	+0.3%	+5.0%
	Agricultural value added (TK/ha)	26842	27315	29630
	Agricultural value added (W/WO)	0	+1.8%	+10.4%

Note: Marks for Common Resource right (fish), Fishing (professional), Water-borne transport differ from Matrix in Annex 3 on Environment.
Mitigation measures are taken into account in the matrix above.

8.9 Conclusions

Decisions for implementing Jamalpur Priority Project cannot be taken solely on the basis of expected financial and economic outcomes, which may be subject to unavoidable variations, owing to multiple uncertainties on determining factors. This point has been stressed above in the sensitivity analysis.

Besides the strict economic point of view, there are other quantitative outcomes that may be expected from the Project implementation. They principally reside in a substantial increase of rice production (40,600 tons above the present production level) and agricultural employment (3250 more man-years). The expected increase of fish production is also important in terms of protein supply.

However, other aspects of more qualitative nature should be taken into consideration: they chiefly result from indirect social impacts of the Project.

All these aspects have been examined through a multi criteria analysis, the qualitative data being weighted, according to a subjective ranking scale. In all respects, except for minor points substantial improvements may be expected from the project.

9 CHAR STUDY

9.1 Introduction

9.1.1 Aims and Objectives of the Char Study

The aim of the FAP 3.1 Char land study was to examine the present social and physical environmental situation in the reach of the Jamuna river adjacent to the FAP 3.1, Jamalpur Priority Project Study area. This was prompted by concern that the area has a more serious flooding problem than the mainland and was being excluded from the FAP. Added to this was the realisation that the already serious flooding problem could be made still worse due to the interventions being proposed by FAP 3.1 and the combined effects of other possible interventions including the Jamuna Multi-purpose Bridge.

9.1.2 Definition of the FAP 3.1 Char Study Area

The defined area of study was all that land which lies between the existing and proposed main Jamuna embankments. This is shown clearly in the Regional Context Map, Figure 5.1. The degree to which these are regarded as Char land is a rather academic point as different people have their own definitions of Char lands. The major criteria for delineation is that the Char study area covers all of the land which lies between the existing west (right) embankment under study by FAP 1 and the FAP 3.1 proposed east (left) embankment. It thus covers all of the land which, if FAP 3.1 were to be implemented, would be unprotected from river flooding.

9.2 Baseline Data Collection

9.2.1 Introduction

Baseline data collection was carried out to ascertain the present situation with particular emphasis on flooding conditions with a view to seeing the consequences of how these are likely to be made worse by construction of main river flood protection embankments, based upon the latest computer modelling of FAP 25. The work included assessments of both the natural and human environment and identification of key issues that need to be considered in drawing up a development planning strategy for the area. This included a "bottom up" needs led approach to public participation so that those issues which are considered by local people to be of priority importance could be identified. This also included canvasing their suggestions for tackling these issues and the degree of commitment they would be prepared to give to achieve this in the hope of making any intervention more likely to succeed and be self-sustaining.

9.2.1 Classification of Char Land Types

Within the Char study area differing types of land form have been identified. The criteria for classifying these were varied and changed as the study progressed. The criteria included location, size, age, stability, and if cultivated and/or inhabited or not. At the outset 12 different sampling areas were delineated for sampling of socio-economic data. For data collation these were aggregated down into 6 zones and this is the basis upon which data has been tabulated. These are shown in Figure 9.1. However in the light of analyzing and interpreting the data, and also that of the FAP 16 National Char Lands Inventory, it would seem necessary for future work to reformat the data into five locational categories. These include a separate category for Island Chars (defined as those requiring a main river channel to be crossed for access even in the dry season low flow situation), Attached Chars which lie between the peak river flood limit of a "normal" annual flood and the extent of the low flow situation main river channels, and Set-back land which is essentially mainland which lies between the existing and proposed embankments and the "normal" year peak flood extent. The latter two categories need to be separated between west and east bank for practical planning purposes and the data split down to Thana level. The FAP 3.1 Char land study has concentrated on the Island Char area as the Attached and Set-back land on the east bank had already been studied under the main study and the staff resources originally planned for the work were not fully forthcoming. The gross area and population data for the Attached and Set-back land have been based upon FAP 16 total Mauza summary data which is at present preliminary pending incorporation into a Geographical Information System at FAP 19 and apportionment of split Mauzas, followed by production of distribution maps.

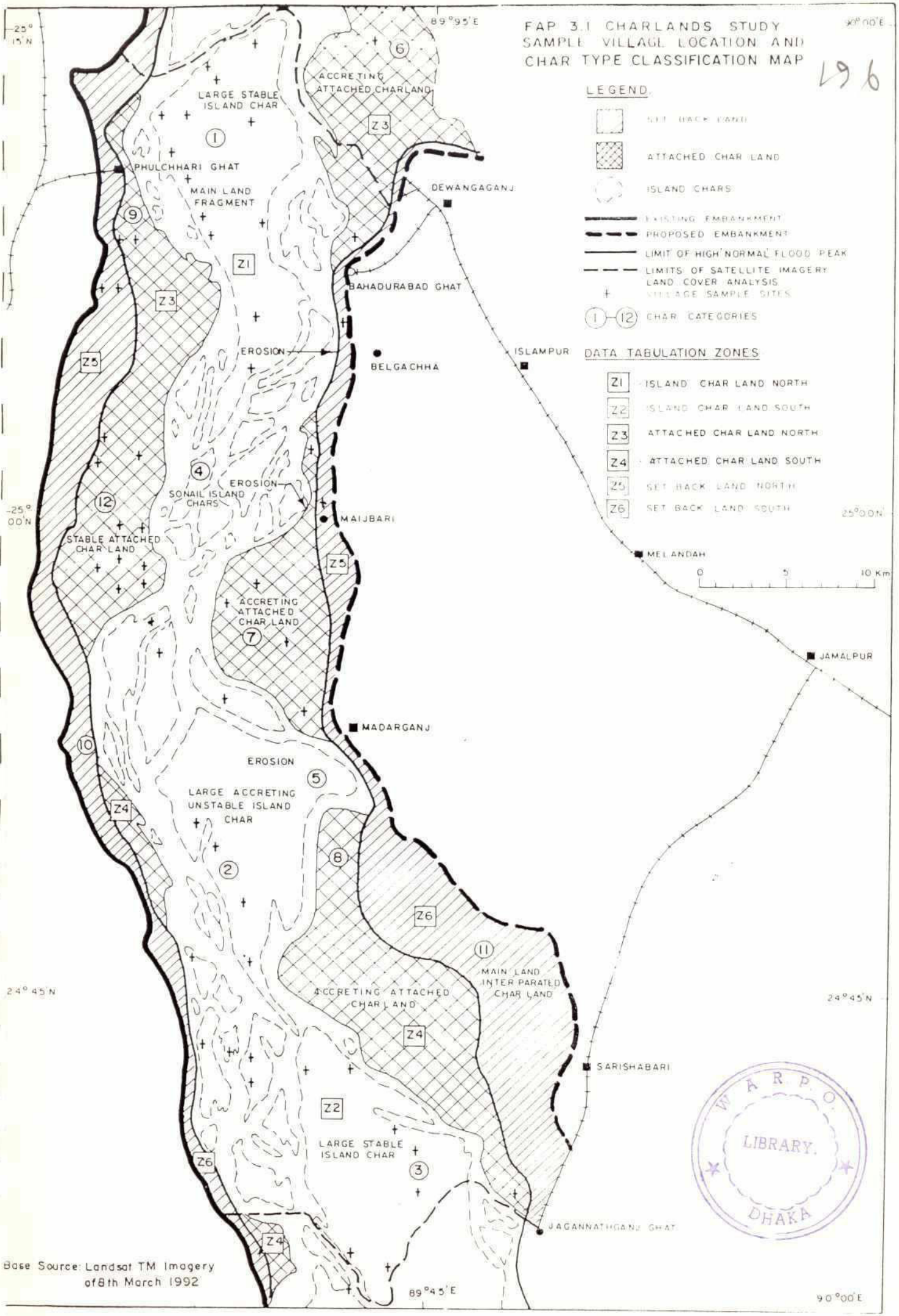
9.2.3 Environmental Data Collection

Data collection has been carried out for both the natural and human environment. For the natural environment use has been made of historical maps and particularly time series digital Landsat imagery of the last 20 years obtained and processed by FAP 19. This has included study of erosion and accretion patterns, including analysis of land age and stability. Land utilisation has also been mapped along with the diffusion of agricultural use of the land as part of the accretion and stabilisation process. This has allowed a classification of Char land to be made and areas to be digitally measured from satellite imagery. In addition inventories were carried out of flora and fauna in the study area with a specific listing being made of homestead flora and its utilisation.

9.2.4 Socio-Economic Data Collection

For socio-economic data collection a sample questionnaire survey of 580 households was carried out. These were selected using land holding

Figure 5.1



stratification criteria from 63 villages drawn up according to their locations to give a range of places in the 12 identified land types. The locations are shown in Figure 9.1. From this sample data estimates of population were extrapolated for the Island Char area and data presented according to locational zone. The data collected included population migration patterns, socio-economic activities and livelihoods including agriculture, fisheries and livestock production. In addition data was collected on occupations, employment patterns, income, land tenure, household assets, housing, health, sanitation and education. Present hazard risk was also assessed with an emphasis on flooding and erosion and peoples responses to these. This data was entered into a database and output tables produced separating the Island Chars from the Attached Chars and Set-back land. These were then analyzed, interpreted and used as the basis for drawing up a development strategy for the area once a basic framework had been established from the perception and needs assessment.

9.2.5 FAP 16 National Char Land Inventory Data

As part of the FAP 16 National Char Lands Study a major resources inventory has been carried out using Mauzas as the smallest data collection and mapping unit. The preliminary summary data from this survey has been made available to the FAP 3.1 study for the middle reach of the Jamuna/Brahmaputra river. This has been used in the drawing up of population estimates of the full FAP 3.1 study area. This data has mapped all the Mauza boundaries at 1:100 000 as an overlay to the Landsat imagery of 8th March 1992. It is tied to the BBS geo-coding system and will be interfaced and checked against the 1991 BBS data when this becomes available.

9.2.6 Institutional Data Collection

As part of the socio-economic survey work an assessment of existing Government and Non-Government Organisations and Institutions in the area has been carried out. In addition a major participation exercise was carried out which comprised structured group discussions to ascertain peoples priorities, needs, perceptions and ideas to cope with these including their commitment to this. Detailed case study interviews were also held to give insights as to household level perceptions and decision taking.

9.3 Conclusions

9.3.1 The Natural Environment

From the satellite imagery analysis and field enquiries the conclusions are that the main river has been eroding along much of the right bank and alternately eroding and accreting on the left bank. The point erosion along the east bank is of a catastrophic nature in three specific locations

and is a far more serious problem for local people than river flooding. This particularly effects people resident on the main land which after the construction of the proposed FAP 3.1 embankment will fall within the Set-back land. There has to be concern as to how any proposed embankment can be protected and quickly rebuilt should it be eroded away. The greatest benefit of embankments to these displaced people could be as permanent places of residence above flood level. Embankments should thus be designed for multi-purpose use with a berm suitable for house placement on the protected side. This should also be drawn up with the provision of flood refuge sites as a specific objective. The disappearance of low Island Chars once the annual river flood subsides is a more common occurrence than bank edge erosion but ironically of a less serious problem as the population expect this to happen and have experience in dealing with such situations. However there was a specific problem with the large shallow Island Char during the 1988 flood when over 300 people were drowned. The overall conclusion is that the river channel has been getting wider, especially when compared to the situation in the early part of the 20th Century.

Island Chars are very different from each other and this is a function of their age and stability. Two of the large Island Chars are very stable and although suffering from localised side bank erosion are accreting southwards and the southern one could well attach itself to the mainland and eventually be incorporated into it as others have in the past. Land utilisation has been mapped for 1992 and the last 20 years using ground truthed satellite imagery. The spread of land cultivation from stabilised nodal centres can be clearly seen. Agricultural activity in the Island Char land is centred around dry land farming systems, despite the area having a high flood risk. The reason for this is that during the dry season the largest area of land is exposed but soils are poor at holding water and irrigation is not perceived as a feasible option.

9.3.2 The Human Environment

The household census data when integrated with the FAP 16 data has produced population estimates for the FAP 3.1 Char land area which are shown in the following table.

Care must be exercised in using these figures as the FAP 3.1 work is from sample data extrapolated over the total Island Char area where as the FAP 16 data includes all those Mauzas which have any part of them in the unprotected area. This work will need to be refined in any next stage by which time the FAP 16 data should be dis-aggregated using the GIS and the FAP 3.1 data has to be reclassified by location. This should allow classification down to individual Mauza level. The 1991 BBS data should also be available by this time and a cross-check will need to be run between the three sets of data. In addition the 1981 BBS census data should be added to the data base to give an indication of trends also allow comparisons with the mainland and national data.

Resources need to be made available for this to be done before any further planning work takes place. To make full use of this data the Char lands Pilot Phase Programme will need access to the FAP 19 GIS facilities or ideally be provided with a suitable GIS system of its own.

FAP 3.1 Char Land Population Estimates 1992

THANA	ISLAND CHARS	ATTACHED AND SETBACK LAND			TOTAL
		WEST	EAST	SUB-TOTAL	
KAZIPUR	22 578 *	2 913	48 166	51 079	73 657 +
SARISHABARI	0 *	0	54 054	54 054	54 054 +
DHUNAT	470 *	10 484	0	10 484	10 954 +
SARIAKANDI	44 214 *	36 826	29 130	65 956	110 170 +
MADARGANJ	9 407 *	0	45 267	45 267	54 674 +
SONATALA	0 *	26 072	0	26 072	26 072 +
SUGHATTA	0 *	59 069	0	59 069	59 069 +
ISLAMPUR	11 288 *	0	99 122	99 122	110 410 +
PHULCHHARI	24 459 *	39 766	0	39 766	64 225 +
DEWANGANJ	5 644 *	0	33 674	33 674	39 318 +
TOTAL	**118 060 ***	**175 130**	**309 413**	**484 543**	**602 603 +**

Sources: * FAP 3.1 Stratified Sample Survey
+ FAP 16 Summary Mauza Key Informant Data
All other figures are proportionally calculated by land area

From this estimated data the mean population density for gross land area (including sand areas on the Chars) is 304/km^2 in the Island Chars and 691/km^2 on the Attached and Set-back land. For cultivable land measured from satellite imagery analysis the figures are 686/km^2 and 1191/km^2 respectively. There is a concentration of "temporarily" located households in the Set-back land and fewest on the Island Chars. This would seem to illustrate that displacees are concentrated on the mainland, many probably being victims of first time main river bank erosion. Those people on the Island Chars who do move appear to do so more frequently than those elsewhere but move shorter distances, probably within their own Mauzas. The existence of split Mauzas, where previously separate Mauzas are now sharing the same piece of land, is highly concentrated in those areas of severe bank erosion. Household sizes are on average larger on the Island Chars and also amongst households owning greater areas of land.

The level of total landlessness is high in the Attached and Set-back land at 66% where the figure for the Island Chars is 37%. In addition the mean area owned per household is much higher on the Island Chars (1.68 acres) than the Attached and Set-back land (0.80 acres). However

consideration needs to be made of the poorer quality and higher flood risk of the Island Char land resulting in its lower utility. The reasons for the low figures on the Attached and Set-back land are probably due to the concentration of erosion displacees. This trend is also true for operated land.

The arrangements regarding land ownership that actually occur have evolved despite the law. All land in the area is allocated and there appears to be no Khas land. Households maintain their land rights by paying land tax even when their land is lost to the river in the expectation (normally correctly) that it will re-emerge at some time in the future. Mauza boundaries were fixed around 1906 and have remained virtually the same ever since and their is very strong territoriality. Some land presently on the east bank was originally on the west bank in 1905, the river having subsequently moved. Residents appear to still maintain stronger links to "their" side of the river despite the obvious difficulties in communication.

The level of infrastructure provision and particularly formal education and medical care is low in the Char land and particularly the Island Chars when compared to the mainland. The provision of safe drinking water appears to be relatively adequate throughout the area. This is probably due to the ease of groundwater extraction and the availability of hand pumps. There could however be a problem with this during peak flood times where access to sources becomes difficult. Housing materials on the Island Chars appear to be deliberately selected to be more transportable and durable with the further advantage of being a saleable asset in times of need. The general level of asset holding is higher (13% higher by value) in the Island Chars than the Attached and Set-back land but the type of assets held is different. There is an emphasis on agriculture (particularly ploughs) and boats on the Island Chars and more bicycles and motorbikes on the Attached and Set-back land. Surprisingly there is little difference in the two areas between levels of fishing net ownership. This ties with figures for household head main occupations which show that professional fishermen are concentrated on the Attached and Set-back land not the Char land, probably because they require good access to market outlets. Farming is the predominant occupation on the Island Char lands and twice as prevalent as the Attached and Set-back land where daily labouring is most important. The situation for second occupations is however reversed and possibly explained by Island Char household heads working during the wet season on the mainland and those from the Attached and Set-back land on the Island Chars during the dry season. There are fewer children working on the Island Chars than on the Attached and Set-back land despite the fact that schooling levels are lower. However the there are more young adults working on the Island Chars. Annual household incomes are disproportionably distributed with 78% below 15,000Tk per annum and little difference within the area. Some 22% of households are indebted each year and 25% take credit,

over 60% of which is for food purchase, the figure for the Island Char being slightly lower. The figure of 15% of all credit being taken for land capital purposes in the Attached and Set-back land could possibly be for payment of land tax arrears on presently eroded land which households are maintaining their land rights on.

Paddy production is more widespread on the Attached and Set-back land where as there is more substitution of dry land crops in the Island Chars in an effort to minimise risk and dependency on poor water availability when the maximum area of cultivable land is available. However in cash terms paddy is still the most important crop on the Island Char lands. Some 18% of all households catch fish but over 70% of these directly consume all the catch themselves. There are more draught animals per household on the Island Char land than the mainland, possibly due to a greater availability of grazing but also out of necessity as farming operations are more remote and require greater self-reliance.

The strength of formal government institutions appears to be weaker in the Attached and Set-back land than the mainland but poorer still on the Island Char land. The NGO and Co-operative organisations are stronger in the Attached and Set-back land than the mainland as they have recently been implementing targeted programmes there in response to perceived needs. The Island Chars have the lowest level of such activity, however this deficiency is recognised by the larger more experienced NGO's in the area and they are considering mobilising programmes in the Island Chars and have expressed great interest in the present study and a willingness to act in partnership with donors and implementing agencies.

9.3.3 Hazard Risk

Data from FAP 16 indicate that whilst erosion is a serious hazard in terms of household livelihood it rarely causes death. However serious flooding as happened in 1988 caused 370 direct and indirect deaths totalling a mean ratio of 1 in 2122 people, with a concentration higher than this in the Island Char lands. A flood proofing programme to prevent this would seem to be justified on humanitarian grounds irrespective of any increased flood risk due to embanking the mainland. The difficulty is justifying it in the narrow economic terms defined in a conventional economic benefit analysis.

The present strategies developed at household level for tackling flood conditions centre around risk minimisation. Given the scarce economic resource base most of the affected people these are small scale. There are general underlying survival strategies for economic livelihood such as diversification, second seasonal occupations in different locations and the practise of dry land farming techniques. To deal directly with high

floods the following strategies are followed to varying degrees, depending upon individual household circumstances:

- the construction of a raised platform on the house floor where family members can cook, sleep and remain until flood water recedes.

- the evacuation of livestock, family members and some assets to nearby higher level areas.

Loss of property and livestock is frequent during flood periods. During these times, the flood victims become dependent on informal assistance from neighbours, relatives and friends and some local wealthy people.

9.3.4 Impacts of the Proposed FAP 3.1 Mainland Intervention

With a FAP 3.1 left bank embanked situation as is being proposed under Option B5 and with Jamuna Bridge in place it has been predicted by FAP 25 that water levels in the southern end of the study area will rise by 0.74m in peak flood times such as happened in 1988. This is predicted to reduce progressively to 0.07m at the northern end of the study area. However the more important situation is the timing, extent, depth and duration of flood times when previously there were none. This is likely to have different implications in the three different land types:

- In the Set-back land that is presently mainland but will not be protected there is likely to be an increased flood risk although this could be quite low depending upon local topographic conditions. There may also be an increased risk of main bank erosion although this seems hard to predict. This land at present does not flood in the peak of a "normal" year and people are not so used to coping with such situations. As such it may require very specific flood proofing work, but the use of the close by embankment a multipurpose permanent settlement area and also as a temporary place of refuge would seem to be attractive.

- The Attached Char land presently floods every peak flood time each year. It thus has a higher present flood risk than Set-back land but people are more used to dealing with it. However much of it is some distance from the proposed embankment and a small scale community and household approach to flood proofing would seem more appropriate.

- Island Chars already have the highest flood risk but people are used to coping with this in a normal year. However human deaths due to drowning in the 1988 flood and consequential ones appear to have been significant. Under embanking of the mainland this will be made worse still, although its detailed nature is uncertain until more hydrological modelling and flood risk mapping are

carried out. It is quite likely to seriously effect the area of land available for agriculture during the wetter times of year and the timing of these increased flood incidence will be crucial in changing possible cropping patterns.

The assessment of this requires the new flooding pattern to be modelled as a matter of urgency. This is presently being carried out by FAP 25 as part of their national programme. A four dimensional output is required using recent topographic data. This needs to show the predicted flood pattern under various scenarios and give mapping of flood extents, depths and duration using a digital terrain model like the work provided for FAP 20. It has recently been learnt that the Char lands mapping programme that was to have been carried out by FAP 18 from the 1990 air photography has been removed from their programme. This is considered a serious constraint to the next stage of the work. Alternative techniques to study Char flood risk will have to be investigated, including consideration of time series remote sensing data (satellite radar imagery may be available by this time) on a rising flood. This may need significant resources.

9.4 Proposed Interventions

9.4.1 Needs Assessment

The needs assessment has indicated that the Char land residents have identified very specific and serious problems in coping with life in their area, due to its dynamic and risk-prone nature. Their priorities and the data collected both by FAP 3.1 and FAP 16 have indicated that flooding is a problem most years but peak flooding is particularly serious and caused a significant number of deaths in 1988. It is certainly a much more serious problem than on the mainland but Char people are used to coping with it and also as a more regular occurrence. However in comparison the number of deaths in the Char lands from disease is even higher and the present level of medical facilities is very poor indeed. In social welfare terms it could be that improved medical services offer an even greater benefit than trying to tackle the flooding problem. Erosion is also a very serious problem, particularly for those displaced from the main river bank areas. It rarely kills people outright but can impoverish them brutally and often in quite short periods of time. The root cause of main bank erosion is difficult if not impossible to solve, but steps could be taken to reduce the effects of this by making peoples livelihoods more secure through diversification of economic activity that depends less on the farming of land.

9.4.2 Intervention Justification

A big problem is the economic and social justification for any intervention in the Char lands, particularly bearing in mind the difficulties in quantifying social benefits and the narrow economic criteria that have

been adopted in the FAP Guidelines for Project Assessment (GPA). This questions why a major intervention to control flooding in the mainland was originally proposed in isolation from the unprotectable land and presumably considered as a higher priority than action in the Char land where the flooding problem has now been demonstrated as being much more acute, even if the inhabitants have developed their own strategies to deal with it. In this situation the people in the Char lands would seem to have a strong case for claiming they are at least being forgotten. However if the mainland intervention were to be implemented in isolation, it seems certain to actually make the situation in the Char lands even worse. Then serious issues of equity, perceived discrimination and likely social conflict with political implications would arise and require very careful consideration. The basic principle outlined in the GPA Environmental Impact Analysis (EIA) is that no person is to be worse off as a result of any FAP intervention and all negative impacts are to mitigated for with the cost of this equated with the benefits. Using this methodology it would follow that the quantified benefits of controlled flooding to the mainland should be used to at least redress the balance to the Char lands and irrespective of this there is a very strong case in its own right for significantly improving their present position.

It would now appear, particularly from a social and humanitarian perspective, that there is a clearly demonstratable case for a major intervention in the unprotectable land, aimed at saving lives and reducing homestead losses and household socio-economic decline during and after times of flooding. This would seem a priority irrespective of any mainland intervention but with even higher priority if the controlled flooding programme were to be implemented as this is likely to make the situation even worse. This has been used as the basis for drawing up an appropriate integrated flood proofing programme for the unprotectable area, aimed at being implemented in parallel with the mainland controlled flooding intervention.

The justification for intervention in the unprotectable land requires to be judged using different criteria than for the mainland and is subject to a political decision as to its comparative priority. At the very minimum the situation should be made no worse than it is already but there would seem to be a very strong case indeed for promoting an integrated flood proofing programme there as a priority. However care needs to be taken to ensure that the programme is made sustainable from an engineering point of view. This requires careful consideration of the locational criteria for flood proofing sites and priorities based upon erosion risk analysis being compiled by FAP 19's time series satellite imagery work and also the flood risk proposed for the next stage of the study. This is in addition to the socially based criteria for location.

If it is assumed that a parallel intervention of flood proofing in the unprotectable land is being carried out then the calculation of the part

of it attributable to the FAP 3.1 intervention becomes easier. This is the incremental increase in peak flood levels that needs to be mitigated for and is presently calculated as a mean figure of 0.3m compared to an average figure of 3.0m used for the earthworks calculations for flood proofing. These costs can also be apportioned between the differing geographical areas related to other interventions that have already taken place but their negative impacts will not be fully realised until they are combined with those of FAP 3.1. Specifically this is the case with the Brahmaputra Right Embankment (BRE-FAP 1) which is already in place and which could be attributed to cause half of the increased flood problem in the Char lands. By rights this cost should have been equated with its benefits when the decision was taken to build it. This is discussed in more detail in Section 5 of the main report and also Annex 3.

9.4.3 The Proposed Integrated Programme

The intervention thus involves flood proofing for some 602 000 people in 114 000 households, 20% of whom live on the Island Chars, 30% on the west bank Attached and Set-back land and the remaining 51% in the east bank attached and Set-back land. The intervention programme will also have to recognise that although there is a far more significant priority to be attached to the southern reach of the river diminishing northwards as the induced flood risk decreases this is only a fraction of the overall existing flood risk.

The previously proposed intervention for mitigation has been an integrated flood proofing programme based around the Option A proposal previously looked at but now rejected for the whole of the FAP 3.1 mainland area. Its principle aim is to save life and in the case of individual homestead flood proofing, secure fixed and movable homestead assets from flooding. However it does not secure agricultural land from flooding and is not in itself full mitigation. Economic livelihoods are still likely to be negatively effected and further steps will be needed to promote conditions where these can be diversified and made less prone to effects by flooding.

Because many of the other issues faced by the Char land population are intrinsically linked to flood risk, it is considered that an integrated approach to socio-economic development is required, with flood proofing as a core activity but which at the same time tackles the issue of economic livelihood and risk. Aligned to this are problems of erosion displacement, lack of community facilities and difficulties of access. This proposed strategy will be aimed at:

- securing human and livestock from death during flooding
- protecting homesteads and fixed homestead assets from loss and damage during flooding
- reducing flood damage to household livelihoods

- flood proofing and developing community infrastructure
- diversify and enlarge household resource bases to make then less vulnerable and more self-reliant.

This has five components:

- Minor Structural Flood Proofing
- Community Infrastructure Development
- NGO Support
- Institutional Support
- Technical Assistance

9.4.4 Minor Structural Flood Proofing

A widespread but small scale flood proofing programme covering 5 000 households in a 3 year first phase pilot programme is proposed. This can then be followed by a programme for the remaining 109 000 households. The Minor Structural Flood Proofing programme centres around the raising of individual homesteads to a level above the 1988 flood plus the additional raising needed to overcome the induced peak flood rise caused by embanking the left bank. In addition it is proposed that there be provision for a subsidised building materials component for 50% of the homesteads, to be targeted to those unable to carry out this work from their own resources.

It is proposed that the minor structural flood proofing programme be 70% subsidised with the remaining 30% being loans to be repaid on a rolling programme, set up in a way so as to promote self investment and negate dependency on external sources. The first phase pilot programme cost estimate for flood proofing is Tk47million this would then be followed by a rolling programme for the whole area estimated to cost a further Tk1036million making a total cost of Tk1083million. This is equivalent to TK 1797 per head when compared to TK2212 per head for the mainland intervention.

9.4.5 Communal Flood Proofing Packages

The second component is a proposal for construction of 400 communal flood proofing packages as the major component in a community infrastructure programme. It is proposed to use NGO involvement in the planning and implementation of this as they already have successful experience in this although at a much smaller scale level. The first stage will be group formation and assessing peoples detailed needs and requirements. Great flexibility will be needed in planning from the small-scale collective level (a "willing group") down to the individual household.

The community development component will be centred around multi-purpose flood shelters with basic facilities including a tubewell, latrines

and a multi-purpose building which could be used as school, welfare centre and a flood refuge with stocks for around 15 days. The design criteria of these will be drawn up to be as flexible as possible to allow them to be appropriate to local people's needs and conditions. The estimated cost of these are Tk500 000 with a proposed 50 units in the first phase and a further 350 subsequently at a total cost of Tk200million, TK25million being in the pilot programme.

9.4.6 NGO Support Programme

In addition there will also be NGO support for income generating activities, which will retain the present emphasis on dry-land farming and promote a wider range of crops. Other programmes already carried out and proposed include land stabilisation using Catkin grass, promotion of small scale fisheries, poultry and egg production, goats, tree planting, petty trade and other services.

9.4.7 Institutional Structure for Planning and Implementation

An institutional structure has been proposed with technical support from an appropriately experienced consultant developing an incremental rolling programme with a large training component. There will also need to be a component that finances the NGO support structure that will provide the means for them to operate as a catalyst for mobilisation, including group formation, detailed needs assessments down to household level, provision of materials, supervision of construction and recovery of loans. The Technical Assistance programme to the project will set the design criteria for design and implementation. This will operate under a Project Management Organisation which will be the executing agency for the Government of Bangladesh.

9.4.8 National Char Land Planning Issues

The wider issue of possible Char land development within the national context has been raised and the formation of a Char Land Development Board suggested. This could build on a FAP component based upon the FAP 16 National Char Lands Inventory. However it is recommended that the area adjacent to the FAP 3.1 area be considered a pilot programme and be developed in parallel with the FAP 3.1 mainland project, with the Technical Assistance component being pooled and shared by both programmes.

9.4.9 Monitoring and Evaluation

It will also be necessary to set up a Monitoring and Evaluation Unit under the PMO to keep the programme on track and learn by its experiences, feeding back into the implementation programme. A Technical Assistance programme is also proposed for the development of a multi-purpose Master Plan for all of Bangladesh's Char lands.

9.4.10 Intervention Cost Estimates

The total cost of the proposed programme is Tk 1460m (US$ 36.5 million), with the pilot phase being Tk145m. Of this some 12% is recoverable loans and 4.2% (TK 62.3m) of the total cost can be attributable to the effects of the FAP 3.1 embankment. In all the cost per head of population is estimated to be TK2140 compared to TK2212 for the mainland controlled flooding intervention which has the additional advantage of securing agricultural land from peak river flooding.

APPENDICES

Appendix - A

Terms of Reference for JPPS

Revised Draft Terms of Reference.

PREAMBLE

A water development plan for the North Central Region is being prepared as part of the North Central Regional Study (NCRS). The NCRS is divided into two phases:

Phase 1: the "Reconnaissance Study", the report of which was completed in June 1990.

Phase 2: the "Main Regional Study", which is to start in October 1990 for a duration of 13 months.

In order to make it possible to start project implementation as soon as possible, priority projects will be identified and feasibility studies undertaken in parallel with Phase 2.

During Phase 1 of the NCRS, the Jamalpur Sub-Region was identified as the most suitable area for the first project to be implemented under the future land and water development plan. These Terms of Reference concern the feasibility study of this project, hereafter called "Jamalpur Priority Project Study" (JPPS).

1 BACKGROUND

1.1 The disastrous 1987 and 1988 floods in Bangladesh raised considerable international interest in helping the country to find a long term solution to its flood problem. A number of studies were undertaken and, in June 1989, the Government of Bangladesh requested the World Bank to coordinate the preparation of a five-year Action Plan for Flood Control in Bangladesh. The role of the Bank in co-ordinating international efforts to assist Bangladesh in flood control was endorsed in the Communique of the G7 economic summit meeting held in Paris in July 1989. The Action Plan was discussed and endorsed by a meeting of donors held in London in December, 1989.

1.2. The Action Plan consists of project-oriented studies in all the country's main regions, supporting activities to promote improved project design and execution, and non-structural measures. For each plan component, one or more donors have expressed an interest in financing first phase activities, comprising surveys, studies or pilot projects. The various actions are to be implemented by these donors in close cooperation with the Government of Bangladesh and under co-ordination of the World Bank, as described in the Action Plan.

1.3. The Action Plan attached high priority to flood control and drainage on the left bank of the Brahmaputra under component n°3, "Brahmaputra Left Bank". The Action Plan identified three specific activities under this component :

- North Central Regional Study
- Brahmaputra Left Embankment (North)
- Brahmaputra Left Compartment (North)

1.4. An overall study of flood control and drainage - the North Central Regional Study (NCRS) - is being undertaken as the first step. The existing embankments are not effective against major river floods because of inadequate sections, gaps and bank erosion ; drainage is impaired by numerous road embankments and restricted waterway sections. The NCRS will examine various alternatives and establish the most suitable pattern of future water resource

development in the region and the most relevant phased implementation. Strengthening of existing embankments, construction of new ones, building appropriate embankment structures for controlled flooding and drainage, remodelling the main drainage systems and compartmentalization would be the main physical features of the regional water development plan.

1.5. A priority project was identified in the Action Plan and confirmed for early implementation in the Reconnaissance Study of the NCRS. This priority project is located in the most northern part of the North Central Region, in the Jamalpur sub-region. It comprises the northern section of the Brahmaputra Left Embankment (about 60 km) and associated water control works and development in the protected area of about 60,000 ha. This Jamalpur Priority Project Study (JPPS) will comprise the feasibility study of the project.

1.6. The North Central Regional Study will be financed under a separate contract, jointly funded by the EEC and France, with the EEC acting as the leader. The Jamalpur Priority Project Study, which is covered by these Terms of Reference, will also be financed by the EEC and France, but with France taking the lead.

2. THE NORTH CENTRAL REGION AND THE JAMALPUR SUB-REGION

2.1 The North Central Region

a) The North Central Region (see Figure 1) is bounded on the west by the Jamuna, on the south by the Padma and the Meghna, and on the north and east by the Old Brahmaputra and the Lakhya. For hydraulic purposes, the NCRS includes left bank tributaries and distributaries of these two rivers; the development of the corresponding catchment areas is included in the North East Regional Study (FAP6). The area of the region is about 12,000 km2 and the total population is around 17.5 million. The population density of about 1460 per km2 is high.

b) Most of the region is rural, though the capital city, Dhaka, is located in the south of the region. Most of the commercial and industrial activities of the region are concentrated in the Dhaka area.

c) Agriculture dominates the rural economy. Rice is the main crop and is grown on 80 % of the cultivated area. Cropping intensities and yields are relatively high, reaching 192% with yields up to 4.1t of paddy/ha, which are high by Bangladesh standards, but low in comparison to international standards.Yields are damaged considerably by flooding. In a normal year, about 68% of the region is flooded ; in severe floods, such as in 1988, over 80 % of the area is inundated. The flooding is largely caused by overbank spillage from the Jamuna, the Padma, the Old Brahmaputra and their distributaries. It is further aggravated by high local rainfall and difficult drainage conditions created by backflow of the Meghna at the south east corner of the region.

d) Three sub-regions may be defined in terms of physiography and flooding characteristics :

- The West, comprising about half the region and subject to flooding from the Jamuna and Padma rivers, suffers from very severe flooding. Phase 1 of NCRS distinguished 4 sub-regions called A1, A2, 13 and B (see figure 2). The sub-region A1 around Jamalpur was identified for priority action.

- The Madhupur Tract, an area of uplifted old alluvium, which is mostly above normal flood levels. Its development is hampered by limited water resources.

- The East, which is flooded mainly from the Old Brahmaputra and its distributaries.

e) Since a separate flood control study is being undertaken in the Greater Dhaka area, the North Central Regional Study only considers the Greater Dhaka area when dealing with inter-relationships between it and the rest of the North Central Region.

2.2 The Jamalpur Sub-region

a) The Jamalpur Priority Project area, located at the extreme north of the NCR (see Figure 3), is bounded by :

- The Jamuna left bank in the west, on which embankments have partially been built.

- The existing Jamalpur-Bahadurabad railway line, following the Old Brahmaputra in the north east. The towns of Dewanganj, Islampur and Jamalpur are also within the area, although partly outside the line of the railway.

- The Jamalpur-Jagannathganj Ghat railway line in the south-east.

The study will also consider the lands between these embankment lines and the dry season river channels, from the point where the Old Brahmaputra leaves the Jamuna to Jagannathganj and Jamalpur on these two rivers.

b) The left bank of the Jamuna is eroding severely near Bahadurabad, Madargang and Jagannathganj. Dewanganj village is severely affected. The Old Brahmaputra branches of from the Jamuna near Dewanganj. The offtake is silted up however, and inflow into the Old Brahmaputra ceases every year on January. The Zinziram river, a northern distributary of the Jamuna, gives the only surface water inflow during the dry season, but this inflow is minor.

c) The project area has the shape of a rhomboid with sides of 35 km and diagonals of 30 and 60 km. Ground elevation varies from 14 to 18 m + PWD.

The gross area is in the order of 60,000 ha and the overall population within the area is about 550,000 or 920/km2. Population density (920/km^2) is high compared to Bangladesh average (about 700/km2).

The project area is located in 5 Upazilas : almost the whole of Melandaha and Madarganj, 40 % of Sarishabari, 20 % of Jamalpur and of Islampur. The area borders the active flood plains of the Bahadurabad and Dewanganj Upazilas in the north.

d) The internal hydrographic network of the sub-region involves two main water courses, flowing southward:

- In the west, the Chatal, a distributary of the Jamuna, partially closed recently by on-going embankment construction. The Chatal drains into the Jamuna.

- In the east, the Jhenai, a distributary of the Old Brahmaputra. The main channel joins the Chatal and flows to the Jamuna, but some flows discharge into the Upper Bangsi; and to the south through the Baushi railway bridge to join the main Bangsi system.

Both watercourses are seasonal and become almost dry during the winter season.

e) Flood-proneness is variable within the sub-region:

- In the western part, the Young Brahmaputra (Jamuna) floodplain is exposed to damaging floods from the Jamuna river. Embankments have been built by local authorities. They ensure some protection from normal river floods, but they cannot be considered to provide reliable protection against severe floods as they are not continuous and have not been properly designed, built or maintained. They have suffered considerable damage in past years, especially due to river bank erosion, and have not been completely repaired.

  The greater part of the western area is flooded up to 90-180 cm deep each year. In a 20-year flood, most of this area falls within the F2 (90-180 cm) and F3 (180-270 cm) flood categories (See Figure 4).

- On the Old Brahmaputra floodplain in the eastern part of the sub-region, the ridges are not inundated in a normal flood year and the basins are only shallowly flooded (maximum of 90 cm). In a 20-year flood, the depth of inundation reaches a maximum of 180 cm on most of the land but up to 180-270 cm in depressions.

  Flooding in the sub-region starts with ponding of rainwater in depressions and extends when the Jhenai and Chatal rivers become active as the Jamuna and Old Brahmaputra river levels rise. In 1988, floodwater covered 75 per cent of the area and overtopped both the railway lines bounding the area (by more than 30 cm at Islampur).

f) Crops in the Old Brahmaputra floodplain, which covers about 40 per cent of the priority area, are only seriously damaged by floods in those years when river floods are very high, such as in 1974 and 1988. This floodplain has a smooth landscape of ridges and shallow basins. The ridges are above normal flood levels and the basins are normally flooded only by rainwater. With the advent of irrigation from hand pumps and deep and shallow tubewells which started in the 1970s, the main cropping pattern has changed from rainfed aus followed by transplanted aman to transplanted aman followed by irrigated boro paddy. The production level of rice and other crops is considerably higher than in other areas of the NCR. Moreover, investment in irrigation equipment is very high: about 80 per cent of the cultivated land is irrigated by tubewells. Irrigation is used not only for boro rice but also for supplementary irrigation of transplanted aman when monsoon rainfall is deficient. Sugarcane is grown on permeable ridge soils, especially in the eastern and northern parts of the priority area, to supply the Dewanganj sugar mill.

Crop production is much less secure on the Young Brahmaputra (Jamuna) floodplain, which covers 52 per cent of the priority area, and on the Active Brahmaputra-Jamuna floodplain which covers the remaining 8 per cent. On the Young Brahmaputra floodplain, the relief comprises a rather irregular pattern of ridges, inter-ridge depressions, old channels and some basins. The soils are predominantly loamy. Aus and jute followed by dryland rabi crops are grown on Medium Highland (F1), together with some late transplanted aman and sugarcane in the north. Medium Lowland (F2) and Lowland (F3) now have considerable areas of irrigated boro rice in the dry season, partially preceded by mustard, but much of the land remains fallow in the monsoon season because of the flood hazard. Irrigation now covers 60 per cent of the cultivated area on this floodplain.

The present and potential yields of boro rice in the priority area are 25 percent higher than the average for the NCR, and it is estimated that transplanted aman yields could be about 30 per cent higher than the average with full flood protection. These higher yields result not only from favourable growing conditions such as better soils and better drainage conditions, but they are also due to higher investment rates in irrigation, fertilizers and pesticides. Therefore, in the case of a severe flood, damage to crops could be relatively higher in the priority area than in other parts of the NCR.

Additional data are given in Annex 2 (hydrology; damage and benefit assessment) and more details can be found in the Reconnaissance Report of the NCRS.

3. SCOPE OF WORK

3.1 General

The Feasibility Study of the Jamalpur Priority Project (JPPS) has to be co-ordinated with the North-Central Regional Study (NCRS). It is necessary both to avoid duplication and as to ensure a strong feed-back between the two studies. Therefore, the scope of work of the NCRS is summarized hereafter (paragraph 3.2.), although it is governed by a separate contract, before defining the scope of work of the JPPS (paragraph 3.3.), governed by the present contract, along with the linkage between both of them (paragraph 3.4.).

3.2 Extracts of the Scope of Work for the North Central Regional Study (NCRS)

a) The overall objective of the North Central Regional Study is to prepare a regional water development plan, with emphasis on the flood control and drainage measures that would be needed to achieve a sustained development of the regional economy, taking into account social and environmental factors. The regional study will focus on areas where flooding and impaired drainage hamper economic activity and will identify a series of measures to alleviate these adverse effects and to develop the land and water resources. The resulting regional water development plan will integrate major components, such as the Jamalpur Priority Project.

b) The NCRS will be guided by the following principles :

(1) Flood protection should not be seen as an end in itself, but should be seen as one, albeit important, component of a comprehensive plan for the development of water resources in the region (including drainage and irrigation), the aim of which should be to improve agriculture and to lead to a process of sustained economic and social development in the region.

(2) The broad environmental effects of all plan components proposed should be examined both in terms of their impacts in the North Central Region and in neighbouring, especially downstream, areas.

(3) The development scenarios and plans proposed should identify a phased development strategy based on clear assessment of those measures that will be needed in both short and longer terms, and in different parts of the region. In doing so, the past studies on the Dhaka South-West Project and Old Brahmaputra Multipurpose Project should be taken into account.

c) The general structure of the NCRS is shown in figure 5. It comprises :

Phase 1: "Reconnaissance Study", completed in June 1990,

Phase 2: "Main Regional Study", which started in March 1991 and involves:

- Preliminary activities (months 1-2) for various reviews and preparation of an Inception Report.
- Comparison of Alternative Development Strategies and Preparation of Draft Regional Water Development Plan (months 3-8).
- Finalisation of the Regional Development Plan (months 9 to 13).

Between Phase 1 and Phase 2 a "bridging hydrologist" has collected hydrologic data on the internal hydrographic network and a "bridging modeller" built up the hydraulic "Coarse Pilot Model" of the North Central Region.

The findings of the completed Reconnaissance Study Report should be considered as an input to both NCRS and JPPS.

3.3 Scope of Work for the Jamalpur Priority Project Study (JPPS)

a) The overall objective of this study is to carry out the Feasibility Study for the Jamalpur Priority Project, so as to implement in this priority area the Land and Water Development Plan in selected in conjunction with the North Central Regional Study.

b) The Feasibility Study and the more detailed project preparation will consider both structural and non-structural development possibilities for the Jamalpur sub-region, such as :

- **Structural elements :**
  - o major river flood protection (embankments) and other earthfills (railways, roads) surrounding the sub-region ;
  - o bank protection and/or river training works ;
  - o minor river and main drain improvements (including possible channels alongside the embankments);
  - o major inlet/outlet regulators for controlled flooding and drainage;
  - o compartmentalisation (water management systems, comprising peripheral inlet/outlet structures, internal water control works, channel improvements, related infrastructures, etc.);
  - o structures where necessary for irrigation, drinking water, fisheries, navigation;
  - o road embankments and cross drainage works.
- **Non structural components :**
  - o involvement of beneficiaries and disadvantaged groups;
  - o operation and maintenance;
  - o land and water management;
  - o institutional programmes.

c) When studying the project components, the consultant will ensure that any adverse environmental impacts are avoided or reduced to an acceptable level and identify where specific measures to improve the environment can be undertaken. Special issues to be considered will include: physical and chemical effects on soil, waterways, surface water and ground water resources;human activities and flora and fauna.

d) The JPPS will last for 11 months (beginning mid August 1991) and will comprise the following phases (see figure 5) :

- preliminary activities and inception report (months 1 and 2),

- surveys and investigations (months 2 to 7.5 with possible extensions),

- preparation of the Jamalpur Sub-Region Land and Water Development Plan (LWDP), involving comparison of alternative LWDP and interim planning report (months 2 - 4) and the preparation of the selected LWDP (months 4 - 6, with possible extensions for ultimate finalisation),

- Feasibility Study of the Jamalpur Priority Project.

3.4 Linkages between NCRS and JPPS

a) In order to avoid any duplication and to maximize feedback between the teams undertaking NCRS and JPPS, the tasks to be carried out will be as follows:

- **to be carried out within the NCRS :**

  - o define main options and strategic planning assumptions, for the Jamalpur Sub-Region as a part of the North Central Region ;

  - o assess the external effects of the Jamalpur Priority Project on the neighbouring region (hydraulic consequences of flood protection and drainage on downstream areas, external economic consequences, etc ...).

- **to be carried out within JPPS:**
  - o perform various surveys within the Jamalpur Sub-Region ;

  - o elaborate options and strategies on the basis of the assumptions mentioned above ;

  - o elaborate the internal hydraulic model of the Jamalpur Sub-Region (in connection with the hydraulic modeller of the NCRS);

  - o analyse the impacts of the JPP inside and outside the project area (e.g., development of agriculture and other sectors, downstream impacts etc) and carry out cost-benefit analyses;

  - o carry out the Feasibility Study of the Jamalpur Priority Project and, in particular, clarify important issues such as the location of the embankments.

b) To this end, the JPPS Consultant and the NCRS Consultant will co-operate as far as necessary and in particular :

- the TOR of JPPS will be reviewed and if necessary modified in the light of the findings of the NCRS Inception Report, in order to clarify the respective responsibilities of both Consultants.The JPPS Consultant, in his Inception Report, shall comment on this review, and propose amendments to improve the responsiveness of the study to the local conditions;

- the JPPS Consultant will discuss his Inception Report with the NCRS Consultant (month 2) ;

- the JPPS Consultant will deliver to the NCRS Consultant the preliminary plan report (month 4) for the Jamalpur Sub-Region, for merging it into the comparison of options and strategies concerning the whole North Central Region;

- a special coordination meeting will be held in month 6 between the FPCO, NCR and JPPS consultants to discuss the selected plan for the Jamalpur Sub-Region prepared by the JPPS Consultant and the selected strategy for the whole North Central Region prepared by the NCRS Consultant for any finalisation of the Jamalpur Sub-Region selected plan;

- the JPPS Consultant will remain available for report finalisation during one and a half months (to the end of month 11).

- all interactions between the JPPS and NCRS consultants including consolidation of criteria will be coordinated through FPCO (see section 6.3 for Management Board)

3.5 Linkage between the Compartmentalisation Pilot Project and JPPS

Although it was originally planned that the Consultant of the Compartmentalisation Pilot Project (CPP) was also involved in survey and installation of gauges in the Jamalpur Pilot Project, for practical reasons these tasks should be kept with the Consultant of JPPS. However, the set up of this hydrologic network should be in close consultation with the CPP study team and with the SWMC.

The CPP consultant will make a study of the compartment management in JPP, although the start date is now uncertain. The study will be based on a review of the studies implemented under JPPS. The JPPS Consultant and the CPP Consultant will communicate regularly to exchange ideas of compartment management, which will develop during the studies.

4. TERMS OF REFERENCE FOR THE JAMALPUR PRIORITY PROJECT STUDY (JPPS)

The Consultant will perform the work detailed below, according to the standards required for Feasibility Studies and Project Preparation.

4.1 Preliminary Activities (months 1 and 2)

During this Inception Period the Consultant will :

- Review previous and on-going activities concerning the project area including :
  - o the report of the Reconnaissance Study of the NCRS, together with related data and maps ;
  - o the topographic and hydrological and geotechnical surveys undertaken during the bridging period and thereafter;
  - o the modelling activities undertaken by the bridging hydro-modeller ;
  - o the Inception Report for NCRS/phase 2 ;
  - o other activities under the Flood Action Plan ;
  - o other relevant development projects and programmes being undertaken in the region (e.g., those of the Bangladesh Water Development Board, Food-For-Work and other infrastructural development programmes).
- Decide on the technical and other surveys to be undertaken under the study, continue on-going surveys and initiate new ones; this will include the selection of sites for new water gauges in the area, for use by others in collecting data on flood levels and other flood characteristics during the monsoon of 1992.
- Takeover the coarse pilot hydraulic simulation model (CPM) and applications, in close consultation with the hydro-modellers of NCRS and SWMC.
- Establish linkages and set up coordination arrangements with the relevant Supporting Activities and Pilot Projects of the Flood Action Plan, and notably with FAP 20 (CPP).
- Prepare an Inception Report, including a detailed work plan for the study (end of Month 2).

4.2 Surveys and Investigations (months 2-7.5, with possible extensions)

4.2.1 The surveys will be carried out through subcontracts with specialist firms under the supervision of the Consultant, with the following activities :

a) Mapping and topography:

Finmap may be providing airphoto maps / photomosaics at 1/20,000 scale with 0.50m contours by March/April 1992. After a review of the programme of implementation of the Finmap project, undertake the necessary surveys, which could be to:

- Locate and check benchmarks in the priority area.

- Prepare longitudinal and cross sections of existing embankments (taking into account work carried out in the Reconnaissance Study and subsequently by NCRS).

- Check existing railway and road long profiles and cross sections.

- Carry out surveys of the internal river/drainage systems with longitudinal and cross sections (taking into account work carried out in the Reconnaissance Study and during the Bridging Period).

- Prepare surveys of existing water structures, levelling and spot level maps at the location of planned structures.

b) Geotechnics:

Review the available subsurface geotechnical data and determine its adequacy for feasibility-level studies of the dykes, roads, bridges and hydraulic structures needed for the project. Plan and undertake additional drilling, sampling and testing as required.

4.2.2 Other Data Collection

The Consultant will review the data and examine whether there are deficiencies that need to be rectified for the purpose of the Feasibility Study and organize and implement the programme to obtain the required data. This will concern in particular :

- hydrology, morphology, hydraulics, hydrogeology ;

- land use and land tenure, land suitability, agriculture activities, other sectorial activities ;

- environment ;

- socio-economic data, particularly in connection with flooding hazards and flood damage, including farmer attitudes and responses to FCD/I projects,

- social and institutional organization, etc.

4.3 Land and Water Development Plan (LWDP) for the Jamalpur Sub-region (months 2-6)

4.3.1 The principles of land and water development alternatives and strategies for the Jamalpur Sub-Region have to be fully consistent with those studied for the whole North Central Region, the TOR of which are given in Annex 1 and constitute guide-lines to be applied to the Jamalpur Priority Project Study (JPPS).

The main options, along with the boundary conditions, to be adopted for the Jamalpur Sub-Region, shall be derived by the JPPS Consultant from the North Central Regional Study, with the agreement of the NCRS Consultant.

4.3.2 Tentatively, the various main alternatives should consider respectively:

major flood control along main rivers; partial flood control along main rivers ; major drainage improvement ; local drainage improvement. Some more detailed options have been proposed in the Reconnaissance Study of the NCRS (see Annex 3). All of them have to be confirmed.

4.3.3 The JPPS Consultant shall, according to the guide-lines above mentioned appended in Annex 1, develop and compare the Sub-Regional land and water development options and prepare a preliminary Sub-Regional Land and Water Development Plan (in month 4).

He will examine alternative options for controlled flooding and drainage, using the coarse or pilot regional simulation model. Aspects would include :

a) Flood protection by embankments, giving full or partial protection to the project area, but not forming totally enclosed polders.
b) Main river intakes (Chatal and Jhenai), closed, open or regulated.
c) Outfall drainage, uncontrolled or regulated.
d) Internal compartments.

He shall perform a comparison of these options in close co-operation with the NCRS Consultant, so as to merge the outcome into the NCRS report concerning the Regional Water Development strategies. In particular, the method and criteria of comparison applied in the JPPS shall be consistent with those of the NCRS.

4.3.4 The JPPS Consultant will prepare in month 6 the selected Land and Water Development Plan of the Jamalpur Sub-Region. Projects would be identified (covering structural and non-structural components), priorities accorded and a preliminary phased programme produced. This plan should take account of existing and planned projects and supporting activities.

He will then finalise (before month 6) this Jamalpur Sub-Region Land and Water Development Plan, taking into account :

- the outcome (in month 3) of the NCRS comparison of Alternative Development Strategies and Preparation of the Draft Land and Water Development Plan for the North Central Region,

- and further, the preparation of the selected plan for this North Central Region.

4.4 Feasibility Study and Project Preparation of the selected Land and Water Development Plan for the Jamalpur Sub-region (months 6-9.5)

4.4.1 After confirmation of the proposed development plan for the Jamalpur Sub-Region as part of the water development strategy for the North Central Region, the Consultant will carry out a Feasibility Study.

a) The Feasibility Study will cover the Sub-Region along with some influenced downstream areas (Bhuapur, Gopalpur and part of Ghatail, Mahdupur and Jamalpur upazlia). The benefits from main flood control and improved drainage will depend on complementary developments in the protected areas. These will comprise water management measures at a minor scale, environmental, social and institutional programmes, all of which are expected to be included in the compartmentalisation concept (see Section 4.4.4).

The Feasibility Study will provide the technical, environmental, socio-economic and financial analyses needed for the appraisal of the project, based on a feasible phasing of implementation of the various project components.

b) The Feasibility Study (Project Preparation) will include, subject to confirmation, main structural works such as embankment construction or re-construction, inlet and/or outlet structures, main drainage improvements etc, together with any priority minor works or non-structural programmes that can be defined at an early stage.

For each of these components, Project Preparation will be at the level of detail required to proceed, after this study with the Detail Design and preparation of Tender Documents, for both of which the JPPS Consultant will prepare Terms of Reference.

4.4.2 Hydraulic conditions

- particular attention will be paid to the following aspects:

a) Hydrology

In conjunction with FAP 25/Flood Hydrology Study, the Consultant will define the complete set of the boundary and inner hydrologic conditions, in particular the run-off hydrographs due to local storms in the various sub-basins of the project area.

b) Hydraulics

Prepare a model adapted to the specific needs of the JPPS and use it for the preliminary design of structures, and for other water management purposes. Check the consistency of this model with the model to be prepared in NCRS phase 2.

- Compute the new water elevations in the hydrographic network.

c) River morphology

Jamuna

Take into account the available findings of the on-going morphological study (such as mathematical and physical models) undertaken under FAP 1, as well as the findings of FAP 21/22 and 25.

Internal rivers

As the Jamalpur Sub-Region may become a closed or partially closed area, fed mainly by local rainfall run-off, the Consultant will study the likely morphological changes of the main river network (the Chatal and Jhenai rivers). Siltation at the outfall of the Chatal river into the Jamuna may cause serious problems and should be studied by the Consultant for various scenarios and conditions.

d) Hydrogeology

Examine the effects of controlled flooding and drainage on the groundwater regime and on the present and planned abstraction of groundwater.

For this part of the study, the consultant will have to coordinate with modelling activities going on in MPO, and to suggest additional modelling activities if necessary.

4.4.3 Structural measures

a) General

The JPPS Consultant shall define principles of development and criteria for planning, design, construction, operation and maintenance of water control systems.

b) Embankments

An important issue of the JPPS is to specify the general lay-out of the embankment network according to the degree of protection (return period to be taken into account) approved by the Panel of Experts.

The choice of the embankment characteristics (alignment, crest level, cross sections, slopes, ...) will be examined through a technical, socio-economic and financial analysis taking into account mainly :

- o assessment of existing embankment effectiveness,
- o risk of erosion (scouring, waves) and related bank protection or river training devices,
- o risk of cutting (man made)
- o deposition of sand during high flood stages,
- o protected/unprotected areas and population,
- o land acquisition and resettlement issues,
- o impact on drainage and groundwater,
- o impact on environment,
- o relation between the security level offered and the agricultural development to be expected.
- o possibility to benefit from the side effects of the embankments to develop specific activities (fishery in borrow pits, slope cultivation, tree plantation for fuel wood and constructions). This will result in a better integrated embankment.

Whenever it is possible, existing embankments, roads and railways will be included in the flood control project, after strengthening and resectioning in order to mitigate detrimental impacts of land acquisition. However local interest considerations should not lead to sub-standard technical characteristics such as erosion prone alignment, steep slopes, or inadequate sections, particularly if of poor material.

The crest of the embankment may be used as an unpaved service road, so as to ensure the possibility of patrolling the dyke, monitoring and operating water structures and carrying out emergency repairs. The crest width will be determined by the conditions at the site, and the type of road which may be included in the layout. When economically justified, and if it is in accordance with the road master-plan, the service road will be included in the regional network. In such cases, the technical recommendations used for design of roads in Bangladesh will be applied to the lengths of embankments supporting such a road.

The study will consider the risk of earthquakes which could trigger off liquefaction of underlying soil, suggest adequate measures or devices to mitigate the effects of overtopping in case of flood exceeding the "reference flood", and take into account the other detrimental effects such as human action (breaching, erosion due to pedestrians crossing, etc ...), or animal action (rat holes, grazing on the slopes, transport by bullock carts on the crest).

Different designs will be suggested for the different types of embankments to be envisaged (either dykes along the Jamuna or dykes along the compartment inner limits). The Consultant will estimate the construction and maintenance costs for each solution and suggest the best adapted one from a technical, economic and environmental viewpoint.

Labour intensive methods will be given preference whenever it is possible; the usefulness of mechanical compaction should be assessed in consultation with the

Specific comments are given below for the Jamuna left embankment and compartment boundaries :

- **The Jamuna left bank embankment.**

  An embankment built by local authorities already exists between Bahadurabad and Jagannathganj. This embankment was severely damaged during the 1988 flood and during 1989 and its design and location do not meet the requirements of commonly accepted standards for large dykes. It cannot offer reliable protection. One option could be to adopt the existing embankment by strengthening and upgrading, but retiring over large sections is unavoidable.

  The new embankment to be designed will constitute the western border of the sub-area, it will be 60 km long approximately.

  As it will be the first stretch of the Jamuna Left Bank Embankment, special care will be devoted to its design. In places where the set-back is large,the option of constructing a smaller embankment close to the river bank or to adopt AFPM or flood proofing measures considering socio-economic and environmental issues should be examined.

- **The bordering railway lines**

  As the railway lines have insufficient height in certain stretches, shouldering the railway embankments should be considered.

- **Compartment embankments**

  The boundaries of compartments and sub compartments will be formed by river embankments and by existing road or rail embankments. The internal embankments would probably not need to be heightened but might need strengthening.

c) **Drainage system :**

- Identify the location and the type of waterlogged areas.

- Identify the river stretches causing drainage congestion (insufficient conveyance capability).

- Suggest effective drainage improvement measures including:

  o re-excavation of drainage network components where silted up (lay out, design water levels, gradients, typical cross-sections ...),
  o additional structures (see below),

- assess the impact of suggested measures downstream.

d) **Hydraulic structures**

- Regulators

  Regulators will be built across the river embankments to enable controlled flooding, drainage and water management operations. Their location and

design will take into account problems related to access, O and M, and specifically so during flood periods. Special attention will be paid to erosion problems siltation and groundwater replenishment. General operation rules will be defined.

In particular, an adequate hydraulic structure will be needed to control the inflow of the Jhenai river, which is a distributary of the Old Brahmaputra.

The offtakes of the Chatal river from the Jamuna have been recently closed by an on-going embankment. It will modify the flood flow distribution above the flood plain within the project area. The outcome of the on-going NCRS phase 2 will indicate the validity of this closure.

Similarly, drainage from the project area through Bangsi and Bhausi railway bridges should be controlled by structures (with or without sill, with or without gates), the alternative designs and operation of which are to be carefully studied.

- Emergency spillways (overflow sections)

  It is generally considered that emergency spillways are not technically feasible along the main rivers. This will be reviewed and their function reconsidered. Where adopted, overflow sections should have adequate erosion protection.

- Internal drainage system

  The general layout of the system(s) have to be designed with details of the main components covering:

  o Channels, showing longitudinal and cross sections,

  o Water management structures

  o Pump stations where technically and economically feasible.

4.4.4 Compartmentalisation

The concept of Compartmentalisation, developed in the Flood Action Plan, involves the creation of water management units, bounded by existing road, rail or river embankments. The works concerned with controlled flooding and controlled drainage have to be designed with particular attention to implementation, operation and maintenance, through maximum involvement and participation of the local people (disadvantaged groups as well as beneficiaries and local government).

FAP 20 consists of a Pilot Project for the development of this concept.

The Consultant shall establish the broad feasibility of compartments in the Jamalpur Sub-Region, following the principal of Compartmentalisation, in close co-ordination with FAP 20. In particular, he will delineate the main compartments, including their main structural and non-structural components, in such a way that they can be integrated into the Sub-Regional Land and Water Development Plan and broad Feasibility Study.

Outline designs for Project Preparation will be undertaken using available criteria from FAP 20.

4.4.5 Impact Assessment

a) Development impacts and other FAP studies

The JPPS Consultant shall carefully assess the impact of the project on the land and water development issues in the various inner "compartments", with special attention to agricultural, fishery, socio-economic and environmental issues. This will be done using available data but where necessary the Consultant will undertake appropriate surveys.

The Consultant shall also take into account the results (as available) of other FAP studies and pilot projects that will be on-going at the same time, especially FAP 12 (FCD/I Agricultural Review), FAP 13 (Operation and Maintenance Study), FAP 14 (Flood Response), FAP 15 (Land Acquisition and Resettlement), FAP 16 (Environment), FAP 17 (Fisheries) and FAP 20 (Compartmentalisation).In assessing the feasibility of the project the consultant will undertake the following activities.

b) Agriculture

Assess the likely changes in cropping patterns and net value added in agriculture in the project area and in the area just south of it and affected by flooding from the project area; "with" and "without" the project, distinguishing carefully the benefits deriving from the project (increased cropping intensities, improved cropping patterns, higher yields, reduced crop damage) from those that would have taken place anyway (e.g., changes due to some minor irrigation development) and taking full account of variations in land suitability in the project area.

Recommend and estimate the costs of any strengthening of agricultural extension and other services in the project area needed to achieve the full development of land and water resources and taking into account, inter alia, irrigated or rainfed farming, present land tenure and agricultural marketing systems.

c) Fisheries

Assess the likely impact of the project on capture and culture fisheries in the area ; identify and cost measures to limit any detrimental effects of the project on capture fisheries and investments necessary for the development of culture fisheries ; estimate the overall impact of the project on the net value added in fisheries.

Recommend and estimate the cost any strengthening of fisheries extension and other services in the project area needed to improve overall development of fisheries resources and taking into account, inter alia, the access of different groups to fishery resources and the fish marketing system.

d) Environment

Assess the likely environmental impacts of the project, both positive and negative, and suggest measures to be incorporated in project design which would eliminate or minimise any adverse environmental effects, particularly those relating to groundwater recharge, water quality, soil fertility, flora and fauna. Estimate the costs and benefits of any environmental impacts and any measures needed to counter negative impacts.

e) Socio-economic impact

Assess the socio-economic impact of the project through an analysis of the distribution of project benefits to different classes of farming households and landless, to

agricultural labourer, petty trader, and fishing households and between men and women from these households. The analysis will be undertaken for broad social categories (e.g., the flow of benefits to rich farming households as a group compared to those accruing to other groups) and to "typical" households from each group (i.e., the impact of the project on the average incomes of "typical" fishing families).

Analyse present patterns of community and farmer organisation. Recommend ways of promoting the effective involvement of farmers and other beneficiaries, and disadvantaged groups, in project planning, implementation, sustained operation and maintenance, agricultural extension services and other aspects of project management.

Estimate the number of households that will have land acquired to build project works or will remain unprotected by project embankments and recommend ways of effectively resettling or addressing the needs of these groups. The costs of these measures will be taken into account in assessing the economic viability of the project.

f) Flood damage

Assess the likely flood damage to capital stock (agricultural, fishery, livestock, other economic activities, housing and infrastructure) with and without the project.

4.4.6 Project implementation schedule

Evaluate the degree of success and effectiveness of the implementation arrangements adapted for similar projects, and identify the causes of difficulties or constraints expressed in the implementation of these projects, resulting in major time overruns.Recommend improved institutional and technical arrangement for project implementation. Assess the availability of technical staff, and if necessary, recommend training and/or other improvements that would strengthen the quality and number of staff for implementation.

In close consultation with implementation agencies, prepare a detailed project implementation schedule for each of the components suggested under the project. In particular, prepare a detailed schedule for land acquisition, procurement of equipment and materials, and for construction methods (including force account, volunteer labour, existing labour groups, NGO groups, contractors, etc) most suitable to local conditions. Specify the number of technical personnel, as well as skilled and unskilled labour, required in each year of project implementation.

4.4.7 Operation and Maintenance (O and M)

Examine the suitability of the existing and suggested institutional arrangements and procedures for the operation and maintenance of the flood control projects in JPP and in the neighbouring areas. Recommend measures for improving the procedures.

Estimate the annual cost of operation and maintenance, covering the costs relating to equipment, spare parts, labour, materials, supervision and consumables, training and administration. Costs should be separately shown for works recommended to be entrusted to the local associations.

4.4.8 Project cost estimates

Based on detailed analyses of the requirements of construction equipment, materials, labour and overheads, prepare estimates of applicable in-country unit rates for the items of work to be executed under the project. Compare these rates with those obtained in recent tenders involving similar works in Bangladesh.

Establish from the feasibility level plans and drawings produced, the quantities of the items of work to be executed and of the goods to be supplied for the project and make an estimate of the cost for the various components of the project and for the overall project including rights of way, taxes and duties, administration, engineering and supervision and contingencies. All estimated costs must be broken down into foreign exchange and local currency components.

Estimate the distribution of project costs in accordance with the implementation schedule.

4.4.9 Economic and financial analysis

Perform economic analysis appropriate to the specific issue of controlled flooding and controlled drainage, considered as protection against major natural risks. Take into account the probability of floods and rainfall and the related probability of damage caused either to output or to infrastructure, equipments or dwellings(damage frequency analysis).

Based on an assessment of "with" and "without project" situations, carry out cost-benefit analysis of direct effects, and perform a multi-criteria analysis in order to take into account non-quantifiable effects such as environmental changes, external impacts on neighbouring areas. The analysis will be undertaken for the overall Jamalpur Sub-Region, and for the main components of the project. FPCO will provide the Consultant with guidelines on the approach to be used in undertaking the cost-benefit analysis (including: effects to be considered, criteria, shadow prices).

Perform sensitivity analysis, considering variations in key factors such as irrigated areas, cropping pattern, crop yields, investment costs, implementation periods, operation and maintenance cost and any other significant factors.

4.5 Participation in Planning

While carrying out the study, the consultants will try to assess, as fully as possible, the views of the general public and of different interest groups in the area. In formulating alternative developments for the area and in detailed project planning, the consultants will hold meetings with local elected representatives (MP's, upazila and union chairmen and members, individually and as a group), farmer and fishermen organisations (e.g., cooperatives), non-governmental organisations, government officials and others in order to assess local views on the problems of the area and to discuss alternative possible development projects. In these discussions, an attempt will be made to understand the views of specific interest groups (e.g. fishermen, farmers with different kinds of land,women) and to seek the fullest possible participation of the local people in the planning of the sub-project.

5. WORK PROGRAM AND REPORTING (SEE FIGURE 5)

The Consultant will deliver reports according to the following schedule:

- month 2: Inception Report R1.
- month 3.5: Interim Report R2, on preliminary Sub-Regional Land and Water Development Plan.
- month 5.5: Interim Report R3 on the selected Sub-Regional Land and Water Development Plan.
- month 7.5: Report R4 on the Surveys and Investigations, with an addendum if necessary in month 9.

- month 9.5: Report R5 on Feasibility Study of the Jamalpur Priority Project (including Terms of Reference suggested for the preparation of Detail Design and Tender Documents for the main components).

A revised edition of report R5 could be requested, for integrating comments and observations of FPCO.

6. STAFFING AND ORGANIZATION

6.1 The man/month input is tentatively estimated to 70 m/m of expatriates and 180 m/m of local consultant with the breakdown of figure 5.

6.2 The consultant is invited to suggest a revised estimate, and bar chart showing the schedule of assignment of his personnel and a detailed task assignment for each member of his staff. The consultant will follow the broad guidelines described below for the organization of his team.

The Consultants should open a main office in Dhaka with a subsidiary office in Jamalpur.

6.3 A Management Committee will be set-up to supervise the activities of NCRS and JPPS, to ensure coordination of effort between the two studies and to encourage effective liaison with other relevant FAP activities. The Committee will comprise FPCO, donor representatives as appropriate and the two team leaders. Meetings will be held at monthly intervals.

8. RESPONSIBILITIES OF THE GOVERNMENT

8.1 Freedom from Taxation and duties:

The Government/Executing Agency shall bear the cost of any taxes,duties, fees, levies and other impositions under the laws and regulations in effect in Bangladesh on the Consultant and expatriate personnel in respect of:

- any payments made to the consultants or their panel other than Bangladesh nationals, in connection with the carrying out of the services;

- any materials, equipment and supplies brought into Bangladesh for the purpose of carrying out the services and which after having been brought to the country will be subsequently withdrawn therefrom:

- any equipment imported for the purpose of carrying out the services and paid out from the funds provided by the Government and which is treated as property of the Government.

Provided that:

(a) The Consultant and his expatriate personnel shall follow the usual customs procedure of the Government in importing property into Bangladesh; and

(b) If the Consultant or any of the expatriate personnel does not withdraw, but disposes of any property in Bangladesh upon which custom duties and taxes have been exempted, the Consultant shall bear such custom duties and taxes in conformity with the regulations of the Government.

8.2 Other Privileges and Exemptions

The Government shall:

- provide the expatriate personnel with work permits and such other documents as shall be necessary to enable them to perform the services including privileges specified in the Government of the People's Republic of Bangladesh notification no /RO 88-L-85/906/CUS dated the 13th February,1985 and /RO 89-/85/907/CUS dated the 13th February,1985 (circular of 1988 is to be incorporated)

- arrange for the personnel and his authorized dependents to be provided promptly with all necessary entry and exit visas, residence permits, work permits, exchange permit and travel documents required for their stay, in Bangladesh;

- facilitate clearance through customs of any property required for the services and of the personal effects of the expatriate personnel and the prompt issue to the Consultants expatriate personnel of Custom Pass Books.

- issue to officials, agents and representatives of the Government all such instructions as may be necessary or appropriate for the prompt and effective implementation of the services;

- exempt the consultants and the personnel for the services from any requirement to register or obtain any permit to practice the profession of Engineer or Architect or to establish himself higher individually or as a corporate entity according to the laws of Bangladesh;

- arrange for duties and taxes on the imported equipment, vehicles and other materials relating to the project which will be retained in Bangladesh to be paid by the implementing agency in Bangladesh;

8.3 Services, Facilities and Equipment

- The Government shall provide assistance to collect pertinent data, maps and information available for the performance of the Services under this Contract.

- The Govt. shall, if available, provide accommodation in the Govt. Rest House at usual rate.

- Indemnify, save and hold harmless the Consultant and its personnel from and against all claims, demands or suits, that may be made or brought against the Consultant and its personnel arising directly from the performance of the services provided that, such claims, demands or suits are not the result of negligence or wilful acts of the Consultant and its personnel.

9. RESPONSIBILITIES OF THE CONSULTANT

9.1 Responsibility of Consultant

The Consultant shall carry out the services as detailed in "Scope and Terms of Reference" in the best interest of the Government for the successful realisation of the programme with all reasonable care, skill and diligence with sound engineering, administrative and financial practices and shall be responsible to Executive Agency (FPCO) for the discharge of responsibilities.

The Consultant shall during the execution of the services appoint and designate a Team Leader to represent the Consultant in Bangladesh in all matters relating to the services.

The Consultant shall be responsible for the professional and technical competence of its employees and the personnel's behaviour and shall use its best efforts to select and employ for work in Bangladesh only those persons who in its judgment will be the best and most likely to perform satisfactorily the terms of their employment.

The Consultant shall keep accurate and systematic records and accounts in respect of the services in such form and detail as is customary in the profession and shall be sufficient to accurately establish the costs and expenditures incurred for the services.

Except with the prior approval of the Government/Executive Agency the Consultant shall not any time communicate to any persons or entity not connected with the services any confidential information, disclose to them for the purpose of the services or disclosed by them in the course of their services, nor shall the Consultant or the Consultant's personnel make public any information relating to the services.

The Consultant shall be responsible in respect of life, health, accident, travel and other insurance which may be necessary for the Consultant's personnel for the purpose of the services.

All existing rules and regulations of the Govt. of Bangladesh related to the classification, custody and issue of restricted map, aerial photograph and other related data shall be maintained.

9.2 Information

The Consultant shall furnish the Executing Agency with such information relating to the services and the Project as the Executing Agency may from time to time reasonably request.

9.3 Assignments, Subcontractors:

Except with the prior written approval of the Government the Consultant shall not assign or transfer the contract or any part thereof nor engage any independent Consultant or sub-contractors to perform any part of the services other than nominated personnel listed in the contract.

The approval of the Executing Agency to the assignment of any part of the Contract or to the engagement by the Consultant of independent Consultants or sub-contractors to perform any part of the services shall not relieve the Consultant of any of his obligations under this contract.

9.4 Prohibition on Conflicting Activity

No member of the personnel assigned to this Project shall engage, directly or indirectly either in his name or through the Consultant any other business or professional activities in Bangladesh during the performance of his duties or assignment under this contract.

9.5 Laws and Regulations.

In accordance with the Aid Agreement signed on 14 March 1990 by the Government of the French Republic and the Government of the Peoples Republic of Bangladesh, and in conformity with the Euro-Bangladeshi Agreement to Finance, and with the Convention between the Credit Nacionale and the Caisse Centrale de Cooperacion Economique (CCCE), who, in the name of the French Government, also represent the European Economic Community, this contract shall be construed in French law.

The Consultant shall respect and abide by all applicable laws and regulations in Bangladesh and shall use his best efforts to ensure that the Consultant's personnel and their dependents while in Bangladesh and local employees of the Consultant shall respect and abide by all laws and regulations of Bangladesh.

9.6 Ownership of Drawings, Data and Reports

All reports and relevant data such as maps, drawings, plans, statistics and supporting records or materials compiled or prepared in the course of Services shall be the absolute property of the Government. The Consultant agrees to deliver all these materials to the Executive Agency upon completion or termination of this Agreement.

9.7 Reports and Communication

All reports, communications, recommendations and general correspondence from the Consultant to the Executing Agency under the Agreement shall be in English language. The number of copies of each report to be submitted shall be stated by the Executing Agency (FPCO), but shall not exceed one hundred.

9.8 Notice of Delay

In the event that the Consultant encounters delays in obtaining the required services or facilities set forth in this contract for the conduct of the services, or the occurrence of the event or condition that might delay or prevent completion of the services in accordance with the time schedule, the Consultant shall promptly notify the Government of such delay indicating what steps are being taken or suggested by the Consultant to meet the situation and he may request an appropriate extension of time for completion of the services.

ANNEX 1

TERMS OF REFERENCE

OF THE NORTH CENTRAL REGIONAL STUDY

(FAP 3)

Will be appended in the final document

ANNEX 2

JAMALPUR Sub-region

Some additional data

Hydrology

The monsoon lasts from June to September. The mean annual rainfall is 2000 mm (2200 mm in the north and 1800 mm in the south). The 10 days rainfall with a return period of 5 years, is 410 mm (450 mm in the north to 390 mm in the south).

Maximum water levels have been observed during the flood of 1988. The corresponding values are:

Water levels (m + PWD):

River	Gauging station		1988		20 Y (MPO)
Jamuna	Bahadurabad		20.61		20.21
Jamuna	Jagannathganj	16.14		-	
O. Brahmaputra	Jhenai Offtake	18.67		-	
O. Brahmaputra	Jamalpur		17.81		17.51
Jhenai	Baushi RW bridge		17.25		16.70

Discharges (m^3/s):

River	Gauging station	Record period	Max	Min
Jamuna	Bahadurabad	1968/1989	98600	2860
Jhenai	Baushi RW bridge	1970/1988	470	(0)

Return period (MPO)

River	Gauging station	2.33 Y	5 Y	10 Y	20 Y
Jamuna	Bahadurabad	65200	71900	76000	80800
Jhenai	Baushi RW bridge	292	374	435	489

The values observed during 1988 exceeded the corresponding values of the last 20 years event as computed by MPO.

DAMAGES AND BENEFITS DUE TO FLOODING AND FLOOD PROTECTION

NB : T 35 = US $ 1.

Additional information collected during Phase II of the North Central Regional Study revealed that losses in gross production value during the 1988 floods are considerably higher than estimated during Phase I.

Within the project area, the June 1988 flood caused by rainwater damaged 1700 ha of Aus rice, 1850 ha of B. Aman rice and 1800 ha of jute with a production capacity of 3800 tons of paddy and 2800 tons of fibre and a value of Tk.44 million gross.

The Jamuna flood in September 1988 however damaged 38 000 ha of T.Aman rice with a production capacity of 97 000 tons of paddy, 1200 ha of sugar cane with a production capacity of 48 000 tons and 380 ha of summer vegetables with a production capacity of 2 000 tons. The total gross value of lost production is Tk. 676 million.

So production value losses due to flooding within the priority project area in 1988 amounted to a total of Tk. 720 million gross.

Both floods did not affect the project area only, but they extended through the Jhenai and Chatal khals also into the area south of the Jamalpur - Jagannathganj railway line. In this area, which includes the upazilas of Bhuapur, Gopalpur and part of Ghatail, Madhupur and Jamalpur, considerable damage resulted also.

In June 1988, 2700 ha of Aus rice, 12 000 of B.Aman rice and 1 000 ha of jute were destroyed, with a production capacity of 16 000 tons of paddy and 1 700 tons of fibre with a total value of Tk. 116 million gross. In September 1988, 26 000 ha of T.Aman rice, 100 ha of sugar cane, and 300 ha of vegetables were affected, producing 66 000 tons of paddy, 4 000 tons of sugar cane and 1 800 tons of vegetables, with a total value of Tk. 441 million gross.

Production value losses due to floods in 1988 in the area south of the railway Jamalpur-Jagannathganj have been Tk. 557 million gross.

Full protection or controlled flood protection, combined with drainage improvement, will lead to a shorter inundation period, lower inundation levels and less rapidly increasing water levels. Inceases in yields are expected by reductions in damages, increases in cropping intensities and higher investment in inputs mainly.

ANNEX 3

Extracts of the Reconnaissance Study

Alternative Water development options and strategies

for the JAMALPUR Sub-Region

Proposed scenarios

For the Jamalpur Sub-Region, three water development scenarios could be considered. They are corresponding to development options presented for the overall North Central Region (NCR), see report R1.

The first scenario would be restricted to opening up a limited number of depressions and (minor) re-excavation of some khals.

Scenario II would consider full flood protection form Dewanganj up to Jagannathganj with a safe set back from the Jamuna to "guarantee" a life time of 20 years and crest levels with security for overtopping with various degrees of safety. A secondary embankment, near to the Jamuna river bank would be considered. Drains would be re-excavated as may be required ; inflow of the Jhenai (and the Chatal) would be halted and the outflow of the Chatal into the Jamuna would be controlled by a regulator. Compartments would be formed inside for water control at various levels, requiring bunds, excavation and minor structures.

Scenario III would be similar to scenario II, but in addition, flood inflow into the system would be allowed by openings, sills or regulating structures and the outfall (and inflow) of the Chatal khal would be left open. In this case the southern part of the Jamalpur-Jagannathganj railway line would need to be raised or shouldered, to protect the southern area from flooding and the railway line from damage.

For scenarios II and III complementary development activities will be considered to flood protection, i.e. compartmentalisation, drainage improvement, water management, irrigation and rural development.

ANNEX 4

JOB DESCRIPTIONS

A) INTRODUCTION

The indicative numbers of staff required to complete the Jamalpur Priority Project Feasibility Study are as follows:

- 70 person-months of expatriate consultants,
- 180 person-months of local consultants.

Consultants will propose the specialists they would assign to the study and the inputs that each would make. A bar-chart will be presented relating the proposed inputs by different specialists to the activities that would be undertaken in the study.

Of the expatriate consultants, 47 person-months will be financed by France. These consultants will be French citizens. 23 person months will be financed by the EEC. These consultants will be citizens of the 12 member states. An indicative list of the specialists to be financed by the EEC and France are given in Figure 5. The Consultant may propose an alternative breakdown if this is necessary to ensure that the most qualified specialists are assigned to each task. If the Consultant does propose such a change, care should be taken to ensure that the total number of person-months of consultancy financed by France and EEC remains about the same.

The minimum professional experience required for the consultants will be as follows :

o **Expatriates :**

-	Team Leader	20 years
-	Irrigation/Drainage Engineers/Socio-economist	15 years
-	Other Specialists.....	10 years

o **Local consultants :**

-	Co-Team Leader (Minimum).....	20 years
-	Other Specialists (Minimum).....	12 years

Previous experience of working in Bangladesh would be desirable for the expatriate consultants.

B) JOB DESCRIPTIONS

1. Project Manager(s)

The Project Manager(s) would be responsible for the overall conduct of the study. They would visit Bangladesh at key points during the study (e.g., during preparation of reports) to review the progress of the study in consultation with the Team Leader and specialists undertaking the work and with the Flood Plan Co-ordination Organization.

Qualifications:

Each should have a degree in Civil Engineering/Water Resources with 20 years experience in related fields. Preferably he should have a post graduate degree. Experience of work in this region will be given preference.

2. Water Resources Planner/Team Leader

The Water Resources Planner/Team Leader will, **as Team Leader**, take responsibility for :

- the day-to-day management of the study, including the guiding and supervision of the study team of local and expatriate consultants, the production of the reports specified in the TOR and the final outcome of the study ;

- liaison with :

  (a) FPCO, the French Embassy and EEC (Dhaka), and participation for the management committee (sec. TOR Para 6.3)

  (b) the BWDB and other Government Agencies,

  (c) the teams undertaking other studies under the Flood Action Plan (especially FAP,3 North Central Regional Study and FAP1, FAP20, 21/22), FAP 25 as well as FAP 12, FAP 13, FAP 14, FAP 15, FAP 16, FAP 17 and the FPCO's recommendations for the methods of economic analyses.

As Water Resources Planner, and in close cooperation with other team members, he will:

- develop, jointly with other team members the sub-regional water development options and strategies compare them and prepare the sub-regional land and water development plan ;

- assess the impact of the plan on ground-water and recharge and propose corrective measure ;

- assess the impact of the plan on the other regions from a water management point of view ;

- propose a comprehensive water management operation.

- ensure the full consistency of the feasibility study for the whole Sub-region and the more detailed project preparation for the priority project with the selective Sub-regional Land and Water Development Plan.

Qualifications

He must have a degree of Civil Engineering / Water Resources Engineering with 20 years experience in related field. Preferably he should have a post Graduate Degree. Experience of work in this region will be given preference.

3. **The Hydrologist/Modeller**

The Hydrologist-Modeller will :

- adapt the hydraulic model for water management, prepared by the North Central Regional Study, to the specific needs of the sub-region and use it for the preliminary planning the preparation of the selected Land and Water Development Plan them, for the feasibility study for the whole sub-region and the more detail project preparation of the priority project.

- For this different stages compute water elevation and discharge in the hydrographic network.

- simulate water management of compartment and rivers;

- assess in coordination with N.C.R. downstream hydraulic consequences of alternative options and design choices.

Qualifications:

He must have a basic Degree of Civil Engineering/Water Resources Engineering with post-Graduate Degree in Hydrology/Water Resources Engineering. He should have a professional experience around 15 years in related fields.

4. **Drainage Engineer**

The Drainage Engineer will, in close cooperation with the Water Resources and Civil Engineers, the Hydrologist/Modeller, the Agronomist, the Environmentalist and the Socio-Economist and Institutions Specialist :

- complete the assessment of the status of the drainage conditions;

- Assess the various options of drainage with major or minor works, considering various types of works (embankments, regulators, open silled or gated outlets) and develop the most desirable drainage improvement plan.
- develop at feasibility study level proposals for internal water management of compartments, with special emphasis on operation and maintenance and on associated irrigation development. This would be done in close consultation with the Consultant undertaking the Compartmentalisation Pilot Project (FAP20) ;

- estimate, in consultation with the Economist, the costs of the works related to the alternative strategies (including: labour, land acquisition and other construction costs and operation and maintenance costs);

- assess, in consultation with the Socio-Economist and Institutions Specialist, the institutional requirements for the execution and the operation and maintenance of earthworks and irrigation and drainage structures.

Qualifications

He must have a basic Degree in Civil Engineering/Water Resources Engineering with a post-Graduate Degree in Hydrology / Water Resources Engineering. He should have a professional experience around 15 years in related fields.

5. **Civil Engineers (earthwork + structure)**

The Civil Engineers will, in close cooperation with the Hydrologist/Modeller and other Engineers :

- complete the assessment of the status of the existing embankments and bank protection works, road and railway earth fills and various structures (regulators, sills, bridges etc.);

- assess the various options for the alignment and locations, the cross sections and the other specifications for embankments and structures;

- specify the physical requirements for the construction or the reconstruction of the embankments and bank protection works, covering stability analysis, Geo-technical and hydrological effects, boro-pits and their best use;

- specify, at feasibility design level, the required types and sizes of major structures (including sluices, controlled and uncontrolled inlets and outfalls - siphons, sills and protection walls, bridges, locks and possibly pumping stations);

- specify, at outline design level, the physical requirements for earthworks and minor structures needed to improve local and regional road communications and/or to delineate the various compartments;

- estimate, in consultation with the Economist, the costs of the various components of the works including: labour, land acquisition and other constructions costs; operation and maintenance costs over the life of the project;

- assess, in consultation with the Socio-Economist and Institutions Specialist, the institutional requirements for operation and maintenance of earthworks and for major and minor structures.

Qualifications

He must have a basic degree in Civil Engineering with a post Graduate Degree in Hydraulic Engineering/Water Resources Engineering with 15 years experience in related fields.

6. **Agriculturalist**

The Agriculturalist will refine and check the results of the Reconnaissance Study, and participate in the identification and in the formulation of the sub-regional water and land development plan. In doing so, the Specialist will :

- interpret the existing 1/50,000 land suitability and land capability maps ;

- undertake and monitor surveys in the project area on :

    o cropping patterns, production methods, yields, and costs and returns, for crops grown in farmers fields and around homesteads,

- o crop damage due to flooding and impaired drainage,
- o constraints that farmers are facing, including flood and drainage problems, and farmers reactions to these constraints,
- o existing and prospective market opportunities.

- assess likely future cropping patterns (including, yields, production methods, costs and returns) for " with" and "without" project cases, at feasibility level, and in close coordination with the N.C. Regional Study Consultant;

- recommend measures to achieve effective involvement of the farmers and other beneficiaries in project planning, implementation, sustained operation and maintenance, agricultural extension services and other aspects of project management;

- recommend measures to improve the agricultural support services.

Qualifications

He must have a basic degree in Agriculture with a post Graduate Degree in an Agricultural field. He should have professional experience of around 15 years.

7. Environmentalist

The Environmentalist will :

- elaborate on the overall environmental assessment prepared during the Reconnaissance Study ;

- assess the potential environmental impacts of alternative options, then of the selected Land and Water Development Plan, notably, on groundwater recharge and quality, soil productivity, fisheries, navigation, conservation of flora and fauna, public health,of the project area as well as from the downstream areas and propose measures to mitigate the possible detrimental effects.

- in conjunction with the river morphologist determine the impact that embankments, compartments, drainage and improved hydraulic structures will have on the affected rivers with respect to sedimentation, scouring and aquatic or riparian habitat; outline the measures which are suggested to be incorporated in the project design in order to mitigate negative impacts.

Qualifications:

He must have a basic degree in environmental science with a Post Graduate Degree/Ph.D in environmental science. He should have an experience of around 15 years in related fields.

8. Socio-Economist/Institutions Specialist

The Socio-Economist/Institutions Specialist will, for the sub-region :

- prepare an analysis of population characteristics and trends in rural and urban parts of the region, including birth death and migration rates, in order to make demographic forecasts for the next 25 years;

- estimate the present and future composition of the economically active population, especially child and female labour and covering formal and informal sectors;

- in conjunction with the agriculturalist;

- estimate the present and likely changes in the agrarian structure and in other sectors over the next 25 years ;

- assess the views of the people concerning flood control and drainage and the significance of these views for alternative development strategies (notably saving behaviour);

- assess the present and possible future roles of Upazila and Union Councils, farmers organisations and NGOs in water and land resource development plan and in project implementation, operation and maintenance and recommend ways of increasing peoples participation.

- assess possible institutional constraints which could hamper the implementation, operation and maintenance of projects in the region and recommend ways in which these constraints could be overcome.

- in doing so the socio-economist will hold meetings with involved people and organization, as stated in the ToR (See para 4.5).

Qualifications

Post Graduate Degree in Social science with at least 15 years of experience in related field. A Doctorate in related field will be given preference.

9. Economist

The Economist will :

- complete the data collection including frequency analysis, for the damages caused by floods and/or impaired drainage, to the output, the infrastructures, the productive capital and to dwellings, in agriculture as well as in other sectors;

- perform at pre-feasibility level, the financial and economic analysis, for the various options of the preliminary plan, then for the selected Land and Water Development Plan;

- establish at feasibility level the financial and economic analysis for the various scenarios with all justification required for appraisal;

- assess the distribution of benefits between different socio-economic groups (large, medium, small farmers; sharecroppers; agricultural labourers; fishermen; others);

- in doing so, the economist shall apply the methods of economic analysis recommended by FPCO to assess the various direct costs and benefits, through appropriate shadow prices, as well as to assess the possible indirect and qualitative effects, through appropriate corrective factors and through multicriterial analysis, which analysis will be part of the comparison for alternative development scenarios.

Qualifications

A post Graduate Degree in economics with at least 15 years experience in related fields. A Doctoral Degree in a related field will be given preference.

10. Fisheries Specialist

The fisheries specialist will:

- assess the likely impact of the various development scenarios on capture and culture fisheries in the project area and the affected area south of it.

- identify and cost measures to limit any detrimental effect of the project on capture fisheries and investments necessary for the development of culture fisheries;

- estimate the overall impact of the project on the net value added in fisheries;

- recommend and estimate the cost of strengthening of fisheries extension and other services in the project area needed to improve overall development of fisheries resources and taking into account, inter alia, the access of different groups to fishery resources and the fish marketing system.

11. River Morphologist

The River Morphologist will, in close cooperation with the hydrologist:

- assess the available findings of the on-going morphological study undertaken under FAP 1, as well as the (preliminary) findings of FAP 21/22 and FAP 25.

- assess the morphological effects of the various development scenarios for the sub-region on the adjacent rivers, on the internal rivers and, in particular, on the offtakes and outfalls at the Jamuna and Old Brahmaputra. The morphological behaviour of the outfall of the Chatal river under various development scenarios should receive particular attention;

- advise on the location of embankments and related structures based on the expected river morphological behaviour;

- advise on physical interventions required to reduce or eliminate undesirable morphological processes.

Qualifications

The River Morphologist should have a degree in Civil Engineering/Water Resources with a post graduate degree in Hydraulic Engineering/Hydrology with at least 10 years experience in related fields. He should have experience in the region in morphological studies, preferably with reference to the Bangladesh river systems.

APPENDIX C: Comments on the Proposal

In a letter to Mr A.Vanden Abeele, of the French Embassy in Dhaka, the Ministry of Irrigation, Water Development and Flood Control raised some queries concerning the Proposal prepared by the consortium. Some of these concerned spelling errors, particularly of place names, which are noted. Other queries are answered below:

Identification as in the Ministry letter FC-VII/France-1p-1/91/590 of 7.7.1991.

1. The likelihood that the Finnmap contour mapping will not be available until the latter stages of this project, if then, is understood, and our planning is not conditional on its use.

Article 3.1.2 Detailed approach. Present situation: 3rd and 4th lines.

This statement was based on information available at the time. At present it can neither be confirmed or denied, but is probably a reasonable indication of the flood depths (it was a statement that flood depths in a 1 in 20 year flood in the area were one metre higher than a normal flood).

Article 3.1.2 Iterative studies by successive approach, 2nd para, 4th line.

The use of the word "approval" was inappropriate; "assistance" would convey the intended meaning more clearly. It is acknowledged that approval rests with the FPCO.

Article 3.1.2, page 2 - double embankments

It is noted that double embankments are not consistent with the ToR concept.

Article 3.1.2, page 3 - drainage Hydraulic Expert

The reference is to the Drainage Engineer.

Page 3, Land and Water Development Plan, 7th line.

It is agreed that controlled flooding should have been mentioned here. Perhaps the point being made was that the embankments would not necessarily be designed to protect the whole area; there is a possibility that the Jamuna embankment could be retired as far as the left bank of the Chatal.

Page 4, 6th para.

The hydraulic team, in this context, refers to the hydro-modellers and the river morphologists.

Page 4, para 2, feasibility - 2nd para, 1st line.

As noted above, the term "drainage Hydraulic Expert" refers to the Drainage Engineer.

Page 5, last para.

The preference for "Tentative" rather than "Conceptual" is noted.

Page 6, 1st para.

It is agreed that "Board" should read "FPCO".

The Ministry letter also noted that the Consultant had made no comments on the Terms of Reference in the Proposal; this omission is rectified in the next Chapter of this report.

With regard to the breakdown of 180 local man months, this was shown in Figure 3-6 at the end of Section 3.3 of the Proposal.

Appendix - B

Terms of Reference for the Extension of JPP Studies

Appendix B

JAMALPUR PRIORITY PROJECT STUDIES

PROPOSAL FOR EXTENSION OF THE STUDIES

1. BACKGROUND

The present study started in August 1991 and is due to end in May 1992. It has thus taken place almost entirely in the dry season, with virtually no chance to observe at first hand the effects of the monsoon flooding on the area. This is of particular importance for the design of the drainage works, and for the hydrodynamic model. The model is further hampered by the lack of water level and flow data within the area; there are no flow gauging stations for flows into or out of the project area and only one water level gauging station within the area. Water level on the main rivers, the Jamuna and the Old Brahmaputra, are available from the General Model, and there is a water level gauge at Bausi Bridge, on the southern boundary.

These limitations mean that the model has been constructed using the limited data available from the SPOT images and the 1:50,000 mapping of the area, combined with information gathered in site visits. Without the level and flow data from internal gauges, it is impossible to calibrate the model or to verify the accuracy of the information generated.

The problems of the modelling are not the only limitation imposed on the study. It was intended to have available photomosaic contour mapping of the area, at a scale of 1:20,000. The photography was flown in 1990, but a series of unexpected delays in the ground control and release of the film for processing mean that the maps are now unlikely to be ready until June 1992. At the time the study started it was known that there would be delays in producing the maps, but it was believed that they would be available during the course of the investigations. Attempts have been made to overcome the lack of mapping by using the old (1960s) Water Development 4 inch to the mile topographic maps with one foot contours, based on 1957 aerial photography, and by more extensive (and expensive) surveys. However, both these have severe limitations: the old mapping is clearly inaccurate in the Jamuna active flood plain, and out of date with regard to roads and housing areas; site surveys are necessarily of limited extent, and can only depict a narrow strip, which may miss important features.

These matters were discussed in the Inception Report, and further aired in the comments on that report and the related replies. As a result, it has been proposed that the studies be extended to cover the 1992 monsoon, and to make use of the new mapping.

It should be clearly apparent that, without the extension, the studies will be incomplete and insufficient for the requirements of making a decision on the funding of further stages of the Jamalpur Priority Project.

2. OBJECTIVES OF THE EXTENSION

The chief objective of the extended studies, and the main justification for extending the project period, is to study, observe and record the conditions during a full monsoon. This study must include the collection and analysis of hydrological data, and the updating and calibration of the hydrodynamic computer model with this data and with amendments

resulting from the field observations of the drainage pattern. It should be evident that, because of the delayed start of the original study, it was not possible to do this within the period of this study; the Team Leader only arrived on 15 August and the team were not fully assembled until the end of September. Thus the peak of the river levels had passed, and the main rainfall was over before the study started. Since it is now clear that many of the problems in the higher land are due to poor drainage of rainwater, rather than river flooding, this is an important omission.

One of the chief concerns at present is that the environmental and the related socio-economic inputs originally proposed are not sufficient to fulfil the requirements of the recently published Environmental Guidelines. It should also be noted that the Socio-Economic Guidelines were not available to the Consultants until after the study had started. The Consultant has already proposed, in the Inception Report, to increase the socio-economic input from 3 man months to 5, but was unable to make a similar extension to the environmentalist's input, for several reasons. It would also have been difficult to justify any further cuts in the engineering and related inputs, which would have been necessary to accommodate an increase in the environmental man months. It is now possible to use the extension advantageously to increase both the duration and relevance of the environmental and the socio-economic studies.

Another significant advantage to the project which will accrue as a result of the extension, is that the long delayed Finnmap aerial photomosaic contour mapping is to be ready in June 1992. Even if these maps are still further delayed, it is most likely that they will be available in time to be used during the extension. This will make it possible to prepare layout plans for the embankments and drainage channels based on these maps, and to examine the proposals in the light of the new contours. This is relevant to both the engineering designs and the modelling, since much of the model output is based on area/elevation curves, which are at present derived from the old Water Development maps.

All these improvements will make the study a much more realistic feasibility study. Without them, it is unlikely if the study will achieve the necessary standard required for appraisal.

The objectives of the of the extension may be summarised as follows:

(i) To observe and record the effects of the monsoon rainfall and river floods in the Jamalpur area. In particular, to observe the drainage flows and take note of any drainage congestion and possible means to relieve such restrictions to free drainage.

(ii) To record water levels and flows during the monsoon, and to use the results to calibrate the hydrodynamic model. When the model is thus properly calibrated, the proposed development options can be studied in the model, and revised results obtained.

(iii) Using the results from the model, and the new mapping, the embankments and structures can be more accurately defined and costed. In the light of the new figures, some redesign may be necessary to make the best use of the available land and other resources.

(iv) With this improved information, updated economic analyses of the options to be studied can be prepared, with more accurate figures for the costs and benefits, to demonstrate clearly the feasibility of the option selected for development.

(v) The socio-economists and environmentalists can make use of the extension to study the wet season conditions on the ground, and observe directly the peoples' reactions to flooding and its effect on the environment. Additional information on water quality in the wet season, nutrition and the ecology can be gathered; there is little or no information on these matters at present.

To sum up, the chief objective of this extension is to include direct observation of monsoon conditions on site in the study. This includes the very important hydrological data collection and the calibration of the hydrodynamic model. Additional benefits to the environmental and socio-economic studies are a necessary addition as the present time allowed for these studies is not sufficient for a complete study, as required by the new Guidelines. A further benefit, in the form of the new mapping, is most likely to be available during the extended studies, and it will clearly be necessary to make use of this information to produce a valid feasibility study.

3. PROGRAMME

During March and April the water level and flow gauging stations will be selected and set up. The current proposals allow for up to 17 stations, of which 5 or 6 will be flow gauging sites. The actual number will be decided after discussions with the SWMC. The cost of installing and monitoring these stations will be included in the extension budget, although the stations must be set up and running before the start of the monsoon rains in April.

During the monsoon, the records and operation of these gauges will be monitored by the expatriate and local hydrologists, who will pass the information to the hydromodellers. It is anticipated that the hydrologists will spend a large proportion of their time in the field, not only monitoring the gauges, but also observing the flooding patterns and noting any discrepancies from the assumptions made in the model. It will also be useful if the hydromodellers themselves can spare the time to visit the site. It is expected that the drainage engineers would also spend time studying the flow paths and modifying their proposals in the light of the field observations. All this information should be fed into the model.

As soon as the 1:20,000 mapping becomes available, the engineers and draughtsmen will be engaged in transferring the development proposals to the new maps. Any anomalies should be investigated, in the field if necessary. New layout drawings, based on the maps, can then be prepared. At the same time, the hydromodellers will be revising the area/elevation curves (presently derived from the old Water Development Maps) in line with the contours on the new mapping.

Once the model is successfully calibrated, probably towards the end of the study period, the final revisions to the designs can be made. It should then also be possible to refine the estimates of agricultural benefits, on the basis of the revised area/elevation curves and the improved water level simulation. With this information, the economists can then finalise the cost/benefit analyses.

The sociologists and environmentalists will be active during the whole of the extension period. The revised Environmental Guidelines require a more comprehensive environmental study than was envisaged when the original proposal was prepared, and this extension will provide an opportunity to extend the related inputs and provide a better understanding of the impacts and of the mitigation measures required. There will also be time to prepare a full Environmental Impact Assessment.

The month of October will be used to write the Draft Feasibility Report. This will be discussed with the FPCO, and the Aid Donors, leading to the issue of the Final Feasibility Report in mid December.

An activity programme is shown in Figure 1.

4. REPORTING

It is proposed to issue an Interim Feasibility Report at the end of the original study period, at the beginning of June. This will detail the proposals at that stage and will include all the features of a full feasibility report. Where information is missing, or there is some doubt about its reliability, these facts will be mentioned. This report will, as a result, give a good indication of the work to be done during the extension. A more detailed programme for the extension can also be included.

As mentioned in the previous section, a Draft Feasibility Report will be issued at the end of the extension, at the beginning of November. This will be amended in the light of comments by the FPCO, and the Aid Donors and the Final Feasibility Report issued in mid December.

There are no proposals for further interim reports during the extension, since the team will be fully occupied with field studies.

5. STAFFING

It is intended that the existing staff will, as far as possible, continue in their present posts for the extension. Additional staff will be needed for the new posts - the hydrologist in the expatriate team and a sociologist to serve as WID specialist in the local team. No great difficulty is expected in filling these posts.

As in the original programme, the two Team Leaders will be expected to continue in post until the issue of the Final Feasibility Report. It will be noted that the expatriate Team Leader has only four months input to the extension; his time for the existing contract will cover the period between the draft and final reports, but he should take one month leave during his extended tour. This may well be taken during the period of the existing contract, as he is likely to be needed full time during the extension and the subsequent discussions on the draft report.

Dealing first with the expatriate team; the Team Leader should be present for most of the time - he will certainly be needed for the reporting stages and to co-ordinate the team activities, with the remainder of the expatriate team being either short term inputs or specialists not involved in management.

The hydrologist and the hydro-modeller will have distinct roles; the hydrologist will be largely concerned with the collection and collation of the field data, while the modeller will manipulate the data and use it to improve the model. Since the collection and use of the hydraulic data is a major part of the reason for the extension, it is also clear that these two posts should have a major input.

The engineers have different tasks. The drainage engineers should certainly make full use of the opportunity to observe the flood drainage in the current situation, and to note where improvements are clearly needed. In many cases in the past it has been found that the actual drainage pattern was somewhat different from the dry season predictions, and this

needs to be checked. It is proposed to combine drainage engineer and structural engineer posts in the expatriate team. The embankment engineer has specialised experience, but will not need to make as much addition to his previous work in the light of the monsoon information as the other engineering disciplines. However, the new mapping will be most useful for the proper delineation of the embankment alignments, particularly as much of the embankment is in the very areas where the existing mapping is most inaccurate, the Jamuna flood plain.

The case for the environmentalist has been made above, but there is also good reason to include more time for the socio-economist and the fisheries expert - there are still queries with regard to the monsoon season fish migrations and on the fishing practice at that time.

Specific Tasks:

(i) Team Leader:

a) Co-ordinate team activities, liaise with FPCO and the other FAP activities.

b) Oversee the work of the team, with particular reference to the water resources studies.

c) Manage the running of the project on a day to day basis.

(ii) Hydrologist:

a) Liaise with the Hydrology Division of the BWDB and with SWMC on the establishment, running and data collection from the gauging stations in and around the project area. The local hydrologist should particularly assist him in this task.

b) Make site visits to establish in the field that the drainage patterns assumed in the hydrodynamic model are correct, or to suggest amendments where differences are observed.

c) Analyze the hydrological data before it is used in the model, and make certain that the data from the various stations is consistent.

(iii) Hydromodeller:

a) Update the model with the new area/elevation curves from the latest mapping.

b) As data becomes available from the field, add this to the data in the model. Data, in this context, includes not only the results from the gauging stations, but also the field observations of drainage patterns and water flow paths.

c) Amend the model to produce a calibrated model which fits all the available data. Once this is done, run the various options for development in the model and produce the basic data for the agricultural and economic analysis of the proposals.

(iv) Drainage/Structures Engineer:

a) Observe the field drainage patterns (in conjunction with the hydrologist, but with different ends in view), and revise, if necessary, the drainage proposals to fit the observed flows. These revisions may extend to the design of the related structures.

b) Using the new mapping, plot the drainage proposals and structure locations. Make sure that there are no anomalies resulting from the previous use of the older mapping.

c) Revise the costs of the drainage and structural proposals for the selected options on the basis of the revisions made above, and any further revisions which may result from the model runs.

(v) Earthworks Engineer

a) Field observations of the alignments will be difficult during the monsoon, as many of the sites for embankments should be under water at that time. However, it will be most useful to observe the behaviour of the existing embankments, particularly in areas where erosion is taking place.

b) Make use of the new mapping to plot the proposed embankments more accurately, and hence to obtain better figures for the costs. It will also be necessary to make sure that the alignments are suitable, and that they relate to the ground conditions shown on the maps.

(vi) Environmentalist

a) Make further field visits to study the effects of the monsoon directly.

b) Prepare the full Environmental Impact Assessments for the options under consideration, including additional information collected during this period.

c) In the "umbrella" role, oversee the work of the socio-economists, the agriculturalists and the fisheries specialists, and integrate their findings into the overall impact assessment and the multi-criterial analysis (with the socio-economist and agro-economist).

(vii) Socio-Economist:

a) Conduct further field studies in the monsoon, with particular reference to the observed flood preparedness strategies of the people in the vulnerable areas. These may well differ from those predicted in the dry season.

c) Update and improve the results of the earlier surveys. There will be areas which, once the results of the surveys are to hand, need further study, and this can be undertaken now.

(viii) Agro-Economist:

a) Make field studies of the actual cropping pattern during the monsoon. While data received from farmers and other sources in the dry season may be good, it cannot be as good as actual observation.

b) Using the data from the calibrated model runs, and the updated engineering costs, prepare revised economic projections of the costs and benefits of the options to be considered.

c) In conjunction with the environmentalists and socio-economists, prepare revised multi-criterial analyses of the options.

A total of 17.0 man-month of additional expatriate input is proposed. A staffing schedule is given in Figure 2.

The Local Team:

With regard to the local team, the Co-Team Leader should stay for the whole period. One engineer each for drainage, embankments and structures is proposed for 5, 3 and 2 man-months respectively. They would support the engineering studies with the updated model results and new mapping.

The hydromodeller and the hydrologist will undertake different and complementary jobs. The hydrologist is required to maintain the links with the Hydrology division of the BWDB, and with the SWMC, and to make sure that the site records from the gauging stations are transmitted to the Jamalpur project office. He should also spend time on site studying the drainage patterns and river flows, and noting any divergence from the patterns assumed in the model (and it would be helpful if this could be done with the hydromodeller). However, the modellers chief task would be to update the model with the information coming from site, both from the river gauges and from the hydrologists reports.

It is proposed to have an addition to the team, to cover womens' interests. With regard to the environmentalist, agriculturalist, fisheries specialist and socio-economist, these inputs all follow from the corresponding inputs in the expatriate team. It is envisaged that a total of 34.5 man months would be needed. A staffing schedule is shown in Figure 3.

Figure 1

JAMALPUR PRIORITY PROJECT STUDIES

EXTENSION - ACTIVITY CHART

Activity / month	June	July	August	Sept	Oct	Nov	Dec
Gauge reading/ flow gauging	==========	==========	==========	==========	==========	==========	
Site study of drainage of rainfall	==========	==========					
Site study of flood drainage			==========	==========	==========	==========	
Transfer of data to the model			==========	==========	==========	==========	
Revision of model to match data				==========	==========	==========	
Running revised model simulations				==========	==========	==========	
Agricultural and Economic analysis				==========	==========	==========	
Environmental studies	==========		==========		==========		
Sociological studies/ WID	==========	==========			==========	==========	
Using new mapping;							
1. To correct area/elevation curve		==========	==========				
2. To produce revised drawings		==========	==========	==========			
3. To correct other data			==========	==========			
Fisheries studies	==========	==========					
Prepare Draft Feasibility Report				==========	==========	==========	
Prepare Final Feasibility Report						==========	==========
	1	2	3	4	5	6	7

Appendix - C

Terms of Reference for Char Study

PROPOSAL FOR CHAR STUDY

-

1. OBJECTIVES AND INTENTIONS

The intention of the proposed subsidiary study is to extend the geographical area of the Jamalpur Priority Project Study (FAP 3.1) westward to include all the chars up to the right bank of the Jamuna River adjacent to the present Project Area, as shown on the attached map. The objective is to incorporate the chars area into the study, culminating in the development of a full flood proofing strategy for these islands and low lying areas. It would seem sensible to integrate the results of this study into the final FAP 3.1 project documentation, treating the area as one. The season that the Jamuna chars area has previously been omitted from the Flood Action Plan work is that it falls between the boundaries of the Regional Studies. However, it is the most risk prone area in terms of economic livelihoods and a major element in land dispossession resulting in rural to urban migration. Its omission has prompted comment as to the inequity of the present FAP approach and also that it is socially divisive. The proposed work could also form a pilot study for the suggested National chars study that has been proposed to be carried out within the framework of FAP 16.

The objectives of the study should be:

- to estimate the total population living on Jamuna chars,
- to get information on social stratification, land tenure and major occupations,
- to ascertain the socio-economic conditions of char inhabitants,
- to identify the constraints faced due to flood, erosion and other environmental hazards,
- to identify the people's responses to such constraints,
- to identify the effects of the FAP on the flooding and erosion patterns,

- to identify the people's perception of such effects,
- to propose strategies to improve the living conditions of char inhabitants,
- to identify the people's perception of such strategies.

2. METHODOLOGY

a) Definition of the Present Physical Situation

It is proposed to carry out the following tasks:

- Mapping, defining and categorising chars, to include island chars, presently attached chars and older chars, some of which may now lie within the mainland. This will require enquiries as to their length of existence and stability. All available data sources will be used to investigate this, particularly time series digital satellite imagery held by FAP 19, although production of hard copy from this could be a problem. A map of the present situation will be constructed using the 1/50 000 enhanced SPOT imagery of 20th November 1990 assisted by study of available air photography.
- Study of the hydrological stability of the chars and the implications for the nature of flood proofing strategies caused by present development proposals, particularly the building of embankments. This will require liaison and a simple review of existing data of the area held by FAP 1 (the Jamuna Right Bank Embankment Study), FAP 25 (National hydrology modelling), the Jamuna Bridge impact study and the Chinese Study.

b) The Present Socio-Economic Situation

Field investigations are proposed to determine the present situation with regard to the following issues:

- The number and locations of people presently living on the chars and an indication of how long they have been there and where they came from before that.
- The area of land that is cultivated and under what crops at which times of the year and how this is affected by flooding.

- The situation with regard to land allocation and tenure, specifically security and the system for reallocation due to land loss from erosion or gain from accretion.

- Indications as to the degree of household livelihood risk due to erosion and flooding.

- The degree of dependence on other economic activities, particularly fishing.

- The present administrative structure of the area, specifically which Districts, Upazilas and Unions do people reside in. The situation is extremely complex as most of the administrative boundaries were fixed in 1905 relative to the then centre line of the river. There are presently some attached chars on the east bank of the river which are in theory administered from the west bank.

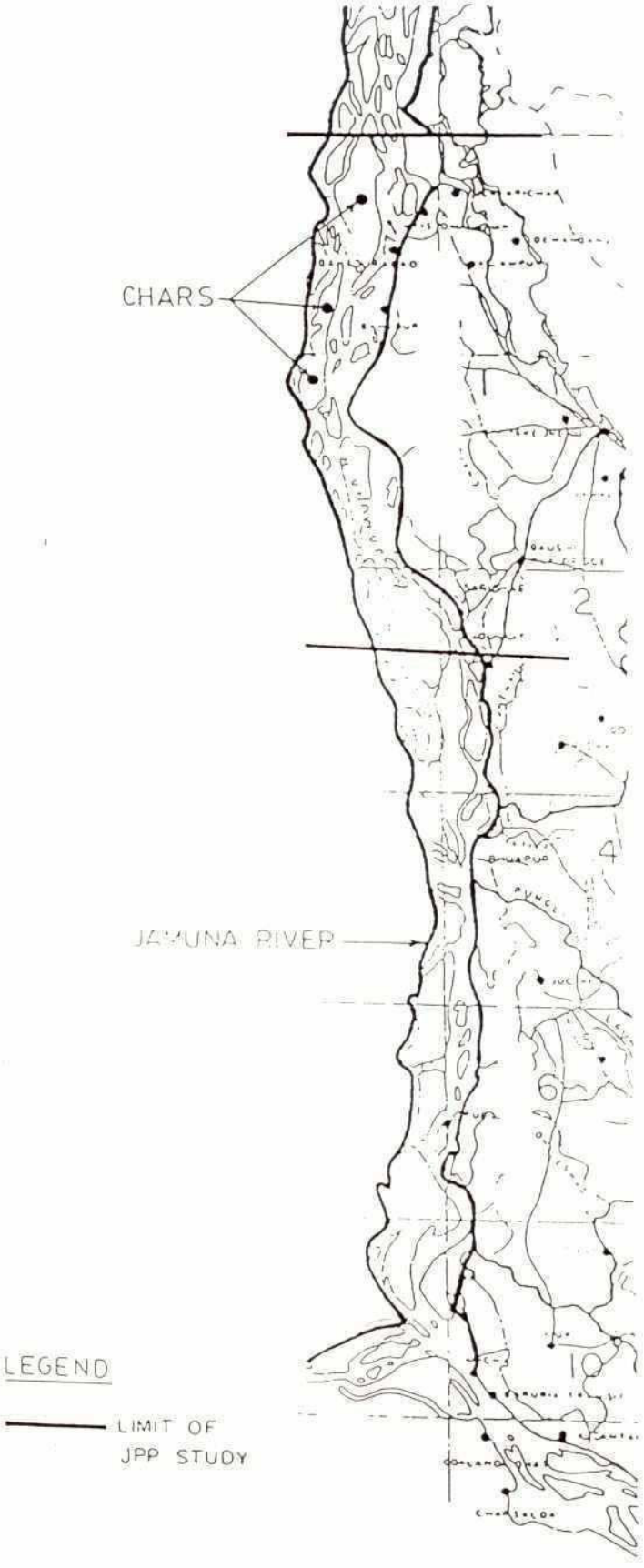
- People's perceptions, awareness, aspirations and commitment to do something about the issues that they themselves define as being important in their livelihood. This would lead to the determination of a "needs led" development approach, probably involving some form of in situ flood proofing and an integrated development approach. Close working links would be maintained with Service Civil International (SCI) an NGO who have already developed this approach in an area of chars just to the south of the proposed extended study areas.

3. REPORTING

The timing of this study will depend upon how quickly it is set up. The present hope is that it will take place from the latter part of March 1992 until late May. In that case, the draft report can be issued three months after beginning of the study.

FIGURE 260

CHARS STUDY



Appendix - D

Provisional Terms of Reference for Detailed Planning And Design And Construction Supervision

Revised 1/11/92

JAMALPUR PRIORITY PROJECT

PROVISIONAL TERMS OF REFERENCE FOR

DETAILED PLANNING AND DESIGN AND CONSTRUCTION SUPERVISION

CONTENTS LIST

REVISED VERSION 1/11/92

JAMALPUR PRIORITY PROOJECT

PROVISIONAL TERMS OF REFERENCE FOR

DETAILED PLANNING AND DESIGN, AND CONSTRUCTION SUPERVISION

PREAMBLE

The JAMALPUR PRIORITY PROJECT is a part of the Bangladesh Flood Action Plan and a priority project of the Government of Bangladesh (GOB).

Under the direction of FPCO, a series of Flood Action Plan Components (FAPs) have been and are being studied. These include country wide general studies as well as specific Pre Feasibility and Feasibility studies.

An Interim Feasibility Report for the Jamalpur Priority Project Study (FAP3.1) was submitted in June 1992, and the final report is due in November 1992. The Flood Action Plan has been developed within the framework of the North Central Regional water development plan prepared under the North Central Regional Study or FAP3.

1. BACKGROUND

1.1. Project History

The disastrous 1987 and 1988 floods in Bangladesh raised considerable international interest in helping the country to find a long term solution to its flood problem. A number of studies were undertaken and, in June 1989, the Government of Bangladesh requested the World Bank to coordinate the preparation of a five-year Action Plan for Flood Control in Bangladesh. The role of the bank in coordinating international efforts to assist Bangladesh in flood control was endorsed in the Communique of the G7 economic summit meeting held in Paris in July 1989. The Action Plan was discussed and endorsed by a meeting of donors held in London in December, 1989.

1.2. Flood Action Plan

The Flood Action Plan consists of project-oriented studies in all the country's main regions, supporting activities to promote improved project design and execution, and non-structural measures. For each plan component, one or more donors had expressed an interest in financing first phase activities, comprising surveys, studies or pilot projects. The various actions are being implemented by these donors in close cooperation with the

Government of Bangladesh and under coordination of the World Bank, as described in the Action Plan.

The Action Plan attached high priority to flood control and drainage on the left bank of the Brahmaputra under component n° 3, "Brahmaputra Left Bank". The Action Plan identified three specific activities under this component :

- North Central Regional Study
- Brahmaputra Left Embankment (North)
- Brahmaputra Left Compartment (North)

An overall study of water resources development - the North Central Regional Study (NCRS) - has been undertaken as the first step. The existing embankments are not effective against major river floods because of inadequate sections, gaps and bank erosion ; drainage is impaired by numerous road embankments and restricted waterway sections. The NCRS examined various alternatives and established the most suitable pattern of future water resource development in the region and the most relevant phased implementation. Strengthening of existing embankments, construction of new ones, building appropriate structures in embankments for controlled flooding and drainage, remodelling the main drainage systems and compartmentalisation were to be the main physical features of the regional water development plan.

The NCRS was divided into two phases :

Phase 1 : the "Reconnaissance study", the report of which was completed in June 1990.

Phase 2 : the "Main Regional Study", for which the Final Report was submitted in July 1992.

A priority project was identified in the Action Plan and confirmed for early implementation in the Reconnaissance Study of the NCRS. This priority project is located in the most northern part of the North Central Region, in the Jamalpur sub-region, the Project Area is about 90,000 ha. This Jamalpur Priority *Project* Study (JPPS) comprised the feasibility study of the project.

The Present Terms of Reference concern preparation of the Detailed Planning and Design Phase for this project, hereafter called the "Jamalpur Priority Project"(JPP), for which the Feasibility Study will be completed in December 1992.

The North Central Regional Study was financed under a separate contract, jointly funded by the EC and France, with the EC acting as the leader. The Jamalpur Priority Project Study is also financed by the CEC and France, but with France taking the lead.

1.3. General Organisation

Project coordination, overall supervision and evaluation and public liaison will be under the control of the Technical Committee of the Flood Action Plan, in which donors will participate.

The lead executing agency for the project will be Bangladesh Water Development Board (BWDB), through a Project management Office (PMO)

The (PMO) will be headed by a Superintending Engineer drawn from the BWDB and located in Dhaka. The PMO will be staffed with full-time representatives from BWDB and from DAE, DOE, Fisheries and LGED.

The Consultant will liaise with the FPCO, as regards coordination with supporting and other FAP activities.

International consultants preferably with experience of Bangladesh in association with qualified national consultants will be engaged for

a) Detailed Planning, Design and Preparation of Contract Documents.
b) construction supervision and allied activities

They will provide a Team Leader and appropriate technical staff who will be responsible to the PMO and the executing/implementing agencies.

2. DESCRIPTION OF THE NORTH CENTRAL REGION AND THE JAMALPUR SUB-REGION

2.1. The North Central Region

a) The North Central Region (see Figure 1) is bounded on the west by the Jamuna, on the south by the Padma, and on the north and east by the Old Brahmaputra and the Lakhya. For hydraulic purposes, the NCRS includes left bank tributaries and distributaries of these two rivers ; the development of the corresponding catchment areas is included in the North East Regional Study (FAP6). The area of the region is about 12,000 km^2 and the total population is around 17.5 million. The population density of about 1460 per km^2 is high.

b) Most of the region is rural, though the capital city, Dhaka, is located in the south of the region. Most of the commercial and industrial activities of the region are concentrated in the Dhaka area.

c) Agriculture dominates the rural economy. Rice is the main crop and is grown on 68% of the cultivated area. Cropping intensities and yields are relatively high, reaching on average 188% with average yields up of 2.8 t of paddy/ha, which are high by Bangladesh standards, but low in comparison to international standards. Yields are damaged considerably by

flooding. In a normal year, about 68% of the region is flooded ; in severe floods, such as in 1988, over 80% of the area is inundated. The flooding is largely caused by overbank spillage from the Jamuna, the Padma, the Old Brahmaputra and their distributaries. It is further aggravated by high local rainfall and difficult drainage conditions created by backflow of the Meghna at the south east corner of the region.

d) Three sub-regions may be defined in terms of physiography and flooding characteristics :

- The West, comprising about half the region and subject to flooding from the Jamuna and Padma rivers, suffers from very severe flooding. Phase 1 of NCRS distinguished 4 sub-regions called A1, A2, A3 and B . The sub-region A1 around Jamalpur was identified for priority action.

- The Madhupur Tract, an area of uplifted old alluvium, which is mostly above normal flood levels. Its development is hampered by limited water resources - forestry development area.

- The East, which is flooded mainly from the Old Brahmaputra and its distributaries.

e) Since a separate flood control study is being undertaken in the Greater Dhaka area, the North Central Regional Study only considers the Greater Dhaka area when dealing with inter-relationships between it and the rest of the North Central Region.

2.2. The Jamalpur Sub-Region

a) The Jamalpur Priority Project area, located at the extreme north of the NCR (see figure 2), is bounded by :

- The Jamuna left bank in the west, on which embankments have partially been built.

- The existing Jamalpur-Bahadurabad railway line, following the Old Brahmaputra in the north east. The towns of Dewanganj, Islampur and Jamalpur are also within the area, although partly outside the line of the railway.

- The Jamalpur-Jagannathganj Ghat railway line in the south-east.

The study also considered the lands between these embankment lines and the dry season river channels, from the point where the Old Brahmaputra leaves the Jamuna to Jagannathganj and Jamalpur on these two rivers.

b) The left bank of the Jamuna is or has been eroded severely near Bahadurabad, Madarganj and Jagannathganj. The Old Brahmaputra branches off from the Jamuna near Dewanganj, which

is severely affected. The offtake is silted up however, and inflow into the Old Brahmaputra ceases every year in January. the Zinziram river, a northern left bank distributary of the Jamuna, gives the only surface water inflow during the dry season, but this inflow is minor.

c) The project area has the shape of a rhomboid with sides of 35 km and diagonals of 30 and 60 km. Ground elevation varies from 13,7 to 19,8 m + PWD.

The gross area is in the order of 90,000 ha and the overall population within the area is about 1,000,000 . Population density (1100p/km^2) is high compared to Bangladesh average (about 750 p/km^2).

The project area is located in 9 Upazilas : almost the whole of Melandaha and Madarganj, 40% of Sarishabari, 20% of Jamalpur and of Islampur. The area includes the active flood plains of the Dewanganj Upazilla in the north and sections of the Fulchhari, Kazipur and Sariakandi Upazilas which are on the east bank of the Jamuna.

d) The internal hydrographic network of the sub-region involves two main water courses, flowing southward :

- In the west, the Chatal, a distributary of the Jamuna, completely closed recently by local embankment construction, but possibly reopening due to embankment erosion downstream of the original inlet. The Chatal drains back into the Jamuna further downstream.

- In the centre, the Dadhbanga khal which drains into the Jhenai.

- In the east, the Jhenai, a distributary of the Old Brahmaputra. The main channel joins the Chatal and flows to the Jamuna, but some flows discharge into the Upper Bangsi ; and to the south through the Bausi railway bridge to join the main Bangsi system.

Both watercourses are seasonal and become almost dry during the winter season.

e) Flood-proneness is variable within the sub-region :

- In the western part, the young Brahmaputra (Jamuna) floodplain is exposed to damaging floods from the Jamuna river. Embankments have been built by local authorities. they ensure some protection from normal river floods, but they cannot be considered to provide reliable protection against severe floods as they are not continuous and have not been properly designed, built or maintained. They have suffered considerable damage in past years and continue to do so, especially due to river bank erosion, and have not been completely repaired.

The greater part of the western area is flooded up to 90-180 cm deep each year. In a 20-year flood, the depth of inundation of this area is between 90 cm and 270 cm.

- On the Old Brahmaputra flood plain in the eastern part of the sub-region, the ridges are not inundated in a normal flood year and the basins are only shallowly flooded (maximum of 90 cm). In a 20-year flood, the depth of inundation reaches a maximum of 180 cm on most of the land up to a range of 180-270 cm in depressions.

Flooding in the sub-region generally starts with ponding of rainwater in depressions and extends when the Jhenai and Chatal rivers become active as the Jamuna and Old Brahmaputra river levels rise. In 1988, floodwater covered 80 per cent of the area and overtopped both the railway lines bounding the area in places (by more than 30 cm in Islampur).

f) Crops in the Old Brahmaputra floodplain, which covers about 40 per cent of the project area, are only seriously damaged by floods in those years when river floods are very high, such as in 1974 and 1988. This floodplain has a smooth landscape of ridges and shallow basins. The ridges are above normal flood levels and the basins are normally flooded only by rainwater. with the advent of irrigation from hand pumps and deep and shallow tubewells which started in the 1970s, the main cropping pattern has changed from rainfed aus followed by transplanted aman to transplanted aman followed by irrigated boro paddy. The production level of rice and other crops is considerably higher than in other areas of the NCR. Moreover, investment in irrigation equipment is very high : about 33 per cent of the cultivated land is irrigated by tubewells. Irrigation is used not only for boro rice but also for supplementary irrigation of transplanted aman when monsoon rainfall is deficient. Sugarcane is grown on permeable ridge soils, especially in the earstern and northern parts of the priority area, to supply the Dewanganj sugar mill.

Crop production is much less secure on the young Brahmaputra (Jamuna) floodplain, which covers 52 per cent of the project area, and on the active Brahmaputra-Jamuna floodplain which covers the remaining 8 per cent. On the young Brahmaputra floodplain, the relief comprises a rather irregular pattern of ridges, inter-ridge depressions, old channels and some basins. The soils are predominantly loamy. Aus and jute followed by dryland rabi crops are grown on Medium highland (F1), together with some late transplanted aman and sugarcane in the north. Medium Lowland (F2) and Lowland (F3) now have considerable areas of irrigated boro rice in the dry season, partially preceded by mustard, but much of the land remains fallow in the monsson season because of the flood hazard. Irrigation now covers 60 per cent of the cultivated area on this floodplain.

The present and potential yields of boro rice in the project area are higher than the average for the NCR, and it is estimated that transplanted aman yields could be about 10% higher than the average with controlled flooding. These higher yields result not only from favourable growing conditions such as better soils and better drainage conditions, but they are also due to higher investment rates in irrigation, fertilizers and pesticides. Therefore, in the case of a severe flood, damage to crops are relatively higher in the project area than in other parts of the NCR.

3. THE JAMALPUR PRIORITY PROJECT

3.1. General

The Jamalpur priority project will be one of the first development programmes implemented as a consequence of the main findings of the Flood Action Plan. The aim of the project is the reduction of flood damages and the development of the area taking into consideration agriculture, fisheries, environment and other water related issues. The solutions proposed will have to be technically, economically, socially and environmentally sound.

The interim feasibility report, presented in June 1992, concludes on the viability of a controlled flooding solution, including drainage improvement inside the area protected, and flood proofing measures outside the embankments ; mitigation and development measures have to be developed in the fields of fishery production, environmental protection, social impact, and finally agricultural production - The proposed Jamalpur priority Project will have to consider those components of the project and as such, will be implemented, at Government level, by a multidisciplinary project management organisation.

The final decision to implement this project will be taken during an appraisal mission, scheduled end of 1992, after completion of the feasibility report (November 1992).

3.2. Scope of physical implementation

3.2.1 The development option includes the following main components :

- construction of riverflood embankments with main hydraulic structures (Islampur inlet, Jhenai inlet, Bausi bridge outlet, Jhenai-Chatal outlet and chatal inlet) and flushing structures ; the aim is to control the importance of the inundation of the area all along the flooding season - such a result needs, to be obtained, an improvement of the drainage network up to farm level ;

- Improvement of the drainage network through implementation of local channels, together with culverts or

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- Improvement of the drainage network through implementation of local channels, together with culverts or

control structures through existing or new inner embankments (access roads) :

- Mitigation measures of the possible negative impacts and pilot development programmes (i) improvement of engineering designs to reduce environmental impacts and to maintain essential fluvial navigation, etc..,
(ii) development of pilot actions in the fishery sector,
(iii) agricultural development of a pilot drainage area.

- Flood proofing actions in unprotected areas and also inside the embankments where necessary.

3.2.2. Description of the main components

The components would ultimately comprise :

Controlled Flooding (figure n°3)

- embankment along the Jamuna river ;
- embankment along the old Brahmaputra river and the eastern side of the railway ;
- embankment along the Jhenai river on the western side of the railway, downstream of Bausi Bridge :
- two control structures to admit floods from the old Brahmaputra river, a major one at Jamalpur for the Jhenai intake and a smaller structure at Islampur ;
- a major control structure at the Chatal inlet from the Jamuna ;
- two major control structures to release water from the project area : one at Bausi bridge (to confirm), and one at Sarishabari;
- minor control structures (flushing sluices) in relation to local topography and needs in order to admit controlled floods and to drain excess water ;

Drainage improvement (fig.4 tentative area)

- Improve channels for the drainage of depressions and water logged areas. Excavate channel and construct control structures to achieve the following :
  . an accelerated release of excess water when open ;
  . the control of water level when water should be retained and beels preserved (if any).
  That component will be developped in a first pilot area of 5000 ha

Mitigation actions

- development of rehabilitation and possible resettlement of households, adversely affected (e.g. capture fisheries households, those whose land is acquired)

- development of supporting programmes in different fishery sectors (ponds, beels, main inner rivers) ; improvement of engineering measures to allow fish migrations ;

- development of engineering structures to allow navigation if necessary ;
- rural development programme on a 5000 ha pilot area to be localized in Jamalpur project area ;

Flood Proofing

As proposed in the Draft "Char study report" (pilot programme), it includes the following items:

- Refuge areas providing safe places and basic life support during extreme floods ;
- Public storage providing storage for people's possessions (food, seeds, personal items) ;
- Flood proofed buildings that would suffer less damage when inundated ;
- Flood proofed wells and latrines providing safe drinking and containment of human wastes during flood events.
- Micro-projects with the support of selected NGOs. (Income generating activities, community centers, raised rural roads, etc...).

4. SCOPE OF CONSULTANCY

The following terms of reference are provisional and are subject to modification, following the review and approval of the feasibility report to be submitted in november 1992, and the appraisal of the project by the funding agencies.

These TORs will also include as a conditional phase, the consultancy for construction supervision and allied activities.

The Consultant will perform the work set out below according to standards generally in use in Bangladesh or judged equivalent by the client. The main objective of the consultancy is the preparation of the detailed engineering design and tender documents including carrying out additional supporting studies and activities required for the project to conform to the Flood Action Plan Objectives. The feasibility study which will be completed in November 1992, will form the basis for the consultancy services. Best use should be made of the surveys and investigations undertaken during the feasibility study.

The consultant will be responsible for soil investigations, engineering survey, preparation of contract drawings, specifications, bill of quantities, preparation of estimated cost including rate analysis, engineering calculations and contract documents.
They will prepare and propose to the PMO and the executing agencies the prequalification of contractors, the bidding documents, evaluation of bids and award of contracts.

4.2.2. Surveys

. The preparation of the 1:10 000 topographical survey for the drainage pilot area is on the critical path of the programme. In their Proposal, the Consultants will provide a detailed description of the personnel (local and foreign), the equipment and the methods they intend to use for meeting the tight schedule.

. Carry out the additional engineering surveys, geotechnical investigations, sociological and environmental surveys and other investigations as necessary based on the feasibility design and project scope established during appraisal.

The extensive topographical, geotechnical, socio-economic and environmental surveys undertaken during the feasibility study, should also be utilised to their full value.

4.2.3. Hydraulic model

. The mathematical model of the Project Area developped during the feasibility study using the MIKE 11 provides a basis for hydraulic simulations under different conditions. The consultant will operate, and refine if needed, this Project flood model in consultation with FAP25 with the latest available data to finalise design criteria in terms of embankments heights and peak discharges at hydraulic structures and to assist in the preparation of a flood control programme. This model will have to enable the definition of the hydraulic operational procedures in order to meet the needs of water management in the area during floods of different severity as well as during the dry season.

4.2.4. Training

. recommend a specific training programme in technical, economical, social, environmental and management fields, to address the needs of the project.

. this training programme will concern national and regional staffs as well as local organisations. This programme will be defined in liaison with the ministries concerned and FAP26.

4.2.5. Land acquisition

. recommend land acquisition programme taking into account GOB regulations and produce the relevant drawings on the basis of the Mouza maps showing the recommended alignments and location of works" (necessary linkage with FAP 15)

4.3. Fisheries

In conjunction with other relevant projects, update the feasibility study findings on the potential disbenefits of the project on fisheries and

. prepare a pilot programme on the basis of the draft final feasibility report (R6),

. design capital works for this purpose

. take into account fisheries considerations in the detailed design of hydraulic structures and drainage networks

. recommend benchmark survey and further research for extending the pilot programme to the rest of the area.

. prepare the necessary detailed drawings, specifications, administrative documents for the implementation of the works and activities.

4.4. Engineering Design

Prepare the detailed engineering, designs, specifications, estimates and tender documents for the works as described below, including quality assurance procedures.

Documents will be split according to stages of investment as referred to in 4.9.

Over a length of about 125 km protection embankments (to be confirmed by R6) along the boundaries of the project area have to be rebuilt or newly constructed with an average height of about 4.5 m.

The approximative discharge capacities for the principal structures are the following (n° and figures to be confirmed by the final feasibility report):

Islampur intake	15 m3/s capacity
Jhenai intake	115 m3/s "
Chatal intake	130 m3/s "
Bausi bridge outlet	50 m3/s "
Jhenai/Chatal outlet	400 m3/s "
Flushing structures (55 no)	2 m3/s per structure

Outline designs for embankments and hydraulic structures are given in the feasibility report.

4.5. Pilot Drainage Project

Prepare the detailed design of structural components for drainage improvement on a pilot area of about 5000 ha and formulate implementation procedures involving the full participation of

beneficiaries in close coordination with FAP 20. The main activities will include :

· preparation of a 1:10 000 topographical survey with contours at 10 cm intervals, showing all natural and man-made drainage features such as bunds, beels, khals and cross drainage structures (to be revised or confirmed by the consultant during bidding);

· the study of drainage patterns, including accelerated drainage of beels and water logged areas, taking into account the views of farmers, fishermen and others affected ;

· the preparation of a detailed implementation plan and proposals for an institutional framework and procedures for the participation of beneficiaries therein.

· prepare and carry out a benchmark agricultural survey (agriculture, livestock, fishing, farming system) of the pilot area - Propose an agricultural development programme on the same area - Check the financial interest of the project for the main existing farming systems.

· prepare necessary drawings, specifications, administrative documents for the implementation of the project.

4.6. flood proofing

The consultant will review the Char study report and on the basis of its technical bid prepare and propose a detailed programme for the implementation of the flood-proofing component.
This programme will be established with the participation of local authorities and inhabitants, detailed planning data being obtained or confirmed on this occasion. The programme will comprise:

-identification of the areas concerning 20 000 households,

-breakdown of activities between contractors, NGOs, local beneficiaries, for house raising and improvements, 50 micro projects and miscellaneous income-generating activities,

-criterias for selection of the above persons,

-definition of the institutional framework for selection and implementation of individual sub-projects and procedures for the participation of beneficiaries for the construction, then for the operation and maintenance of the proposed structures,

-time-shedule for implementation,

He will take into account for the above purpose the results of successful schemes operated by NGOs in Bangladesh and the latest findings of the FAP 23 and other relevant FAPs (FAP 14 and FAP 16)

.The consultant will prepare detailed design and costs estimates ; propose alternative methods of implementation of the works.

.prepare administrative documents for the solution chosen by the client, to enable executing agencies to implement the project.

4.7. Public participation approach

A programme of public participation will be developped and implemented for the detailed design studies and prepared for the implementation phase.

The consultant will have to consult widely with local communities in the planning of the project and to encourage the fullest participation of men and women from different social groups (e.g. lowland, highland farmers, fishermen, boatmen, have inside and outside the project, elected representatives and local officials) in the work. The consultants will follow the Guidelines on people's participation of FAP projects issued by FPCO.

The programme of public participation will include :

. presentation and agreement on localisation and purpose of any structure ;

. land acquisition policy and procedure including compensation

. participation in the construction ;

. participation in specific phases of operation and maintenance

A specific attention will be given to the possibility of involving selected NGOs in the organisation of this programme for the identification of needs, selection of representative groups of people and implementation of the participatory approach. Criterias and procedures will be established to select the NGOs and names will be proposed.

This programme will also permit the consultant to obtain or confirm detailed planning data with the local population.

4.8. Other environmental and social issues

An environmental review will analyse the impacts of the proposed implementation programme, interalia the following issues :

. nutritional issues in view of FAP 16 results and of the benchmark agricultural survey (farming system).

. environmental considerations for design, particularly construction impact, land acquisition policy and procedures including compensation.

4.9 An Impact monitoring programme will be defined to assess the economic social and environmental impact of the proposed project. Propose the needs in expertise and equipment to carry out this programme.

4.10. Project implementation schedule

In close consultation with implementation agencies, district representatives, and local inhabitants, prepare a detailed project implementation schedule for each of the components suggested under the project. In particular,for land acquisition, procurement of equipment and materials, and for construction methods (including force account, volunteer labour, existing labour groups, NGO groups, contractors, etc) most suitable to local conditions. Specify the number of technical personnel, as well as skilled and unskilled labour, required in each year of project implementation.

4.11. Project cost estimates

Establish from the detailed level plans and drawings produced, the quantities of the items of work to be executed and of the goods to be supplied for the project and make an estimate of the cost for the various components of the project and for the overall project including rights of way, taxes and duties, administration, engineering and supervision and contingencies. All estimated costs must be broken down into foreign exchange and local currency components.

Estimate the distribution of project costs in accordance with the implementation schedule.

(5 CONSTRUCTION SUPERVISION)

6. WORK PROGRAMME AND REPORTING

6.1. Detailed planning and design phase

The consultant will confirm or amend if justified its proposal for field surveys within the first two weeks of its assignment. The PMO will have two weeks to make observations on this proposal.

The approval of conceptual and detailed drawings, subject to BWDB's regulations, is a continuous process, and the consultant should submit them through the PMO as early as possible, when he is in possession of supporting data (borelogs and lab. tests).

The consultant will deliver reports according to the following schedule :

- month 2 - Preliminary design report R1, including
  -review of project documents and available data , design criteria and designs proposals ; proposals for additional surveys and revision of methodology if necessary;
  -a proposal for a public participation programme in the design phase

- month 5 Interim report R2, on results of operation of the flood model, findings and progress of surveys first conclusions of development activities (fishery, institutional, rural development of the pilot drainage sector), progress of detailed design ; first recommendation for flood proofing pilot projects.

- month 8 - Detailed designs, drawings and tender documents for priority works ; corresponding mitigation programmes proposed (report R3)

- month 11 - Detailed designs, drawings and tender documents for the remaining works ; corresponding mitigation programmes proposed (report R4)

- month 12 - Final design report containing specifications of works, design manual based on detailed design criteria, a draft O/M Manual with emphasis on public participation ; draft guidelines for supervision of the works; environmental impact monitoring (Report R5).

All reports will include a section describing the participation of local people in the planning process during the period covered.

(6.2 Construction supervision...to be completed)

7 STAFFING AND ORGANISATION

7.1. Detailed planning and design and tender documents' phase

The man month input is tentatively estimated at (maximum) 100 man month expatriates and 220 man month local consultants comprising the following disciplines: Senior agricultural-civil engineer/Team leader, Senior civil engineer, drainage-irrigation specialists , hydrologists/modellers, civil engineering specialists (geotechnics/ structures/embankments), agronomist, agroeconomist, hydro-mechanical specialists, contract specialist, sociology/institutions specialists, environmentalists, fisheries experts, and specialists in participatory rural development

The consultant team would have a team leader and two deputy team leaders, one in the field of civil and hydraulic engineering, the other in the field of rural development and environment. These three specialists should stay in Bangladesh throughout the study.

The consultants are invited to suggest a revised man months estimate, and propose the disciplines they consider the most appropriate for the assignment. They should submit a bar chart showing the schedule of assignment of their personnel and a detailed task assignment for each member of their staff. They will precise for each expert the time spent in Bangladesh.

The consultant should open an office in Dhaka and be responsible for providing accomodation and transport for their own staff.

Job descriptions for the main fields of expertise of the team are given in Annex II.

(7.2 Construction supervision and allied works...to be completed)

8. RESPONSABILITIES OF THE GOVERNMENT

8.1. Freedom from Taxation and duties :

The Government /Executing Agency shall bear the cost of any taxes, duties, fees, levies and other impositions under the laws and regulations in effect in Bangladesh on the Consultant and expatriate personnel in respect of :

- any payments made to the consultants or their panel other than Bangladesh nationals, in connection with the carrying out of the services ;

- any materials, equipment and supplies brought into Bangladesh for the purpose of carrying out the services and which after having been brought to the country will be subsequently withdrawn therefrom :

- any equipment imported for the purpose of carrying out the services and paid out from the funds provided by the Government and which is treated as property of the Government.

Provided that :

(a) The Consultant and his expatriate personnel shall follow the usual customs procedure of the Government in importing property into Bangladesh ; and

(b) If the Consultant or any of the expatriate personnel does not withdraw, but disposes of any property in Bangladesh upon which custom duties and taxes have been exempted, the Consultant shall bear such custom duties and taxes in conformity with the regulations of the Government.

8.2. Other Privileges and Exemptions

The GOB shall :

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8.2. Other Privileges and Exemptions

The GOB shall :

- provide the expatriate personnel with work permits and such other documents as shall be necessary to enable them to perform the services including privileges specified in the Government of the People's Republic of Bangladesh notification no /RO 88-L-85/906/CUS dated the 13th February, 1985 and /RO 89-/85/907/CUS dated the 13th February, 1985 (circular of 1988 is to be incorporated)

- arrange for the personnel and his authorized dependents to be provided promptly with all necessary entry and exit visas, residence permits, work permits, exchange permit and travel documents required for their stay, in Bangladeshh ;

- facilitate clearance through customs of any property required for the services and of the personnal effects of the expatriate personnel and the prompt issue to the Consultants expatriate personnel of Custom Pass Books.

- issue to officials, agents and representatives of the Government all such instructions as may necessary or appropriate for the prompt and effective implementation of the services ;

- exempt the consultants and the personnel for the services from any requirement to register or obtain any permit to practice the profession of Engineer or Architect or to establish himself higher individually or as a corporate entity according to the laws of Bangladesh ;

- duties and taxes on the imported equipment, vehicles and other materials relating to the project: customs' rules and regulations at the date of bidding will be taken into account by the consultant. Expenses incurred by the consultant will be refunded by the implementing agency, for items which it retains in Bangladesh on completion of the contract.

8.3. Services, Facilities and Equipment

- *The GOB shall provide assistance to collect pertinent data, maps and information available for the performance of the services under this contract (to be amended).*

- The GOB shall, if available, provide accommodation in the Govt. Rest House at usual rate.

- The GOB shall indemnify, save and hold harmless the consultant and its personnel from and against all claims, demands or suits, that may be made or brought against the consultant and its personnel arising directly from the performance of the services provided that, such claims, demands or suits are not the result of negligence or wilful acts of the consultant and its personnel.

9. RESPONSIBILITIES OF THE CONSULTANT

9.1. Responsibility of consultant

The Consultant shall carry out the services as detailed in the Terms of Reference in the best interest of the Government for the successful realisation of the programme with all reasonable care, skill and diligence with sound engineering, administrative and financial practices and shall be responsible to Executive Agency (BWDB) for the discharge of responsibilities.
The Consultant shall during the execution of the services appoint and designate a Team Leader to represent the Consultant in Bangladesh in all matters relating to the services.

the Consultant shall be responsible for the professional and technical competence of its employees and the personnel's behaviour and shall use its best efforts to select and employ for work in Bangladesh only those persons who in its judgment will be the best and most likely to perform satisfactorily the terms of their employment.

The consultant will ensure full association of local experts in the work.

The Consultant shall keep accurate and systematic records and accounts in respect of the services in such form and detail as is customary in the profession and shall be sufficient to establish accurately the cost and expenditures incurred for the services.

Except with the prior approval of the Government/Executive Agency the Consultant shall not at any time communicate to any persons or entity not connected with the services any confidential information, disclose to them for the purpose of the services or disclosed by them in the course of their services, nor shall the Consultant or the Consultant's personnel make public any information relating to the services.

The Consultant shall be responsible in respect of life, health, accident, travel and other insurance which may be necessary for the Consultant's personnel for the purpose of the services.

All existing rules and regulations of the Govt. of Bangladesh related to the classification, custody and issue of restricted map, aerial photograph and other related data shall be maintained.

9.2. Information

The Consultant shall furnish the Executing Agency with such information relating to the services and the Project as the Executing Agency may from time to time reasonably request.

9.3. Assignments, Subcontractors :

Except with the prior written approval of the Government the Consultant shall not assign or transfer the contract or any part

thereof nor engage any independent Consultant or sub-contractors to perform any part of the services other than nominated personnel listed in the contract.

The approval of the Executing Agency to the assignment of any part of the Contract or to the engagement by the Consultant of independent Consultants or sub-contractors to perform any part of the services shall not relieve the Consultants of any of his obligations under this contract.

9.4. Prohibition on Conflicting Activity

No member of the personnel assigned to this Project shall engage, directly or indirectly either in his name or through the Consultant any other business or professional activities in Bangladesh during the performance of his duties or assignment under this contract.

9.5. Laws and Regulations

In accordance with the Aid Agreement signed on (date to mention) by the Government of the French Republic and the Government of the People's Republic of Bangladesh, and in conformity with the Euro-Bangladeshi Agreement to Finance, and with the mandate given to the Caisse Centrale de Coopération Economique (CCCE), who, in the name of the French Government, also represents the European Community, this contract shall be construed in French law.

The Consultant shall respect and abide by all applicable laws and regulations in Bangladesh and shall use his best efforts to ensure that the Consultant's personnel and their dependents while in Bangladesh and local employees of the Consultant shall respect and abide by all laws and regulations of Bangladesh.

9.6. Ownership of Drawings, Data and Reports

All reports and relevant data such as maps, drawings, plans, statistics and supporting records or materials compiled or prepared in the course of Services shall be the absolute property of the Government. The Consultant agrees to deliver all these materials to the Executive Agency upon completion or termination of this Agreement.

9.7. Reports and Communications

All reports, communications, recommendations and general correspondence from the Consultant to the Executing Agency under the Agreement shall be in the English language. The number of copies of each report to be submitted shall be stated by the Executing Agency (BWDB), but shall not exceed one hundred.

9.8. Notice of Delay

In the event that the Consultant encounters delays in obtaining the required services or facilities set forth in this contract for the conduct of the services, or the concurrence of the event or condition that might delay or prevent completion of the services in accordance with the time schedule, the Consultant shall promptly notify the Government of such delay indicating what steps are being taken or suggested by the Consultant to meet the situation and he may request an appropriate extension of time for completion of the services.

ANNEX I MAPS

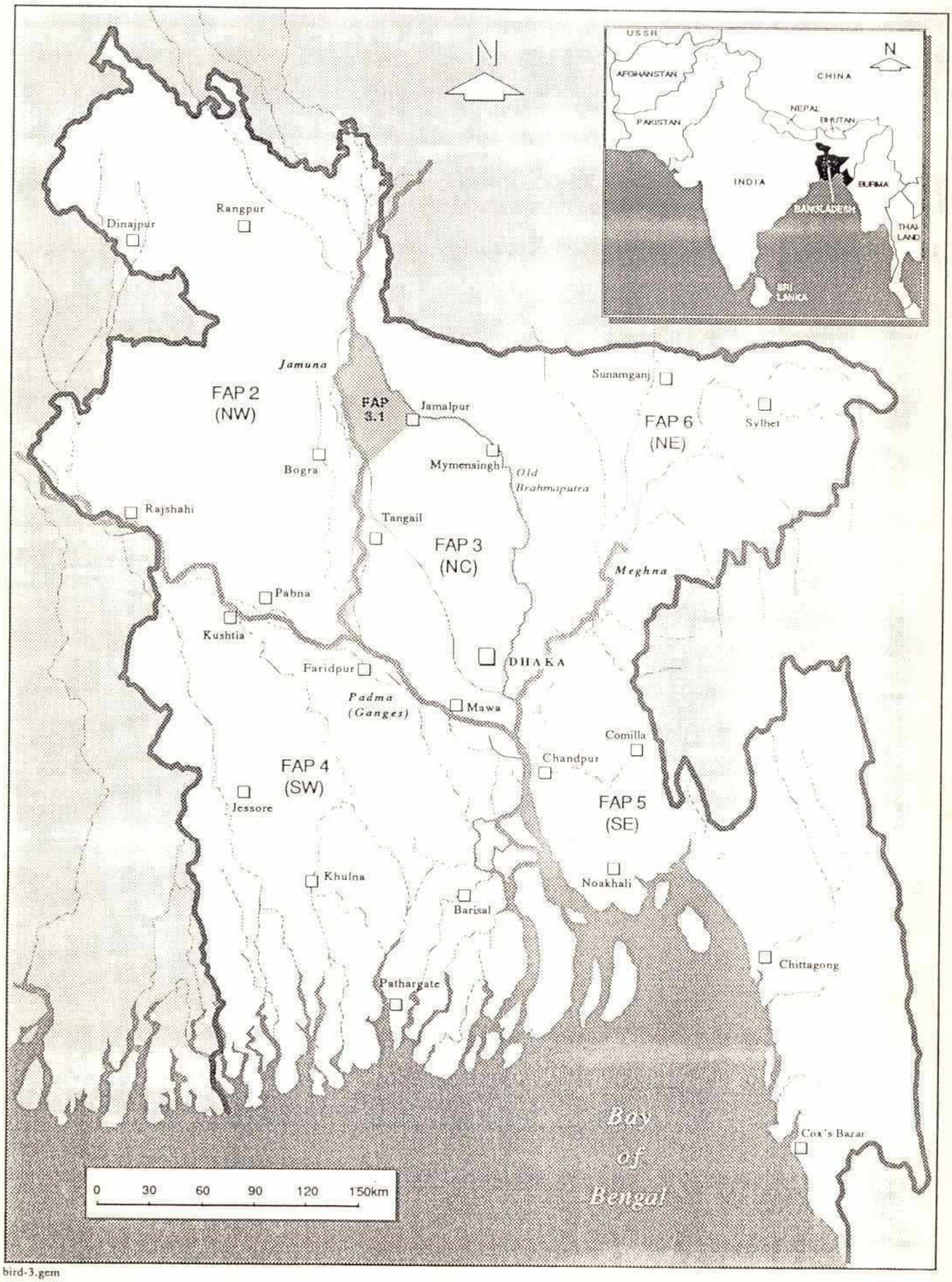
Figure 1 : Location map

Figure 2 : Project area / existing situation

Figure 3 : Project area / with project situation

Figure 1

285



bird-3.gem

N

LEGEND:

1. PROJECT BOUNDARY
2. RIVER / KHAL
3. ROAD (PUCCA / SEMI PUCCA
4. RAILWAY LINE
5. PROJECT EMBANKMENT
6. ALTERNATIVE EMBANKMENT ALIGNMENT
7. PROJECT MAIN STRUCTURES
   a) ISLAMPUR INLET ... S1
   b) JHENAI INLET ... S2
   c) BAUSI BRIDGE OUTLET ... S3
   d) JHENAI /CHATAL OUTLET S4
   e) CHATAL INLET ... S5

S-1 S-2 S-3 S-4 S-5

JAMUNA RIVER

DIWANGANJ

HARINDHARA

BAHADURABAD GHAT (46.9 C)(75.6 J/S)

BELGACHHA

AMRUL

MELANDAHA

GHUGUMARI

CHATAL

MADERGANJ GAUGE STATION

PHULKOCHA

JHORA KHAL

GUNARITALA

MADERGANJ UPAZILA H.Q

BARGACHA

SUKHASAR

BRAHMAPUTRA

JAMALPUR

RIVER

B.M.

KENDUA

JHENAI R.

PROJECT BOUNDARY

CHANDANBAISA

BAUSI RAILWAY BRIDGE

SARISHABARI RAILWAY BRIDGE

SARISHABARI

FERTILIZER FACTORY JAMALPUR

PUMPING STATION

FERRY GHAT

0 1000 2000 3000 4000 5000 Metre

GOVERNMENT OF THE PEOPLES REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION

FAP 3.1: JAMALPUR PRIORITY PROJECT STUDY

PROJECT AREA

WITH PROJECT SITUATION

DRAWING NO.	SCALE :
DRAWN: Kashem	
CHECK'D: Junaid	
APPRV'D: Baize	
DATE: 01-10-92	

BOURNE-HALCROW-LAHMEYER WITH EPC & AQUA
Project office
House 60, Road 7, Block 'H'
Banani, Dhaka

Figure 3

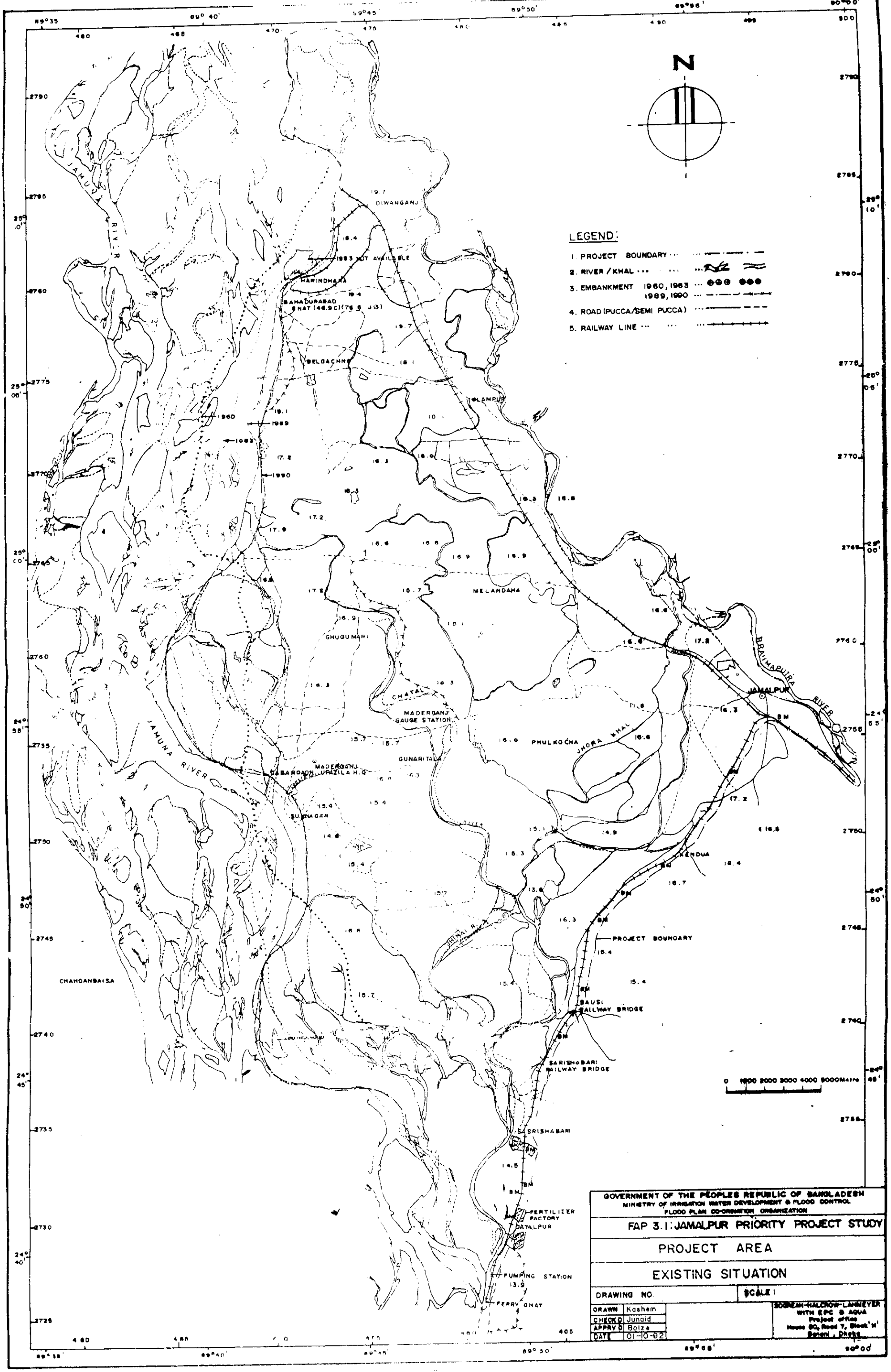

N
LEGEND:
1. PROJECT BOUNDARY
2. RIVER / KHAL
3. EMBANKMENT 1960, 1963
1989, 1990
4. ROAD (PUCCA/SEMI PUCCA)
5. RAILWAY LINE
JAMUNA RIVER
DIWANGANJ
HARINDHARA
BAHADURABAD
BELGACHHA
GLAMPUR
GHUGUMARI
MELANDAHA
CHATAL
MADERGANJ GAUGE STATION
GUNARITALA
SUTNAGAR
PHULKOCHA
JHORA KHAL
BRAHMAPUTRA RIVER
JAMALPUR
KENDUA
PROJECT BOUNDARY
BAUSI RAILWAY BRIDGE
SARISHOBARI RAILWAY BRIDGE
SARISHABARI
FERTILIZER FACTORY
DATALPUR
FERRY GHAT
CHANDANBAISA
0 1000 2000 3000 4000 5000Metre
GOVERNMENT OF THE PEOPLES REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN CO-ORDINATION ORGANIZATION
FAP 3.1: JAMALPUR PRIORITY PROJECT STUDY
PROJECT AREA
EXISTING SITUATION
DRAWING NO.
SCALE 1
DRAWN Kashem
CHECKED Junaid
APPRVD Bolze
DATE 01-10-92
BOSREAH-HALCROW-LAHMEYER
WITH EPC & AQUA
Project office
House 90, Road 7, Block 'H'
Banani, Dhaka

Figure 2

ANNEX II

JOB DESCRIPTIONS

A) Introduction

The indicative numbers of staff required to complete the Detailed Engineering Design and Preparation of Tender Documents for the Jamalpur Priority Project are as follows :

. 100 person-months of expatriate consultants :

. 220 person-months of local consultants.

Consultants will propose the specialists they would assign to the study and the inputs that each would make. A bar-chart will be presented relating the proposed inputs by different specialists to the activities that would be undertaken in the study. Consultants will precise the time spent by each specialist in Bangladesh.

The minimum professional experience required for the consultants will be as follows :

. Expatriates :

. Team Leader	20 years
. Other Specialists	10 years

. Local consultants :

. Co-Team Leader	15 years
. Other Specialists	10 years
. Junior engineers.....	5 years

The Co-Team leader will be fully associated in the study and take part in the decision making process.

Previous experience of working in Bangladesh or in an Asian country with similar climate and agriculture is highly desirable for the expatriate consultants.

JOB descriptions of the staff required for the study are given below.

B) Job Descriptions

1. Project Manager(S)

The Project Manager(S) would be responsible for the overall conduct of the study. They would visit Bangladesh at key points during the study (e.g., during preparation of reports) to review the progress of the study in consultation with the Team Leader and specialists undertaking the work and with the Technical Committee and PMO.

2. Team-leader

Qualification : He should have a Post-Graduate Degree on Water Resource/Hydraulic Engineering or equivalent and have at least 20 years practical experience in related field.

The team leader will take responsability for :

- the day-to-day management of the study, including the guidance and supervision of the study team of local and expatriate consultants, the production of the reports specified in the TOR and the final outcome of the study ;

- liaison with :

a) The PMO, FPCO, Technical Committee and the representatives of the donors

b) The BWDB and other government agencies

c) The teams undertaking other studies under the Flood Action Plan.

He will have a large experience in the management of similar projects, including civil engineering and rural development components - He will be responsible for the success of the necessary liaison between the hydraulic and civil engineering constraints on one hand, the agronomical/environmental/fishery constraints on the other end.

CIVIL ENGINEERING TEAM

3. senior civil engineer/deputy team leader

Qualification : He should have a Post-Graduate Degree in Civil Engineering/Hydraulic Engineering or equivalent with ten years experience in related fields.

The senior civil engineer will assist the team leader in the day-to-day coordination and supervision of the study team, and in the production of reports specified in the TOR.

As civil engineer, he will be responsible of the civil engineering and hydraulic components of the study. He will have at least 10 years of experience in a similar position for similar work - In close cooperation with other team members, he will :

. assess, jointly with other team members, the adequacy of available geotechnical and topographical data and prepare programmes and contracts for supplementary survey and investigation programmes ;

. assess, jointly with other team members, the design criteria required for the detailed designs ;

. ensure the full efficiency of the detailed design study with the findings and structural recommendations of other studies under the Flood Action Plan.

4. Drainage-Irrigation Specialist

Qualification : He should have a Post-Graduate Degree in Civil Engineering/Hydraulic Engineering or equivalent with a least ten years experience in related fields.

In close cooperation with the Hydrologist/Modeller, the Civil Engineering Specialist, the agronomist, the Environmentalist and the Fisheries Expert, he will :

. prepare drainage design criteria and other criteria related to the hydraulics of structures, prepare specifications for and supervise the topographical survey for the drainage pilot area ;

. assess the status of the drainage conditions in the selected drainage pilot area ;

. prepare the detailed design of the drainage pilot area taking into account the views of beneficiaries as assessed by the sociologist and with due consideration to environmental impacts ;

.assist the hydrologist/modeller in the formulation of water management procedures ;

. prepare the guidelines and programme for the implementation of drainage improvements over the whole area, taking into account the findings of the detailed study of the pilot drainage area ;

. analyse the present systems of irrigation and propose in liaison with the agronomist, further developments.

5. The Hydrologist/Modeller

Qualification : He should have a Post-Graduate Degree in Hydraulic/Water Resources Engineering or equivalent with at least ten years experience in Modeling works.

The Hydrologist-Modeller will in close cooperation with the Drainage Specialist and the agronomist :

. update, improve and operate the hydraulic model for water management, prepared during the feasibility study, using the latest available topographic and hydrometric data ;

. compute water elevation and discharge at the main hydraulic structure locations and finalise design water levels and design discharges ;

. simulate water management of hydraulic structures and propose comprehensive water management procedures for inclusion in the Design Report.

6. Civil Engineer (geotechnics + earthworks + structures)

Qualification : He should be basically Civil Engineer and should have a Master in the field of Geo-technical/Structures/Hydraulic Engineering or equivalent with a least ten years experience in related field.

The Civil Engineering Specialist will, in close cooperation with the Hydrologist/Modeller, the Contracts Specialist and other specialists :

. supervise any additional geotechnical survey which would be required

. finalise the layout, cross sections and other technical specifications for embankments and structures ;

. study the detailed physical requirements for the construction of the embankments and bank protection works, covering stability analysis, geotechnical considerations and the identification of borrow areas ;

. Study at detailed design level, the major control structures and flushing structures including the production of reinforcement drawings ;

. Study at detailed design level, earthworks and minor structures for drainage improvements and compartment boundaries of the drainage pilot area ;

. Study at detailed design level, physical components for the flood proofing pilot areas ;

. measure quantities for the preparation of the bills of quantities ;

. estimate the cost of various components of the project, based on the detailed designs and tender documents for inclusion in the engineer's estimate ;

. formulate in consultation with the Sociologist/Institutions Specialist, the institutional requirements for the operation and maintenance of the Works for inclusion in the O & M Programme.

7. Hydromechanical Specialist

Qualification : He should be Mechanical Engineer with Post-Graduate Degree or equivalent with at least ten years experience in relevant fields.

The Hydromechanical Specialist will, in close cooperation with the Civil Engineering Specialist and the Contracts Specialist ;

. study at detailed design level the gates and hydromechanical equipment to be incorporated in the hydraulic structures ;

. prepare technical specifications for the hydromechanical works ;

. estimate the cost of various hydromechanical components of the project based on the detailed designs and tender documents;

. assist the Executing Agency with the preparation of a list of suitable suppliers of hydromechanical equipment and with the evaluation of tenders.

8. Contracts Specialist

Qualification : He should be Civil Engineer with Post-graduate Diploma or equivalent in related field. he should have at least ten years experience in the related works.

The Contracts Specialist will, in close cooperation with the Civil Engineering Specialist, the Hydromechanical Specialist ;

. prepare the technical specifications, conditions of contract;

. prepare instructions for tendering and any other documents required to complete the tender documents ;

RURAL DEVELOPMENT TEAM

9. AGRO-ECONOMIST - Deputy-team leader -

Qualification : He should have a Post-Graduate Degree or equivalent in the relevant field with at least fifteen years experience in related works.

The agro-economist will assist the team leader in the day-to-day coordination and supervision of the study team, and in the production of reports specified in the TOR.

In close cooperation with the agronomist, the socio-economist and the fishery specialist, he will :

. prepare and carry out a benchmark agricultural survey in the drainage pilot area. This survey should include agriculture and livestock.

. assess the existing economic situation of the different typical farming systems.

. prepare an impact monitoring programme.

10. Agronomist

Qualification : He should have a Post-Graduate Degree or equivalent in the relevant field with at least ten years experience.

The agronomist will, in close cooperation with the drainage specialist :

- prepare, for the drainage pilot programme, a present landuse map (scale 1/5000) and assess the present cropping patterns according to the land categories (F0, F1, F2, F3) ;
- propose the possible evolution in cropping patterns and yields in the area of the drainage pilot programme ;
- project the possible evolution of livestock production with the present farming systems.
- participate in the benchmark agricultural survey of the drainage pilot programme area.
- examine possibilities of extension of conclusions from the pilot drainage area to the whole project area.
- assist the hydrologist/modeller and civil engineer in defining water management procedures for controlled flooding and drainage structures.

11. Socio-Economist/Institutions Specialist

Qualification : He should have a Post-Graduate Degree or equivalent in the relevant field with at least ten years experience.

The Socio-Economist/Institutions Specialist will, in close cooperation with the Drainage Specialist, the agronomist, the Civil Engineer and the Environmentalist :

- implement surveys and propose measures to achieve effective involvement of the farmers and other beneficiaries in the detailed formulation of the project, in terms of structural requirements such as ; location of embankments, location of drainage structures; location of drainage channels, flood proofing measures ;
- implement surveys and formulate recommendations to achieve effective involvement of the farmers and other beneficiaries in the operation and maintenance of the Project ;
- participate in the formulation of measures which are needed to compensate for land acquisition ;
- assess the possible roles of the farmers, local authorities, NGOs etc. in the project implementation and construction of the works and propose an appropriate institutional framework and the required organisation for this.

12. Environmentalist

Qualification : He should have a Post-Graduate Degree or equivalent in the relevant field with at least 10 years experience.

The Environmentalist will, in conjunction with the Sociologist/Institutions Specialist, the Drainage Specialist, the Civil Engineering Specialist, and the Fisheries specialist :

. address issues raised in the environmental assessment section of the Feasibility Report and propose measures to be incorporated in the project detailed designs ;

. for flood proofing, assess the location, spacing and size of refuges in consultation with the local people and provide criteria for the formulation of measures related to the preservation of population health during flood events ;

. assess the possible multi-purpose use of embankments ;

. consider the likely environmental impact of drainage improvements on fisheries in particular ;

. assess the impact and health hazard of borrow pits and other water bodies created under the project ;

. propose implementable mitigation programmes covering nutrition and public health ;

. assess road transport requirements under the drainage improvement project, when the present waterborne navigation system is affected ;

. prepare a data collection programme concerning the natural environment (water quality, waterborne diseases...) to monitor project environmental impacts.

13. Fisheries Specialist

Qualification : He should have a Post-Graduate dgree or equivalent in a relevant field. The Fisheries Specialist should be qualified in pisciculture, river fisheries management, and have experience in the evaluation and mitigation of adverse impacts of hydraulic structures on floodplain fish capture.
He will, in coordination with the Environmentalist, the Sociologist/Institutions Specialist and the agro-economist :

. propose optimum beel and pond management procedures to maximise project benefits and minimise conflicting situations between farmers and fishermen ;

. provide guidance for pit location and depth policies related to fish farming potential ;

. provide guidance for the formulation of design criteria and water management procedures for flood control structures, drainage infrastructure to minimise losses to fish recruitment and fish growth ;

. propose detailed mitigation measures to minimise the Project impact on fisheries and for the extension of fish farming.

. prepare a data collection programme concerning fish production to monitor project impacts.

14. Bangladeshi specialists
Job descriptions and qualifications of other local experts will be similar to expatriate consultants.

15 Junior engineer (local). He will have a degree in civil engineering and have at least 5 years experience in the field of design works.

(ANNEX III SUPERVISION PHASE to be completed)

PROVISIONAL TERMS OF REFERENCE FOR DETAILED PLANNING AND DESIGN AND CALCULATION AND CONSTRUCTION SUPERVISION DATED 01/11/92

FAP 3.1 main comments

p.7. 3.2.1 bullet 1
Reference to Bausi Bridge outlet should be deleted. This structure is not included in FAP 3.1 components

p.8 3.2.1 bullet 6
Read: Pilot flood proofing actions is unprotected area.
Delete the end of the sentence, no flood proofing needed within embankments

p.8 3.2.3 bullet 6
Delete reference to Bausi Bridge

p.11 4.2.2 bullet 1
1/10 000 reference to Bausi bridge
1/5 000 survey advised

p.11 4.2.3
To add that the model should be extended with the inclusion of Jhenai river downstream Bausi Bridge in order to assess the impact of a discharge restriction at the bridge on the drainage conditions within the embanked area. This has to be assessed in conjunction with the maximum discharge acceptable to PU 2 of the NCR.

p.12 4.4 para 3
Length of 125 km of embankments is confirmed

p.12 4.4 para 4
delete Bausi bridge outlet from the list

p.13 top of the page, bullet 1
1/10 000 survey to be replaced by 1/5 000 survey

p.13 4.6 bullet 1
read 5 000 households instead of 20 000

p.14 4.8
add bullet with reference to FPCO Environmental Guidelines issued by end of 1992

Comfpco12