United Nations Development Programme
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Ministry of Irrigation, Water Development and Flood Control
Government of the People's Republic of Bangladesh

South East Region Water Resources Development Programme BGD/86/037

FAP-5

Noakhali North Drainage and Irrigation Project Feasibility Study

Volume 9

Annex J — Economics

Annex K — Comments and Replies on the Draft Feasibility Study Report

October, 1993

Sir M MacDonald and Partners Limited, UK
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ANNEX J

ECONOMICS

8

NOAKHALI NORTH DRAINAGE AND IRRIGATION PROJECT
FEASIBILITY STUDY

ANNEX J - ECONOMICS

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ECONOMICS

CHAPTER J.1

INTRODUCTION

J.1.1 Objectives and Scope

The economic analysis of alternative development proposals for the Noakhali North Project area comprises an appraisal at feasibility level of different options. Financial analyses of alternatives are restricted to those developments which the economic analysis identifies as more worthwhile. The objective is to determine the economic and financial viability of proposals in accordance with the FAP Guidelines for Project Assessment. In general this has been based on estimating the impact of proposed interventions on farm income, government expenditure and the overall economy.

J.1.2 The FAP Guidelines for Project Assessment

The Guidelines for Project Assessment have been produced by the FPCO with the aim of standardising the methodology and assumptions applied in the economic analyses undertaken by different FAP studies. They were originally produced with the intention of providing assistance to pre-feasibility studies, generally undertaken as Regional Plans but progressively have been modified for use by feasibility studies.

They are based on widely accepted techniques for the appraisal of water resource development projects and provide a good basis for achieving the necessary degree of uniformity and comparability between FAP studies.

The guidelines provide some specific values, criteria and principles to be applied in the economic analysis, including the following:

1. Only primary benefits to be included.
2. Analysis period : 30 years from the start of project construction.
3. Exclude residual values of project facilities and equipment.
4. Price basis: costs and benefits to be expressed in mid-1991 Taka.
5. Costs of specific measures to mitigate a project's adverse social and environmental impacts, including those associated with an environmental management plan, should be included.
6. "Sunk" costs should be excluded.
7. Physical contingencies on project costs: 25% for pre-feasibility studies, 15% for feasibility studies.
8. Discount rate of 12% to be used.
9. A standard conversion factor (SCF) of 0.87 to be used, reflecting the general divergence between "border" prices and internal market (financial) prices caused by taxes, subsidies, monopoly prices etc.

10. Conversion factors to convert financial prices of inputs to economic prices:

- unskilled labour shadow wage rate (SWR) (construction)	0.65
- unskilled labour shadow wage rate (SWR) (crop production)	0.75
- urea fertiliser	1.45
- TSP	1.88
- MP	2.02
- animal draft power	0.87
- diesel fuel	0.63
- electricity for pumping	1.54
- transport equipment	0.68
- cement	0.79
- steel	0.75
- bricks	0.87
- paddy	0.88
- wheat	1.44
- jute	1.06
- sugar cane	0.95
- other crops	0.87

12. Economic decision criteria:

- EIRR (Economic Internal Rate of Return)
- NPV (Net Present Value)
- Switching values: the percentage change in a given variable necessary to reduce a project's NPV to zero or the EIRR to 12% should be calculated.
- Other sensitivity analyses should be made, to test the effects of changes in possibly critical variables such as capital and O & M costs, project benefits and delays in project implementation and in the achievement of full benefits.

One change has been made to the conversion factors recommended by FPCO, which is a revision of the factor for wheat from 1.29 to 1.44, and excludes costs and conversions of wheat to flour.

The standard conversion factor of 0.87 has been used to convert financial prices of fish into their economic equivalents.

The economic analysis is based on constant 1991 prices as recommended whereas the financial analysis is based on 1992/93 farmgate prices.

J.1.3 Components of Economic Analysis

The Guidelines for Project Assessment require a more broadly based assessment of proposed interventions than one based solely on the financial and economic analysis of costs and benefits. The methodology recommended is a multi-criteria analysis which facilitates a comparison of expected impacts in economic, quantitative and qualitative terms. Where possible impacts have been evaluated within the economic analysis and include the following:

- benefits resulting from changes in cropped areas.
- benefits derived from reduced flood damage to crops, property, infrastructure, livestock and fishponds.
- costs associated with reduced fish catches.

Quantitative estimates of important parameters such as increments in crop production, declines in fish catches and changes in employment for differently affected occupations area also presented wherever practicable. Impacts which cannot be quantified with confidence are included via an assessment of their significance both in terms of overall importance and the extent to which proposed interventions will result in changes. In general the major concerns for flood control projects which are not easily quantified are the consequences for health, nutrition, transportation and the quality of life on one hand and the effects on the natural environment on the other.

J.1.4 Components of Financial Analysis

The principal benefit of the project is an increase in farm incomes for farmers and their families and improved employment opportunities for those engaged as agricultural labourers. Thus a major component of the financial analysis is the calculation of farm incomes at financial prices based on proposed cropping patterns and crop budgets. Potential increases in farmers' incomes are estimated with farm models for typical farm sizes. Their function is to demonstrate that project proposals are worthwhile and that farmers are indeed likely to adopt the opportunities which the project makes possible given the constraints under which existing farming practices are pursued.

CHAPTER J.2

METHODOLOGY FOR PROJECT APPRAISAL

J.2.1 Sources of Data

Field surveys of the following target groups have been completed and provide the major source of data used in this study. The results of the surveys are presented in the appendices to the Agricultural Annex (E) and have covered:

	Respondents per Zone				Total
	A	B	C	D	
Farmer	96	96	96	96	384
Farmer Case Study	12	12	12	14	50
Landless	24	24	24	24	96
Capture Fishermen	20	20	20	20	80
Culture Fishermen	24	24	24	24	96
Women	24	24	24	24	100
Plot Surveys	60	60	60	120	300

For the purposes of field surveys and investigations the project area is divided into four zones as illustrated in Figure J.2.1. Thanas whose boundaries do not coincide with zones are listed below:

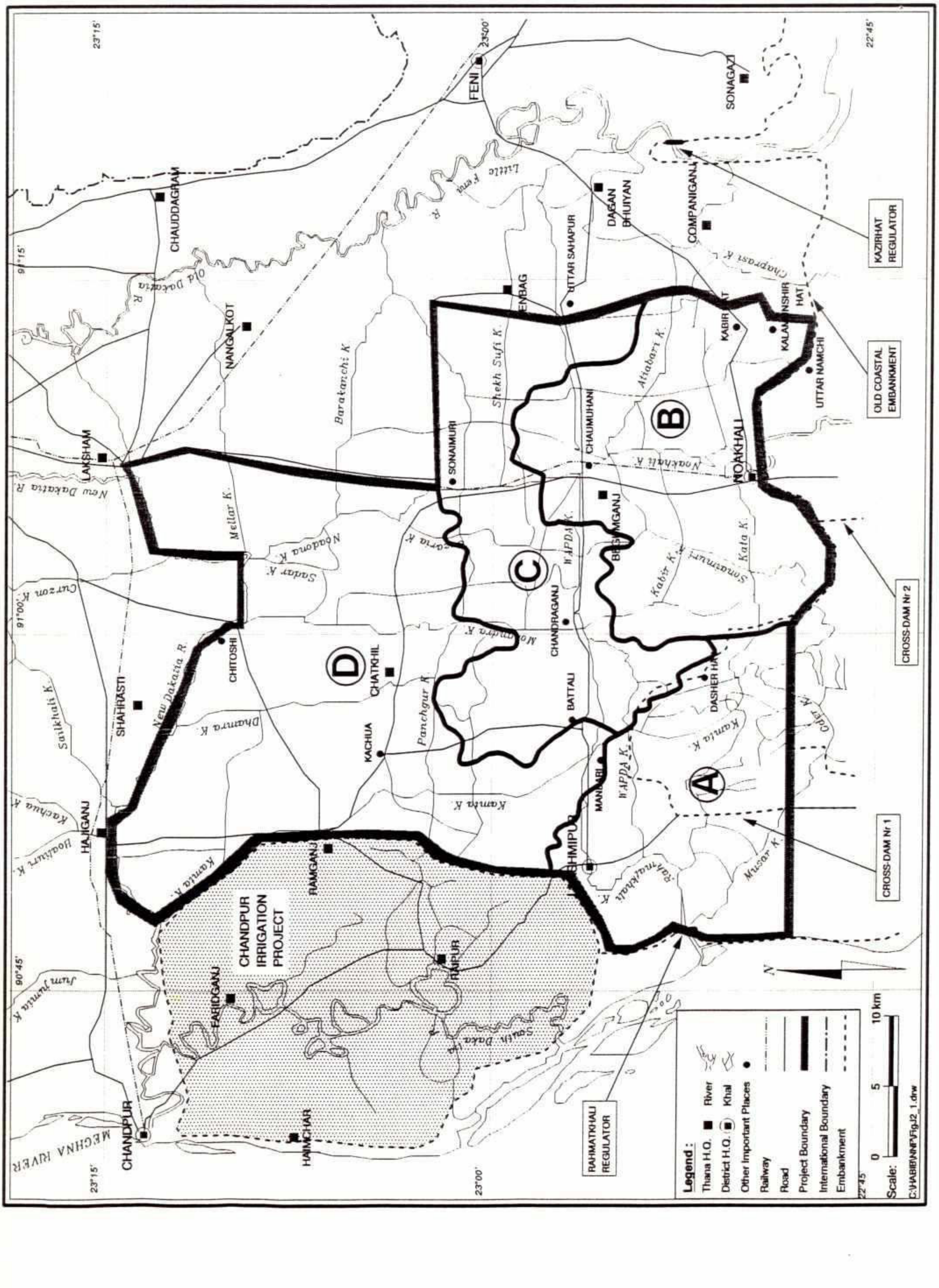
	Thanas
Zone A	Lakshampur, Ramgati, Noakhali Sadar
Zone B	Noakhali Sadar, Senbagh, Begumganj
Zone C	Lakshampur, Noakhali Sadar, Senbag, Chatkhil, Begumganj.
Zone D	Lakshimpur, Ramganj, Chatkhil, Begumganj, Hajiganj, Faridganj, Shahrasti, Laksham.

The estimated area of each zone is :

	Gross	Net
Zone A	29332	22956
Zone B	35553	21115
Zone C	32769	22107
Zone D	63160	42450
Total	160814	108628

Figure J.2.1

Planning Zones



The surveys provided specific data for use in the economic and financial analyses on wage rates, pesticide costs, hire rates for bullocks as well as the value of crop residues and animal manure. Fertiliser prices were obtained from the International Fertiliser Development Centre. Seeds prices were obtained from the Bangladesh Agricultural Development Corporation for those crops for which farmers normally purchase their seed (i.e. potatoes), from FPCO guidelines for jute and by multiplying the output price by 1.5 for those crops for which farmers retain their own seed.

Commodity prices were collected from the Directorate of Agricultural Marketing for a five year period (1988-1992) from three producer markets and two wholesale markets. When information was available producer market prices were used, based on an average of the lowest three or four months of the year (i.e. harvest time) when farmers are most likely to sell their crops.

Three year averages were calculated for the periods 1989-91 and 1990-92 and are adjusted for farm to market transport. No allowance for inflation was incorporated in these calculations as no upward trend could be discerned in price data from individual markets over the period covered. Financial and economic prices for agricultural products and inputs are presented in Table J.2.1. The price of draught animals in Table J.2.1 is for a pair of bullocks less the cost of the driver. While teams of bullocks are invariably hired with a driver, the costs have been separated to avoid double counting of labour as crop labour requirements also include an allowance for cultivations with draught animals.

J.2.2 Conversion Factors for Capital and O&M Costs

Project capital and operating costs have been adjusted to economic prices by applying the conversion factors given in the Guidelines for Project Assessment to the total estimated capital and operation and maintenance costs at financial prices. Capital and operating costs for the main items (embankments, pump stations, khal excavation etc) have been broken down by main category (labour, materials, machinery, equipment etc) in terms of the percentage share of costs, and the relevant conversion factor applied for each category. The results are presented in Table J.2.2. All capital and O&M costs are adjusted to 1991 prices (factor = 0.952, construction index) for inclusion in the economic analysis.

Physical contingencies are included at 15 per cent of capital costs at both economic and financial prices. Engineering costs for detailed design and the supervision of construction are charged at 12 per cent of capital costs in financial prices and converted into economic prices by applying the standard conversion factor.

J.2.3 Economic Cost of Land Acquisition and Resettlement

The issues of land acquisition and resettlement are being studied as a separate element (FAP 15) of the Flood Action Plan Studies; FAP 15 Final Report has not yet been published. At present individuals who own land or other assets which are compulsorily purchased are entitled to compensation payments from the Government at the current market rate, which in the case of the Noakhali North project area has been assessed at Tk 500 000 per hectare of agricultural land. Homestead areas have been valued at Tk 1 620 000 per hectare which includes allowances for resettlement and the construction of new houses.

TABLE J.2.1

Financial and Economic Prices for Agricultural Products and Inputs (Taka)

Commodities	Unit	Financial Prices (1991)	(1992)	Conversion Factor	Economic Prices (1991)
Main Products					
B Aus	kg	6.17	6.17	0.88	5.43
T Aus	kg	6.17	6.17	0.88	5.43
B Aman	kg	6.96	7.47	0.88	6.12
LT Aman	kg	6.96	7.47	0.88	6.12
HYV Aman	kg	6.96	7.47	0.88	6.12
L Boro	kg	5.89	6.19	0.88	5.18
HYV Boro	kg	5.89	6.19	0.88	5.18
Wheat	kg	6.53	7.18	1.44	9.40
Potato	kg	4.09	4.16	0.87	3.56
Jute	kg	7.94	7.67	1.06	8.42
Pulses: keshari	kg	12.63	12.31	0.87	10.99
mung	kg	17.62	17.05	0.87	15.33
masur	kg	20.48	21.89	0.87	17.82
mash	kg	12.11	14.57	0.87	10.54
Groundnuts	kg	13.93	13.27	0.88	12.26
Mustard	kg	13.93	13.27	0.88	12.26
Sugarcane	kg	0.70	0.70	0.95	0.66
Spices (onion)	kg	8.73	8.64	0.87	7.60
Spices (chilli)	kg	7.64	8.40	0.87	6.65
Veg. (brinjal)	kg	3.73	3.79	0.87	3.25
Veg. (tomatoes)	kg	4.50	4.50	0.87	3.92
Veg. (taro)	kg	4.26	4.99	0.87	3.71
By Products					
Rice straw HYV	kg	0.50	0.50	0.87	0.44
local	kg	0.50	0.50	0.87	0.44
Wheat straw	kg	0.50	0.50	0.87	0.44
Jute sticks	kg	1.11	1.11	0.87	0.97
Pulse straw	kg	1.50	1.50	0.87	1.31
Oilseed straw	kg	0.23	0.23	0.87	0.20
Inputs					
Human Labour	day	40.00	43.00	0.75	30.00
Bullock pair*	day	40.00	57.00	0.87	34.80
Seeds					
B Aus	kg	9.26	9.26	0.88	8.15
T Aus	kg	9.26	9.26	0.88	8.15
B Aman	kg	10.44	11.21	0.88	9.19
LT Aman	kg	10.44	11.21	0.88	9.19
HYV Aman	kg	10.44	11.21	0.88	9.19
L Boro	kg	8.84	9.28	0.88	7.78
HYV Boro	kg	8.84	9.28	0.88	7.78
Wheat	kg	9.80	10.80	1.44	14.11
Potato	kg	9.50	10.00	0.87	8.27
Jute	kg	22.00	22.00	1.06	23.32
Pulses	kg	24.00	24.00	0.87	20.88
Groundnuts	kg	19.00	19.00	0.88	16.72
Mustard	kg	19.00	19.00	0.88	16.72
Spices (onion)	kg	600.00	600.00	0.87	522.00
Spices (chilli)	kg	600.00	600.00	0.87	522.00
Veg. (brinjal)	kg	400.00	350.00	0.87	348.00
Veg. (tomatoes)	kg	400.00	350.00	0.87	348.00
Veg. (taro)	kg	400.00	350.00	0.87	348.00
Fertiliser					
Urea	kg	4.72	5.26	1.45	5.90
TSP	kg	5.78	7.60	1.88	10.76
MP	kg	4.54	7.24	2.02	8.27
Animal manure	kg	0.10	0.10	0.87	0.09
Pesticide	kg	500.00	500.00	0.87	435.00
Diesel fuel	litre	14.00	14.00	0.63	8.82

Table J.2.2

Breakdown of Capital Costs in Financial Prices by Main Category

Share of Costs (per cent)

	Skilled labour	Unskilled labour	Transport		Cement and Bitumen		Steel		Machinery & equipment		Gravel/ Bricks	Total		
	local cost	local cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	local cost	F. E. cost	Total
Embankments	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Canals	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Major drains	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Drainage	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Regulators	11.0	42.0	1.0	1.0	6.0	2.0	6.5	6.5	10.0	10.0	4.0	80.5	19.5	100.0
Culverts	12.0	49.0	1.5	1.5	4.5	1.5	6.5	6.5	6.5	6.5	4.0	84.0	16.0	100.0
Pump stations Civil	12.0	48.0	1.0	1.0	6.0	2.0	6.5	6.5	6.5	6.5	4.0	84.0	16.0	100.0
Pump stations E & M	5.0	1.0	1.5	1.5	0.0	0.0	0.0	0.0	45.5	45.5	0.0	53.0	47.0	100.0
Roads E/W	6.0	56.0	3.0	3.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	81.0	19.0	100.0
Roads Pavement	13.0	13.0	2.0	2.0	10.0	3.0	0.0	0.0	10.5	10.5	36.0	84.5	15.5	100.0
Bridges	12.0	47.0	1.5	1.5	7.0	2.0	6.5	6.5	6.0	6.0	4.0	84.0	16.0	100.0
Footbridges	13.0	48.0	2.0	2.0	7.0	2.0	6.5	6.5	4.5	4.5	4.0	85.0	15.0	100.0
Power supply	5.0	1.0	2.0	2.0	0.0	0.0	0.0	0.0	45.0	45.0	0.0	53.0	47.0	100.0
Buildings	15.0	14.0	0.0	0.0	17.0	6.0	6.5	6.5	3.0	3.0	29.0	84.5	15.5	100.0

Breakdown of O&M Costs in Financial Prices by Main Category

Share of Costs (per cent)

Item	Skilled labour	Unskilled labour	Transport		Cement and Bitumen		Machinery & equipment		Electricity		Total		
	local cost	local cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	local cost	F. E. cost	Total
Embankments	22.5	57.5	1.5	1.5	0.0	0.0	8.5	8.5	0.0	0.0	90	10	100
Canals	22.5	57.5	1.5	1.5	0.0	0.0	8.5	8.5	0.0	0.0	90	10	100
Major drains	22.5	63.0	1.5	1.5	0.0	0.0	5.8	5.8	0.0	0.0	93	7	100
Drainage	11.5	87.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	100	1	100
Regulators	28.0	56.5	1.3	1.3	3.0	3.0	3.5	3.5	0.0	0.0	92	8	100
Culverts	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100
Pump stat. Civil	28.5	57.5	1.3	1.3	0.0	0.0	5.8	5.8	0.0	0.0	93	7	100
Pump stat. E & M	29.0	29.0	1.0	1.0	0.0	0.0	20.0	20.0	0.0	0.0	79	21	100
Pump stat. Power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	25.0	75	25	100
Roads	22.0	59.5	1.3	1.3	3.0	3.0	5.0	5.0	0.0	0.0	91	9	100
Bridges	28.5	56.0	1.3	1.3	3.0	3.0	3.5	3.5	0.0	0.0	92	8	100
Footbridges	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100
Buildings	28.5	63.0	1.3	1.3	3.0	3.0	0.0	0.0	0.0	0.0	96	4	100

Note: Figures may not sum to total due to rounding

Estimates of Conversion Factors for Capital Cost Items

Item	Skilled labour	Unskilled labour	Transport	Cement/ Bitumen	Steel	Machinery & equpt	Gravel/ Bricks	Weighted Average Conversion Factor
Conversion Factor	0.87	0.65	0.79	0.79	0.75	0.62	0.87	
Embankments	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Canals	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Major drains	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Drainage	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Regulators	9.6	27.3	1.6	6.3	9.8	12.4	3.5	0.70
Culverts	10.4	31.9	2.4	4.7	9.8	8.1	3.5	0.71
Pump stations Civil	10.4	31.2	1.6	6.3	9.8	8.1	3.5	0.71
Pump stations E & M	4.4	0.7	2.4	0.0	0.0	56.4	0.0	0.64
Roads E/W	5.2	36.4	4.7	0.0	0.0	19.8	0.0	0.66
Roads Pavement	11.3	8.5	3.2	10.3	0.0	13.0	31.3	0.78
Bridges	10.4	30.6	2.4	7.1	9.8	7.4	3.5	0.71
Footbridges	11.3	31.2	3.2	7.1	9.8	5.6	3.5	0.72
Power supply	4.4	0.7	3.2	0.0	0.0	55.8	0.0	0.64
Buildings	13.1	9.1	0.0	18.2	9.8	3.7	25.2	0.79

Other conversion factors from FPCO Guidevehicles 0.68

standard conversion factor 0.87

Estimates of Conversion Factors for O&M Cost Items

Item	Skilled labour	Unskilled labour	Transport	Cement/ Bitumen	Machinery & equpt	Pump station power	Weighted Average Conversion Factor
Conversion Factor	0.87	0.65	0.79	0.79	0.62	1.54	
Embankments	19.58	37.38	2.37	0.00	10.54	0.00	0.70
Canals	19.58	37.38	2.37	0.00	10.54	0.00	0.70
Major drains	19.58	40.95	2.37	0.00	7.13	0.00	0.70
Drainage	10.01	56.88	0.79	0.00	0.00	0.00	0.68
Regulators	24.36	36.73	1.98	4.74	4.34	0.00	0.72
Culverts	24.79	40.95	1.98	4.74	0.00	0.00	0.72
Pump stat. Civil	24.79	37.38	1.98	0.00	7.13	0.00	0.71
Pump stat. E & M	25.23	18.85	1.58	0.00	24.80	0.00	0.70
Pump stat. Power	0.00	0.00	0.00	0.00	0.00	154.00	1.54
Roads	19.14	38.68	1.98	4.74	6.20	0.00	0.71
Bridges	24.79	36.40	1.98	4.74	4.34	0.00	0.72
Footbridges	24.79	40.95	1.98	4.74	0.00	0.00	0.72
Buildings	24.79	40.95	1.98	4.74	0.00	0.00	0.72
					standard conversion factor		0.87

The economic value of agricultural land acquired for project works has been taken to be the present value, at 12%, of the net income foregone from future production on the land over thirty years. It varies with cropping pattern and yield and has been calculated on the basis of present average value of production per hectare which on lands near the khals has been evaluated on the basis of one boro crop and 0.84 T.aman crop (0.3 HYV). This gives a value in economic prices of Tk. 210 000 per hectare.

J.2.4 Costs of Minor Irrigation

Capital and annual operating costs for different types of minor irrigation equipment have been estimated on the basis of surveys of pump operators, farmers and secondary data. Details of cost calculations are in Appendix J.1. Costs have been calculated for a range of different modes including:

a. LLP 1 - 0.7/1.0 cu.sec pump irrigating 10 ha, using the same 8hp engine as a STW.

b. LLP 2 - 2 cusec pump irrigating 20 ha.

c. STW - a conventional STW using a Japanese engine. Although many STWs have cheaper Chinese engines, these are slightly less fuel efficient and have a shorter life (crankshafts usually break after 2 or 3 years, so their overall cost has been calculated to be slightly higher than the Japanese engine.

d. DSSTW - as for the STW but in an unlined pit 1.5 m deep.

e. DFMTW 1 - a 1 cu sec version of a DTW for deeper aquifers. Now that BADC is no longer installing DTWs it is likely that future private investment in this mode will be in this type of smaller well. Although most existing DTWs are the larger and more costly 2 cusec wells, the cost of a smaller cheaper well has been used as the replacement cost of existing DTWs.

Capital costs include the cost of water channel construction (unlined earth). Costs of additional LLP required for surface water irrigation schemes has not been included in the cash flow as a capital item, with replacement costs being incorporated at the end of their life. Rather capital costs for both existing and additional equipment has been annualized over the life of the well/pump at an interest rate of 12% per year (16% at financial prices). Not only is this approach more straightforward, and treats project related and non-project investments in the same way, but it is more than likely that at least some of the LLPs purchased by farmers would be second-hand and so have a different cost and replacement profile. This approach can distort IRR calculations if returns are very different from the 12% discount rate, although because the cost of LLPs is not very large relative to overall project costs and benefits, the distortion is unlikely to be significant.

Operating costs are based on an irrigation water pumping requirement of 740mm per year. Although this is about 25% less than the calculated crop water requirements for boro in Noakhali, it is thought to reflect the actual amount that farmers apply. If the full crop water requirement is provided, then irrigation costs at financial prices for STW and DTW exceed the actual fees charged, leaving the pump operator to make a loss. In addition it would require tubewells to operate for unrealistically long hours to supply known command areas. What farmers are doing is making a realistic compromise between irrigation costs and crop water requirements.

Average costs by mode have been calculated as, for LLP, the average between LLP 1 and LLP 2, and for STW/DSSTW, an average weighted 80% STW and 20% DSSTW. The cost of traditional irrigation has been calculated as a labour cost of Tk 7,200 per ha in financial prices or Tk5,400 at economic prices. This is substantially more than alternative sources such as LLP and STW. In fact what the farmer is paying for with his own labour is a saving on hiring a mechanical pump. Therefore the labour cost has been reduced by 50% which puts it between an LLP and STW. In practice actual labour use may be less than 180 days per ha as farmers apply less than optimal amounts of water. There is evidence from Gumti (but not Noakhali) that traditionally irrigated boro does yield less (and also gets lower levels of fertiliser).

An overall fee for irrigating boro has been calculated using the average for different modes weighted by the proportion of modes found in the region. The cost for other crops has been calculated according to the proportion that their fees are to the boro fee. These costs are:

Boro	Tk 6710/ha
T Aus	Tk 2185/ha
Wheat	Tk 3460/ha
Potatoes	Tk 4734/ha

Only 33% of the aus fee is applied as it is assumed that aus requires less irrigation. For wheat and potatoes the full amount is applied to the irrigated crop budget. It is assumed that local boro only needs half the irrigation of HYV boro as it is grown in naturally wet places. In both Noakhali and Gumti a flat rate irrigation fee is the normal method of charging for water, rather than a share of the crop.

For the purposes of comparing technologies and assessing the potential for groundwater use under difficult conditions a number of other technologies have been evaluated in Appendix J.1. These indicate that both DSSTW and SFMTW can provide an economic alternative to STW in situations where the water table has fallen sufficiently to reduce the efficiency of STW operation.

J.2.5 The Use of the Mike II Hydrodynamic Model

The evaluation of flood mitigation projects in Bangladesh has for some time been based on classifications of flood depth known as flood phases. These are categorised as follows:

- F0 - flood depths of ,0.3 M
- F1 - flood depths of 0.3 - 0.9 M
- F2 - flood depths of 0.9 - 1.8 M
- F3 - flood depths of .1.8 M (for less than nine months per year)
- F4 - flood depths of .1.8 M (for more than nine months per year)

This classification system has been in use for some time and is retained by the Regional Plan for broad level planning purposes, as both crop statistics and cropping distributions have been developed by the Master Planning Organisation for flood phases by planning unit which enable flood mitigation programmes to be evaluated on the basis of changes in flood phasing which result from proposed interventions. A drawback of the present classification, for other than broad level planning is that it relates neither to the duration of flooding nor to the frequency with which the inundation occurs. Thus, for example, an intervention which reduced the duration of flooding while at the same time having little impact on its peak depth might well enable an aman crop to be transplanted on the receeding flood for which no benefit under the depth of flooding rules can be claimed. As a result FPCO have produced (but not yet officially published) a new set of guidelines which specify the maximum depths of flooding which various types of rice can withstand throughout their life cycle. These are presented in Table J.2.3.

The rules have been incorporated within the processing package of the Mike II hydro-dynamic model as follows:

- depths of flooding tolerances, as presented in Table J.2.3 are transformed into histograms of maximum allowable flooding depths by 10 day periods to accord with the 10 day analysis used by the model for a range of planting/sowing dates.

- in each decad (with three decads per calendar month) crop failure occurs on the fourth day on which the level exceeds the critical value. Hence each decad should be represented as a maximum of a four day minimum level, starting by looking three days backwards into the previous decad. Water levels were analysed at each representative river level node in terms of four day exceedances over the whole year for the 25 year run which enabled them to be expressed in terms of probabilities.

- water levels are translated into areas of land flooded to various depths by comparison with area elevation curves for each minute square (311 hectares) which are calculated by reference to the land level data base. The data base itself is simply a large number of entries of topographic heights for each minute square which is based on the 4 inch to one mile BWDB Water Development Maps compiled in the 1960's, where each point represents approximately three hectares.

- areas on which crops can be safely grown are calculated by application of FPCO submergence rules over a range of conditions, which include the extreme, average and one in 3, 4, 5, 8 and 10 wet years.

The output from the model is consequently a list of the percentages of an area on which crops can be safely grown at specified probability levels. For many crops the list is academic as the area actually grown is determined by other factors such as access to irrigation. The model only produces areas on which crops can be theoretically grown, other things being equal. In addition, because the model is unable to represent flash floods satisfactorily, it cannot be used to assess either their impact or frequency. Fortunately this aspect is not of major significance in the Noakhali North area.

J.2.6 Cropping Patterns

Cropping patterns are determined by a large variety of factors but among the more important are :

- access to irrigation in the dry season which to a very large extent decides whether or not a boro crop is grown.

- the flooding regime in the monsoon season which determines whether or not a farmer can grow transplanted high yielding aman, transplanted local varieties of aman, deep water aman or nothing.

TABLE J.2.3

SUBMERGENCE TOLERANCE RANGE OF RICE AT DIFFERENT GROWTH STAGES

CROP	GROWTH STAGE	SUBMERGENCE RANGE	PERIOD
HYV Boro	Transplanting	10 - 20 cm	January - February
	Vegetative	30 - 50 cm	March
	Reproductive	20 - 30 cm	April
	Maturity	30 cm	May
B Aus	Seeding	Field Capacity	March - April
	Vegetative	50 - 70 cm	May
	Reproductive	30 - 50 cm	June
	Maturity	50 cm	July
HYV Aus	Transplanting	10 -20 cm	March - April
	Vegetative	30 - 50 cm	May - June
	Reproductive	20 - 30 cm	July
	Maturity	30 cm	August
LT Aus	Transplanting	20 - 30 cm	March - April
	Vegetative	50 - 70 cm	May - June
	Reproductive	30 - 50 cm	July
	Maturity	50 cm	August
LT Aman	Transplanting	20 - 30 cm	July - September
	Vegetative	50 - 70 cm	September - October
	Reproductive	30 - 50 cm	November
	Maturity	50 cm	November - December
HYV Aman	Transplanting	10 - 20 cm	July - August
	Vegetative	30 - 50 cm	September - October
	Reproductive	20 - 30 cm	October - November
	Maturity	30 cm	November - December
DWR	Seeding	Field Capacity	March - April
	Transplanting	30 - 50 cm	April - May
	Vegetative	50 - 400 cm*	June - September
	Reproductive	50 - 90 cm	October - November
	Maturity	Field Capacity	November - December

* Rise in water level has to be gradual so that the plants can keep pace.

- attitudes to risk which are generally determined by farmers' expectations of likely costs and returns but which are also a function of farmers' ability to bear losses should they arise. These are not clear cut for some farmers are in a position where crop failure is not much worse an outcome than not planting because either strategy is catastrophic in terms of providing food for their families. Other farmers are in a more fortunate position where they are able to grow sufficient food for consumption with relatively low risk crops and are unwilling to gamble this security on the chance of either higher returns or the possibility of jeopardising their holdings through incurring losses. Larger farmers are generally in a position to decide for themselves what strategy to adopt although evidence from the farmer survey suggests that the very large farmers tend to farm at lower intensities than either medium or small farmers, and invariably have other sources of income to rely on.

Changes in cropping patterns which can be anticipated are expected to result from both increased access to irrigation and changed flooding regimes. Increased irrigation invariably results in increased boro cultivation, as the crop produces high yields, good returns and is generally perceived as being less risky than most other crops except in areas prone to flash floods. Any increase in boro cultivation has widespread implications for many other crops in both the rabi and aus seasons. Some short duration crops such as pulses and oilseeds may preceed a boro crop but only if they are planted on the receeding flood. Wheat, potatoes and most winter vegetables are not generally harvested in time for a boro crop to be planted. The same is true of aus, mixed aus-aman and jute crops which are seeded in March, April (and May to some extent) and thus compete with the boro crop which is harvested in (late) April, May and early June. Transplanted aus and deepwater aman crops may follow boro but require an early boro harvest as well as a fast turnround in land preparation and transplanting. Consequently this sequence of crops cannot be expected to cover a very high proportion of the area. Broadcast deep water aman is another crop which can follow boro but it is more safely sowed in March or April when it is unlikely to be damaged by severe early rains (the crop cannot be broadcast into standing water) and has plenty of time to establish itself well enough to elongate with the arrival of floods (a period of about two months). Thus broadcasting aman after the middle of April becomes increasingly more risky the later it is sowed, and consequently has been restricted in the development of cropping patterns to a maximum of ten per cent of the area in question.

Transplanted aman crops (HYV varieties are transplanted July and August, local varieties in July, August and September) may follow aus crops but it is more common for them to follow the boro crop as this gives farmers plenty of time to prepare the land and tend their nurseries. In general transplanted aman crops do not compete for land with any other seasonal crops except deepwater varieties which are by definition generally grown elsewhere.

They do conflict with early sown rabi crops as transplanted aman is generally harvested in November and December, by which time the residual moisture has evaporated sufficiently to hinder germination of unirrigated rabi crops. Some farmers overcome this problem by broadcasting seed into the standing aman crop, but in general it may be concluded that increased areas of transplanted aman crops are likely to restrict the ability of farmers to grow crops in the time between the harvest of aman and the transplanting of boro.

From the above it can be seen that future cropping patterns will be mainly determined by assumptions concerning both access to irrigation and projected flooding regimes.

All existing irrigation within the project area turns under the category of minor irrigation; that is to say that there are no schemes involving major pump stations and/or extensive gravity distribution. Estimates of irrigated area in each of the project area zones have been based on the following sources:

- the farmer survey which asked whether (and how) a crop grown on each of the farmers' plots is irrigated or not

- data collected by the Bangladesh - Canada Agricultural Sector Team (AST) on numbers of and areas commanded by minor irrigation equipment by extension block and Thana.

- Thana statistics from the Development of Agricultural Extension (DAE) and the Bangladesh Bureau of Statistics on irrigation areas and modes.

A discussion of the development trends of all modes of minor irrigation based upon AST and other data sources is presented in Chapter 2 of the Main Report.

In general it was found that the farmer survey produced higher irrigation coverage than either AST figures or DAE/BBS statistics.

A comparison of results is presented in Table J.2.4 below. At first sight the discrepancy between AST data and the farmer survey look large in all Zones other than Zone A. However an adjustment, based on the pump operator survey which showed that about 20% of pumps are used to irrigate two separate areas and consequently increases the area irrigated, draws the two figures closer together. As it is not known whether the AST data or the farmer survey are correct, a mid-way point between the two was calculated. As the mid way point is close (ie within 3000 hectares) to the adjusted AST data, there is reasonable justification for accepting these numbers. They are obviously very important because they determine how much benefit the project can claim in the future by increasing water availability in the khals. In this respect it is fortunate that the best correlation between AST data and the farmer survey occurs in Zone A as this is where the greatest increase in water availability in the "future with" is expected. Table J.2.4 presents estimates of increased irrigation in the "future with" project where it can be seen that an additional area of 18,509 ha will be irrigated of which 9,626 are in Zone A, 2621 ha are in Zone B, 4230 ha are in Zone C and 2034 ha in Zone D.

Overall the area irrigated across the whole project is forecast to increase from 46% to 64%. Only minor increases in groundwater exploitation are anticipated for the reasons given in Chapter two of the main report and Annex C (Groundwater).

2?

TABLE J.2.4

Irrigation Areas in Noakhali North Project Area

Irrigation Areas	Zone A	Zone B	Zone C	Zone D	Total
Gross area	29332	35553	32769	63160	160814
Net cultivable area	22956	21115	22107	42450	108628
Farmer survey:					
Irrigated area %	18.70	64.14	56.20	72.50	
area	4293	13543	12424	30776	61036
AST data %	15.49	37.86	39.80	44.16	
area	3557	7994	8799	18744	39094
AST adjusted area	4268	9488	11265	24366	49387
Average %	17.10	51.00	48.00	58.10	46.01
area	3925	10769	10611	24673	49978
Areas to be irrigated by project	12129	3615	8944	3157	27845
Areas already irrigated (1991)	2384	947	4490	1070	8891
(1992)	2503	994	4715	1124	9336
Additional areas	9626	2621	4230	2034	18509
Irrigation coverage	13551	13389	14841	26707	68487
(with project) %	0.59	0.63	0.67	0.63	0.63

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J.2.7 Flooding Regimes

Output from the hydro-dynamic model post processing runs provides maximum areas of crops which can be safely grown at various levels of risk in both the "present" and "future with" project situations. While these give a useful indication of the potential improvements which an intervention might achieve, it is necessary to establish how well the model predicts present cropped areas of transplanted aman before it can be used to predict future cropped areas. As far as the model results are concerned transplanted amans are the key crops (both HYV and LT) because these are directly controlled by the flooding regime and can be increased with little adverse affect on other crops other than the deepwater amans which they might replace.

A comparison between the model output and farmer survey predictions for T Aman areas is presented in Tables J.2.5, J.2.6 and J.2.7, where it can be seen that both the model and MPO predict far higher areas of HYV aman than the survey, whilst simultaneously under predicting the areas of LT aman. If the total of all T aman is considered (for a 1 in 5 wet year) both MPO and the model predict accurate results in Zone A whereas MPO is more accurate in Zone B and the model more accurate in Zones C and D. Where the output of the model for a 1 in 2 wet year is included, it can be seen that the model's predictions for LT aman are much closer to the survey's estimates. In other words, whilst farmers are not prepared to risk growing HYV aman it seems clear that either they are happy to take far greater chances with LT aman or that restrictions within the model, especially those which limit transplanting to maximum depths of 20 cms are too severe in a 1 in 5 wet year simulation. Certainly one strategy available to farmers is to grow taller seedings for planting into deeper water, up to 25 to 30 cams for example, even though it is to be expected that the transplant will take longer to establish itself and is vulnerable to any increased water levels for about three weeks. What is clear from the comparison is that the model is more conservative than MPO in its predictions of total T. aman, whilst at the same time allowing larger areas of HYV aman (15% more). Unfortunately it is also clear that both the model and MPO overpredict the HYV aman area actually grown at present.

As the reasons for farmers underplanting HYV aman were not known a special additional 30 farmer survey was organised in Zone A (4 moussas) and C (2 moussas) to try and find out. The results are not clear out but the following views emerged

- every farmer interviewed stated that HYV aman was more profitable than LT aman
- costs of production of HYV aman an higher than LT aman
- HYV aman seedlings are scarce every year
- Sharecropping systems in which the owner provides no inputs and receives 50% of output are a disincentive
- farmers receive little advice or encouragement from the extension service
- lack of cash (credit) to purchase inputs is a disincentive
- damage by tidal bores, insect and pests are more serious (and expensive) for HYV aman.

TABLE J.2.5

Comparison of Model Areas (1:5 wet year), Survey Areas, DAE and BBS Areas

AREAS		Gross	Net	HYV without project Aman	LT Aman	1:5		HYV with project Aman	LT Aman	HYV Aman	LT Aman		Actual HYV Aman	LT Aman	Total
Zone A		Probability		(1:5)	(1:5)	(1:5)	(1:5)	(1:5)	(1:5)	(1:5)	(1:5)				
	A1	10035	7854	0.92	0.95	7226	7461	0.94	0.97	7383	7618				
	A2	8456	6618	0.78	0.91	5162	6023	0.91	0.97	6023	6420				
	A3	10841	8484	1	1	8484	8484	1	1	8484	8484				
													0.185	0.72	
	Total	29332	22956			20872	21968			21890	22522		4247	16529	20776
Zone B												Ratio,Model:Survey			0.95
	B1	8296	4927	0.01	0.03	49	148	0.43	0.53	2118	2611	Error,difference:NCA			0.05
	B2	11851	7038	0.21	0.34	1478	2393	0.76	0.87	5349	6123	BBS area		11574	
	B3	3555	2111	0.01	0.02	21	42	0.02	0.06	42	127	DAE area		17002	
	B4	7703	4575	0	0	0	0	0.28	0.56	1281	2562	MPO HYV Aman		13986	
	B5	4148	2463	0.19	0.34	468	838	0.97	0.99	2389	2439	MPO LT Aman		6099	20085
													0.03	0.386	
	Total	35553	21115			2016	3421			11180	13862		633	8150	8784
Zone C												Ratio,Model:Survey			2.57
	C1	3921	2645	0.46	0.62	1217	1640	0.84	0.94	2222	2487	Error,difference:NCA			-0.25
	C2	1680	1134	0.07	0.21	79	238	0.57	0.82	646	930	BBS area	9628		
	C3	3361	2267	0.02	0.1	45	227	0.16	0.2	363	453	DAE area	11881		
	C4	6442	4346	0.11	0.13	478	565	0.18	0.23	782	1000	MPO HYV Aman		3297	
	C5	4761	3212	0.06	0.09	193	289	0.11	0.15	353	482	MPO LT Aman		5214	8511
	C6	5882	3968	0.68	0.83	2698	3293	0.95	0.97	3770	3849				
	C7	3361	2267	0.15	0.33	340	748	0.98	0.99	2222	2245				
	C8	3361	2267	0.02	0.05	45	113	0.77	0.93	1746	2109				
													0.029	0.416	
		32769	22107			5096	7114			12104	13553		641	9197	9838
Zone D												Ratio,Model:Survey			1.38
	D1	7486	4607	0.01	0.03	46	138	0.1	0.17	461	783	Error,difference:NCA			-0.12
	D2	7015	4234	0.06	0.08	254	339	0.12	0.24	508	1016	BBS area	7876		
	D3	6224	3743	0.03	0.09	112	337	0.25	0.45	936	1684	DAE area	9392		
	D4	7010	5093	0	0.01	0	51	0.02	0.02	102	102	MPO HYV Aman		5738	
	D5	3618	2227	0	0.01	0	22	0	0.02	0	45	MPO LT Aman		6308	12047
	D6	13215	8929	0	0.01	0	89	0.01	0.02	89	179				
	D7	9143	6868	0	0.01	0	69	0.01	0.02	69	137				
	D8	9448	6840	0	0	0	0	0	0	0	0				
													0.016	0.027	
	Total	63160	42540			412	1045			2164	3946		681	1149	1829
												Ratio,Model:Survey			1.75
												Error,difference:NCA			-0.02
												BBS area	11087		
												DAE area	na		
												MPO HYV Aman		1680	
Grand Total		160814	108718			28397	33548					MPO LT Aman		6868	8548
										47338	53883				41226.18
								Ratio Present T.Aman to Model Prediction							1.23
								Error,difference:NCA							-0.07
								BBS area			40165				
								DAE area			na				
								MPO area Total				HYV Aman		24701.81	
												LT Aman		24489.60	
												Total MPO		49191.41	

TABLE J.2.6

Comparison of Model Areas (1:5 wet year), Survey Areas, DAE and BBS Areas

AREAS	Gross	Net	HYV Aman	without project LT Aman	HYV Aman	LT Aman	GTV Aman	with project LT Aman	HYV Aman	LT Aman		Actual HYV Aman	LT Aman	Total
Zone A	Probability		(1:5)	(1:2)	(1:5)	(1:2)	(1:5)	(1:2)	(1:5)	(1:2)				
A1	10035	7854	0.92	0.97	7226	7618	0.94	0.98	7383	7697				
A2	8456	6618	0.78	0.97	5162	6420	0.91	0.99	6023	6552				
A3	10841	8484	1	1	8484	8484	1	1	8484	8484				
												0.185	0.72	0.905
Total	29332	22956			20872	22522			21890	22733		4247	16529	20776
Zone B											Ratio,Model:Survey			0.92
B1	8296	4927	0.01	0.12	49	591	0.43	0.72	2118	3547	Error,difference:NCA			0.08
B2	11851	7038	0.21	0.54	1478	3801	0.76	0.98	5349	6897	BBS area		11574	
B3	3555	2111	0.01	0.11	21	232	0.02	0.15	42	317	DAE area		17002	
B4	7703	4575	0	0.06	0	274	0.28	0.88	1281	4026	% HYV grown		20.35%	
B5	4148	2463	0 19	0.71	468	1749	0.97	1	2389	2463				
												0.03	0.386	
Total	35553	21115			2016	6648			11180	17251		633	8150	8784
Zone C											Ratio,Model:Survey			1.32
C1	3921	2645	0.46	0.82	1217	2169	0.84	1	2222	2645	Error,difference:NCA			-0.10
C2	1680	1134	0.07	0.77	79	873	0.57	0.97	646	1100	BBS area		9628	
C3	3361	2267	0.02	0.07	45	159	0.16	0.55	363	1247	DAE area		11881	
C4	6442	4346	0.11	0.24	478	1043	0.18	0.35	782	1521	% HYV grown		31.41%	
C5	4761	3212	0.06	0.21	193	675	0.11	0.36	353	1156				
C6	5882	3968	0.68	0.94	2698	3730	0.95	1	3770	3968				
C7	3361	2267	0.15	0.76	340	1723	0.98	1	2222	2267				
C8	3361	2267	0.02	0.25	45	567	0.77	0.99	1746	2245				
												0.029	0.416	
	32769	22107			5096	10938			12104	16150		641	9197	9838
Zone D											Ratio,Model:Survey			0.90
D1	7486	4607	0.01	0.09	46	415	0.1	0.45	461	2073	Error,difference:NCA			0.05
D2	7015	4234	0.06	0.16	254	677	0.12	0.53	508	2244	BBS area		7876	
D3	6224	3743	0.03	0.33	112	1235	0.25	0.88	936	3294	DAE area		9392	
D4	7010	5093	0	0.03	0	153	0.02	0.13	102	662	% HYV grown		12.58%	
D5	3618	2227	0	0.06	0	134	0	0.14	0	312				
D6	13215	8929	0	0.03	0	268	0.01	0.05	89	446				
D7	9143	6868	0	0.09	0	618	0.01	0.16	69	1099				
D8	9448	6840	0	0.03	0	205	0	0.07	0	479				
												0.016	0.027	
Total	63160	42540			412	3705			2164	10608		681	1149	1829
											Ratio,Model:Survey			0.49
											Error,difference:NCA			0.04
											BBS area		11087	
											DAE area		na	
											% HYV grown		165.06%	
Grand Total	160814	108718.0584			28397	43813			47338	66742				41226.18
							Ratio Present T.Aman to Model Prediction						0.94	
							Error,difference:NCA						0.02	
							BBS area		40165					
							DAE area		na					

TABLE J.2.7

Summary of Model Predictions, Survey Results and MPO Predictions

		Zone A		Zone B		Zone C		Zone D		Total	
Probability		1:5	1:2	1:5	1:2	1:5	1:2	1:5	1:2	1:5	1:2
Model Predictions											
	HYV Aman	20872		2016		5096		412		28396	
	LT Aman	21968	22522	3421	6648	7114	10938	1045	3705	33548	43813
	Total	21968	22522	3421	6648	7114	10938	1045	3705	33548	43813
Survey Predictions											
	HYV Aman	4247		633		641		681		6202	
	LT Aman	16529		8150		9197		1149		35025	
	Total	20776		8783		9838		1830		41227	
MPO Predictions											
	HYV Aman	13987		3297		5738		1680		24702	
	LT Aman	6099		5214		6308		6860		24481	
	Total	20086		8511		12046		8540		49183	

Note: MPO predictions are based on flood phases produced by the model.
A comparison between MPO and model flood phases is presented below.

	F0	F1	F2	F3+
Model	24%	20%	54%	2%
MPO	7%	38%	50%	5%

Whether or not these reasons are convincing it is clear that it is unrealistic to expect farmers to plant HYV aman to the extent which the model (or MPO) would expect. Thus in formulating "future with" cropping patterns only modest increases in HYV aman have been incorporated. In estimating cropping intensities for LT aman, the 1 in 2 year model predictions have been used as the basis for deciding areas likely to be grown in the "future with" project situation. The basis of these selected intensities are shown in Table J.2.8 and are discussed below:

TABLE J.2.8

Percentages of LT and HYV Aman

					Percentage of NCA	
		FO	F1	F2 +	LT Aman	HYV
Aman						
Zone A	Present +FWO	91	9	0	71.9	18.6
	Future with	95	5	0	73.0	19.0
Theoretical Maximum area					99.0	95.0
Zone B	Present FWO	4	33	63	39.0	3.0
	Future with	42	50	8	58.0	17.0
Theotrical Maximum					81.7	53.0
Zone C	Present + FWO	17	39	44	41.6	3.0
	Future	47	32	21	50.0	17.0
Theoretical Maximum					73.1	53.0
Zone D	Present + FWO	1	9	90	2.7	1.6
	Future with	2	28	70	7.0	5.0
Theoretical Maximum					25.0	5.0

Notes:

Zone A

Both HYV and LT aman are increased marginally in the "future with", in the same proportions as HYV and LT aman are grown at present. The present situation, where 90% of the possible T Aman area is actually cultivated is taken as a maximum for the other Zones in the "future with".

Zone B

A substantial change in flooding regimes is expected. HYV aman currently occupies 31% of the area predicted by the model and is expected to account for the same proportion in the future. LT aman which currently exceeds "safely grown" areas predicted by the model is expected to be grown over an area of 90% of model predictions in the "future with", after having deducted the area planted to HYV aman.

Zone C.

HYV aman currently occupies 13% of the area predicted by the model. In future it is expected to cover the same proportion of the area as in Zone B, as the area currently grown is very similar to Zone B. LT aman currently exceeds model predictions and is expected to be cultivated over 90% of model predictions in the "future with", after having deducted the area planted to HYV aman.

Zone D.

At present HYV aman is planted over an area greater than the model allows. Thus in the future 100% of HYV aman predicted area is included (which is only 5% of NCA). LT aman areas currently occupy an area rather smaller than the model predicts and consequently the same proportion is applied in the "future with" cropping patterns.

J.2.8 Crop Input Use

Estimates of input use have been made for the following crops which were selected from an analysis of cropped areas obtained from the survey of farmers.

B Aus	Local	T Aman	Local deepwater	Wheat	Not irrigated
B Aus	HYV	T Aman	Local	Potato	Irrigated
T Aus	Local	T Aman	HYV irrigated		Not irrigated
T Aus	HYV irrigated	T Aman	HYV not irrigated	Jute	
T Aus	HYV not irrigated	Boro	Local	Pulses	
Mixed	B Aus/Aman	Boro	HYV	Mustard	
B Aman	Local deepwater	Wheat	Irrigated	Spices (chilli)	
				Vegetables (Brinjal)	

Data from both primary (farmer surveys and case studies, SERS 1991 Survey) and Secondary Sources (MPO Technical Report No 14, FAP12 reports, Gumti Feasibility Study, 1990, IFDC Publications) have been reviewed to make estimates of agricultural input use. Principal data sources were the farmer surveys and 1990 feasibility study which were checked against other secondary sources. The physical inputs used in crop budgets are shown in table J.2.9.

TABLE J.2.9

Physical Input Quantities and Production per Hectare

Crop	Labour	Draft Animals	Seed	Fertiliser kg			Animal manure	Pesticide	Production (t/ha)	
									Main	By-
	days	pairday	kg	Urea	TSP	MP	kg	kg	Crop	Product
B Aus, local	138	45	85	60	30	0	1000	0.25	1.60	3.20
B Aus, HYV	144	45	85	80	40	0	1000	0.25	2.40	2.40
T Aus, local	154	47	30	80	40	0	1000	0.25	2.40	4.80
T Aus, HYV irri	178	47	30	140	50	10	1000	0.50	3.25	3.25
T Aus, HYV n-ir	174	47	30	140	50	10	1000	0.50	2.85	2.85
Mixed aus/aman	165	44	83	80	40	0	0	0.13	2.30	2.30
B Aman local dw	108	44	83	40	0	0	0	0.13	1.60	1.60
T Aman local dw	130	40	44	90	0	0	0	0.13	2.00	2.00
T Aman, local	141	40	44	80	40	9	0	0.25	2.10	4.20
T Aman HYV irri	170	43	30	120	80	25	700	1.16	3.75	3.75
T Aman HYV n-i	166	43	30	120	80	25	700	1.16	3.55	3.55
Boro, local	118	25	40	120	0	0	0	0.00	2.80	5.60
Boro, HYV irrig	210	43	30	170	140	30	1000	1.00	5.00	5.00
Boro HYV p-irr.	205	43	30	170	140	30	1000	1.00	4.50	4.50
Wheat irrig.	127	45	130	115	80	30	0	0.30	2.25	2.25
Wheat unirrig.	102	45	130	80	50	24	0	0.30	1.80	1.80
Potato irrig.	194	44	1000	277	290	102	1500	3.00	15.00	0.00
Potato unirrig.	175	44	1000	277	290	102	1500	2.00	10.00	0.00
Jute	215	45	9	89	67	9	2000	0.00	1.90	3.80
Pulses: ave.	50	30	31	0	0	0	0	0	0.68	0.68
Mustard	58	37	10	192	144	40	750	0.40	0.75	0.75
Spices (chilli)	157	30	1	100	180	90	2500	0.00	4.00	0.00
Veg. (brinjal)	270	44	1	100	60	40	2500	0.30	8.00	0.00

J.2.9 Crop Yields

Results of the survey for the Noakhali Project area are given in Table J.2.10. DAE and BBS figures are averages for the thanas in both project areas over the period 1989-90 to 1991-92. Rice yields are in tonnes of paddy per hectare. In general the farmer survey yields are higher than both DAE and BBS yields although DAE yield estimates are generally higher than BBS's. The higher yield rates used in the crop budgets reflect the farmer survey as these yields are to some extent confirmed by the survey done by FAP 12 in the Meghna Dhonaghoda Irrigation Project and by the Deep Tubewell Monitoring Project which covers part of the northern area and which gave a yield of 5.5 tonnes per hectare for boro.

Future Yields

Previous appraisals of FCDI projects have commonly assumed that substantial input supply and agricultural extension programmes would accompany projects, and that farmers would use recommended doses of inputs and achieve yields appropriate to these levels of inputs. In reality, while FCDI projects and irrigation have generally been found to lead to changes in cropping patterns (due to altered flood phasing), it is not immediately apparent that they have resulted in an increase in input applications or yields received for a given crop type grown under the same land and water conditions as before.

In one of the most detailed recent evaluations of a major FCDI project (Thompson 1989), no differences were found in yields for winter crops (mainly boro) and aus between Chandpur Irrigation Project (CIP) and adjacent 'control' areas outside the project boundaries. In summarising the yield impacts of FCDI the following extract from Thompson is particularly relevant:

> "Flood protection appears to be successful in maintaining yields closer to 'normal' in unusual flood years, compared with unprotected areas, but otherwise CIP has not provided an additional benefit over the switch in cropping pattern. That is, yields in a normal year are not higher compared to outside when the same type of paddy is considered. In general this probably reflects levels of input use... fertiliser use for a given crop type is not higher inside CIP compared to outside areas. Thus CIP does not appear to have provided more effective extension services relative to non-project areas, nor has any supposed increase in wealth due to more productive agriculture been reinvested as working capital in an attempt to further increase yields."

This finding is supported by detailed analysis of farmer survey results which did not identify any improvement in yield or associated change in input use for the same crop grown on higher, and therefore less flood-prone, land. Although evaluations of completed projects by FAP 12 has in some cases identified yield improvements inside FCD project areas (see Table J.2.11), it concluded that:

> "in most projects the major impact on weighted mean paddy yields is from farmers switching to more productive types of paddy when hydrological conditions change sufficiently to permit this".

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TABLE J.2.10

Crop Yields Used in Economic Models

	Farmer Survey	DAE	BBS	Used in Budgets
B Aus, local	1.69	1.34	1.57	1.600
B Aus, HYV	2.6	2.78		2.40
T Aus, local	2.25		2.98	2.40
T Aus, HYV irri				3.25
T Aus, HYV n-ir	2.88		2.30	2.85
Mixed aus/aman	2.29			2.30
B Aman local dw	1.56	1.63	1.71	1.60
T Aman local dw	2.19			2.00
T Aman, local	2.14	2.20	2.0	2.10
T Aman HYV irr				3.75
T Aman HYV n-ir	2.90	3.74	2.63	3.55
Boro, local	1.42	2.39	2.13	2.80
Boro, HYV irrig	5.08	4.46	4.17	5.00
Wheat irrig.	1.38	-	-	2.25
Wheat unirrig.	1.29	1.30	-	1.80
Potato irrig.	24.25	12.24(1)	10.28(1)	15.00
Potato unirrig.	11.98	5.51(1)	7.65(1)	10.00
Jute	1.69	1.53	1.72	1.90
Pulses: keshari	0.57	0.63	0.61	0.70
mung	0.62	0.60	1.31	0.60
masur	0.59	0.73	0.97	0.50
mash	0.61			0.70
Mustard	0.84		0.69	0.75
Spices (chilli)	1.60	1.89	1.86	4.00
Veg. (brinjal)	8.06		7.17	8.00

Note (1) BBS and DAE potato yields are for HYV and local varieties and not by irrigation status.

TABLE J.2.11

Comparison of Yield Data From different Sources

Tonns per hectare (rice as paddy)	Farmer survey	FAP 12 (MDIP)		BBS avg. 1989-91	Used in crop budgets
		project	outside		
B Aus, local	1.69	2.08	2.04	1.57	1.6
B Aus, HYB	2.6	3.59		-	2.4
T Aus, local	2.25	2.99		2.98	2.4
T Aus, HYV	2.88	4.22		2.30	2.85
Mixed aus/aman	2.29	1.71	1.14	-	2.30
B Aman local d.w.	1.56	1.87	2.04	1.71	1.6
T Aman, local d.w.	2.14			-	2.10
TAman, local	2.14	3.31	1.29	2.00	2.10
TAman, HYV	2.90	4.66	2.8	2.63	3.55
Boro, local	1.42	3.15		2.13	2.80
Boro, HYV	5.08	5.04	4.47	4.17	5.0
Wheat irrigated	1.38	1.92	1.98	-	2.25
Wheat unirrigated	1.29	1.96	1.98	1.27	1.80
Potato irrigated	24.25	9.52	17.38	10.28	15.00
Potato unirrigated	11.96	9.52	17.38	7.65	11.00
Jute	1.94	1.26	1.02	1.72	1.90
Pulses: keshari	0.57		0.9	0.61	0.70
mung	0.62		0.9	1.31	0.60
musur	0.59		0.9	0.97	0.50
mash	0.61		0.9	-	0.70
Mustard	0.84	0.74	0.49	0.69	0.75
Spicdes (chilli)	1.60	1.21	0.58	1.86	4.00
Veg. (brinjal)	8.01			7.17	8.00

For the purposes of the economic analysis, it has been assumed that for a given crop a single yield value (and level of inputs) is applicable in both the without and with project conditions. The yield figures used have been assumed to allow for normal levels of crop damage due to flooding. Differences in yields between the with and without project cases have been assumed only in cases where flood protection would cause a reduction in the average annual level of crop damage and which are accounted for separately.

Similarly no difference is assumed between present and future yields (with and without the project). There is no evidence that there is an upward trend in the yields of individual crops. Analysis of BBS statistics by IFDC[1] indicate that although hyv boro yields rose by 0.3% per year from 1973 to 1979, they then declined by 0.4% per year up to 1989, despite increased use of fertiliser. This is attributed to an increasing proportion of the expanding area being grown under less suitable conditions. Boro yields are best on heavy soils and these areas were the first to be cultivated with the crop. As boro expands it has in turn pushed wheat, pulses and oilseeds on to more marginal land so their yields have also suffered. Analysis of data on hyv aman paddy IFDC[2] shows an annual yield decline from 1972 to 1988 of 0.5%. Analysis of yields reported by BBS for the region shows a pattern of static yields for major crops over the last six years (see Agriculture Annex). Static and declining yields are also attributed to increasing cropping intensity, reduced flooding (which may add organic matter to the soil, reduced production of pulses and use of animal manure) both of which improve soil structure and fertility.

This approach, both for with and without project, and present and future yields, is consistent with the FPCO Guidelines for Project Appraisal.

J.2.10 Crop Budgets

Net economic and financial returns to each of the crops included in the analysis are presented in Table J.2.12. The budgets show that in economic prices the crops which show the highest returns (excluding irrigation costs which are charged separately in the economic analysis) are the high value ones such as vegetables and spices, which are likely to be restricted by market constraints, and boro, HYV aman, HYV aus and to a lesser extent irrigated wheat. At financial prices returns per hectare are much reduced but as crop ranking is unchanged there is unlikely to be a conflict between farmers' wishes and the national interest. The budget for boro clearly illustrates why farmers are so keen to grow the crop and why minor irrigation has expanded so rapidly in areas with access to surface or groundwater.

Financial returns per hectare for each farm size category are presented in Table J.2.13 (whilst it is appreciated that per hectare returns for each farm size category are meaningless, it does enable comparisons to be made) These differ from the financial budgets in Table J.2.12 in that only cash costs are included. In these budgets net returns are determined by how much labour is provided by the farmers' family which decreases with farm size as a percentage of the total on one hand and what proportion of land preparation costs have to be purchased, which increases with farm size, on the other. Analysis of the farmers' and case study surveys suggests that farmers hire labour and draught power in the following proportions (of the total requirement)

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[1] Farm Level Fertiliser Use Survey, 1990/1 Rabi/Boro Season, I Jahan, K Sanyal, IFDC, 1993

[2] Farm Level Fertiliser Use Survey, 1989 Aman Season, Sidhu and Ahan, IFDC 1991

TABLE J.2.12

Gross Income, Costs and Net Income per Hectare (Taka)

1992 Financial Prices

Crop	Gross Income: Main Crop	Gross Income: By-Product	Gross Income: Total	Production Costs: Labour	Draught	Seed	Irrig.	Fert.& Pest.	Total	Net Income
B Aus, local	9872	1600	11472	5917	2565	787		769	11041	431
B Aus, HYV	14808	1200	16008	6192	2565	787		950	11543	4465
T Aus, local	14808	2400	17208	6622	2679	278		950	11581	5627
T Aus, HYV irri	20053	1625	21678	7633	2679	278	2185	1539	15744	5933
T Aus, HYV n-ir	17585	1425	19010	7461	2679	278		1539	13152	5858
Mixed aus/aman	15686	1150	16836	7108	2508	930		790	12470	4366
B Aman local dw	11952	800	12752	4627	2508	930		275	9175	3577
T Aman local dw	14940	1000	15940	5590	2280	493		538	9792	6148
T Aman, local	15687	2100	17787	6063	2280	493		913	10724	7063
T Aman HYV irri	28013	1875	29888	7289	2451	336	1639	2070	15163	14724
T Aman HYV n-ir	26518	1775	28293	7117	2451	336		2070	13171	15122
Boro, local	17332	2800	20132	5074	1425	371	3355	631	11942	8190
Boro, HYV irrig	30950	2500	33450	9030	2451	278	6710	2775	23369	10081
Boro HYV p-irr.	27855	2250	30105	8815	2451	278	6679	2775	23099	7006
Wheat irrig.	16155	1125	17280	5461	2565	1404	3460	1580	15917	1363
Wheat unirrig.	12924	900	13824	4369	2565	1404		1125	10409	3415
Potato irrig.	62400	0	62400	8342	2508	10000	4734	6050	34796	27604
Potato unirrig.	41600	0	41600	7525	2508	10000		5550	28141	13459
Jute	14573	4218	18791	9224	2565	198		1243	14552	4239
Pulses: ave.	9211	1015	10226	2169	1710	744		0	5085	5141
Mustard	9953	173	10125	2473	2109	190		2669	8184	1941
Spices (chilli)	33600	0	33600	6751	1710	600		2796	13042	20558
Veg. (brinjal)	30320	0	30320	11610	2508	175		1672	17561	12759
Economic prices										
B Aus, local	8687	1392	10079	4128	1566	693		872	7985	2094
B Aus, HYV	13031	1044	14075	4320	1566	693		1098	8444	5631
T Aus, local	13031	2088	15119	4620	1636	244		1098	8358	6761
T Aus, HYV irri	17646	1414	19060	5325	1636	244		1751	9852	9208
T Aus, HYV n-ir	15474	1240	16714	5205	1636	244		1751	9720	6994
Mixed aus/aman	13288	1000	15088	4959	1531	763		959	9033	6055
B Aman local dw	9800	696	10496	3228	1531	763		293	6396	4100
T Aman local dw	12250	870	13120	3900	1392	404		588	6912	6207
T Aman, local	12862	1827	14689	4230	1392	404		1083	7821	6869
T Aman HYV irri	22968	1631	24599	5085	1496	276		2341	10118	14482
T Aman HYV n-ir	21743	1544	23287	4965	1496	276		2341	9986	13302
Boro, local	14513	2436	16949	3540	870	311		708	5972	10977
Boro, HYV irrig	25916	2175	28091	6300	1496	233		3279	12440	15651
Boro HYV p-irr.	23324	1958	25282	6150	1496	233		3279	12275	13007
Wheat irrig.	21157	979	22136	3810	1566	1835		1918	10041	12095
Wheat unirrig.	16926	783	17709	3048	1566	1835		1339	8566	9143
Potato irrig.	53375	0	53375	5820	1531	8265		7033	24914	28461
Potato unirrig.	35583	0	35583	5250	1531	8265		6598	23808	11775
Jute	15991	3670	19661	6435	1566	210		1494	10676	8985
Pulses: ave.	8074	883	8957	1513	1044	647		0	3525	5432
Mustard	9194	150	9344	1725	1288	167		3252	7075	2269
Spices (chilli)	26587	0	26587	4710	1044	522		3488	10740	15847
Veg. (brinjal)	25961	0	25961	8100	1531	174		1914	12891	13069

Calculation of wieghted average for pulse budget — NOAKALI

	Total area of sampled plots in farmer surveys (ha.)	%	Percent weight	Market price Tk/kg 1991	Tk/kg 1992	Yield t/ha
Keshari (lathyrus)	9.63	54.7%	67.3%	12.63	12.31	0.70
Masur (lentil)	0.32	1.8%				
Chola (chick pea)	0.65	3.7%				
Mung (greem gram)	3.27	18.6%	22.8%	17.62	17.05	0.60
Mash (black gram)	1.41	8.0%	9.8%	12.11	14.57	0.70
Barbati (cowpea)	0.00	0.0%				
Other pulses	2.33	13.2%				
Total	17.61	100.0%	100.0% weighted ave.	13.71	13.61	0.68

TABLE J.2.13

Financial Crop Budgets

Crop	Marginal Farmers Labour & power	Others	Cash Costs	Interest	Miscellaneous Costs	Total Costs	Return per ha	Return per day	Small Farmers Labour & power	Others	Cash Costs	Interest	Miscellaneous Costs	Total Costs	Return per ha	Return per day
B Aus, local	3890	926	4816	0	482	5297	6175	64	5425	926	6351	0	635	6987	4485	70
B Aus, HYV	3908	1107	5015	0	502	5517	10491	102	5557	1107	6664	0	666	7330	8678	127
T Aus, local	4092	1005	5097	0	510	5607	11601	105	5721	1005	6726	0	673	7399	9809	128
T Aus, HYV irri	4159	3779	7938	0	794	8732	12946	97	7094	3779	10873	0	1087	11961	9717	128
T Aus, HYV n−ir	4147	1594	5742	0	574	6316	12694	98	6994	1594	8588	0	859	9447	9563	129
Mixed aus/aman	3891	976	4867	0	487	5353	11483	93	6961	976	7937	0	794	8731	8105	125
B Aman local dw	3726	461	4188	0	419	4607	8145	118	5383	461	5844	0	584	6428	6324	182
T Aman local dw	3479	637	4116	0	412	4528	11412	123	5046	637	5683	0	568	6252	9688	159
T Aman, local	3511	1012	4522	0	452	4975	12812	124	5278	1012	6290	0	629	6919	10868	160
T Aman HYV irri	3825	3776	7601	0	760	8361	21526	168	6933	3776	10709	0	1071	11780	18108	263
T Aman HYV n−i	3814	2137	5951	0	595	6546	21747	175	6826	2137	8963	0	896	9859	18434	276
Boro, local	2279	4060	6340	0	634	6974	13158	141	4178	4060	8239	0	824	9062	11070	194
Boro, HYV irrig	3940	9541	13482	0	1348	14830	18620	112	8462	9541	18003	0	1800	19804	13646	165
Boro HYV p−irr.	3926	9510	13436	0	1344	14780	15325	95	8317	9510	17827	0	1783	19609	10496	131
Wheat irrig.	3859	5321	9180	0	918	10098	7182	83	5398	5321	10719	0	1072	11791	5489	101
Wheat unirrig.	3787	1405	5192	0	519	5712	8112	130	4833	1405	6239	0	624	6863	6961	179
Potato irrig.	3973	12783	16756	0	1676	18431	43969	291	7136	12783	19919	0	1992	21911	40489	448
Potato unirrig.	3918	7550	11468	0	1147	12615	28985	218	6681	7550	14230	0	1423	15653	25947	327
Jute	4109	1282	5391	0	539	5930	12861	76	7343	1282	8625	0	863	9488	9303	86
Pulses: ave.	2475	149	2624	0	262	2887	7339	292	2246	149	2395	0	239	2634	7592	295
Mustard	3040	2707	5746	0	575	6321	3804	144	2989	2707	5696	0	570	6266	3859	166
Spices (chilli)	2779	2916	5695	0	569	6264	27336	216	5290	2916	8206	0	821	9026	24574	311
Veg. (brinjal)	4189	1707	5896	0	590	6485	23835	107	7214	1707	8920	0	892	9812	20508	124

Crop	Medium Farmers Labour & power	Others	Cash Costs	Interest	Miscellaneous Costs	Total Costs	Return per ha	Return per day	Large Farmers Labour & power	Others	Cash Costs	Interest	Miscellaneous Costs	Total Costs	Return per ha	Return per day
B Aus, local	5762	926	6688	0	669	7356	4116	77	6793	926	7719	0	772	8491	2981	104
B Aus, HYV	5959	1107	7066	0	707	7772	8236	147	7121	1107	8228	0	823	9051	6957	238
T Aus, local	6110	1005	7116	0	712	7827	9381	146	7622	1005	8628	0	863	9491	7717	250
T Aus, HYV irri	8114	3779	11893	0	1189	13083	8595	164	8828	3779	12607	0	1261	13868	7810	235
T Aus, HYV n−ir	7964	1594	9558	0	956	10514	8496	166	8623	1594	10217	0	1022	11239	7771	236
Mixed aus/aman	8055	976	9031	0	903	9934	6902	171	8220	976	9196	0	920	10115	6721	216
B Aman local dw	5687	461	6149	0	615	6763	5989	249	5260	461	5721	0	572	6293	6459	255
T Aman local dw	5453	637	6090	0	609	6699	9241	188	6433	637	7070	0	707	7777	8163	312
T Aman, local	5800	1012	6812	0	681	7494	10293	191	6997	1012	8009	0	801	8810	8977	329
T Aman HYV irri	8072	3776	11848	0	1185	13032	16855	385	8441	3776	12217	0	1222	13439	16449	528
T Aman HYV n−i	7911	2137	10048	0	1005	11053	17240	405	8236	2137	10373	0	1037	11411	16883	549
Boro, local	4932	4060	8993	0	899	9892	10240	252	5906	4060	9966	0	997	10963	9169	457
Boro, HYV irrig	10345	9541	19886	0	1989	21875	11575	261	10519	9541	20060	0	2006	22066	11384	324
Boro HYV p−irr.	10127	9510	19637	0	1964	21601	8504	197	10262	9510	19772	0	1977	21750	8355	241
Wheat irrig.	5705	5321	11025	0	1103	12128	5152	118	6249	5321	11570	0	1157	12727	4553	165
Wheat unirrig.	4858	1405	6263	0	626	6889	6935	210	4946	1405	6351	0	635	6987	6837	273
Potato irrig.	8348	12783	21131	0	2113	23245	39155	614	9692	12783	22475	0	2248	24723	37677	1111
Potato unirrig.	7666	7550	15216	0	1522	16737	24863	438	8717	7550	16267	0	1627	17894	23706	740
Jute	8622	1282	9904	0	990	10895	7896	99	10738	1282	12020	0	1202	13222	5569	153
Pulses: ave.	1867	149	2016	0	202	2218	8008	278	2411	149	2559	0	256	2815	7411	496
Mustard	2587	2707	5294	0	529	5824	4301	167	2731	2707	5438	0	544	5982	4143	231
Spices (chilli)	6337	2916	9252	0	925	10177	23423	411	7877	2916	10792	0	1079	11872	21728	849
Veg. (brinjal)	8528	1707	10235	0	1024	11259	19061	139	13591	1707	15298	0	1530	16827	13493	325

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Farm size	Marginal	Small	Medium	Large
Draught power	0.8	0.65	0.49	0.3
Labour	0.05	0.40	0.75	0.9

Neither financial or economic crop budgets have included any allowances for interest charges on seasonal credit as the farm surveys (case studies) clearly indicated that very few farmers borrow from either informal or formal sources for this purpose. In addition the 10% allowance included for miscellaneous costs in accordance with FPCO guidelines is sufficient to cover the small amount of credit that farmers do require.

Models for Analysis of Incremental Crop Production cropping patterns have been developed for each option and zone within the project area using the methodology described above. Net crop income (excluding on farm irrigation costs) has been calculated for the areas of each crop grown in the present, future without and future with project situations by multiplying areas and net economic returns per hectare. The analysis has been carried out for the following cases :

1) Present (1992 in 1991 prices)

2) Future without (1) : without project conditions in the year in which full benefits would have been achieved in the with project case, generally taken to be year 10.

3) Future without (2): without project conditions in Year 30 (the final year of the analysis period).

4) Future with (1): with project conditions in Year 10

5) Future with (2): with project conditions in Year 30

On farm irrigation costs are calculated on the basis of predicted proportions by mode (ie STW, LLP etc) of irrigation.

J.2.11 Phasing of Incremental Benefits

Incremental benefits are phased to reach their maximum 5 years after project completion in line with FPCO recommendations.

J.2.12 Methodology for Estimating Impacts on Fisheries

The main potential impacts of FCD and FCDI projects on fisheries can be summarised as follows :

Negative impacts

(i) Construction of flood control embankments and/or drainage works reduces the area of floodplain available for fish spawning, nursery and feeding grounds, reducing overall fish production potential both within and outside the FCD area. Within the area, this affects not only the capture fishery but also pond culture fishery, which depends partly on the collection of fish fry from the wild.

(ii) Construction of regulators or cross dams on rivers prevents migration of fish to and from breeding grounds, resulting in reduced stocks of affected species both within and outside specific project areas; within FCD areas, the result will be a change in the species composition, with the migratory species (principally higher value carp and prawns) being displaced by resident (generally lower value)fish species.

(iii) Access to the reduced areas of open waters within FCD schemes for the purpose of 'subsistence' fishing may be restricted, with deterimental consequences for nutrition, particularly of the poorest sections of the community who obtain a significant part of their animal protein and vitamin intake from fish caught in 'common property' waters.

(iv) Increased use of chemical fertilisers and pesticides, resulting mainly from the extension of the area of irrigated high yielding crop varieties within flood controlled areas, accelerates the contamination of natural water bodies and may lead to higher fish mortality rates.

(v) Reductions in fish stocks endangers the livelihood of professional full time fishermen, who may be obliged either to emigrate from the area or to seek employment as unskilled labourers.

Positive impacts

(vi) Improved water control reduces the risk of loss of stocks in fish ponds due to flooding, and may thereby encourage a more rapid development of fish farming, subject to availability of fish and/or shrimp fry - see (i) above. Benefits will, however, accrue mainly to land owners with adequate areas for fish ponds rather than to displaced capture fishermen or other poorer groups.

(vii) Improved control similarly improves the prospective returns from stocking and management of fish production in other water bodies such as canals and borrow pits.

Quantification of any of these impacts is subject to a high degree of uncertainty, due to:

- an absence of reliable data on current fish resources (species composition, standing stocks, etc.)
- inadequate information on present fish catches (quantities by species from different water bodies) and past trends in catches.

- limited data on catch rates achieved by different categories of fishermen (full-time, part-time or subsistence).

- inadequate information on the numbers, locations, status (cultivated or uncultivated) and yields of ponds.

- limited experience of the actual impacts of FCD schemes on the fisheries resource.

Impacts on Capture Fisheries Production

Losses of output of capture fisheries are assumed to be caused by:

- obstruction of fish migration and spawn by the construction of embankments and regulators

- reduction in the area of flood plains and in the duration of flooding

Reducing the area of flood plain is assumed to result in a straightforward decline in their productivity in direct proportion to their loss. Obstructing migration of fish and spawn is also expected to result in a change of the catch composition with substantial losses of the higher value fish species which are generally migratory.

To assess the economic impact of FCD it is necessary to:

- value the catch in terms of potential sales by fishermen.

- calculate the cost of catching in terms of gear cost and fishermen's time

1992 was an exceptionally dry year in Noakhali and the prices collected in the fish market survey are probably unrepresentative. Indeed it was so untypical a year that the evaluation of fisheries losses was not based on the catch surveys done in 1992 alone because there was very little floodplain to evaluate. As the object of the exercise is to account for floodplain losses within the economic analysis, it did not seem sensible to use market prices collected for a year which was sufficiently extreme to be rejected as "normal" in terms of catch. As a result market prices collected by the Gumti study have been used as it is felt that these reflect the composition and prices of floodplain capture fisheries more accurately.

Surveys by FAP 17 show that fishermen receive about 69% of the market prices for fish. Surveys in the project area collected the following data on fish catch and market prices which are corrected to fishermens' prices by deducting 31%.

	Tonnage	**Market Price**	**Fishermens' Price**
High value fish	3825	Tk 58 / kg	40.02
Medium value fish	4443	Tk 39 / kg	26.91
Low value fish	12037	Tk 27 / kg	18.63
	20305	Weighted average 24.5	

The cost of catching has been estimated as Tk 30 for one day of labour plus Tk 10 per day for gear with a daily catch of 3 kg. In fact most fishermen are self employed and the Tk 30 represents a low season agricultural wage (being lower than the Tk 43 used in crop budgets). It could be argued that a lower figure than Tk 30 should be used as fishermen have few alternative sources of income but it could also be said that a catch of 3 kg per day is on the high side. A catch of 2 kg and a wage of Tk 20 per day would result in a similar cost per kg of fish. As the yield potential of the flood plain falls, the amount of time needed to catch the remaining fish will increase; daily catches will decline and costs per kg fish caught will rise.

The net value of fisheries has been calculated as the ex-boat production value less the cost of catching. This has been converted into economic prices using the SCF of 0.87 for fish and gear, and labour conversion factor of 0.75. The net value of the fishery can fall below zero if average daily catches are worth less than the Tk 30 nominal wage plus Tk 10 gear cost - in this case fishermens' income falls below Tk 30. Losses of net benefits from the more productive fisheries will be split between fishermen and lessors of jalmahals, (controlled fishing grounds) who will be able to extract less rent from fishermen to the point where it is no longer worthwhile to enforce their fishing rights.

At economic prices the net value of fish after deducting catching costs declines rapidly as both catching costs increase and the proportion of high value fish is reduced.

Assuming a catch of 3 kg per day catching costs at economic prices are Tk 10.4 / kg. With a catch of 2.5 kg/day, catching costs increase to Tk 12.4 per kg. Thus the net value of fish is calculated as follows:

Financial Price Tk/kg	**Economic Price Tk/kg**	**Catch per day kg**	**Net Value Tk/kg**
24.5	21.32	3	10.92
24.5	21.32	2.5	8.92

J.2.13 Estimates of Flood Damage.

Flood damage in the project area is caused by excessive rainfall and poor drainage, and is only indirectly related to water levels in the River Meghna. Both of the floods in 1987 and 1988 resulted from exceptionally high rainfall, but were of significantly lower severity than in most other parts of the country where flooding is directly "river related" In 1987 extremely high rainfall was the primary cause of flooding whereas in 1988 when rainfall was less heavy, drainage of the area was impeded by high river levels in the Meghna.Both the 1987 and the 1988 floods in the project area have return periods based on peak water levels of one in ten years whereas elsewhere the nation was experiencing very high floods with return periods of between one in twenty and one in fifty or even one in a hundred years.

The impact of improved drainage by the project on flooding depths in Zones B and C is substantial (see Annex B) and should reduce maximum flooding depths to below current 1 in 5 return period depths in a "future with" project 1 in 50 year flood, with peak depths falling by up to 75 cms. In Zones A and D the impact of improved drainage is less dramatic. Zone A is nearly all highland (90% Fo) and does not benefit as significantly because peak flooding depths are only reduced by 25 cms in a 1 in 50 year flood. Zone D is located further away from the Ramatkhali regulator, where the effect of improved drainage through the regulator is diminished both by the distance and by the characteristic of flow in the major drains carrying water to the regulator. Thus for the purposes of the economic analysis, only Zones B and C are included within areas which are expected to benefit from reduced flood damage.

Reduced Crop Damage.

Crop damage statistics were collected from DAE and BBS thana offices for the years 1987/88 to 1991/92. Damage estimates are expressed as areas of crop which are completely destroyed and are an amalgamation of totally and partially destroyed crop areas, where partially damaged areas are converted into totally destroyed areas by estimating the extent of damage in the partially damaged areas. Percentage areas of the crop destroyed can consequently be calculated.

There is considerable divergence between DAE and BBS figures and as a result the two sets of data have been averaged. As 1987 are 1988 were approximately equivalent to 1 in 10 year floods, figures for two these years were also averaged. Estimates of flood damage to crops for a larger flood than a 1 in 10 were obtained by selecting the worst year possible for Greater Noakhali District as published in BBS Agricultural Yearbooks. This turned out to be 1974 which was interesting as it coincided with the ranking of years produced by the hydro-dynamic model. If damage caused by the 1991 cyclone is excluded, very little damage is reported other than for the years 1987 and 1988 and as a consequence it has been assumed that there is no damage in a one in five wet year. The calculation of annual expectations of loss is presented in Table J.2.14 and is based on the area under the curve from points given in the table in accordance with FPCO guidelines except that losses are calculated as percentage areas of crops and these are converted to financial and economic costs in the economic analysis model. As explained in the previous paragraphs these losses would be eliminated in zones B and C by the proposed project.

TABLE J.2.14

Crop Losses Due to Flooding

Crop	Return Period	1;7	1.:10	1:50	Annual Expected Loss (%)
		0.85	0.9	0.98	
Zone B	Aus LV	0	4	66	2.9
	Aus HYV	0	3.5	71	3.1
	B. Aman	0	3.4	71	3.1
	T. Aman	0	3.4	25	1.2
Zone C	Aus LV	0	2.6	66	2.8
	Aus HYV	0	0	71	2.8
	B. Aman	0	7.5	71	3.3
	T. Aman	0	4.9	25	1.3

Non Crop Flood Damage.

All damage calculations have been calculated as annual values using damage areas as per FPCO guidelines but derived as described in the following paragraphs.

Infrastructure.

Damage estimates caused by flooding to roads, schools, and other Government property were collected from thana engineering offices for the years 1987/88 to 1991/92. These were highly unsatisfactory in the sense that the figures provided were massively inflated, a practice which in the view of one thana engineer is nowdays nearly universal.

As a result, cost estimates were reviewed by the project architect and engineers and reduced substantially. At first sight many of the estimates look odd as many thanas report large damages in 1987 and none in 1988 or vice versa. However it later transpired that roads repaired after the 1987 flood usually survived the 1988 flood whereas those which were not repaired in the 1987 flood, virtually disintegrated in 1988. As estimates of damage for a 1 in 10 year flood were obtained by averaging the 1987 and 1988 figures this did not give rise to any difficulties. Estimates of the damage done in a 1 in 50 year flood are unobtainable and consequently an estimate based on the multiple between a one in ten and one in fifty year flood for non crop damage in the FAP 2 study has been used. Surprisingly the factor is only 1.65. While this method is unsatisfactory it nevertheless has been used both because there is no alternative and because it is more likely to underestimate the damage than otherwise.

The results expressed as annual expected repair costs are (in financial prices) Tk 287 704 (Tk 14 per ha of NCA) for Zone B and Tk 434 939 (Tk 20 per ha of NCA) for Zone C.

Housing and Livestock

Damage statistics for the years 1988 to 1991 were collected by the farmers and landless surveys for both housing and livestock losses. Unlike those collected during the Gumti surveys, these results were hardly credible, and indeed were so proved by a comparison of peak water depths for 1988 with village heights in the sample squares, which clearly demonstrated that in most cases only minor damage was likely to have occurred other than in very low lying areas. As a result both housing damage and livestock losses were downgraded. In the case of housing the more reasonable figures, ie those provided in Zone C by farmers, were adopted but even these had to be adjusted. The problem is that the damage estimates (which are presented in the Appendices to the Agriculture Annex) refer to only a 1 in 10 year flood and consequently produce unrealistic costs if even greater costs are assumed for a one in fifty year event. As a result the estimates were amended by reducing the one in ten year event by a factor of 2.5. and assuming that the one in fifty event was 1.65 times worse. Costs of repairs to housing are based on the Jamalpur Priority project flood proofing component which estimated the total cost of floodproofing a house at Tk 10 000 (in financial prices). For the purposes of this study, only those items which are expected to be destroyed in a flood have been included and these (including labour for reconstruction) sum to Tk 4000. Assuming that half of all houses have completed 50% of their expected life and that a 20% quality discount is appropriate, an overall cost of repairing a "destroyed" house is Tk 1600. Costs of repairing "major damage" are estimated at Tk 1000 per house and "minor damage" Tk 200 per house.

per year in Zone C, which is Tk 57 per ha of NCA per year. Using a similar set of adjustments for livestock an annual cost in lost stock of Tk 300 000 was estimated which is Tk 14 per ha of NCA per year.

Given the very wide confidence limits attached to these estimates, care has been taken to subject the analysis to a wide range of sensitivity tests so that their relative importance (which should not be great) can be properly assessed.

Fish Ponds.

Damage statistics for fish pond losses were collected during the survey of fishfarmers for the period 1988/89 to 1991/92. Very high losses were reported for 1988/89 which averaged 65% of production, which for a 1 in 10 year flood seems unlikely. Given the very high production from fish ponds in Zones B (4387 tonnes per year) and C (4446 tonnes per year) a six to seven per cent annual loss, valued at Tk 35 per kg (Tk 40 less Tk 5 per kg for catching) gives annual losses of Tk 10 million per year (which is Tk 500 per ha of NCA) and is clearly an overestimate. Much of the reported loss from fish ponds is caused by floods overtopping the banks which allows the fish to escape. As these losses could be avoided by building a bamboo fence on top of the embankment around the pond it has been assumed that in future only losses resulting from damage to the embankments themselves will be included. This reduces losses to 55% of production in 1988 which is still excessive.

As a result this was reduced by factor of 2.5 and a multiple of 1.65 applied to obtain the one in fifty year event, giving an overall annual expected loss of 3% per year which translated into Tk 4.7 million per year in Zone C or Tk 221 per ha of NCA per year. While this seems high, it should be remembered that the production of over 4000 tonnes per year is also very high (133 tonnes lost annually out of a total of 4446 tonnes).

CHAPTER J.3

PROJECT OUTLINE

J.3.1 Background

The Noakhali North Drainage and Irrigation Project was identified during the preparation of the South East Regional Study's Draft Regional Plan.

The project was approved for feasibility study in August 1992 by GOB and by the donor and executing agencies.

The project may generally be described as a sub-regional drainage project with substantial additional irrigation benefits.

The nature of the drainage element of the project precludes drawing well defined boundaries to the likely benefited areas but the primary areas of influence and the project proposals are defined on Figure J.4.1. This shows the northern boundary as the Dakatia river. The eastern boundary as the Dakatia to Begumganj railway and then east to the divide between the Little Feni and Noakhali khal basins. The southern boundary largely follows the old coastal embankment but in the west the line has been taken to include the extreme northern parts of polder 58/2A. The western boundary comprises the Meghna left embankments in the southern parts and the Chandpur Irrigation Project eastern embankment up to the Dakatia river.

J.3.2 Project Objectives

The principle problems of the area are long duration congested drainage in the monsoon period and extreme shortages of water for irrigation in the dry season.

These drainage problems steadily worsened during the 1960's and early 1970's as new lands accreted to the south and fresh water for irrigation has always been a problem for much of the area.

The project objectives are, as far as possible, to improve drainage conditions in the severely flooded Begumganj depression and its surrounding areas and at the same time to maximise the irrigation area which can be supplied from the Lower Meghna by gravity supplies.

J.3.3 Project Concept

The project seeks to build on the works carried out in the early 1970's under the Noakhali Comprehensive Drainage Scheme by deepening and widening the main khal system and also by enlarging the Rahamatkhali regulator.

The design of the scheme is based on a completely free flowing "natural" drainage system so that there is minimal opportunity for obstruction and mal-operation.

At the same time care has been taken to ensure that improvements in drainage are balanced so that no area suffers higher water levels as a result of improvements elsewhere .

The scheme is also designed to overcome a number of subsidiary problems in the area. Improved drainage is principally achieved through lower water levels. These lower levels are achieved by flatening water gradients. In turn this tents to produce lower channel velocities which reduces bank erosion.

In addition to the improvement of the main khal system further improvements are proposed in the larger secondary khals to provide a more comprehensive drainage system which spreads the drainage benefits wider within the project area.

Also the proposed scheme will allow Meghna water into the khal system during the dry season on a massively increased scale to provide greatly increased areas of irrigation. Once again the absence of intermediate structures in the system is an essential element in the design. The khal system will operate as a tidal storage system allowing maximum water entry and the widest distribution possible.

This dual free drainage and irrigation system removes the need for the construction of cross-dams in the main system. Indeed construction of such dams would merely impede both drainage and irrigation and thus no benefits would accrue to the builder.

J.3.4 Scheme Operation

The entire scheme will operate automatically without power requirements and only minimal operation activities are required on a seasonal basis at the regulator. This seasonal operation would be arranged to provide unrestricted access for fish during April and May up until risng Meghna levels require the closure of the drainage flaps. The design of the flaps has also been arranged to provide better acess for fish for the remainder of the monsoon season.

CHAPTER J.4

SOURCES OF AGRICULTURAL BENEFITS

J.4.1 Introduction

The sources of agricultural benefit in the Noakhali North Project are:

- increased boro cultivation in the dry season
- increased T. aman cultivation in the wet season due to improved drainage.

J.4.2 Increased Boro Cultivation

The project anticipates supplying an area of 29 000 hectares with irrigation water through increased flows in the re-excavated and deepened khal network. It is estimated that nearly 9500 hectares, within the area to receive improved supplies, are already irrigated, which allows the project an incremental area of 19500 hectares. It is not expected that farmers will be slow in making use of increased supplies because boro is generally held to be one of the more profitable crops which also is less likely to be attacked by pests and diseases in the dry season. In Noakhali Project Area it is also the only crop for which land owners who rent out land (i.e. sharecrop) are prepared to finance a part of the cost of the inputs, notably fertiliser and irrigation. It is thus unlikely that farmers will be unwilling to cultivate boro in the same way as many farmers are unwilling to grow HYV aman.

J.4.3 Increased Areas of T. Aman

A distinguishing feature of Zones A B and C in Noakhali Project Area is the intensity at which farmers cultivate locally transplanted aman. In Zones B and C, areas of the crop planted at present substantially exceed the model predictions of safely plantable areas in a 1 in 5 wet year. Thus while farmers do appear to show some reluctance in growing HYV aman, they go to the opposite extreme in their attitudes to LT aman and are expected to expand the area of LT aman quite rapidly. Farmers are more likely to adopt a cautious approach to HYV aman, and this is reflected in the cropping patterns (This was discussed in section J.2.7). In addition the sensitivity of the project to lower than expected adoption of HYV aman is tested. An amalgamated cropping pattern (Zones A+B+C+D) is presented in Table J.4.1).

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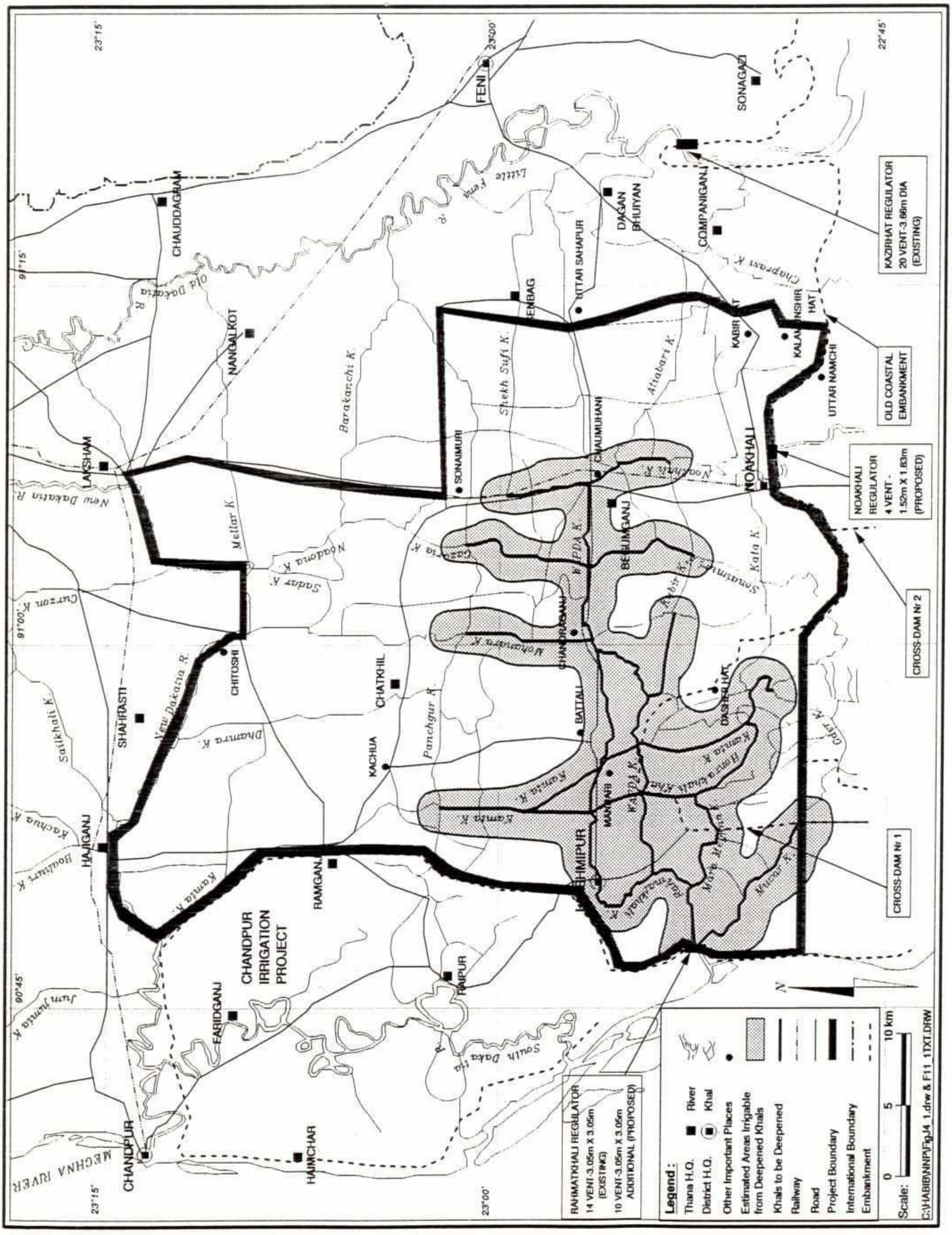
TABLE J.4.1

Summary of Cropping Pattern Changes

(% of NCA)

	Future Without Project	Future With Project
B Aus, local	10.8%	8.0%
B Aus, HYV	4.6%	4.6%
T Aus, local	3.6%	3.2%
T Aus, HYV irri	0.3%	0.4%
T Aus, HYV n-ir	8.4%	8.2%
Mixed aus/aman	7.6%	5/6%
B Aman local dw	26.3%	19.6%
T Aman local dw	4.5%	4.0%
T Aman, local	32.2%	39.6
T Aman HYV irri	0.0%	0.0%
T Aman HYV n-ir	5.7%	12.7%
Boro, local	0.0%	0.0%
Boro, HYV irrig	46.0%	63.0%
Boro HYV p-irr	0.0%	0.0%
Wheat irrig.	0.0%	0.0%
Wheat unirrig.	0.1%	0.1%
Potato irrig.	0.1%	0.1%
Potato unirrig.	0.2%	0.2%
Jute	0.7%	0.0%
Pulses:ave.	8.9%	8.5%
Mustard	2.1%	1.7%
Spices (chilli)	3.2%	3.2%
Veg. (brinjal)	0.8%	0.8%
Total	166.3%	183.5%

Figure J.4.1
Proposed Intervention



CHAPTER J.5

PROJECT COSTS

Capital costs of the project are presented in Tables J.5.1 and J.5.2.

Table J.5.1 presents costs which include the purchase of land for the disposal of spoil from the excavated khals whereas Table J.5.2 presents costs for an alternative in which land is rented from farmers for one season and the spoil spread on those lands, rasing them approximately 30 cms. The latter option also includes a once only fertiliser allowance of 150 kg/ha to compensate farmers for any reduced in fertility which the spoil may temporarily cause.

Table J.5.3 presents both financial and economic costs for both capital and O&M cost.

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TABLE J.5.1

Bill of Quantities for Noakhali North Project
Land Acquisition for Disposal of Spoil

Sl No	Description	Unit	Rate	Quantity	Amount (Tk. Mil.)	Implementation Year				
						1	2	3	4	5
1	Modification of Existing	Nr	L.S.	1	20.50	–	5.00	10.00	5.50	–
	14 Vent Rahmatkhali Regulator									
2	New 10 Vent Rahmatkhali Regulator	Nr	L.S.	1	69.20	–	15.00	35.00	19.20	–
3	New 4 Vent Noakhali regulator	Nr	L.S.	1	5.92	–	–	5.92		–
4	Modification of Existing Bridges									
	a) Modification of Structures	Nr	L.S.	1	7.49	–	–	3.74	3.75	–
	on WAPDA/Rahmatkhali Khal									
	b) Scour Protection of Bridge Piers	Nr	L.S.	1	3.30	–	–	1.65	1.65	–
	c) Modification/Reconstruction									
	of Bridges on Minor Khals	Nr	L.S.	1	7.14	–	–	3.57	3.57	–
5	Dredging Rahmatkhali & WAPDA Khal	cu.m	50.0	7388393	369.42	–	36.82	138.80	138.80	55.00
6	Manual Excavation Rahmatkhali	cu.m	39.5	2340206	92.44	–	–	–	46.22	46.22
	& WAPDA Khal									
7	Khal Bank Protection	m	18000.0	1850	33.30	–	–	–	16.00	17.30
8	Manual Excavation of Minor Khals									
	(115 Km)									
	a) Noakhali Khal	cu.m	31.0	229026	7.10	–	–	–	3.00	4.10
	b) Sonaimuri Khal	cu.m	31.0	631608	19.58	–	–	–	10.00	9.58
	c) Mohandra Khal	cu.m	31.0	509238	15.79	–	–	5.79	5.00	5.00
	d) Honrakhali Khal	cu.m	31.0	195411	6.06	–	–	3.06	3.00	–
	e) Marameghna Khal	cu.m	31.0	169795	5.26	–	–	2.00	3.26	–
	f) Khal No 28	cu.m	31.0	99154	3.07	–	–	3.07	–	–
	g) Kamta Khal	cu.m	31.0	406035	12.59	–	–	6.59	6.00	–
	h) Kabir Khal	cu.m	31.0	210972	6.54	–	–	3.00	3.54	–
	i) Musar Khal	cu.m	31.0	164614	5.10	–	–	5.10	–	–
9	a) Strip topsoil, Store,	ha	85000	19.01	1.62	–	–	0.81	0.81	–
	and Respread (Loop Cutting)									
	b) Strip topsoil, Store,	ha	85000	456.80	38.83		4.45	12.94	12.94	8.50
	and Respread (Spoil Heaps)									
10	Buildings and Equipment									
	a) Refurbishment of BWDB offices at	Nr	L.S.	600000	0.60	–	0.60	–	–	–
	Lakshmipur, Noakhali and Feni									
	b) Computers, Generator									
	and Survey Equipment	Nr	L.S.	850000	0.85	–	0.85	–	–	–
11	Vehicles	Nr	L.S.	2100000	2.10	–	2.10	–	–	–
	(1 No Truck, 2 No pickup, 10 Motorcycle)									
12	Land Acquisition									
	a) Regulator Site	ha	500000.0	10.000	5.00	–	5.00	–	–	–
	b) WAPDA/Rahmatkhali Khal (Agricultural)	ha	500000.0	61.000	30.50	–	18.30	12.20	–	–
	c) WAPDA/Rahmatkhali Khal(Homestead)	ha	1620000.0	5.000	8.10		4.86	3.24	–	–
13	Land Acquisition for Spoil Heaps	ha	500000.0	456.800	228.40	–	114.20	114.20	–	–
	(Spoil Dump 2.5 m High)									
14	NGO's Cost	Nr	L.S.	28250000.0	28.25	3.53	7.06	7.06	7.06	3.54
	Sub–Total of Direct Construction Cost = A				1034.04	3.53	214.24	377.74	289.30	149.24
	Physical Contingencies 15% of (A) = B				155.11	0.53	32.14	56.66	43.40	22.39
	Sub–Total (A) + (B) = C				**1189.15**	**4.06**	**246.38**	**434.40**	**332.70**	**156.80**
	Engineering Service Cost 12% of C				142.70	28.00	28.00	33.00	33.00	20.70
	Total Project Cost (Tk. mil.)(A)+(B)+(C)=				**1331.85**	**32.06**	**274.38**	**467.40**	**365.70**	**192.32**

TABLE J.5.2

Bill of Quantities for Noakhali North Project
Land Renting for Disposal of Spoil

Sl No	Description	Unit	Rate	Quantity	Amount (Tk. Mil.)	Implementation Year 1	2	3	4	5
1	Modification of Existing	Nr	L.S.	1	20.50	–	5.00	10.00	5.50	–
	14 Vent Rahmatkhali Regulator									
2	New 10 Vent Rahmatkhali Regulator	Nr	L.S.	1	69.20	–	15.00	35.00	19.20	–
3	New 4 Vent Noakhali regulator	Nr	L.S.	1	5.92	–	–	5.92		–
4	Modification of Existing Bridges									
	a) Modification of Structures	Nr	L.S.	1	7.49	–	–	3.74	3.75	–
	on WAPDA/Rahmatkhali Khal									
	b) Scour Protection of Bridge Piers	Nr	L.S.	1	3.30	–	–	1.65	1.65	–
	c) Modification/Reconstruction									
	of Bridges on Minor Khals	Nr	L.S.	1	7.14	–	–	3.57	3.57	–
5	Dredging Rahmatkhali & WAPDA Khal	cu.m	50	7388393	369.42	–	36.82	138.80	138.80	55.00
6	Manual Excavation Rahmatkhali	cu.m	39.5	2340206	92.44	–	–	–	46.22	46.22
	& WAPDA Khal									
7	Khal Bank Protection	m	18000	1850	33.30	–	–	–	16.00	17.30
8	Manual Excavation of Minor Khals									
	(115 Km)									
	a) Noakhali Khal	cu.m	31	229026	7.10	–	–	–	3.00	4.10
	b) Sonaimuri Khal	cu.m	31	631608	19.58	–	–	–	10.00	9.58
	c) Mohandra Khal	cu.m	31	509238	15.79	–	–	5.79	5.00	5.00
	d) Honrakhali Khal	cu.m	31	195411	6.06	–	–	3.06	3.00	–
	e) Marameghna Khal	cu.m	31	169795	5.26	–	–	2.00	3.26	–
	f) Khal No 28	cu.m	31	99154	3.07	–	–	3.07	–	–
	g) Kamta Khal	cu.m	31	406035	12.59	–	–	6.59	6.00	–
	h) Kabir Khal	cu.m	31	210972	6.54	–	–	3.00	3.54	–
	i) Musar Khal	cu.m	31	164614	5.10	–	–	5.10	–	–
9	Strip topsoil, Store, and Respread									–
	a)Loop Cuts	ha	85000	19.01	1.62	–	–	0.81	0.81	–
	b)Soil spreading areas	ha	85000	1816	154.36	–	15.44	51.20	51.20	36.52
10	Buildings and Equipment									
	a) Refurbishment of BWDB offices at	Nr	L.S.	600000	0.60	–	0.60	–	–	–
	Lakshmipur, Noakhali and Feni									
	b) Computers, Generator									
	and Survey Equipment	Nr	L.S.	850000	0.85	–	0.85	–	–	–
11	Vehicles	Nr	L.S.	2100000	2.10	–	2.10	–	–	–
	(1 No Truck, 2 No pickup, 10 Motorcycle)									
12	Land Acquisition									
	a) Regulator Site	ha	500000	10	5.00	–	5.00	–	–	–
	b) WAPDA/Rahmatkhali Khal(Agricultural)	ha	500000	61	30.50	–	18.30	12.20	–	–
	c) WAPDA/Rahmatkhali Khal(Homestead)		1620000	5	8.10		4.86	3.24	–	–
13	Land Compensation	ha	16000	3633	58.13	–	5.80	20.23	30.00	2.10
	(Soil Spreading, 0.3 m depth)									
14	NGO's Cost	Nr	L.S.	3E+07	28.25	3.53	7.06	7.06	7.06	3.54
	Sub–Total of Direct Construction Cost = A				**979.30**	**3.53**	**116.83**	**322.03**	**357.56**	**179.36**
	Physical Contingencies 15% of (A) = B				146.90	0.53	17.52	48.30	53.63	26.90
	Sub–Total (A) + (B) = C				1126.20	4.06	134.35	370.33	411.19	206.26
	Engineering Service Cost 12% of C				135.14	26.50	26.50	31.00	31.00	20.14
	Total Project Cost (Tk. mil.)(A)+(B)+(C)=				**1261.34**	**30.56**	**160.85**	**401.33**	**442.19**	**226.41**

TABLE J.5.3

Noakhali Land Acquisition Option

Project Cost (Tk million)	Financial Cost	Price Factor	Conversion Factor	Economic Cost	O&M % pa	Conversion Factor	Economic Cost	Financial Cost
Excavation	173.5295	1.0524	0.66	108.8	6.0%	0.7	6.93	10.41
Dredging	369.4196	1.0524	0.75	263.3	6.0%	0.7	14.74	22.17
Bridges	17.93	1.0524	0.71	12.1	3.0%	0.72	0.37	0.54
Regulators	95.62	1.0524	0.7	63.6	3.0%	0.72	1.96	2.87
Bank Protection	33.3	1.0524	0.7	22.1	10.0%	0.72	2.28	3.33
Topsoil Strip etc	40.44385	1.0524	0.66	25.4	0.0%	0.7	0.00	0.00
Vehicles	2.1	1.0524	0.68	1.4	4.0%	0.87	0.54	0.57
Buildings	0.6	1.0524	0.79	0.5	6.0%	0.71	0.02	0.04
Equipment	0.85	1.0524	0.87	0.7	4.0%	0.87	0.03	0.03
NGO	28.25	1.0524	0.87	23.4	0.0%			
Land Acquisition	263.9	1.0524	0.42	105.3	0.0%			
(homesteads)	8.1	1.0524	0.87	6.7	0.0%			
	1034.043			633.2			26.86	39.96
Contingencies	155.1064			95.0				
Engineering	142.6979	1.05	0.87	118.2				
	1331.847			846.4				
	0.024071	0.206011	0.350942	0.274577	0.144404			
	20.37407	174.3679	297.03714	232.4021	122.2234	846.40474		

Noakhali Spoil Spreading Option

Project Cost (Tk million)	Financial Cost	Price Factor	Conversion Factor	Economic Cost	O&M % pa	Conversion Factor	Economic Cost	Financial Cost
Excavation	173.5295	1.0524	0.66	108.8	6.0%	0.7	6.93	10.41
Dredging	369.4196	1.0524	0.75	263.3	6.0%	0.7	14.74	22.17
Bridges	17.93	1.0524	0.71	12.1	3.0%	0.72	0.37	0.54
Regulators	95.62	1.0524	0.7	63.6	3.0%	0.72	1.96	2.87
Bank Protection	33.3	1.0524	0.7	22.1	10.0%	0.72	2.28	3.33
Topsoil Strip etc	155.9758	1.0524	0.66	97.8	0.0%	0.7	0.00	0.00
Vehicles	2.1	1.0524	0.68	1.4	4.0%	0.87	0.54	0.57
Buildings	0.6	1.0524	0.79	0.5	6.0%	0.71	0.02	0.04
Equipment	0.85	1.0524	0.87	0.7	4.0%	0.87	0.03	0.03
NGO	28.25	1.0524	0.87	23.4	0.0%			
Land Acquisition	35.5	1.0524	0.42	14.2	0.0%			
(homesteads)	8.1	1.0524	0.87	6.7	0.0%			
Land Compensation	58.128	1	0.73	42.4				
	979.3030			656.9			26.86	39.96
Contingencies	146.8954			98.5				
Engineering	135.1438	1.05	0.87	112.0				
	1261.342			867.4				
	0.024228	0.127526	0.318180	0.350574	0.179498			
	21.01606	110.6209	276.00168	304.1011	155.7028	867.44274		

CHAPTER J.6

RESULTS OF THE ECONOMIC ANALYSIS

J.6.1 General

The economic analysis of the Noakhali North Project has been based on the assumptions presented in the previous chapters. The analysis assumes a project life of 30 years, with no residual values, and employs a discount rate of 12%. The principle economic indicator is the Internal Rate of Return (IRR).

The analysis is based on the amalgamated cropping pattern (ie the sum of Zones A, B, C and D) presented in Chapter J.4. Construction of the project should be completed in year 5 and the first incremental benefits obtained in year 6. Full benefits are assumed to be reached in year 10.

Fishery losses are included from year 6 onwards, as are crop protection and non-crop protection benefits. Flood protection benefits are only applicable to Zone B and C, or 40% of the project NCA.

The main analysis is carried out for the option in which land is purchased for disposal of spoil excavated from the khals, along the banks of the khals. An alternative is also presented which includes the cost of renting land next to the khal for one season and spreading the spoil over the (estimated) 3633 hectares required. Costs for removing the topsoil first and replacing it afterwards, as well as an allowance of 150 kg of fertiliser per hectare are included. Yet another alternative which is to transport the spoil and tip in the River Meghna has not been evaluated directly but can be assessed through the sensitivity analysis.

J.6.2 Results of the Economic Analysis

Tables J.6.1 to J.6.11 present the results of the analysis and include the following:

- annual net income and cropped area by crop
- calculation of agricultural flood loss
- labour requirement and paddy production
- irrigation phasing and net crop income - future without
- irrigation phasing and net crop income - future with
- fisheries losses
- non-agricultural flood damage
- project cash flows
- summary of benefits in financial prices
- summary of cropping pattern changes
- summary of result and sensitivity analysis
- principal agricultural benefits by zone

The analysis of the main option (land acquisition for spoil disposal through the construction of embankments) produces an IRR of 18.4%.

TABLE J.6.1

Annual Total (Net) Income, and Cropped Area by Crop

economic prices

Economic prices	Net Income (Tk/ha)	Project Year 1 Area (ha)	Project Year 1 Total Income (Tk'000)	Future WO (1) Area (ha)	Future WO (1) Total Income (Tk'000)	Future WO (2) Area (ha)	Future WO (2) Total Income (Tk'000)	Future With (1) Area (ha)	Future With (1) Total Income (Tk'000)	Future With (2) Area (ha)	Future With (2) Total Income (Tk'000)
B Aus, local	2094	11786	24684	11786	24684	11786	24684	8637	18090	8637	18090
B Aus, HYV	5631	4984	28066	4984	28066	4984	28066	4984	28066	4984	28066
T Aus, local	6761	3910	26439	3910	26439	3910	26439	3488	23584	3488	23584
T Aus, HYV irri	9208	287	2642	287	2642	287	2642	464	4273	464	4273
T Aus, HYV n–ir	6994	9098	63635	9098	63635	9098	63635	8921	62395	8921	62395
Mixed aus/aman	6055	8254	49977	8254	49977	8254	49977	6070	36750	6070	36750
B Aman local dw	4100	28621	117345	28621	117345	28621	117345	21240	87081	21240	87081
T Aman local dw	6207	4843	30060	4843	30060	4843	30060	4356	27041	4356	27041
T Aman, local	6869	35022	240549	35022	240549	35022	240549	43036	295592	43036	295592
T Aman HYV irri	14482	0	0	0	0	0	0	0	0	0	0
T Aman HYV n–ir	13302	6225	82803	6225	82803	6225	82803	13836	184048	13836	184048
Boro, local	10977	0	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	15651	49979	782234	49979	782234	49979	782234	68458	1071466	68458	1071466
Boro HYV p–irr.	13007	0	0	0	0	0	0	0	0	0	0
Wheat irrig.	12095	32	385	32	385	32	385	32	385	32	385
Wheat unirrig.	9143	127	1163	127	1163	127	1163	127	1163	127	1163
Potato irrig.	28461	63	1780	63	1780	63	1780	63	1780	63	1780
Potato unirrig.	11775	250	2945	250	2945	250	2945	250	2945	250	2945
Jute	8985	796	7151	796	7151	796	7151	0	0	0	0
Pulses: ave.	5432	9685	52612	9685	52612	9685	52612	9226	50118	9226	50118
Mustard	2269	2324	5272	2324	5272	2324	5272	1819	4126	1819	4126
Spices (chilli)	15847	3513	55670	3513	55670	3513	55670	3513	55670	3513	55670
Veg. (brinjal)	13069	816	10669	816	10669	816	10669	816	10669	816	10669
Total		180614	1586079	180614	1586079	180614	1586079	199336	1965241	199336	1965241

Notes:
Total income is net of all on–farm costs except for irrigation which is analysed separately
Project Year 1: assumed 1994/95
Future Without (1): Future Without Project Conditions, Year 10
Future Without (2): Future Without Project Conditions, Year 30
Future With (1): Future With Project Conditions, Year 10
Future With (2): Future With Project Conditions, Year 30
% Increment (1): % difference FW (1) over FWO (1)
% Increment (2): % difference FW (2) over FWO (2)

Calculation of Agricultural Flood Loss

economic prices

	percent loss	income/ha lost*	Year 1 area	Year 1 Tk'000	Year 1 tons	Future without (1) area	Future without (1) Tk'000	Future without (1) tons	Future without (2) area	Future without (2) Tk'000	Future without (2) tons
B Aus, local	2.86%	8083	133	1077	213	133	1077	213	133	1077	213
B Aus, HYV	2.96%	11964	58	698	140	58	698	140	58	698	140
T Aus, local	2.96%	13030	46	596	110	46	596	110	46	596	110
T Aus, HYV irri	2.96%	16597	3	56	11	3	56	11	3	56	11
T Aus, HYV n–ir	2.96%	14284	106	1520	303	106	1520	303	106	1520	303
Mixed aus/aman	3.20%	12829	104	1339	240	104	1339	240	104	1339	240
B Aman local dw	3.20%	8897	362	3220	579	362	3220	579	362	3220	579
T Aman local dw	3.20%	11392	61	698	122	61	698	122	61	698	122
T Aman, local	1.27%	12734	176	2242	370	176	2242	370	176	2242	370
T Aman HYV irri	1.27%	22070	0	0	0	0	0	0	0	0	0
T Aman HYV n–irr.	1.27%	20791	31	651	111	31	651	111	31	651	111
Boro, local	0.00%	15456	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	0.00%	24981	0	0	0	0	0	0	0	0	0
Boro HYV p–irr.	0.00%	22213	0	0	0	0	0	0	0	0	0
Jute	0.00%	16992	0	0	0	0	0	0	0	0	0
percent of area to which damage reduction applies		total	1082	12096	2200	1082	12096	2200	1082	12096	2200
		39.6%									

* lost income is gross crop income less 25% of costs

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TABLE J.6.2

Labour requirements and paddy production

	Labour	LABOUR REQUIREMENTS					PADDY PRODUCTION				
		Present Labour	FWO (1) Labour	FWO (2) Labour	FW (1) Labour	FW (2) Labour	Present	FWO (1)	FWO (2)	FW (1)	FW (2)
	md/ha	md ('000s)	md ('000s)	md ('000s)	md ('000s)	md ('000s)	tonnes	tonnes	tonnes	tonnes	tonnes
B Aus, local	138	1622	1622	1622	1188	1188	18857	18857	18857	13820	13820
B Aus, HYV	144	718	718	718	718	718	11962	11962	11962	11962	11962
T Aus, local	154	602	602	602	537	537	9385	9385	9385	8372	8372
T Aus, HYV irri	178	51	51	51	82	82	932	932	932	1508	1508
T Aus, HYV n-ir	174	1578	1578	1578	1548	1548	25929	25929	25929	25424	25424
Mixed aus/aman	165	1364	1364	1364	1003	1003	18984	18984	18984	13960	13960
B Aman local dw	108	3080	3080	3080	2285	2285	45794	45794	45794	33983	33983
T Aman local dw	130	630	630	630	566	566	9685	9685	9685	8712	8712
T Aman, local	141	4938	4938	4938	6068	6068	73546	73546	73546	90375	90375
T Aman HYV irri	170	0	0	0	0	0	0	0	0	0	0
T Aman HYV n-ir	166	1030	1030	1030	2290	2290	22099	22099	22099	49119	49119
Boro, local	118	0	0	0	0	0	0	0	0	0	0
Boro, HYV irrig	210	10496	10496	10496	14376	14376	249893	249893	249893	342292	342292
Boro HYV p-irr.	205	0	0	0	0	0	0	0	0	0	0
Wheat irrig.	127	4	4	4	4	4					
Wheat unirrig.	102	13	13	13	13	13					
Potato irrig.	194	12	12	12	12	12					
Potato unirrig.	175	44	44	44	44	44					
Jute	215	171	171	171	0	0					
Pulses: ave.	50	489	489	489	465	465					
Mustard	58	134	134	134	105	105					
Spices (chilli)	157	552	552	552	552	552					
Veg. (brinjal)	270	220	220	220	220	220					
	Total	27746	27746	27746	32078	32078	487067	487067	487067	599528	599528

TABLE J.6.3

Irrigation Phasing and Net Crop Income – Future Without

Year	Irrigated Area (ha) LLP	STW/SFMTW	DSSTW	DTW	Manual	Total	On–Farm Irrigation Cost (Tk'000)	Crop Income (1) (Tk'000)	Net Crop Income(2) (Tk'000)
1	38020	1086	0	2173	8690	49969	93449	1586079	1492630
2	38020	1086	0	2173	8690	49969	93449	1586079	1492630
3	38020	1086	0	2173	8690	49969	93449	1586079	1492630
4	38020	1086	0	2173	8690	49969	93449	1586079	1492630
5	38020	1086	0	2173	8690	49969	93449	1586079	1492630
6	38020	1086	0	2173	8690	49969	93449	1586079	1492630
7	38020	1086	0	2173	8690	49969	93449	1586079	1492630
8	38020	1086	0	2173	8690	49969	93449	1586079	1492630
9	38020	1086	0	2173	8690	49969	93449	1586079	1492630
10 FWO 1	38020	1086	0	2173	8690	49969	93449	1586079	1492630
11	38020	1086	0	2173	8690	49969	93449	1586079	1492630
12	38020	1086	0	2173	8690	49969	93449	1586079	1492630
13	38020	1086	0	2173	8690	49969	93449	1586079	1492630
14	38020	1086	0	2173	8690	49969	93449	1586079	1492630
15	38020	1086	0	2173	8690	49969	93449	1586079	1492630
16	38020	1086	0	2173	8690	49969	93449	1586079	1492630
17	38020	1086	0	2173	8690	49969	93449	1586079	1492630
18	38020	1086	0	2173	8690	49969	93449	1586079	1492630
19	38020	1086	0	2173	8690	49969	93449	1586079	1492630
20	38020	1086	0	2173	8690	49969	93449	1586079	1492630
21	38020	1086	0	2173	8690	49969	93449	1586079	1492630
22	38020	1086	0	2173	8690	49969	93449	1586079	1492630
23	38020	1086	0	2173	8690	49969	93449	1586079	1492630
24	38020	1086	0	2173	8690	49969	93449	1586079	1492630
25	38020	1086	0	2173	8690	49969	93449	1586079	1492630
26	38020	1086	0	2173	8690	49969	93449	1586079	1492630
27	38020	1086	0	2173	8690	49969	93449	1586079	1492630
28	38020	1086	0	2173	8690	49969	93449	1586079	1492630
29	38020	1086	0	2173	8690	49969	93449	1586079	1492630
30 FW0 2	38020	1086	0	2173	8690	49969	93449	1586079	1492630
							PV (12%),Tk Mn		12023

Note: (1) Net of costs other than on–farm irrigation
(2) Net of costs including on–farm irrigation

TABLE J.6.4

Irrigation Phasing and Net Crop Income – Future With

Year	Irrigated Area (ha) LLP	STW/SFMTW	DSSTW	DTW	Manual	Total	On–Farm Irrigation Cost (Tk'000)	Crop Income (1) (Tk'000)	Net Crop Income (2) (Tk'000)
1	38020	1086	0	2173	8690	49969	93449	1586079	1492630
2	38020	1086	0	2173	8690	49969	93449	1586079	1492630
3	38020	1086	0	2173	8690	49969	93449	1586079	1492630
4	38020	1086	0	2173	8690	49969	93449	1586079	1492630
5	38020	1086	0	2173	8690	49969	93449	1586079	1492630
6	43017	1086	0	2173	7387	53662	97631	1661912	1564281
7	48014	1086	0	2173	6344	57616	102517	1737744	1635227
8	53010	1086	0	2173	5510	61779	107966	1813577	1705611
9	58007	1086	0	2173	4842	66108	113866	1889409	1775543
10 FW 1	63004	1086	0	2173	2173	68436	114359	1965241	1850882
11	63004	1086	0	2173	2173	68436	114359	1965241	1850882
12	63004	1086	0	2173	2173	68436	114359	1965241	1850882
13	63004	1086	0	2173	2173	68436	114359	1965241	1850882
14	63004	1086	0	2173	2173	68436	114359	1965241	1850882
15	63004	1086	0	2173	2173	68436	114359	1965241	1850882
16	63004	1086	0	2173	2173	68436	114359	1965241	1850882
17	63004	1086	0	2173	2173	68436	114359	1965241	1850882
18	63004	1086	0	2173	2173	68436	114359	1965241	1850882
19	63004	1086	0	2173	2173	68436	114359	1965241	1850882
20	63004	1086	0	2173	2173	68436	114359	1965241	1850882
21	63004	1086	0	2173	2173	68436	114359	1965241	1850882
22	63004	1086	0	2173	2173	68436	114359	1965241	1850882
23	63004	1086	0	2173	2173	68436	114359	1965241	1850882
24	63004	1086	0	2173	2173	68436	114359	1965241	1850882
25	63004	1086	0	2173	2173	68436	114359	1965241	1850882
26	63004	1086	0	2173	2173	68436	114359	1965241	1850882
27	63004	1086	0	2173	2173	68436	114359	1965241	1850882
28	63004	1086	0	2173	2173	68436	114359	1965241	1850882
29	63004	1086	0	2173	2173	68436	114359	1965241	1850882
30 FW 2	63004	1086	0	2173	2173	68436	114359	1965241	1850882
							PV (12%),TK Mn		13289

Note: (1) Net of costs other than on–farm irrigation

(2) Net of costs including on–farm irrigation

TABLE J.6.5

Fisheries losses

Year	Fish production tons FWO	tons FW	Financial Value per kg Tk. FWO	Tk. FW	Economic value net of catching Value per kg Tk. FWO	Tk. FW	Economic price net of catching Total value Tk'000 FWO	Tk'000 FW	Tk'000 FWO−FW	Financial prices Net of catching Total value Tk'000 FWO	Tk'000 FW
1	8139	8139	24.50	24.50	10.92	10.92	88837	88837	0	90886	90886
2	8017	8017	24.50	24.50	10.92	10.92	87506	87506	0	89523	89523
3	7895	7895	24.50	24.50	10.92	10.92	86174	86174	0	88161	88161
4	7773	7773	24.50	24.50	10.92	10.92	84842	84842	0	86799	86799
5	7651	7651	24.50	24.50	10.92	10.92	83511	83511	0	85436	85436
6	7529	3884	24.50	24.50	10.92	8.92	82179	34645	47534	84074	33014
7	7529	3884	24.50	24.50	10.92	8.92	82179	34645	47534	84074	33014
8	7529	3884	24.50	24.50	10.92	8.92	82179	34645	47534	84074	33014
9	7529	3884	24.50	24.50	10.92	8.92	82179	34645	47534	84074	33014
10	7529	3884	24.50	24.50	10.92	8.92	82179	34645	47534	84074	33014

Fish labour use	present	FWO 1	FWO 2	FW 1	FW 2		fin.	econ.
kg per day	3.0	3.0	3.0	2.5	2.5	gear cost per day	10.00	8.70
'000 days	2713	2510	2510	1554	1554	labour cost per day	30.00	22.50
TK per day	54	54	54	41	41 (fishermans total income per day less gear cost in financial prices)			

Non−agricultural flood damage

value of reduction per ha	306 Tk/ha
@ economic prices	266 Tk/ha
damage reduction applies to	40% of NCA
Total damage reduction	11447 Tk'000

TABLE J.6.6

Project Cash Flows (1991 Economic Prices)

(Million Taka)

Year	Benefits: Net Crop Income FWO	Net Crop Income FW	Incre- mental Crop Income	Flood damage: Non-ag	Flood damage: Crop	Total Benefits	Costs: Capture Fisheries Losses	Capital Costs	O&M Costs	Total Costs	Net Incremental Benefits
1	1493	1493	0	0.0	0.0	0.0	0.0	20.4	0.0	20.4	−20.4
2	1493	1493	0	0.0	0.0	0.0	0.0	174.4	0.0	174.4	−174.4
3	1493	1493	0	0.0	0.0	0.0	0.0	297.0	0.0	297.0	−297.0
4	1493	1493	0	0.0	0.0	0.0	0.0	232.4	0.0	232.4	−232.4
5	1493	1493	0	0.0	0.0	0.0	0.0	122.2	0.0	122.2	−122.2
6	1493	1564	72	13.3	12.1	97.0	47.5	0.0	26.9	74.4	22.6
7	1493	1635	143	13.7	12.1	168.4	47.5	0.0	26.9	74.4	93.9
8	1493	1706	213	14.1	12.1	239.2	47.5	0.0	26.9	74.4	164.7
9	1493	1776	283	14.5	12.1	309.5	47.5	0.0	26.9	74.4	235.1
10	1493	1851	358	14.9	12.1	385.3	47.5	0.0	26.9	74.4	310.9
11	1493	1851	358	15.4	12.1	385.7	47.5		26.9	74.4	311.3
12	1493	1851	358	15.8	12.1	386.2	47.5		26.9	74.4	311.8
13	1493	1851	358	16.3	12.1	386.7	47.5		26.9	74.4	312.2
14	1493	1851	358	16.8	12.1	387.2	47.5		26.9	74.4	312.7
15	1493	1851	358	17.3	12.1	387.7	47.5		26.9	74.4	313.2
16	1493	1851	358	17.8	12.1	388.2	47.5		26.9	74.4	313.7
17	1493	1851	358	18.4	12.1	388.7	47.5		26.9	74.4	314.3
18	1493	1851	358	18.9	12.1	389.3	47.5		26.9	74.4	314.8
19	1493	1851	358	19.5	12.1	389.8	47.5		26.9	74.4	315.4
20	1493	1851	358	20.1	12.1	390.4	47.5		26.9	74.4	316.0
21	1493	1851	358	20.7	12.1	391.0	47.5		26.9	74.4	316.6
22	1493	1851	358	21.3	12.1	391.6	47.5		26.9	74.4	317.2
23	1493	1851	358	21.9	12.1	392.3	47.5		26.9	74.4	317.8
24	1493	1851	358	22.6	12.1	392.9	47.5		26.9	74.4	318.5
25	1493	1851	358	23.3	12.1	393.6	47.5		26.9	74.4	319.2
26	1493	1851	358	24.0	12.1	394.3	47.5		26.9	74.4	319.9
27	1493	1851	358	24.7	12.1	395.0	47.5		26.9	74.4	320.6
28	1493	1851	358	25.4	12.1	395.8	47.5		26.9	74.4	321.3
29	1493	1851	358	26.2	12.1	396.5	47.5		26.9	74.4	322.1
30	1493	1851	358	27.0	12.1	397.3	47.5		26.9	74.4	322.9
Present Value @12%		13289	1266	73.4	53.8	1393.0	211.5	585.7	119.7	916.9	476.0
										EIRR (%)	18.43

TABLE J.6.7

Summary of Benefits

	Unit	Project year 1	Future Without (1)	Future Without (2)	Future With (1)	Future With (2)	% Incremen (1)	% Increment (2)
Net Cultivated Area	'000 hectares	108.6	108.6	108.6	108.6	108.6	0	0
Irrigated Area	'000 hectares	50.0	50.0	50.0	68.4	68.4	37	37
Labour Requirement (ag & fish)	million man days	30.5	30.3	30.3	33.6	33.6	11	11
Paddy Production	'000 tonnes	487	487	487	600	600	23	23
Cropping Intensity (excl. orchard)	% NCA	166%	166%	166%	184%	184%	10	10
Irrigated area	% NCA	46%	46%	46%	63%	63%	37	37
Net Crop Income	million Taka	1 264	1 264	1 264	1 572	1 572	24	24
Net fishery income	million Taka	91	84	84	33	33		
Crop flood loss reduction	million Taka				14	14		
Non-agric. flood loss reduction	million Taka				18	32		

Notes:
Project Year 1: assumed 1994/95
Future Without (1): Future Without Project Conditions, 5 years after project would have been completed
Future Without (2): Future Without Project Conditions, Year 30
Future With (1): Future With Project Conditions, 5 years after project completion
Future With (2): Future With Project Conditions, Year 30
% Increment (1): % difference FW (1) over FWO (1)
% Increment (2): % difference FW (2) over FWO (2)
Flood losses refer to average annual losses that will be eliminated by the project.
Values in 1991 financial prices

TABLE J.6.8

Summary of Cropping Pattern Changes

(% of NCA)

	Year 1	Future w'out(1)	Future w'out(2)	Future with(1)	Future with(2)
B Aus, local	10.8%	10.8%	10.8%	8.0%	8.0%
B Aus, HYV	4.6%	4.6%	4.6%	4.6%	4.6%
T Aus, local	3.6%	3.6%	3.6%	3.2%	3.2%
T Aus, HYV irri	0.3%	0.3%	0.3%	0.4%	0.4%
T Aus, HYV n-ir	8.4%	8.4%	8.4%	8.2%	8.2%
Mixed aus/aman	7.6%	7.6%	7.6%	5.6%	5.6%
B Aman local dw	26.3%	26.3%	26.3%	19.6%	19.6%
T Aman local dw	4.5%	4.5%	4.5%	4.0%	4.0%
T Aman, local	32.2%	32.2%	32.2%	39.6%	39.6%
T Aman HYV irri	0.0%	0.0%	0.0%	0.0%	0.0%
T Aman HYV n-ir	5.7%	5.7%	5.7%	12.7%	12.7%
Boro, local	0.0%	0.0%	0.0%	0.0%	0.0%
Boro, HYV irrig	46.0%	46.0%	46.0%	63.0%	63.0%
Boro HYV p-irr.	0.0%	0.0%	0.0%	0.0%	0.0%
Wheat irrig.	0.0%	0.0%	0.0%	0.0%	0.0%
Wheat unirrig.	0.1%	0.1%	0.1%	0.1%	0.1%
Potato irrig.	0.1%	0.1%	0.1%	0.1%	0.1%
Potato unirrig.	0.2%	0.2%	0.2%	0.2%	0.2%
Jute	0.7%	0.7%	0.7%	0.0%	0.0%
Pulses: ave.	8.9%	8.9%	8.9%	8.5%	8.5%
Mustard	2.1%	2.1%	2.1%	1.7%	1.7%
Spices (chilli)	3.2%	3.2%	3.2%	3.2%	3.2%
Veg. (brinjal)	0.8%	0.8%	0.8%	0.8%	0.8%
Total	166.3%	166.3%	166.3%	183.5%	183.5%

TABLE J.6.9

Summary of Results and Sensitivity Analyses
(Land Purchase Option)

Capital cost	846.4 Tk.m.(economic pricconstruction period		5 years
Annual O&M cost	26.9 Tk.m.(economic prices)		
Net Present Value @12%	476.0 Tk. m. (economic prices)		
Economic Internal Rate of Return	18.4 %		

Sensitivity Analyses				Economic IRR (%)				
	Base			**Change in Variable**				**Switching**
Variable	**Case**	**+10%**	**+25%**	**+50%**	**−10%**	**−25%**	**−50%**	**Value (%)**
Capital Costs	18.4	17.3	15.9	13.9	19.7	22.1	27.8	81.28
O&M Costs	18.4	18.3	18.1	17.7	18.6	18.8	19.2	397.63
Fisheries Losses	18.4	18.2	17.8	17.1	18.7	19.1	19.7	225.03
Reduced flood losses	18.4	18.6	18.8	19.2	18.3	18.0	17.6	174.25
Total Benefits	18.4	20.0	22.1	25.4	16.8	14.0	8.0	34.17
Incremental Net								
Crop Income	18.4	19.8	21.8	24.7	16.9	14.4	9.2	37.61
Delay in full benefits								
2 years	16.4							
4 years	14.9							
Delays in completion								
2 years	15.7							
4 years	14.1							

TABLE J.6.10

Summary of Results and Sensitivity Analyses
(Land Renting Option)

Capital cost	867.4 Tk.m. (economic prices) construction period	years
Annual O&M cost	26.9 Tk.m. (economic prices)	
Net Present Value @12%	476.7 Tk. m. (economic prices)	
Economic Internal Rate of Return	18.6 %	

Sensitivity Analyses	Economic IRR (%)							
	Base	Change in Variable						Switching
Variable	Case	+10%	+25%	+50%	−10%	−25%	−50%	
Capital Costs	18.6	17.5	16.0	14.0	19.9	22.3	28.3	81.49
O&M Costs	18.6	18.4	18.2	17.8	18.8	19.0	19.4	398.22
Fisheries Losses	18.6	18.3	17.9	17.2	18.9	19.3	20.0	225.36
Reduced flood losses	18.6	18.8	19.0	19.4	18.4	18.2	17.8	174.80
Total Benefits	18.6	20.2	22.4	25.8	16.9	14.0	7.9	34.22
Incremental Net								
Crop Income	18.6	20.1	22.1	25.1	17.0	14.5	9.2	37.66
Delay in full benefits								
2 years	16.5							
4 years	14.9							
Delays in completion								
2 years	15.5							
4 years	13.9							

TABLE J.6.11

Principal Agricultural Benefits by Zone

Item	Unit	Zone			
		A	B	C	D
Incremental Labour Requirement	million mandays	1.714	1.246	0.971	0.401
Incremental Paddy Production (including reduced Crop Damage)	'000 tonnes	45.24	27.91	28.16	13.34
Incremental Crop Income (including reduced Crop Damage)	million Taka	92.98	95.50	93.93	39.75

Inspection of Table J.6.6 shows that the major portion of benefit is incremental crop income. The percentage contributions to crop income of major crops are given below (after deducting irrigation costs)

	Present / Fwo	Future with
boro	45%	51%
LT aman	16%	16%
HYV aman	6%	10%
B aman	8%	5%

Flood damage benefits account for less than 10% of all benefits, whereas fishery losses are the equivalent of just over 3%, even though an annual loss of over 3600 tonnes is anticipated.

Inspection of Table J.6.9, Summary of Results and Sensitivity Analyses gives the results of various tests of the project's sensitivity. These indicate that

- o the project is insensitive to increases in capital costs, O + M costs, fishery losses and reduced flood losses.

- o the project is reasonably sensitive to reductions in crop benefits delays in construction and delays in achieving full benefits

A number of additional sensitivity tests have been undertaken.

1) Fish losses increased by 50% (to 165 kg/he of lost flood plain) : IRR = 17.1%.

2) In addition to the above, no infrastructural damage benefits are included : IRR = 16.2%.

3) In addition to 1) and 2) above, no crop damage protection benefits are included : IRR = 15.4%.

These tests show that the relative importance of the above items within the analysis is not great.

If no increase in HYV aman is included in the "future with" cropping patterns and that all increases in T. aman are the local variety, the IRR falls to 16.3%.

If on the other hand, the full area of HYV aman is planted in both the "future without" and "future with" project situations, the IRR increases to 22.3% which can be regarded as the highest possible rate of return.

If the incremental area of boro is halved the IRR falls to 13.0%, clearly demonstrating where the project may be vulnerable.

Project Mitigation

A major disadvantage of the project as formulated above is that it could require the compulsory purchase of over 500 hectares of agricultural land. This is likely to be socially disruptive and, if past experience is a guide, may well delay the project's implementation. A strategy to overcome this has been devised whereby 3600 hectares are rented by the project for one season (3-4 months) (about 1000 ha/yr of construction) and used to dispose of the spoil, raising ground levels by about 30 cms. In order to preserve soil fertility, costs for removing and replacing the top soil have been included for half of the area (1816 ha) where sandy soils which farmers would not welcome on their lands are likely to be encountered. Overall this option is more expensive than the former in economic prices, but not significantly so and It produces a slightly higher IRR of 18.6%. A summary of results for this option is presented in Table J.6.10.

It is this option which is recommended for implementation.

J.6.3 Financial Analysis

J.6.3.1 Farm Models

Financial analysis of farm models is restricted to Zones A, B and C. Zone D is excluded as only minor changes in both dry and wet season cropping are expected.

Farm models have been prepared for each farm size (marginal small, medium and large farmers) and for sharecroppers where small and medium sized farmers constitute over 90% of their number. The modelling of sharecropping systems is based on analysis of the farmer survey where it can be seen that of those farmers who sharecrop land, the area of land rented (ie sharecropped) represents about 50 and 40 per cent of the cultivated area for small and medium farmers respectively. Systems for sharecropping are based on an equal sharing of output for all crops with all input costs borne by the grower with the single exception of boro, where the owner of the land generally makes a contribution amounting to 50% of the fertiliser and irrigation costs. Thus a typical sharecropper receives 75% of the product over the entire farm if he is a "small sized" farmer and 80% if he is a "medium sized" farmer.

The results of the farm model analysis are presented in Tables J.6.12, J.6.13 and J.6.14 for Zones A, B, and C. They are based on average cropping patterns and farm sizes for each Zone, and demonstrate that both owner occupiers and sharecroppers will benefit from the project if they adopt the proposed cropping patterns. Clearly some farmers will benefit more than others, most notably those who are either enabled to grow a boro crop or who are benefitted by an improvement in flooding regimes. Equally important is the fact that the farm models suggest that noone will be worse off, although those farmers whose flooding regime is not significantly improved and who do not have access to increased irrigation supplies will experience little change.

TABLE J.6.12

Returns per Ha at Financial Prices assuming no change in land type

Noakhali — ZONE A Farm Models

	Marginal HL	Small HL	Medium HL	Large HL	Marginal ML	Small ML	Medium ML	Large ML	Marginal LL	Small LL	Medium LL	Large LL
Present	24626	20582	19326	17366	20834	16800	15510	14691	0	0	0	0
Future Without	24626	20582	19326	17366	20834	16800	15510	14691	0	0	0	0
Future With	31448	25462	23353	21464	29176	23303	21155	19567	0	0	0	0
FW less FWO	6821	4880	4027	4098	8342	6504	5645	4876	0	0	0	0

Returns per Ha at Financial Prices assuming changes in land type

	ML to HL	ML to HL	ML to HL	ML to HL	LL to ML	LL to ML	LL to ML	LL to ML
Present	20834	16800	15510	14691	0	0	0	0
Future Without	20834	16800	15510	14691	0	0	0	0
Future With	31448	25462	23353	21464	0	0	0	0
FW less FWO	10613	8663	7843	6773	0	0	0	0

Returns per average farm size at Financial Prices assuming changes in land type

Farm size	0.12	0.53	1.83	5.75	0.12	0.53	1.83	5.75
Present	3125	10080	23266	57295	0	0	0	0
Future Without	3125	10080	23266	57295	0	0	0	0
Future With	4717	15277	35029	83711	0	0	0	0
FW less FWO	1592	5198	11764	26416	0	0	0	0

Sharecropper Returns per ha at Financial Prices assuming no changes in land type

	Small HL	Medium HL	Small ML	Medium ML	Small LL	Medium LL
Present	12790	13093	9640	9783	0	0
Future Without	12790	13093	9640	9783	0	0
Future With	13361	13672	11655	11837	0	0
FW less FWO	571	579	2015	2054	0	0

Sharecropper Returns per average farm size at Financial Prices assuming changes in land type

	ML to HL	ML to HL	LL to ML	LL to ML
	0.53	1.83	0.53	1.83
Present	9640	9783	0	0
Future Without	9640	9783	0	0
Future With	13361	13672	0	0
FW less FWO	3721	3889	0	0

TABLE J.6.13

Returns per Ha at Financial Prices assuming no change in land type

Noakhali — ZONE B Farm Models

	Marginal HL	Small HL	Medium HL	Large HL	Marginal ML	Small ML	Medium ML	Large ML	Marginal LL	Small LL	Medium LL	Large LL
Present	25674	21948	20735	18978	26821	21595	19826	17653	20297	15565	13782	13268
Future Without	25674	21948	20735	18978	26821	21595	19826	17653	20297	15565	13782	13268
Future With	30516	24653	22593	20884	29660	23421	21107	19822	20791	15929	14064	13782
FW less FWO	4842	2705	1858	1906	2840	1826	1281	2169	493	364	283	515

Returns per Ha at Financial Prices assuming changes in land type

	ML to HL	ML to HL	ML to HL	ML to HL	LL to ML	LL to ML	LL to ML	LL to ML
Present	26821	21595	19826	17653	20297	15565	13782	13268
Future Without	26821	21595	19826	17653	20297	15565	13782	13268
Future With	30516	24653	22593	20884	29660	23421	21107	19822
FW less FWO	3695	3057	2767	3231	9363	7856	7325	6554

Returns per average farm size at Financial Prices assuming changes in land type

Farm size	0.15	0.53	1.69	3.26	0.15	0.53	1.69	3.26
Present	4023	12957	29739	68846	3045	9339	20672	51745
Future Without	4023	12957	29739	68846	3045	9339	20672	51745
Future With	4577	14792	33890	81448	4449	14053	31660	77304
FW less FWO	554	1834	4151	12602	1404	4713	10988	25559

Sharecropper Returns per ha at Financial Prices assuming no changes in land type

	Small HL	Medium HL	Small ML	Medium ML	Small LL	Medium LL
Present	12910	13472	12203	12266	8233	7892
Future Without	12910	13472	12203	12266	8233	7892
Future With	14428	14414	12814	12621	8497	8118
FW less FWO	1518	942	612	355	264	227

Sharecropper Returns per average farm size at Financial Prices assuming changes in land type

	ML to HL 0.53	ML to HL 1.69	LL to ML 0.53	LL to ML 1.69
Present	12203	12266	8233	7892
Future Without	12203	12266	8233	7892
Future With	14428	14414	12814	12621
FW less FWO	2226	2148	4581	4730

TABLE J.6.14

Returns per Ha at Financial Prices assuming no change in land type

Noakhali — ZONE C Farm Models

	Marginal HL	Small HL	Medium HL	Large HL	Marginal ML	Small ML	Medium ML	Large ML	Marginal LL	Small LL	Medium LL	Large LL
Present	27381	22183	20493	17985	24552	19634	18000	16224	19395	14725	13015	12818
Future Without	27381	22183	20493	17985	24552	19634	18000	16224	19395	14725	13015	12818
Future With	32040	25741	23458	21841	30062	23802	21482	19851	19968	15256	13539	13314
FW less FWO	4659	3558	2965	3856	5510	4168	3482	3626	573	531	525	496

Returns per Ha at Financial Prices assuming changes in land type

	ML to HL	ML to HL	ML to HL	ML to HL	LL to ML	LL to ML	LL to ML	LL to ML
Present	24552	19634	18000	16224	19395	14725	13015	12818
Future Without	24552	19634	18000	16224	19395	14725	13015	12818
Future With	32040	25741	23458	21841	30062	23802	21482	19851
FW less FWO	7488	6108	5458	5617	10667	9076	8467	7033

Returns per average farm size at Financial Prices assuming changes in land type

Farm size	0.13	0.50	1.72	3.33	0.13	0.50	1.72	3.33
Present	3683	11780	27000	63274	2909	8835	19522	49990
Future Without	3683	11780	27000	63274	2909	8835	19522	49990
Future With	4806	15445	35187	85179	4509	14281	32223	77417
FW less FWO	1123	3665	8187	21906	1600	5446	12701	27427

Sharecropper Returns per ha at Financial Prices assuming no changes in land type

	Small HL	Medium HL	Small ML	Medium ML	Small LL	Medium LL
Present	12801	12931	11015	11064	7349	7095
Future Without	12801	12931	11015	11064	7349	7095
Future With	14679	14608	13178	12983	7761	7544
FW less FWO	1879	1678	2162	1919	413	448

Sharecropper Returns per average farm size at Financial Prices assuming no changes in land type

	ML to HL 0.50	ML to HL 1.72	LL to ML 0.50	LL to ML 1.72
Present	11015	11064	7349	7095
Future Without	11015	11064	7349	7095
Future With	14679	14608	13178	12983
FW less FWO	3664	3545	5829	5888

While the farm models suggest that it would be in their own interests for farmers to make use of the opportunities which the project should generate, there are constraints which may hinder development. There is little doubt that the major crop rotation proposed, boro followed by T. aman, is the most preferred amongst farmers. It is popular because it allows farmers plenty of time between crops to organise and prepare for the next one and a reasonable window in which to plant and harvest the crop. In addition there is no doubt that LLPs are the preferred (and cheapest) mode of irrigation. The constraint which might delay its implementation is the poor access which farmers have to credit with which to finance the purchase of LLPs. However in the past, this has not proved a constraint when farmers have been able to finance the purchase of LLPs out of savings and loans from other family members. Whether the sudden availability of extra water and consequent high demand for LLPs will stretch these resources too severely is unknown. It is possible that the banks will also see that the project will provide an opportunity for them to do more business and streamline their procedures to make credit more accessible.

J.6.3.2 Funding of operation and maintenance costs.

It has never been the practice in Bangladesh to recover operation and maintenance costs for improved drainage. There are many reasons for this but the most important are that it would be extremely difficult to devise a system that is fair and more practically, very hard to collect the fees.

Irrigation changes are simpler to organise because they can be levied on the pump owner / operator whom it would not be difficult to register.

The justification for such an irrigation fee is that those with access to irrigation are likely to benefit from the project more than those with none. In financial prices, operation and maintenance of the project will cost Tk. 39 million per year which is equivalent to Tk 1325 per hectare of land irrigated from the khals. Provided that the fee is used to maintain the system in such a way that water supplies are guaranteed and those paying the fee can see their money is well spent such a charge would not be excessive.

It is likely that irrigation changes which are currently rather high in Noakhali and probably include a "scarcity" value of water will decline after implementation of the project to similar levels charged in Gumti. With increased competition between pump owners' farmers may even experience no increase in charges beyond current levels.

J.6.3.3 Capture Fishery Losses.

It is extremely difficult to mitigate against losses of "common good" low value wild fish as these are thought to provide a significant proportion of the animal protein consumed by poorer sections of the community. While commercial aquaculture can make good the loss in fish catches (which in Noakhali North Project requires less than a 20% increase over current production levels), production from commercial ponds is high value carp which are beyond the budgets of the poor. In these circumstances the only realistic mitigation which can be made is to increase incomes sufficiently to enable the purchase of replacement protein.

Employment in agriculture is expected to increase from 27.8 million to 32.11 million days in the future, an increase of 4.3 million days. The amount of time spent catching fish is expected to decline from 2.5 million days to 1.6 million days, a decline of 0.9 million days, which gives an incremental net gain of 3.4 million days.

4.3 million days at Tk 43 per day is worth Tk 185 million in wages which exceeds the total value of all fish losses by two times even, if they are valued at Tk 25 /Kg (an assumption which places no value on the fishermen's time). In addition it is unrealistic to assume that the landless, and very small farmers catch 100 percent of the fish caught. Thus, provided those sections of the community who are vulnerable in this respect secure the same proportion of additional work as their share of the fish catch, they will at least have the choice as to whether to replace the lost protein or not.

APPENDIX J.1

ECONOMICS OF MINOR IRRIGATION

APPENDIX J.I

ECONOMICS OF MINOR IRRIGATION

Costs used in project economic appriasal

1. Specification

The attached tables show the cost of different modes of minor irrigation. Capital and operating costs have been calculated for a range of different technologies. These include:

a. LLP 1 - 0.7/1.0 cu.sec pump irrigating 10 ha, using the same 8hp engine as a STW.

b. LLP 2 - 2 cusec pump irrigating 20 ha.

c. STW - a conventional STW using a Japanese engine. Although many STWs have cheaper Chinese engines, these are slightly less fuel efficient and have a shorter life (crankshfts usually break after 2 or 3 years, so their overall cost has been calculated to be slightly higher than the Japanese engine.

d. DSSTW - as for the STW but in an unlined pit 1.5 m deep.

f. SFMTW 1 - force mode shallow well for areas where there is gas. Although it uses the same engine, it has higher output that the STW as it would not run into suction problems at the end of the season.

g. SFMTW 2 - for areas where there is also a salinity problem as well as gas - this well skims of fresh water from a shallow fresh upper aquifer.

h. SFMTW 3 - a larger version of SFMTW 1

i. DFMTW 1 - a 1 cu sec version of a DTW for deeper aquifers.

j. DFMTW 2 - a 2 cusec DTW similar to existing wells but with materials and costs adjusted to make it more appropriate for private sector investment.

k. DFMTW 3 - a special well for the conditions of the saline area of Noakhali.

2. **Capital costs**

a. The screen cost of SFMTW 2 is high as its a large diameter screen into which the pump in placed.

b. Capital costs annualized over the life of the well/pump at an interest rate of 12% per year.

c. The pump survey showed that less than 10% of engines are used for other purposes in the off-season so no allowance has been made for this extra income.

d. The cost of water channel construction (unlined earth) has been calculated for different well options. The length of channel per ha irrigated and the average cross section rises as the command area increases, as more and bigger channels would be needed. The cost is purely that of labour for earth moving.

3. **Operating Costs**

a. Hours of pump operation are all well within normal limits. The relative short hours of LLP 2 and DTW 2 indicate that command areas for 2 cusec pumps are more likely to be limited by management/distribution issues than by pump capacity.

b. Pump and engine efficiency is based on the DTW II Project Technology Report. The efficiency of centrifugal pumps in STW is lower than the same pump in LLP or FM pumps as they reach suction limits when water levels fall.

c. The static water table varies between modes to reflect the varying conditions that they would be used under.

d. Draw down is based on well output and well yield - the 2 cusec DTW 3 is 12 lt/sec/m, the 1 cusec DTW is 10.29 (as screen diameter is smaller) -this is also used for the FMSTWs - and STW/DSSTWs, with crude and cheap screen only get 6 l/s/m.

e. Total pumping head is SWL + draw-down +2% friction loss + 1 metre above the surface.

f. Fuel consumption is calculated as cu.m. water ÷ 275 ÷ pump efficiency × 0.25. It gives similar fuel consumption rates to the DTW II report for DTW, but rather less for STW.

g. Fuel cost is Tk14/lt plus 10% for oil. Costs have not been calculated for electric pumps as, although the financial cost is lower, the economic cost is similar to that of diesel as the high cost of rural power disrtribution needs to be taken into account.

h. Spares cost as a percentage of engine and pump cost per 1000 hours of operation. 10% is added for mechanics charges.

i. The cost of the pump operator is the hourly wage rate times the annual hours of operation. However as operators do other work such as water distribution, only a third of a man is need for the LLP, STW and SFMTW, and half a man for the DTW.

j. Water guard and channel maintenance as based on the cost of one man per day of the season per 30 ha irrigated.

k. Miscellaneous costs include annual re-excavation of DSSTW pits.

3. Total cost per ha indicates that:

- LLP is significantly cheaper, at a cost of under Tk2,500 per ha per year.
- DTW and DSSTW are more expensive, at over Tk5,500 per year. The special DTW 3 for the special saline conditions of Noahkali is particularly expensive, suggesting that development of alternative surface water supplies is a more feasible option.
- There is little difference between STW and SFMTW. For small command areas STW remain the cheapest option, and will continue to be prefered due to their lower capital costs. Howver SFMTWs do provide a low cost option,even at slightly greater depths to water than STW and DSSTW: - but this is a new and largely untried concept in Bangladesh.

4. Costs have also been calculated at economic prices using conversion factors determined by FPCO. Irrigation costs are substantially lower than at financial prices, but the relative ranking of the different modes and technologies remain broadly similar.

5. The cost of traditional irrigation has been calculated as the cost of two men operating a swing basket for a 90 day period during the boro season. This amounts to Tk7,200 per ha in financial prices or Tk5,400 at economic prices. This is substantially more than alternative sources such as LLP and STW. In fact what the farmer is paying for with his own labour is a saving on hiring a mechanical pump. Therefore the labour cost has been reduced by 50% which puts it between an LLP and STW. In practice actual labour use may be less than 180 days per ha as farmers apply less than optimal amount of water. There is evidence from Gumti (but not Noakhali) that traditionally irrigated boro does yields less (and also gets lower levels of fertiliser).

6. Crop budgets at financial prices include irrigation costs based on fees charged in pumps surveyed in the Gumti II irrigation pump survey. An overall fee for irrigating boro has been calculated using the average for different modes wieghted by the proportion of modes found in the region. The cost for other crops has been calculated according to the proportion that their fees are to the boro fee. It is assumed that local boro only needs half the irrigation of hyv boro as it is grown in naturally wet places. In both Noahkali and Gumti a flat rate irrigation fee is the normal method of charging for water, rather than a share of the crop.

Appraisal of Shallow Force Mode Tubewells

In some parts of the region farmers complain that groundwater supplies are limited and STW run dry towards the end of the season. Although recharge may be sufficient to support a larger area of irrigation, the aquifer may lack suffient storage in its uppermost layer which is easily accessible to STWs. As the water table falls the STWs' suction pump reaches its limit and the operator has to reduce the rate of pumping by slowing the engine. This in turn makes the pump less efficient in terms of energy needed to raise water and the reduced supply also limits the command area.

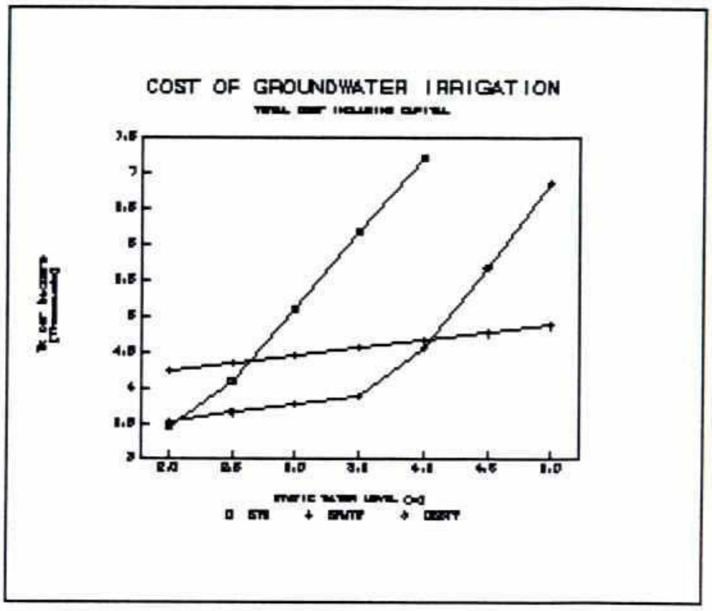

Table 2 and Figure 1 compare the cost of three technologies, STW, DSSTW and SFMTW, with the depth to water table varying from 2 to 5 metres. The STW, with its low capital cost, produces water most cheaply when the water is within 2 m of the surface, but as soon as the water table starts to fall, it is worth deep setting the STW to maintain pump efficiency. It is prehaps surprising that more STW are not deep set - which only tends to happen as the water table falls out of reach of the suction limit. The SFMTW has a higher capital cost, but its efficiency is not effected by the depth to the water table. At over 2.5 metres the SFMTW becomes a cheaper water source than the STW, but the DSSTW maintains its efficiency up to 4.5 m - and if the pit were deeper than 1.5m its advantage would be continued further.

This analysis indicates that both DSSTW and SFMTW can provide an enonomic alternative to STW in situations where the water table has fallen sufficiently to reduce the efficiency of STW operation.

COST OF MINOR IRRIGATION

WATER CHANNELS

Type of well	LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
Command area	10.0	20.0	4.5	4.5	7.5	7.5	11.0	15.0	22.0	15.0
Channel length/ha	80	80	60	60	60	60	80	90	90	90
Ave. cross section	0.9	0.9	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9
Cu.m. soil per ha	72	72	36	36	36	36	72	81	81	81
Cu.m. dug per day	3	3	3	3	3	3	3	3	3	3
Cost/person–day	40	40	40	40	40	40	40	40	40	40
Cost per ha	960	960	480	480	480	480	960	1080	1080	1080
Cost per well	9600	19200	2160	2160	3600	3600	10560	16200	23760	16200

SPECIFICATION	LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
Discharge l/sec	20	56	8	8	15	15	23	30	60	30
Command area	10.0	20.0	4.5	4.5	7.5	7.5	11.0	15.0	22.0	15.0
Pump chamber – m	0	0	0	0	18	12	18	21	24	27
Screen length – m	0	0	12	12	12	12	18	18	24	18
Blank casing – m	3	3	18	18	0	0	0	21	22	105
Well depth – m	0	0	30	30	30	24	36	60	70	150

CAPITAL COST (financial prices)

		LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
Prices:											
Pump chamber	per metre	0	0	0	0	330	330	340	1250	1608	1250
Well screen	per metre	0	0	180	180	240	1280	656	656	656	656
Blank casing	per metre	150	150	150	150	330	330	340	623	623	623
Installation	per metre	0	0	60	60	300	300	400	500	780	900
Costs:											
Pump chamber		0	0	0	0	5940	3960	6120	26250	38592	33750
Well screen		0	0	2160	2160	2880	15360	11808	11808	15744	11808
Blank casing		450	450	2700	2700	0	0	0	13083	13706	65415
Other costs		500	500	1700	1700	10000	10000	12000	15000	25000	15000
Total well components		950	950	6560	6560	18820	29320	29928	66141	93042	125973
Engine and pump		26500	66250	26500	26500	51500	51500	63000	74500	200000	74500
Installation & pit		0	0	2160	3160	10800	9000	16800	33000	59280	140400
Water channels		9600	19200	2160	2160	3600	3600	10560	16200	23760	16200
Total capital		37050	86400	37380	38380	84720	93420	120288	189841	376082	357073
Assumed life	years	5	5	5	5	10	10	10	10	10	10
Capital cost (incl.channel)		37050	86400	37380	38380	84720	93420	120288	189841	376082	357073
Cost per year – int. = 16%		11315	26387	11416	11722	17529	19329	24888	39278	77812	73879
Total/ha/yr.		1132	1319	2537	2605	2337	2577	2263	2619	3537	4925

	STW	STW	STW	STW	STW	SPMTW 1	SPMTW 1	SPMTW 1	SPMTW 1	SPMTW 1	SPMTW 1	SPMTW 1	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW
OPERATING COSTS (financial prices)																			
Requirements																			
Water: mm/season	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740	740
Peak: mm/day	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Length of season	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Hours of operation																			
Per day: peak	16.93	16.25	15.23	17.15	17.33	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.93	16.25	15.23	17.15
	9.17	8.80	8.25	9.29	9.39	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	9.17	8.80	8.25	9.29
Total per year	1284	1233	1155	1301	1315	1284	1284	1284	1284	1284	1284	1284	1284	1284	1284	1284	1233	1155	1301
Pump/engine efficiency	45%	42%	38%	32%	30%	50%	50%	50%	50%	50%	50%	50%	45%	45%	45%	45%	42%	38%	32%
Static water level	2.0	2.5	3.0	3.5	4.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Drawdown – m	2.0	1.7	1.3	1.0	0.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.7	1.3	1.0
Total pump head	5.1	5.3	5.4	5.6	5.9	5.1	5.6	6.1	6.6	7.1	7.6	8.1	5.1	5.6	6.1	6.6	6.8	7.0	7.1
Fuel consumption: lt/hr	0.44	0.41	0.37	0.34	0.32	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.44	0.49	0.53	0.58	0.53	0.48	0.44
lt/year	569	504	431	446	425	512	564	615	667	718	769	821	569	626	683	741	651	553	568
lt/ha	31	34	39	48	54	28	30	33	36	39	42	44	31	34	37	40	44	50	61
Operating costs																			
Fuel and oil	8766	7765	6645	6872	6549	7889	8681	9473	10265	11057	11849	12641	8766	9646	10526	11406	10028	8521	8753
Spares cost as % of pump/engine																			
Cost per 1000 hours	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Taka per year	1361	1306	1225	1379	1394	2645	2645	2645	2645	2645	2645	2645	1361	1361	1361	1361	1306	1225	1379
Mechanics charges	136	131	122	138	139	264	264	264	264	264	264	264	136	136	136	136	131	122	138
Labour cost	2140	2054	1926	2168	2191	2140	2140	2140	2140	2140	2140	2140	2140	2140	2140	2140	2054	1926	2168
Water guard/channel maint.	1400	1120	840	709	597	1400	1400	1400	1400	1400	1400	1400	1050	1050	1050	1050	840	630	532
Micscelleneous costs & pit	300	300	300	300	300	600	600	600	600	600	600	600	1300	1300	1300	1300	1300	1300	1300
Total cost per yr.	14102	12676	11058	11567	11170	14938	15730	16522	17314	18106	18898	19690	14752	15632	16512	17392	15659	13724	14271
(operating) per ha	1880	2113	2457	3044	3491	1992	2097	2203	2309	2414	2520	2625	1967	2084	2202	2319	2610	3050	3755
TOTAL ALL COSTS PER HA	3461	4089	5092	6164	7196	4230	4335	4441	4546	4652	4758	4863	3530	3647	3765	3882	4563	5655	6840
Total cost per ha/mm	4.68	5.53	6.89	8.34	9.73	5.72	5.86	6.01	6.15	6.29	6.43	6.58	4.77	4.93	5.09	5.25	6.17	7.65	9.25

		LLP 1	LLP 2	STW	DSSTW	SFMTW 1	SFMTW 2	SFMTW 3	DFMTW 1	DFMTW 2	DFMTW 3
OPERATING COSTS (financial prices)											
Requirements											
Water: mm/season		740	740	740	740	740	740	740	740	740	740
Peak: mm/day		9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Length of season		140	140	140	140	140	140	140	140	140	140
Hours of operation											
Per day: peak		13.54	9.67	15.23	15.23	13.54	13.54	12.95	13.54	9.93	13.54
Average		7.34	5.24	8.25	8.25	7.34	7.34	7.02	7.34	5.38	7.34
Total per year		1027	734	1155	1155	1027	1027	982	1027	753	1027
Pump/engine efficiency		50%	50%	38%	38%	50%	50%	50%	50%	55%	50%
Static water level	metres	3.0	3.0	3.0	4.5	5.5	5.5	5.5	9.0	9.0	9.0
Drawdown – m	metres	0.0	0.0	1.3	1.3	2.5	1.3	2.2	2.9	5.0	2.9
Total pump head	metres	4.1	4.1	5.4	7.0	9.2	7.9	8.9	13.2	15.3	13.2
Fuel consumption	litre/hr.	0.53	1.49	0.37	0.48	0.90	0.77	1.34	2.58	5.46	2.58
	litre/yr.	546	1092	431	553	924	795	1315	2653	4109	2653
	litre/yr.	55	55	39	50	50	43	48	72	76	72
Operating costs											
Fuel and oil		8407	16813	6645	8521	14225	12245	20250	40858	63278	40858
Spares cost as % of pump/engine											
Cost per 1000 hours per yr.		4%	4%	4%	4%	4%	4%	4%	4%	3%	4%
Taka per year		1089	1944	1225	1225	2116	2116	2476	3061	4519	3061
Mechanics charges		109	194	122	122	212	212	248	306	452	306
Labour cost	operator	1712	1223	1926	1926	1712	2568	2456	2568	1883	2568
Water guard/channel maint.		1400	2800	630	630	1050	1050	1540	2100	3080	2100
Micscelleneous costs & pit		300	450	300	1300	600	600	700	750	1000	750
Total cost	per year	13016	23425	10848	13724	19914	18790	27670	49643	74212	49643
(Operating)	per ha	1302	1171	2411	3050	2655	2505	2515	3310	3373	3310
TOTAL ALL COSTS PER HA		2433	2491	4948	5655	4992	5083	4778	5928	6910	8235
Total cost per ha/mm		3.29	3.37	6.69	7.65	6.75	6.87	6.46	8.02	9.34	11.14
ECONOMIC PRICES											
Capital costs:	C.F.										
Pump chamber	0.61	0	0	0	0	3623	2416	3733	16013	23541	20588
Well screen	0.61	0	0	1318	1318	1757	9370	7203	7203	9604	7203
blank casing	0.61	275	275	1647	1647	0	0	0	7981	8361	39903
Other costs	0.87	435	435	1479	1479	8700	8700	10440	13050	21750	13050
Total well components		710	710	4444	4444	14080	20485	21376	44246	63256	80744
Engine and pump	0.62	16430	41075	16430	16430	31930	31930	39060	46190	124000	46190
Installation & pit	0.87	0	0	1879	2749	9396	7830	14616	28710	51574	122148
Water channels	0.75	7200	14400	1620	1620	2700	2700	7920	12150	17820	12150
Total capital cost		24340	56185	24373	25243	58106	62945	82972	131296	256649	261232
Cost per year – int. =	12%	6752	15586	6761	7003	10284	11140	14685	23237	45423	46234
Total/ha/yr.		675	779	1503	1556	1371	1485	1335	1549	2065	3082
Operating Costs	c.f.										
Fuel and oil	0.63	5296	10592	4186	5368	8962	7714	12758	25741	39865	25741
Spares	0.62	675	1205	759	759	1312	1312	1535	1898	2802	1898
Mechanic	0.87	95	169	107	107	184	184	215	266	393	266
Operator	0.75	1284	917	1444	1444	1284	1926	1842	1926	1412	1926
Water guard	0.75	1050	2100	473	473	788	788	1155	1575	2310	1575
Miscelleneous	0.87	261	392	261	1131	522	522	609	653	870	653
Total		8661	15375	7230	9282	13051	12446	18114	32058	47652	32058
Total per ha		866	769	1607	2063	1740	1659	1647	2137	2166	2137
TOTAL ALL COST PER HA		1541	1548	3109	3619	3111	3145	2982	3686	4231	5219

COMPARISON OF COST OF SUCTION AND FORCE MODE PUMPS AT DIFFERENT DEPTHS TO WATER TABLE

SPECIFICATION	STW	STW	STW	STW	STW	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	SFMTW 1	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW	DSSTW
Depth to water table(m)	2.0	2.5	3.0	3.5	4.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Discharge l/sec	12	10	8	6	5	12	12	12	12	12	12	12	12	12	12	12	10	8	6
Command area	7.5	6.0	4.5	3.8	3.2	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	6.0	4.5	3.8
													0	0	0	0	0	0	0
Pump chamber – m	0	0	0	0	0	18	18	18	18	18	18	18	12	12	12	12	12	12	12
Screen length – m	12	12	12	12	12	12	12	12	12	12	12	12	18	18	18	18	18	18	18
Blank casing – m	18	18	18	18	18	0	0	0	0	0	0	0	30	30	30	30	30	30	30
Well depth – m	30	30	30	30	30	30	30	30	30	30	30	30							
CAPITAL COSTS (financial prices)																			
Prices:																			
Pump chamber/m	0	0	0	0	0	330	330	330	330	330	330	330	0	0	0	0	0	0	0
Well screen/m	240	240	240	240	240	240	240	240	240	240	240	240	180	180	180	180	180	180	180
Blank casing/m	230	230	230	230	230	330	330	330	330	330	330	330	150	150	150	150	150	150	150
Installation/m	100	100	100	100	100	300	300	300	300	300	300	300	60	60	60	60	60	60	60
Costs:																			
Pump chamber	0	0	0	0	0	5940	5940	5940	5940	5940	5940	5940	0	0	0	0	0	0	0
Well screen	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2160	2160	2160	2160	2160	2160	2160
Blank casing	4140	4140	4140	4140	4140	0	0	0	0	0	0	0	2700	2700	2700	2700	2700	2700	2700
Other costs	1700	1700	1700	1700	1700	10000	10000	10000	10000	10000	10000	10000	1700	1700	1700	1700	1700	1700	1700
Total well components	8720	8720	8720	8720	8720	18820	18820	18820	18820	18820	18820	18820	6560	6560	6560	6560	6560	6560	6560
Engine and pump	26500	26500	26500	26500	26500	51500	51500	51500	51500	51500	51500	51500	26500	26500	26500	26500	26500	26500	26500
Installation & pit	3600	3600	3600	3600	3600	10800	10800	10800	10800	10800	10800	10800	3160	3160	3160	3160	3160	3160	3160
Water channels	2160	2160	2160	2160	2160	3600	3600	3600	3600	3600	3600	3600	2160	2160	2160	2160	2160	2160	2160
Total capital	40980	40980	40980	40980	40980	84720	84720	84720	84720	84720	84720	84720	38380	38380	38380	38380	38380	38380	38380
Assumed life	5	5	5	5	5	10	10	10	10	10	10	10	5	5	5	5	5	5	5
Capital cost	38820	38820	38820	38820	38820	81120	81120	81120	81120	81120	81120	81120	38380	38380	38380	38380	38380	38380	38380
Cost per year	11856	11856	11856	11856	11856	16784	16784	16784	16784	16784	16784	16784	11722	11722	11722	11722	11722	11722	11722
	1581	1976	2635	3120	3705	2238	2238	2238	2238	2238	2238	2238	1563	1563	1563	1563	1954	2605	3085

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ANNEX K

COMMENTS AND REPLIES ON THE DRAFT FEASIBILITY STUDY REPORT

9r

NOAKHALI NORTH DRAINAGE AND IRRIGATION PROJECT
FEASIBILITY STUDY

ANNEX K - COMMENTS AND REPLIES ON THE DRAFT FINAL REPORT

CONTENTS

PREFACE

The comments in this annex were received between 15th August and 21st September 1993 on the nine volumes of the draft final report issued in mid-July 1993.

The consultants have reviewed the comments and replied to all of them indicating, where appropriate, what action has been taken to clarify or correct errors or omissions where possible.

A number of the comments request information or studies which were beyond the scope of the TOR or would have required resources of time or manpower not available under the current contract. No remedy is possible in these cases except through further studies which in some cases the consultant has recommended.

Of the Agencies submitting comments only FPCO have indicated categories and therefore only for those comments are categories indicated.

COMMENTS AND REPLIES
NOAKHALI NORTH DRAINAGE & IRRIGATION PROJECT
(Draft Feasibility Study)

1. **Main Report - Volume 1**

Comment Nr	Comment from The Directorate of Planning (General, BWDB)	Replies & Action
M.1	Page 1-4, Sec 1.3.1 The gross area stated in location should be same as in page (1-7) section 1.3.5 under the title soils and Agriculture.	Noted the figure on page 1-7 is correct, and that on page 1-4 is simply rounded. Corrected
M.2	2. Page (1-6) Sec 1.3.3 Climate Hydrology Construction year of the cross dams nos 1 and 2 stated in this page may be corrected as illustrated in page (1-8) under section 1.3.8.	Noted. Corrected
M.3	3. Page (1-9) Sec 1.3.9 Irrigation Development As stated, Existing Irrigation is indicated in figure 1.4 but the figure is absent which may be incorporated.	Noted Figure 1-4 now inserted
M.4	4. Fig.2.3 Meghna Water Surface Profile An additional water surface profile along Meghna-Dakatia (Daulat Khan-Chandpur-Hajiganj-Laksham) could better focus hydrological situation of the project area, using recent years data in stead of 1980-81.	The principal drainage path for the project area is however via WAPDA/Rahmatkhali Khal, for which a profile is given in Figure 10.2. The year 1980-81 was selected as representative. More recent data would give the same result. In any case the aim of the figure is to illustrate the relationship between Meghna levels as the drainage control on the area with flood plain levels. No action
M.5	5. Page(2-3) Sec.2.1.4 Flooding Characteristics The Statement regarding flood free area in this section is also confusing with section B.3.2.1 of Vol.2. An area - elevation curve presenting also flood level may be incorporated to focus the flooded area & flood free area.	The figure of 20% quoted in Section B.3.2.1 of Vol. 2 is in error, and should read 7% as should the second figure quoted in Section 2.1.4 of Vol. 1. The sentence is to be reordered for greater clarity. See also reply to Nr. 7 below. Section B.3.2.1 of Vol 2 corrected
M.6	6. Page(2-4) Water level and flow Data. Stated water level & discharge stations have not been actually shown in figure 2.1 which may be shown.	Noted. Stations added to Figure 2.1

Comment Nr	Comment from The Directorate of Planning (General, BWDB)	Replies and Action
M.7	7. Page(2-10) Sec.2.2.3 Impacts of flooding The statement in the 3rd, 4th & 5th para may be conclusive after being supported by- (a) Area - elevation curve & presenting flood level on it. (b) Area - Volume curve and flood routing considering flood embankment along Dakatia river & draining through open outlets channels.	Chapter 10 and Annex B give a much more detailed discussion of the modelling results. The modelling incorporates the type of analysis mentioned. No single flood level area elevation or area-volume curve can represent the entire area. The model uses 32 sub-catchments each having its own flood level and area-elevation relationship built up from data for each one minute square. No action
M.8	8. fig.B.2.9 Areal reduction factor From plotted points, best fitted smooth curve may be developed.	Noted. This analysis was conducted only as part of the general review of data quality and the derived factors are not used in the study. No action required
M.9	10. Page (13-3) Sec 13.4.2 Issues to be address Statement is the third para regarding corrupt practices is dependent on evidence. So, the comment is not fair as well as does not look good which may be deleted.	This is a summary of local people's opinions from the people's participation programme, which the Consultant has endeavored faithfully to record and summarise without necessarily agreeing with those opinions. (For evidence see Annex G). No action required
M.10	11. Sec.1.3.5 Page-1-7 Soil & Agriculture Data on soil & Agricultural aspect of the project area are inadequate and are secondary in nature. No primary data on soils, landuse, land capability & crop suitability are provided which are essential for the appraisal of Agricultural aspect.	Soils - Since the principal determinants of agricultural development are the flooding regime and availability of irrigation, rather than any intrinsic soil properties, it was not considered necessary or a good use of limited resources (nor did the TOR require) to carry out new soil survey. Localised investigation in connection with the suitability of excavated materials being spread on fields was however carried out (Page I.1-14 of Annex I). Land Use, land capability and crop suitability - The evaluation methodology for directly relating crop suitability (without assigning a land capability classification) to flooding characteristics generated by the SERM, and calibrating by means of data obtained from the agro-socioeconomic surveys primary data is set out in Chapter E.4 of Annex E.
M.11	12. Page (1-7) Sec.1.3.5 Soil & Agriculture The net cultivated area (NCA) stated to be 108718 ha may be verified with the NCA described in page B.1-1 of Vol. 2 under section B.1.2.	The figure in Section B.1.2 was an earlier estimate Section B.1.2 Corrected

Comment Nr	Comment from The Directorate of Planning (General, BWDB)	Replies and Action
M.12	13. Page 1-16, Sec.1.7.3 Survey & Investigation Sampling programme for water quality is not clear. No data on water quality have been provided and hence no interpretation for water analyses has been made.	This is merely a brief description of the sampling programme. Full details of the analyses and interpretation are presented in Section 6.3 and Annex H (Appendix H.V). No action required
M.13	14. Fig.3.3 & Fig.3.4 Soil type & Land capability i) A soil type map is presented in Fig. 3.3 to which no explanation has been provided. The legend also lacks explanation. As a result purpose of the map is not known. ii) A land capability map is presented in Fig. 3.4 which seems to be unrealistic. Land potentialities classified as good, moderate and poor are not possible without conducting soil survey. So, clarification is needed for the above classification	Noted, this map has now been deleted from the main report but remains in Annex E, Agriculture, where a legend is also available (Figure E.2.2 and Table E.2.2). Further detail is given in Annex E, Agriculture, especially Figure E.2.3 and Table E.2.3, including the source of the material quoted as Annex I of the SE Regional Plan Report. The source of the Land Capability Classification in the SE Regional Plan Report was "Reconnaissance Soil Survey Report of Sunamganj - Habiganj (1976), Brahmanbaria (1973) and Noakhali, Comilla Sadar North & South and Chandpur Districts (1965-66) prepared by Department of Soil Survey of Bangladesh, but improved and developed with additional data available from other sources.
M.14	15. Page 3-2 Sec.3.2.2 Soils Soils are not quantified in respect of major soil parameters like soil texture, soil permeability, soil drainage class & fertility status. These are very important in the field of irrigation management & crop suitability determination. To identify the above parameter, soil survey are essential which has not been done by the consultant. It may be mentioned that TOR of the project indicated for necessary soil survey to be done by the consultant.	See reply to question M.10 above. The ToR require only "Necessary soil surveys........ as required". The proposal and approved evaluation methodology did not include a new soil survey, and hence no inputs were provided for one in the revised consultancy contract. No action required.
M.15	16. Fig.6.1 & Fig.12.2 Planning Zone Planning Zone map of similar nature have-been provided in two separate chapters. One at chapter 6 and another at chapter 12. The reason may be clarified.	Two copies of the same map have been provided for reference from the adjacent text and for easy compansion with adjacent thematic maps. No action required.

Comment Nr	Comments from Water Resources Planning Organisation (WARPO)	Replies and Action
M.16	The project is a complicated one due to its surrounding problems like shifting of coast line towards sea, lengthening of Noakhali Khal (the original source of drainage excess water from the project area and its surrounding areas) & siltation of the mouth of little Feni River. In the Feasibility report it is proposed to widen and deepen the existing channels and khals discharging the excess water to Meghna at Rahmat Khali through existing Rahmat Khali Regulator and a new regulator nearby. In the past it was observed in reconnaissance survey that water from little Feni River basin area and surrounding area of Mixed Town used to flow toward Rahmathkhali through Begumganj depression.	
	It would be a risky proposition to drain all the water from the project and its surrounding areas towards Rahmat Khali keeping the problem of southern part of the project area alive.	
	The original natural drainage channel for the Begumganj depression area was to the south via Noakhali Khal but it is now ineffective due to siltation and shifting of coast line towards south. The coast line is likely to continue to southwards. So it is better to find out a way to discharge the water from Begumganj depression to a suitable place in the Begumganj as far as possible with a provision of a regulator at it outfall.	The consultants stand by their analysis. The proposed alternative given in the comment would cost more (longer drainage path) and could not provide the irrigation benefits of the proposed scheme. Thus the economics of southward drainage would be very poor.
	This will help drain polder 59/1B otherwise the WAPDA khal and Ramat Khali Khal and regulator will be over-loaded with the flow from part of the Polder 59/1A and 59/1B also from the little Feni basin. It is true that there would be severe problem in making Noakhali Khal into an effective drain at its present outfall. But it is possible to find out a new outfall of Noakhali Khal with a provision of a regulator towards west in Meghna River at the southern end of Ramgati at Meghna stable bank. This will also help drain Noakhali North.	No action required

Comment Nr	Comments from Water Resources Planning Organisation (WARPO)	Replies and Action
M.17	2. Page 11-7 Regulator at Noakhali Khal It is proposed to construct a 4 -vent regulator on Noakhali Khal where it flows through the old coastal embankment. The regulator will be kept open during monsoon to allow free drainage from the project area as required. During dry season the gates shall remain closed to prevent ingress of saline tide water. But this closing will invite siltation in the downstream of the regulator and needs annual removal of silt as experienced in this region. Noakhali south area is expanding towards the sea (south). To fight with saline intrusion through seepage and to keep salt-and fresh water interface away from the land (i.e. near coast line) during dry season, it would be necessary to supply water from Meghna-Dakatia-Kamla khal system to the project area and then to coastal area. This supply may need pumping and this will also facilities it is not provided now.	The Noakhali Khal has already silted up. The consultants proposals have accepted this and the regulator allows continued drainage as at present. Further siltation of bed level at the regulator is not envisaged since it is far upstream of the critical section. The regulator prevents saline intrusion and replaces annually constructed cross-dams. For reasons explained in the Regional Plan Report the diversion of Meghna water via the Dakatia-Kamla Khal is considered non viable and is not recommended. No action required.

Comment Nr	Comment from Directorate of Planning Schemes-I, BWDB	Replies Action
	Soil:	
M.18	1. The reconnaissance soil survey information incorporated in the report is very inadequate. In this modern scientific age project preparation requires detailed information on each field study for successful completion of the project and soil survey information is a must.	See replies questions M.10 and M.14 from the BWDB Directorate of Planning (General) above. No action required
M.19	2. Detailed information of soil in feasibility study needs to be incorporated in the report to help suitable application of fertilizer dozes and inputs by the farmers in order to boost up crop yield.	As above
M.20	3. The base line of TOR is not followed and in the report (Main Report, Appendix-A, Page-4) necessary information of soil is absent.	As above

Comment Nr	Comment from Directorate of Planning Schemes-I, BWDB	Replies and Action
M.21	4. The information of soil incorporated in the Report have been compiled from Draft Regional Plan (FAP-5) April/92 and concerned Reconnaissance soil survey Report (1965-66) revised addition 1970 reprinted in 1983 which is suitable for planning stage. But in feasibility stage detailed soil information is necessary which is not found in the report. At least Detailed sample Block Survey (as Gumti Phase II) is needed to know the physio-chemical properties and for determination of present & future crop suitability ratings. The crop suitability ratings shown in the report is an old one. Cropping practices and patterns have now been changed.	As above. The 1993 Gumti Phase II feasibility study was able to draw on the detailed work carried out for the 1990 study. Such detail was not available for the Noakhali North Study. Cropping patterns have changed remarkably little in the last 20 years according to Figure II.5 (Trends of Difference of Rice Crops) of Annex II of the South East Regional Plan Report.
M.22	5. Detailed land capability reports and maps is necessary in the project report.	As above (see replies to M.10 and M.14)
Comment Nr	**Comment from Department of Environment (DoE)**	**Replies Action**
M.23	Environmental Impact Assessment of the Noakhali North Drainage and Irrigation Study the Department of Environment (DoE) has the following comments to offer: 1. The Report under review is a Feasibility Study wherein a comprehensive EIA is required. 2. The Draft EIA produced by the Consultants in addition to recommendations have proposed a programme of supporting studies which "would allow a full scale EIA to be produced".	The limitations of the current study were foreseen, understood and accepted by the donors, GoB and the consultants as discussed in the various meetings held in July 1992 and at the Tipartiate meeting held in November 1992. The consultants have made recommendations and provisions for additional studies in their recommendations. No action required.

Comment Nr	Comment from Department of Fisheries	Replies and Action
M.24	The report indicates that the feasibility study in the project area has been done specially on the basis of impact assessment guideline of FAP-16. The suggestions and recommendations on possible mitigation measures, development strategy and fisheries management programme will be helpful for the improvement of fisheries development in the project area depending on proper implementation.	Thank you No action required.

Comment Nr	Comments from Surface Water Modelling Centre (SWMC)	Replies and action
M.25	1. From run R2 it appears that the peak water level at Begumganj depression may be lowered by 0.50m by increasing the conveyance of WAPDA khal only./ From run R4 and R5 it appears that increasing the number of gates of the regulator to 20 or even 28 will reduce the peak level immediately u/s of the regulator by only 10 to 20 cm with no further improvement (compared to run R2) in the Begumganj depression. As such, the recommendation for construction of one additional regulator of 10 vents only to lower the water level at the upstream of the regulator by 20 cm may not be justified.	It should be noted that for Run R2 peak water levels at the regulator are increased and this was considered unacceptable. Whereas the later runs a produced a reduction at the regulator which is also used to good effect in later runs to achieve further improvements at Begumganj.
M.26	2. The findings of different option runs are not supported by relevant plots and figures.	Supporting data with plots and figures are given in Annex B. No action required.
M.27	3. Chapter 10.4.2(c) It is recommended that Peak discharge of 300m³/s will be available for irrigation from spring tidal cycle during late February/early March. A demonstrative figure (Fig. 10.9) has been attached to show the general operation of the regulator. But the basis of calculating irrigation availability of 300m³/s is not clear either from this figure.	Figure 10.9 shows typical operation not peak inflow. Irrigation potential was calculated using a full season analysis incorporating water level and khal storage characteristics as described in Annex B. Irrigation availability is not 300 m³/s and has not been stated as such.
M.28	4. Chapter 10.2.2(a) About the length of lower Meghna, it is to be mentioned that SWMC handed over the General Model to FAP-5 at a stage half-way of the updating activities. Later on it was found that the length of the channel is 91.5 Km. Accordingly, this length was incorporated into the model and also intimated to FAP-5. SWMC has also accepted the datum correction of 11.5cm as has been confirmed by GOB	Agreed No action required.
M.29	5. Chapter 10.2.2 (b): About the length of channel from Rahmathkhali to Piarapur, it is to be mentioned that SWMC has measured the channel length from Topo maps by rotometer. However, due to personal error, slight variation in length might have occurred and is not likely to influence the model result significantly. The type of investigation carried out and the way of measuring the length of the channel by FAP-5 is not clear and the numerical value is also not mentioned.	The methods used by the consultant are similar to those used by SWMC. Since agreement has now been reached there is no problem. The consultants have simply reported the progress to agreement. No action required.
M.30	6. Chapter 10.2.2 (c): About the problems in the representation of control structure by using culvert routine, it is to be mentioned that it is a software problem detected by SWMC and intimated to DHI, Denmark for correction. The corrected version of the programme will be furnished as soon as it is received from DHI.	Noted. No action required.

Comment Nr	Comments from Surface Water Modelling Centre (SWMC)	Replies and action
M.31	7. Chapter 10.2.2 (d): About cross section area and channel conveyance between Piarapur and Rahmathkhali regulator it is to be mentioned that SWMC measured cross sections at 5 locations between Piarapur and Rahmatkhali Regulator in 1991 dry period. A team from SWMC was involved in the task. The variation in the measurements of SWMc and FAP-5 was not intimated to SWMC and as such no action could be taken in this connection. Regarding over estimation of water level in the model results at Piarapur and upstream it may be mentioned that due to the shortage of tidal data at the boundary, SWMC has run the tidal model for only 2 months of 1991.	Noted and agreed the report was not intended to be criticisum of SWMC. The calibration problems are fully understood. No action required.

Comment Nr	Comments from Flood Plan Coordination Organisation (FPCO)	Replies and Action
M.32	**Section 2.1.7 Salinity Data, Para 2nd** The consultant should delete the full para. He has not understood the coastal area. The salinity line has gone further down due to other reasons. The sea-coast in between Noakhali and Chittagong has gone further down due to emergence new chars and siltation of the existing channel. The coast in polder 59/1 and 59/2 has shifted largely due to construction of Cross-Dam 1 and 2. The controversial and un-wanted utterances would misguide others. Such type of sentences if mentioned in other places of the report or Appendices should be deleted.	 The second part of the sentence will be deleted and the first part added to the preceding paragraph. Also the last sentence of paragraph 3 will be deleted. The consultants have not misunderstood the reasons for salinity reduction the analysis largely agrees with that expressed in the comment.
M.33	**Page 20-8 (b) Noakhali Khal, Para 1 & 2** The Meghna Cross Dam 1 was constructed in 1959 and Cross-Dam 2 in the year 1964. The first 2nd sentence does not mean anything. There is nothing like late 1950 and early 1960.	 With respect the sentence is clear and correct english and inaccordance with the stated facts.
M.34	Para 3 - to drain the Begumganj through Noakhali Khal was abandoned in 1963/64 and accordingly the construction of Noakhali Khal drainage regulator was stopped (though the construction materials etc were brought to the construction site near Sonapur) after observing the siltation process in that area. The comprehensive Drainage scheme, Noakhali was modified. The drainage of that area was designed through the Rahmathkhali Regulator. The size & slope of the drainage channel were modified including increasing the capacity of the regulator which was originally designed to take a part of the discharge.	Other commentators disagree (See WARPO comments). However, the consultants proposals seem appropriate to this comment. No action required.
M.35	**Page 2-11 Art 2.3.2 Hydrology, 3rd Para** The consultant did not visit the sites properly and did not collect all the relevant information on the ground water resource. There are two deep tubewells at the end of cross Dam 2 (in BWDB compound) which are pumping water from more than 600 feet since 1963. The interesting thing is that there was not dearth of any sweet water supply from those two tubewells though no sweet water could be struck through deep tubewells in Sonapur (Noakhali) BWDB colony. The data should be available in the office of Executive Engineer BWDB Division, Noakhali.	 This statement is not correct. Examination of the Annex C and its appendices reveals the extent of field data collection. The comment on the scarcity of data is not invalidated by the existence of these wells, but the need for additional investigations is confirmed. No action required

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Comment Nr	Comments from Flood Plan Coordination Organisation (FPCO)		Replies and Action
M.36	**Page 2-12 Art 2.3.3(D) deep Aquifers 2nd para** BWDB Ground Water Circle regularly collect data from open wells which should have been checked before recommending a monitoring programme.		This comment misunderstands the referred paragraph. The consultants have recommended monitoring combined with a proper investigation to evaluate the resource. No action required
M.37	**Page 2-1 Chapter -2** It was expected that a summary would be available on water resources after the description of the climatic and hydrological conditions. The consultant would find out availability of the water resources and the requirements for agriculture, fisheries, navigation, salinity etc. Then he would find out the different uses of water through existing projects (which he has done) and then he would optimise the sources of water and suggest projects. One of the main objective of Muhuri water transfer has been referred in a very scanty way, though the present study was initiated with this purpose.		These aspects are dealt with in the Regional Plan Report. Muhuri water transfer was not included as a part of this feasibility study. No action required.
M.38	**Chapter 11** Recommended options should have a consolidated statement showing all the recommended activities though each activity is described separately		
	11.3.1 (i)	Raising of sill level of Rahmathkhali Regulator	
	11.3.2 (ii)	a new regulator of size 10 x 3m z 3m re-excavating and deeping of the Rahmathkhali & WAPDA Khal.	Figure I.1.1 shows the activities quite clearly. The information is now presented in concise form in the Executive Summary.
	11.3.3	Excavation of new secondary khals to connect with the main khals.	The secondary khals are not new but enlarged existing khals.

Comment Nr	Comments from Flood Plan Coordination Organisation (FPCO)	Replies and Action
M.39	11.3.4 - A A four vent regulator for Noakhali Khal The suggestion of a new regulator over Noakhali Khal is not justified. The sedimentation/siltation process that is going in the bay area and also behind the other regulators would also affect the outfall of this regulator in the shortest time. This would make the regulator ineffective and create more problem of drainage congestion. We may continue to keep this khal open.	We do not agree, (See reply to comment M.17) siltation is now far downstream of the proposed regulator and the site appears stable. No action required.
M.40	Procedure for generating present yield and assumption of the same yield for future with project situation is not a realistic approach and also a contradiction to the observation made in 3rd paragraph of section 1.3.5, page 1-7 and last two paragraphs of page 2-10. Section 2.2.3 (Vol 1, Main Report). In the above mentioned paragraphs present low yield is attributed to prevailing poor drainage and severe drainage problems and creating opportunities for irrigation would definitely have positive effect on yield of those relevant crops at least to the extent that the proposed intervention would be abe to reduce damage yield. Recent FAP 12 study and findings to this aspect also testify this. Further, it needs to be mentioned here that a number of both expatriate an local consultants were involved in those FCD/FCDI projects feasibility studies covered by FAP-12 and others. Based on their field surveys/ observations also supported by case studies it had been concluded in all the cases and proposed that there would be higher yield/unit area with the removal of prevailing constraints. Accordingly, they assumed higher yields with project situation which have been proved by FAP-12 findings.	See reply to comment E.7 re with and without project yields. Re Section 1.3.5 on page 1) the point is taken, but nevertheless the yield obtained for boro from the surveys was surprisingly high (5.08 t/ha), and to use a figure in excess of 5 t/ha in the analysis did not seem prudent. Re crop damage, the yields used in the analysis are assumed to be net of average annual damage, and without project yields are adjusted to account for exceptional damage saved (See Annex J). No action required.
M.41	**Input use** **(Section 1.3.5 page 1-7; Vol 1 and Table E3.19 page 3-19)** Same unlikely because secured crop production siltation would encourage producers to invest more for higher yield. In this respect, attention is drawn to the conclusion of the 3rd paragraph of section 1.3.5, page 1-7 attributing to low fertilizer input use due to uncertain availability of irrigation water resulting low yield. FAP-12 study also observed that there is evidence of increased use of input.	Re, boro yield see reply to previous comment. Also the yield used <u>is</u> lower than that used for other areas (eg Gumti II) but no differences in the project area, were observed by different access to water (unfortunately. Re assumed input see reply to comment E.7 as referred in the above comments. No action required.

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Comment Nr	Comments from Bangladesh Academy for Rural Development (BARD)	Replies and Action
M.42	**Vol I, Main Report** This comprehensive report that covers water resources, agriculture, fisheries, demography and socio-economic, environment, infrastructure, institution, people's participation, hydrology and all other aspects directly or prepared on each of these aspects. The intention of the whole project is to devise a project which will reduce the existing conflicts of interest among different sector of development and different regions within the project area causing minimum permanent to the population through land acquisition and possibly construction of elaborate structures. The individual reports of different subjects have highlighted components of different aspects. While it appears that the Consultants have kept this intention in mind the intended beneficiaries' view on the issues of new construction and other programmes for drainage and irrigation could have been more elaborately dealt with. Our comments on different issues on each of the volumes are given separately.	See replies to other BARD comments and in particular Annex G does include an analysis of peoples views on construction issues and on irrigation and drainage. No action required

2. Annex B & C, Hydrology and Hydrogeology - Volume 2

Comment Nr	Comment from Directorate of Planning of BWDB Dhaka	Replies and Action
B.1	9. Vol 2 Page (B.3-1), Sec B.3.1 Introduction The runoff (discharge) of the Padma is not relevant here as the Padma meets the Meghna at Aklaspur some 12 km upstream of Chandpur. The runoff of lower Meghna may be stated. In addition, information on stage & discharge of Dakatia river may be stated if possible.	The Padma discharge is by far the dominant component of the Lower Meghna discharge. Figures for the Padma have been quoted because these are gauged, whereas for the Lower Meghna they are not. This is an introductory section only - details are given elsewhere. No action required.
Comment Nr	**Comment from BARD**	**Replies and Action**
B.2	The finding of the study will help to assess and understand the present flood problems and to assess the impacts of measures to alleviate these problems. But this report does not include non-hydraulic assessment techniques. The following issues might be considered in the study.	This volume is specially about hydraulic assessment, non-hydraulic aspects are included in other volumes.
B.3	- Social and scope of people's involvement in the Planning and implementation of the project does not get coverage in this paper, though this is one of the most important factors for making a project effective and sustainable	These are dealt with in Annex G and in the main report (Chapter 5,9 and 14)
B.4	- Environmental issues with and without project stages may be computed to avoid possible negative effects of the project.	See Annex H and Main Report, Chapter 12
B.5	- Effects of the project on growth of agricultural products and change of cropping patterns may be highlighted in the study.	See Annex E and Main Report Chapter 3.
B.6	- Scope of fisheries development in the post project stage may be computed in the study.	See Annex F and Main Report Chapter 4. No action required

3. Annex D - Ecology - Volume 3

Comment Nr	Comments from FPCO	Replies and action
D.1	Vol 3 - Annex D - As far as I am concerned this volume could be an Appendix to Vol 7.	No action proposed.
D.2	Secondary data supplemented by some first hand information generated through RRA type of technique has been the basis of this volume.	Agreed. No action required.
D.3	Very good tentative list of different flora and fauna and fish population have been tabled but what would be the impact of project intervention have not been indicated. Why and how some floral and faunal population are helpful as biological control and how these could be profitably used could be/should be highlighted and only then such treatises become meaningful under Bangladesh context. Another weakness of the report is the collection of primary data only during dry period.	Impact is discussed in Annex H. The limited data collection period was made unavoidable by delay in approval of the study. No action.
D.4	P D.1-1 sub-section D.1.1 (4th line). It is Changes - Brahmaputra-Barak be replaced by Meghna. Is it 40,225 sq.m?	It should be sq.km and will be corrected.
D.5	3rd para 5th line - FAP 2 has produced a functional ecological report. What is functional ecology?	Please see Section 2.3 of Volume 14 (Ecology) of the FAP 2 Draft Final Report, which defines and describes functional ecology. No action required.
D.6	**Subsection D 1.1.1** Ecology study do not cover all the natural resources (2nd line) but only concentrates on biological natural resources	Noted. The word 'biological' has been inserted.
D.7	Sub-section D 1.1.3 - Homestead Area: Are they really local centres of high species diversity? Because of conscious human intervention homestead groves are rather skewed in preference to few economically desirable species.	The consultants confirm their view that these habitats provide opportunities for high species diversity.
D.8	The exhaustive treatise of aquatic and terrestrial flora and fauna including birds, frogs, reptiles, rats, various insects, benthic flora and fauna in the food web are fascinating. How they could be inter-related, used and augmented for the benefit of people and the extent of it could be an interesting exercise, even in qualitative terms. For example (chapter D.4 - 3rd para) the profuse growth of water hyacinth can be used for paper and furniture making and in engineered wetland management (Mennonite Central Committee P-APP-H.11-5).	Agreed. There is much useful research waiting to be done. However the listing gives detailed indications of use and a separate list of medicinal plants has been prepared. No action required.
D.9	Chapter D.6 Droughts 1779 and 1783 should likely to 1979 and 1983. In 1974 it was not drought but wide spread flood which was of importance. No drought condition was recorded anywhere in Bangladesh in dominant form in 1979.	The dates 1779 and 1783 were taken from the District Gazettes for Comilla (page 25). The 1974 effect was from the 1973/74 drought before the 1974 flood. No action required.
D.10	Cyclone storm speed has been defined by Ananthakrishnan and Rao (1964) as winds>35 knots.	Noted. The sentence has been revised.

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Comment Nr	Comments from FPCO	Replies and action
D.11	Conclusions Good reports. Given an overall suggestive picture of present situation (though scanty) and likely impact of project intervention (not very quantitative). It appears that the project intervention is likely to benefit the population of the area.	Noted. No action required.
D.12	This is a very good report, which identified and recorded almost all the terrestrial and aquatic and faunal existing in the project area.	Thank you.
D.13	It is important to list down all the flora and fauna of various seasons. It seems that the duration for collecting field data was not adequate and it was mentioned in the report that when the field data were collected, it was an unusually dry year and the floodplain was virtually non-existent. A survey of floodplain areas when flood exist will be useful. The invertebrate fauna existing in the project area may be recorded.	This is agreed and proposals have been included in the report for additional studies. No action required.
D.14	Fish migration or movement was not observed. It is an important area because fish access to the river channels and flood-plain areas is crucial to the ecology. Information/ Opinion on fish ecology was mainly taken from the fishermen. In fact, local people catch fish from khal, ditches, flood-plain areas and irrigate rice fields. So, it is important to collect information also from the local people.	Agreed. This was not possible owing to the timing of the study and the lack of floodplain area in 1992. No action required.
D.15	It was mentioned in the report that there was no available information in either the flora or the fauna, especially of aquatic water-bodies. Through this study, a detail list was made and now it is essential to institutionalize this process by involving concerned government and non-government organizations, local government institutions and local organizations like cooperatives, youth clubs, women's groups, landless groups etc.	Agreed. No action required.

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4. Annex E, Agriculture - Volume 4

Comment Nr	Comments from BWDB Planning Directorate	Replies and Action
	No Category	
E.1	General Comments The Report on the Noakhali North Drainage and Irrigation Project, Vol 4, Annex E, has discussed in detail various aspects regarding present and future agriculture of the project area. The deliberations made in the report may be quite helpful for future guidance. While appreciating the reporting and suggestions of the consultants made on the report, the following omission or short coming have been identified Consultants may take these into consideration, whichever deemed proper, for inclusion in the report to make the same well furnished with information:	
E.2	(a) The project area has been divided into 4 zones depending on the flood characteristics. Various investigations have been made and inferences drawn on different aspects, but (i) Zone-wise demarcation of the project is absent, (ii) Cropping patterns for the present and future agriculture have been furnish cropping patterns zone-wise. (b) Present production of different crops have been given, but yield/ unit of land has not been furnished and yield recorded through farmers' survey have been adjusted. What is the need to adjust yield recorded through survey with other sources?	Noted, Map of planning zones now included as Figure E.1-1. Average yield (t/ha) from the surveys is presented in Table E.1.8 of Appendix E.1 by flood phase, farm size and irrigation availability. Tables E.4.7 and E.4.8 present comparisons of the yields used for the study with those from other sources where farmer surveys produce few data (minor crops) the other sources may be more authoritative.
	(c) Animal manures are in use for application in the soil mostly at the rate of 1000 kg, per hectare, while it is discussed that animal manure is extensively used for field. It is known if any exercise have been done too assess availability of such huge quantity of animal manure which may be required at present and in the future.	No such exercise has been carried out. Assumed with project conditions may perhaps entail a larger quantity of animal manure than will actually be available, leading to substitution by chemical fertilisers and this already happens. This would be difficult to quantify reliably and would have little effect upon the overall analysis (See Annex H). No action required
	(d) No crop rotation has been considered for the project which would contribute to crop diversification, replenishing natural soil fertility etc.	Cropping patterns do indeed change from year to year (i.e. rotation) but the permutations and combinations are many. The evaluation method does not imply the exclusion of any rotations, but these will be for the individual farmer to decide. Crop diversification is the subject of other ongoing projects in Bangladesh. No action required.

Comment Nr	Comments from BWDB Planning Directorate		Replies and Action
E.3	17.	Page 3-4, Sec 3-4 Land Use Project area, gross and NCA, appear to be different in the text and tables. Uniformity of figures may be maintained. In table E 3.8 the figure for total will be 108,628 ha.	Noted. Although the figures in the text were generally suitably rounded, all have now been amended.
E.4	18.	Page E 3-5, Table 3.7 6th line of the text on the page may be referred to 'Zone C' is to be replaced by 'Zone D'.	Noted and corrected
E.5	19.	Page E3-8 Sec 3.3 & Fig E.3.1 and Table E.3.14 Study of the table and the cropping patterns reveals that:	
	(a)	In F_o land type HYV T aman occupies 5% of land while local T aman cover 17% area. But in the text it is stated that HYV dominate in aus and Local Aus is also 1:1. Therefore, consultants observation in this respect need to be modified and correct position may be discussed.	Agreed. The situation does however vary from zone to zone. The text has now been amended.
	(b)	In case of F_2+F_3 land type it is stated that Boro is followed by Jute, but the relevant cropping pattern belies it.	Agreed. the area of Jute on F_2+F_3 is too small to justify the reference. Text amended.
	(c)	It appears that there is scope to allocate more area to HYV Boro in F_0 land type, but only a small area (8%) of the total cropped area F_0 type of land is occupied by Boro. The constraints that limit HYV Boro area to such low has not been discussed.	The constraint to boro cultivation is cyclone risk and irrigation availability which is discussed elsewhere. Generally F_0 land has poorer access to irrigation than lower land. No action required.
	(d)	Study of the table reveals that T Aman (LV) has been bracketed with B Aman and Deepwater Aman. In fact, T aman and B Aman grow under two different hydrological condition. Their sowing/ transplanting time also differ. Therefore, it is not logical to grow T Aman with B Aman and Deepwater Aman.	It is assumed the comment refers to the "Summary of Rice Cropped Area" where the B and LT Aman are lumped together. The purpose of this presentation is to identify at a glance where there is a potential for more productive cropping through reduced flood depths. The detail is available in the body of the table. Alternatively, the comment may refer to the separate entry under Kharif 2 Season of T Aman: LV (deep water). This crop is grown over a small area, and is to be distinguished from ordinary B Aman: LV (which is also deep water). No action required.

Comment Nr	Comments from BWDB Planning Directorate		Replies and Action
	(e)	In Table E.3.14 HYV T Aus is wrongly shown in Kharif II season. This may be placed under appropriate season (same is the case with project condition) (Table E 5.1)	T Aus: HYV has actually been shown as both Kharif I and Kharif II in recognition of the wide range in planning dates. The two are additive. No action required.
	(f)	In Table E.3.14 B Aman has been shown in Kharif II season. On the basis of planting season to be placed under Kharif I season, though it covers Kharif I & II. (same is the case with project condition table E 5.1).	B Aman: LV has also been shown as either Kharif I or Kharif II according to planting date, e.g whether or not it is preceded by boro (see Figure E.3.1)
	(g)	In Table E.3.19 it is seen that unirrigated Boro has been listed. This may be deleted (pl. ref to section E 1.4, page E 1-8 to Appendix E.1).	Agreed. Table amended.
	(h)	The future cropping pattern appears to be pragmatic with exception that HYV T aman could be suggested to more areas.	Noted. Other factors appears to limit HYV aman cultivation in the without project situation, and these are assumed to continue to apply. (See discussion on pages E.4-7 through E.4-14)
E.6	20.	Page E 5-1, Section 5.1 It is stated that power tillers are used for land preparation by about 33% farmers in the project area. But nothing has been discussed regarding ownership of the tillers, land coverage, which group of farmers mainly use these tillers etc. Information on the above may be incorporated in the report.	The balance of estimated present and future labour and draught power requirements are presented in Tables E.5.2 and E.5.3, with the deficit in draught power said to require a further expansion in power tillers. The factors mentioned have not been investigated in detail but since power tillers are already increasingly being used the assessment of project viability will not be significantly affected. Ownership of power tillers is in the private sector and they are usually hired since few farmers have sufficient land to made good use of them on their own. Further information on power tillers is given in the Regional Plan Report Annex II pages II.13 to II.15. No action required.

Comment Nr	Comments from BWDB Planning Directorate	Replies and Action
E.7	21. Page E 4.14 & E 4.16 Consultants argument regarding yield of paddy in particular with project condition that FCD/FCDI projects lead to change in cropping pattern and that it is increase in input application or yield received for a given crop type grown under the same land and water conditions as before (last 2 lines of page E 4,14). This observation is confusing and need clarification. It is obvious that FCD/FCDI projects greatly facilitate change of variety (from local to HYV). HYVs demand high inputs - fertilizer, irrigation (if necessary), labour etc, on the one hand and on the other hand project condition being about certain favourable agronomic situation like opportunity for timely sowing/ transplanting, timely intercultural practices, timely harvesting, lessening crop damage etc. which are expected to contribute to realise yield potential of the crop in question. At the top of every thing, farmers' will to invest money and labour in crop husbandry are strengthened when they are sure that their investment will not be washed by flood/ drought. Consultants may review their observations as to equal yield concept for both with project and without project condition.	The meaning of the section seems fairly clear. Page 5 of the Revised Annex I to the FPCO Guidelines for Project Assessment (Agriculture Impact Assessment) (issued March 1993) states "Average annual yields will be estimated assuming average management and taking into account year to year fluctuations (due, for example, to differences in flood damage to crops) Yields obtained in problem-free and/or damage-free areas in the project, or in relevant on-going FCD/I project areas should be considered as the achievable yield level" and on page 16, "The level of inputs used by farmers on different crops on problem-free and damage-free areas under pre-project conditions should be considered as the level expected to be adopted by neighboring farmers with such conditions with project. It should not be assumed that all farmers will use the recommended level of inputs. Similarly, potential yield levels of different crops and varieties should not be targeted. Yield levels achieved on problem-free and damage-free areas under pre-project conditions should be considered to be the achievable yield levels with project on equivalent land types". The consultants have adhered to the Guidelines in this matter. No action required.

Comment Nr	Comments from Directorate of Planning Schemes I BWDB, Dhaka	Replies and Action
E.8	Area and percentage of each soil and land capability unit must be shown in the report. (Table E.2.3 and E.2.4)	Tables E.2.2 and E.24 have been modified to include this information.
E.9	1. Present Land Use Survey along with map required for identifying area under different cropping patterns needs to be incorporated in the report.	The ToR do not require present land use mapping and inputs were not provided for the necessary survey work. Farmer surveys were used to establish cropping in relation to flood characteristics. No action required.
E.10	2. In page E. 3-2 and Table E.3.2 percentage shown in area rented out (B), figures in literature in the same size of medium farm size shown 1678 ha. & large farm size 441 ha. is to be corrected as 178 ha. and 4.41 ha. respectively. And in Table E.3.3 Farm size category needs correction.	Agreed. Corrections have been made.
E.11	3. In page E.3-9, crop sequence para (c) and Figure E.3.1 crop calendar land type by Flood Phase F_2 & F_3 have been shown together which should be produced separately due to division of nomenclature. Standard nomenclature is not followed. Cropping pattern of those two phases also varies from each other.	F_2 and F_3 flood phases were combined because less than 2% of the project area floods to deeper than F_2 and the differences, between F_2 and F_3 were considered to be insignificant especially as the modelling was principally concerned with the question of whether it was possible to grow T Aman (i.e F_1 or better vs F_2 or worse). No action required.
E.12	4. Two stage sampling method shown in the report is not sufficient. The agro-economic survey report should include two stage sampling data according to BWDB's method of 2.5% of total holding of the project area. But the consultant interviewed 384 households which results in 0.0935% of total households is not acceptable to the feasibility study. Any standard is not followed in Gumti Phase-II and North Noakhali Project. Because, 384 households were interviewed in both project, but total households are far different from each other in the feasibility study report.	The total number of household interviews carried out was over 1,200 (see Appendix E.1). The number of interviews is in line with that proposed in Chapter 7 of the Draft Regional Plan Report. Mr S Jones (FPCO Panel of Experts) made suggestions for further simplifications to reduce costs (see comments Nr 4 on page category 2-24 of Annex XI to the South East Regional Plan Report) and these were taken into account. The sampling methodology is described in Appendix E.V (which has been expanded in the Final Report) and explains why the sample sizes for Noakhali North and Gumti Phase II are the same - at this level of sampling, the statistical validity of a sample depends upon its absolute size and not in proportion to the size of the population under investigation. The 2.5% sampling criteria (which does not appear in the revised ToR) would have required over 10 000 interviews, for which resources were not available.

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Comment Nr	Comments from Directorate of Planning Schemes I BWDB, Dhaka	Replies and Action
E.13	5. In Main Report, Page-3-10, Table 3.5 and Annex-E, Report, Page E.4-19, Table E 4.9 the percentage of Jute in present and future without project condition 0.7% has been shown in Main Report and 0.2% shown in Annex-E Report. These discrepancies should be corrected and in future with project condition. Jute production has been shown as nil. As the jute is the main cash crop of the country, the prediction of jute cultivation in future with project condition as nil is against the agriculture policy of the government of Bangladesh.	The Table E.4.9 relates to Zone A only. The weighted average for all zones (Tables E 4.9. to E 4.12) is 0.7% as per Table 3.5 of the Main Report. Jute tends to be displaced by increased- boro cropping (see discussion of Cropping Pattern in Section E.4.3.1) In the project area jute is of very minor importance and its elimitation from the cropping pattern is not significant in terms of national policy.

Comment Nr	Comments from FPCO	Replies and Action
	General	
E.14	1. Comments furnished on Agriculture Annex of Gumti Phase II Sub Project Feasibility Study Report apply to this report as the same methodology were followed in both the projects.	Noted (For replies see Annex K of Gumti Final Report)
E.15	2. The report do not contain any information or efforts in respect of crop damage estimation which is essential for economic analysis. Were these data not collected in the farmer survey? If the answer is yes, then those information should be incorporated with the model results to arrive at a more accurate estimation of crop damage. But if the answer is no then we have a serious problem.	Crop damage is dealt with in Section J.2.13 of Annex J (Economics). Questions on the last 5 years crop damage were included in the surveys but 1992 was a year with very little crop damage. Farmers could not give reliable data about the amount of crop damage over the last 5 years. Thana statistical data (although limited) was therefore considered to be more reliable for use in the economic analysis. No action required.
	Category II	
E.16	**Page E.1-1: Article E.1.2 Methodology** Minimum requirement at feasibility study stage is to carry out land use survey for identification area under different cropping patterns. Data based in interviewing 384 farmers (0.09 percent of total population) only is not acceptable at this stage.	See replies to comments (E.9) and (E 12) above. No action required.
E.17	**Page E.3-5: Table E.3.7** Estimation of area under different land types would give a distorted picture since it is not possible to have representative elevation of the project area. This should have been done using the hydrodynamic model and cross checked with the survey results.	It was done as suggested. Table E.3.7 is based upon the hydrodynamic model results. The model results (i.e simulated without project potential crop areas) are compared in detail with data from the surveys and other surveys on Section E.4.3.1 - see also table E.4.3 and E 4.4.
E.18	**Page E.3-7: Table E.3.10** The number do not agree with those presented in Table E.3.7.	The only discrepancy is one incorrect % in Table E.3.7. (which has been corrected) and some rounding to the nearest whole percent.
	Figure E.3.1 following Page E.3.9	
E.19	1. Area under different land types do not agree with the data presented in Table E.3.7. Cultivated area appear to be 105,656 ha whereas Table E.3.7 show this to be 108,628.	The total in the figure is 108 600 ha - a reasonable rounding. The only discrepancy with Table E.3.7 is again in rounding to the nearest 100 ha. No action required.

Comment Nr	Comments from FPCO		Replies and Action
E.20	2.	Field duration of all crops (except B Aman) has been shown as 110 days. These vary from 90 to 120 + days for different crops.	This is only a generalised schematic diagram, and cannot show precise details for every crop. 110 days shown includes shorter periods and is a reasonable approximation. No action required.
E.21	3.	There is no logic grow Mixed Aus-Aman of F^1 land type, possible response of the farmers were not correctly interpreted. Moreover Table E.3.14 do not show this crop on F^1 land type.	The farmers surveys suggest the contrary. Timing and rate of rise of flooding may be a factor. Table E.3.14 does show this cropping. No action required.
E.22	4.	Photosensitive B Aman can not be harvested in September.	it is shown as being harvested in October. No action required.
E.23	**Page E.3-19:Table E.3.19**		
	1.	Source of the data has not been provided.	The source is given in the second sentence of section E 3.4.2, but has now been added to the table.
E.24	2.	Yield data of mixed aus-aman is on the high side. If this is accepted, there is not logic of controlling floods with huge investments.	There has been an error in transferring the yield from the surveys in Table E.I.8 (2.29 t/ha) to Table E.4.8 (2.92 t/ha). The full analysis has therefore been repeated using a figure of 2.3 t/ha.
E.25	3.	Human labour requirement of Mixed Aus-Aman is too high.	The figure has been adjusted in accordance with the reduced yield.
E.26	**4.**	**Table E.3.19** (a) Jute is totally omitted in post project condition. The area may be reduced, but total omission of Jute is not possible since has local demand also.	See reply to comment E.13. No action required.
E.27	**5.**	**Page E.3.2 Table E.3.2** The percentage shown in the land Tenure arrangement table seems not correct. This needs checking. Table E.3.3 Farm size category needs be corrected.	Agreed. This has been corrected. Agreed. This has now been corrected
E.28	**6.**	**Page E.11** Only 384 house hold out of about 4 lakh house hold have been surveyed only. Statistically if seems insufficient for evaluation of the project.	See reply to comment E.12.

Comment Nr	Comments from FPCO	Replies and Action
E.29	**7. E 3.19** (a) The heading of different tables should be marked pre or post project condition for easy identification. (b) Farm labour man days for Jute crop appears high. Generally it is below 200. This needs checking.	The table has been applied to both pre and post project conditions, its source (consultants' Farmers and Case Study Surveys) has now been added. The figure was obtained from farmers surveys, although from a limited number of respondents and this is a minor crop in the project area. The effect upon the overall analysis will be correspondingly small. No action required.
E.30	8. On completion of the project, the incremental Food grain production incremental net income, incremental agricultural employment, may be furnished zone-wise in the final report.	This information presented for the whole project area in Table J.6.7 of Annex J (and also in Table 15.9 of the Main Report). Table J.6.12 has been added to the economic annex to provide the requested data in the Annex J.
E.31	**Page E.4.3: Hydrodynamic model** 1. There is no "nine month" concept in the MPO land type classifications.	Noted. The text has been amended.
E.32	2. Present land types has been generated based on farmer survey whereas future land types has been generated using the hydrodynamic model results. These two sets of data not comparable. Ideally land type data before and with the proposed interventions should be generated using the hydrodynamic model for maintaining uniformity.	Present land types have also been generated using the hydrodynamic model results. The survey data was used to calibrate interpretation of those results for the without and with projects situations as discussed later in the section (pages E 4.7 to E 4.14). No action required.
E.33	**Page E 4-9: Last Para** Why not consider existing percent coverage of each cropping pattern of different land types and experiences of completed projects in making future projects.	This is the type of approach adopted see pages E.4-13 and E.4-14 for the four zones. However, to use experiences from completed projects would require us to model them, since our analysis of flood characteristics in relation to crop suitability considers timing and duration of flooding as well as peak depth (flood phasing). No action required.

Comment Nr	Comments from FPCO	Replies and Action
E.34	**Page E.4-13: Table E.4.6** Why should present and future without project be the same?	In the absence of any intervention the flooding constraints on cropping are unchanged. FWO cropping patterns only differ from the present when there is ongoing minor irrigation development - e.g. groundwater. No action required.
E.35	**E-4-14: Table E.4.3** Yield data used in the budgets are on the high side. These data should have been confirmed by taking crop cuts because yield data are one of the very important components of economic analysis. What about yield level when crops are damaged of floods or drainage congestion?	The yields are based on a substantial database other commentors seem to think future yields should be higher. With a data collection period of only 6 months crop cuts could have given results only for the aman crop in what was an unusually dry year. This was outside the scope of the ToR or the available inputs. Flood damage is discussed in Annex J where it is shown that yield adjustments were made in Zones B and C for the without project situation (ie lower yields as the commentator has suggested).
	Figure E.4.2 following page E.4.18	
E.36	1. Field duration of all crops (except B Aman) has been shown as 110 days. These vary from 90 to 120 + days for different crops.	See reply to comment E.20 above.
E.37	2. There is no logic to proposed Mixed Aus-Aman of F_1 land type.	See reply to comment E.21 above.
E.38	3. Photosensitive B Aman can not be harvested in September.	See reply to comment. E.22 above.

Comment Nr	Comment from Bangladesh Academy for Rural Development (BARD)	Replies and Action
E.39	It is an excellent report which elaborately narrates the present agricultural situation and indicates the possibility of future development in the area. However, the predictions made about the future potentials could have been better founded and more realistic if the sample size were larger and the crop suitability rating for all crops could have been done.	Thank you ! Re sample size, see reply to comment E.12. Any uncertainty in predictions on the minor (non-rice crops) is unlikely to affect the viability of the project. For crop suitability ratings see TAble E.2.5.
E.40	It has been estimated that there will be a rise in cropping intensity at different zones from 2.1 to 35.1 percent. However, availability of water in any project area, our experience suggests, leads to an increase in rice production and a decrease in the production of winter vegetables, pulses and spices. This results into an imbalance in our farming system. Any feasibility study would do a good job if this contradictions are highlighted and adjustment formulae is provided.	Noted. This is a national problem, which is probably best tackled by national projects, such as the Crop Diversification Project. The farmers' will naturally respond according to what they see as their best interests. Since winter vegetables and spices generally produce higher returns than boro they are unlikely to be affected.
E.41	Higher cropping intensity and adoption of modern agricultural practices will demand increased supply of draft power. But our studies indicate a depletion in the stock of draft animals. It will be of great use if an estimation of the probable increase in demand of draft power can be made and a suggestion for meeting the anticipated shortage in this sector can be incorporated.	Such a projection is given in Section E.5.1 of Annex E. See reply to comment E.6 re making up the shortfall using power tiller.
E.42	Agricultural development will be need a ready market for farm products, continuous supply of new technologies and an easy availability of farm supplies to keep the development moving. The Consultants would do a good job if some indications are given about these issues.	The constraints are recognised, but again this is a national problem, beyond the scope of the present study. The ASSP project is addressing these issues.

Comment Nr	Comments of the Dte of Land and Water Use BWDB	Replies and Action
E.43	1. **Page E.2.3** Area and percentage of different soil association may pleased be furnished in the Table E 2.2.	This has now been provided.
E.44	2. **E.2.6** The furnished table is very old, up-dated land capability and crop suitability needs to be included, in the Table.	The Consultants were unable to acquire more up to date data. See also reply to comment M.10. No action required.
E.45	3. **Page E.3.9 Fig E.3.1 and Fig E.4.2** The area under different crop sequence may please be furnished in tabular form both for pre and post project condition	Table E.I.4 in Appendix E.I shows the dominant existing cropping patterns, from the farmers surveys. In the case of F_1 land (for instance) the thirteen most important cropping patterns have been identified and these still account for only 59.4% of the total cropped area. Since there appears to be such a huge number of patterns practiced and indeed, farmers vary the pattern from one year to the next no attempt has been made to quantify the areas devoted to each pattern in the with and without project situation, but Figure E.3.1 and E.4.2 are intended to give a general impression of their relative significance. The with and without project % planted to each crop (i.e. the sum of all cropping patterns) for the four zones are presented in tables E.4.9 to E.4.12. No action required.

5. Annex F - Fisheries - Volume 5

Comment Nr	Comments from FPCO	Replies and Action
	Category 1	
F.1	Chapter F.1 Sub-Section F.1.1 (General) Para 5, page (p) F.1-1; It is said that a good assessment of the existing environmental situation is beyond the project's scope because of the time constraint. Time available for the study should be given.	Agreed and the consultants have made appropriate recommendations to remedy this No action required.
F.2	Chapter F.1 Sub-section F.1.2(Scope) Para 1, F.1-1: The objectives as required in ToR should be summarised well outlining the specific tasks relating to the study. The scope should cover the consultants cognizance of the on-going relevant studies including those of the FAP. How about the earlier investigations and records ?	This information is given the main report Volume I and is not repeated in all the Annexes. No action required.
F.3	Chapter F.1 Sub-section F.1.7 (fisheries Environment) para 3, p F.1-3: Table F.1.1 has limited the ponds to the cultured ones only. The culturable and the derelict ponds also contribute to and are potential sources of fish production in the project area. These should, therefore, be included in the quantification of ponds here.	As stated, the source of data only included cultured ponds data. This cannot be changed.
F.4	Chapter F.2 Sub-section F.2.1 (secondary data), para 1,p.F.2-1: For a report to be published in 1993, the latest set of data corresponding to 1988-89 cannot be accepted. How about the work done recently (DANIDA and other agencies)?	This only applies to the FRSS data. As explained elsewhere (Sections 2.2, 2.3) other sources were also used we agree that it would be preferable for more recent data from FRSS to be available but this is not under the control of the consultants. DANIDA's work does not cover all the project area. No action required.
F.5	Chapter F.2, Sub-section F.2.1, Para 3-5, P.F.2-1: It has been stated that in Bangladesh, comprehensive fisheries surveys for project studies are not possible with the allocated resources and that the validity of the FRSS data is questionable. Then what is the justification for spending millions of dollars if the reports are based on inadequate and unreliable data, for which the consultant must end up with wrong planning ?	As stated additional surveys and sources of data were used to supplement the existing data. The consultants do not consider that the planning is wrong.

Comment Nr	Comments from FPCO	Replies and Action
F.6	Chapter F.2 Sub-section F.2.2 (primary data), Paras 1-2 p.F.2-2: Here again, we come across the same problem inadequacy of data on the plea of time and resource constraints. Also, the field data that should have been collected during both the dry and the late monsoon period, have been collected during mid-October to early December 1992. Pond fish production has not been estimated from primary sources. The approach to data collection was not proper as per ToR.	The reason for the limitations on data collection have been clearly explained in the reports. The approach to data collection fully meets the revised ToR. No action required.
F.7	**Chapter F.2 Sub-section F.2.3 (Impact Assessment) p.F. 2-2:** The GPA of 1992 have not been followed for good ecological and/or biological cycles.	Impact Assessment is fully described in Appendix H and the GPA guidelines were followed except that the period of study was inadequate as already mentioned. No action required.
F.8	**Chapter F.2 Sub-section F.7.5 (Dev strategy) pp.F.7.2 to F.7-4** The development and strategies suggested are alright but who would do what, when and how ? There should be concrete proposals say for instance, to stop any further deterioration of fish stocks, to minimise conflicts between fishermen and others etc. The specific tasks of the present feasibility study include, among other things, the following:	The proposals made do include concrete proposals but additional measures suggested must await the results of the proposed additional studies (see Volume I chapter 11 and 12) No action required.
F.9	i. determine the design levels of embankments and drainage/supply khals, etc ii. establish design criteria and planning concepts, prepare project layouts, feasibility level engineering designs and drawings of relevant project components, etc. iii. prepare cost estimates of project works including annual expenditure schedules in both local and foreign exchange currencies. iv. prepare proposals for improving the institutional infrastructure (e.g. extension, research, credit, marketing and farmers organisation) in the area, and v. assessment of benefits for relevant project alternatives and evaluations of project economics. The above mentioned important tasks of the ToR ought to be done alright.	All these items (i to v) are fully dealt with in the various volumes of the report and are summarised in the main report Volume 1. No action required.

Comment Nr	Comments from FPCO	Replies and Action
	Category 2	
F.10	**Chapter 2, Sub-section F.2.5 (Hydraulic Model)** The model was used for estimating impacts on fish production. What method was followed for determining the impact on the fishing community ? And how has the reduction in area been determined ?	The social impact analysis is included in Annex G and the environmental effects including human environment in Annex H. The area reduction was determined from comparison of land areas having flood depths greater than F_0 in the "with" and "without" project situations. No action required.
F.11	**Chapter 3, section F.3 (Fisheries Production) Para 2-3, p.F. 3-1** How do these percentage contribution of capture and pond fisheries compare with those obtained in previous studies and elsewhere in Bangladesh ? This needs a special discussion, because the situation appears to be just the reverse here.	This is discussed later in the report. It may be noted that the 1991-92. TFO estimate for capture fisheries production is within 10% of that calculated from the sample catch assessment summary. Also as the study points out 1992 was an exceptionally poor year for capture fisheries in this area. Thus comparison with previous studies is of no real value

Comment Nr	Comments from FPCO	Replies and Action
	Chapter 3, Subsection F.3.5 (NGO) p.F.3-10	
F.12	What are the different fisheries development activities the different NGOs have been involved in ? Only the names of the NGOs and those of the area of operation do not serve the purpose.	This is one of the activities to be investigated during the proposed additional studies. it was beyond the scope of the present study. No action required
	Chapter 4, Subsection F.4.7 (species Composition) p.F.4-7	
F.13	Appendix F.3 provides useful data on the fish/shrimp species but this could be improved by the addition of the columns serial number of the species, name of taxon preceding the scientific name. That would have clearly indicated the total number of the species, general and families represented. Why do the Figures F.4.1, 4.2 and 4.3 show the major fish and prawn species occurring in the Gumti Project Area?	Appendix F IV gives the species. Additional information is given Annex D Chapter D5. The Fish species illustrations have been overlaid on the wrong title captions. This will be corrected.
	Chapter 5, section F.5.1 para 4, p.F.5-1	
F.14	Access for fish into the flood plains would be provided during April and May; but how about their return journey when the flood water will be receding? How about the month of June ?	The flap gates will be open most of the time in the period June to October allowing drainage of the area. However, velocities through the gates will sometimes be excessive for fish entering the area. No action required.
	Chapter 5, Subsection F 5.2.3 (Flood Plain) para 1, p.F.5-2	
F.15	How has it been estimated that 62% of the flood plain will be lost in the project area and a further 69% will be lost outside the project area ?	This is explained in section F.2.5 and also in Annex B. (see reply to question F.10 above) No action required.
	Chapter 6, Subsection F.6.1, para 1, p.F.6-1	
F.16	Have the benefits and disbenefits been estimated by comparing the (W) and (WO) project conditions ?	Yes. Table F 6.1 shows the numbers. No action required.
	Chapter 6, Subsection F.6.4.1 (Fishing Households), p.6-3	
F.17	How about the fishing rights, access to credit facilities average annual catch and per capita daily income of a fisherman?	Social aspects are discussed in Annex G. Credit facilities in Annex J which also discusses the estimated value of a fisherman's daily catch. No action required.

Comment Nr	Comments from FPCO	Replies and Action
	Chapter 7, (Mitigation), Subsection 7.2. (Gate Design and Operation)p.F.7-1	
F.18	How about the design criteria of Fish Passes that are to be incorporated in the hydraulic structures to reduce any adverse effect on the flood plain fisheries and what about operation of the hydraulic structures? The costs need to be shown for inclusion into the projects economic analyses.	For this project no fish passes have been incorporated as there is only one significant structure and this is being altered to improve access. No action required.
	Chapter 7, Subsection F.7.3 (culture Fisheries) p.F.7-2	
F.19	All the mitigation plans suggested should be clearly laid out and costed.	The costing and detailed application must awaits the result of the proposed additional studies. No action required.
	Chapter 7, Subsection F.7.4.1 (Gate Structures) p.F.7-2	
F.20	The measures recommended are in no way specific. How wide would be the overshot gates, what are the criteria migration periods, what should be the flow rate for allowing movement of fish of different sizes etc. What are the location of khal reexcavation.	Khal reexcavation locations are given in the report. There are no overshot gates in this project. The information on migration periods requires further study. No action required.
	Chapter 7, Subsection F.7.4.2 (Fish Bypass) p.F.7-2	
F.21	Recommendations should be specific. What should be the structural designs for fish bypass? Costing of the appropriate fish friendly structures should be provided.	No fish pass is recommended. The costing of the proposed structures is given in the Main Report and Annex I. No action required.
Comment Nr	**Comments from BARD**	**Replies and Action**
F.22	The report nicely highlighted the fishery development and its potential in the area. The information were collected on capture and culture fishery activity production level, nutritional implication and also fish marketing system. The report also made some recommendations for future plan of activities. It is a comprehensive report.	Thank you.
F.23	However, the status of pond fish culture practices in project area may be discussed in further details. It is necessary to discuss about NGO involvement on fisheries actives. Some discussed ont eh socio-economic acceptable development projects. While the views of the Thana prevailing at the farmers' level. It is equally important to indicate the problems of transfer of fisheries technology to the farmers level. The ensures to elicit peoples participation on project activities may be discussed elaborately.	Pond culture was investigated through a questionnaire survey of 96 operators. See Appendix E.11 of the Agro-socio-economic survey. As indicated by the ToR the emphasis for this study was on capture fisheries. Measures to elicit people's participation are described in Annex G and the Main Report.

Comment Nr	Comments from FPCO	Replies & Action
	General Comments	
G.1	61. The objectives of this report should also include testing strengths and weaknesses of GPP in light of the Field Work	This was not an objective in the ToR, but effectively this is what has happened. No action required.
	Specific Category 2	
G.2	62. G.2-23 Para 3 The idea seems attractive, but how one goes about in implementing the idea?	The development proposals should ensure that the numbers of such people is reduced and hopefully eliminated (i.e. the polarisation process can be reversed by development)
G.3	64. Page G.2-32 Bullet 3 Who is responsible for O&M of these tubewells ?	Sometimes DPHS/LGED but after these are private wells maintained by the owners.
G.4	65. Page G.3-2 para 3, sentence 4 What is the possibility of using village matbors and doctors?	Yes, these people also have a role to play.
G.5	66. Page G.4-2 section G.4.3, Para 1, line 1 Is this argument came from all sections of the people or it is limited to farming groups only?	From both farmers and from agricultural labourers. These groups together comprise a majority of the population.
G.6	67. Page G.4-16 bullet 2 How much a woman should expect as her daily wage ?	Under SRP the canal maintenance groups are proposed as all male because of the heavy nature of the work. However if women's groups are envisaged one would expect the same pay for the same performance.
G.7	68. Page 4-17, section G.4.5.3 Do the consultants believe that this methodology can be used by concerned officials? or they need some training for the purpose before they are given this assignment.	The proposals suggest this is done through NGOs who will need to train the staff themselves.
G.8	69. Page G4-17, section 4.5.3 para 2 This suggestion should work, but under the prevailing condition a very high level political decision is needed for the purpose and follow up of the decision.	Correct
G.9	70. Page 4-17, bullet 1 All these recommendations pre-suppose the existence of committed persons involved in project implementation. Is it really so?	The appointed consultants and NGO(s) are required to achieve their ToR - hence commitment should not be lacking.

Comment Nr	Comments from FPCO	Replies and action
G.10	71. Page 4-18, Bullet 1 Is it possible under conditions of a high level illiteracy?	Although not easy it has been achieved in other countries (e.g. Philippines, Indonesia)
G.11	72. Page G4-20, para 3 The idea is well taken. This raise another issue, i.e. of NGOs by necessity takes over most, if not all, developmental activities, the role and functions of Local Government Institutions for development work will be squeezed if not made redundant? The question remains then what will happened if all NGOs depending on foreign aid does not receive any or little aid from donors?	This could happen but need not do so if NGO operates sensibly. If would be counter productive to ignore local government. The proposals suggest that resources are channelled to NGOs.
	Category - 3	
G.12	73. G 2-7 Table G.2.6 Any data available on the school drop out rate of the region in terms gender, family size and economic condition?	This data was not collected for this study.
G.13	74. G 2-18 Section Shamaj Organisation What role if any, the consultants found, as played by the Samaj in matters of floods and water management?	None identified.
G.14	75. Page G.2-24 Bullet 1 To what extent coordination in the programme implementation and cooperation exists between GoB programme personnel and NGO activities ?	No details are known in this respect. Cooperation will be needed at design stage.
G.15	76. Page G.2.4-2, Women in the project area The section offers few answers but raises many	This section is only a discussion of the existing situation. Proposals come later.
G.16	77. Page G.2-25 G.2.4.2 para 1, last sentence What about migration within the country?	Yes, this also occurs
G.17	78. Culturally defined women in "ideal family" with Purdah seems to be in conflict with the concept of women in development, now being pursued by various NGOs and the GoB. How does this modern project concept is coping with the traditional and strong conservatism?	See section 2.4.5.

Comment Nr	Comments from FPCO	Replies and Action
G.18	79. P2-26, Table G.2.22 When women are bound by Purdah system and at the same time how they attained higher level of literacy even incomparision with male population? The given explanation does not help in understanding the phenomenon.	The figures show that the women's literacy rate is still below that of men. However, purdah affects young girls at school much less than adult females and therefore has less effect on literacy rate.
G.19	80. G 2-26, Table G.2.22 Does this literacy include religious education? If so, what is the proportion of literates representing only madrasah educated literacy and the rest?	Information not available
G.20	81. Page G 2-26 para 2 How international migration contributes to higher literacy rate among women?	It does not do so directly but the explanation is given within the paragraph.
G.21	82. Page G 2-26 last sentence This finding seems to contradict findings of other literacy related studies of Bangladesh. Generally the latter studies show that boys go to school. Girls remain at home to help their mother with household work and taking care of younger siblings. This is a very unusual finding. Is it possible to explain phenomenon?	Again explanations offered in the second paragraph of page G2-26.
G.22	83. Page G 2-29, Table G.2.24 It is not clear whether the division as shown in the table related to work of women's own home or outside her home from which she gets remuneration both booth in cash and kind.	It is clearly stated that few women get remuneration (most are therefore contributing to family labour requirements) Also most remuneration, where it occurs, is in kind (Also see page G 2.31).
G.23	84. Page G 2-31 Table G.2.27 Third column, 1st line Is wheat locally grown in the Family Farm? or it is bought from the market for paying wages of the labour?	The table says wheat or rice and the latter is more common. Probably all remuneration is of local origin.
G.24	85. Page G 2-32 Para 3 How far the motivation programme of NGO or GoB is accepted by the people? or is it effective at all?	The paragraphs shows that there has been a 22% increase quite good acceptance and effectiveness.
G.25	86. Page G 2-32, last but one para. Last but one sentence Why tubewells were not sunk on this side of the embankment? Is it due to the official policy?	Tubewells outside embankments would be susceptible to flooding with saline waters.

Comment Nr	Comments from FPCO	Replies and Action
G.26	87. Page G 2.36 para 5 Is there a scope for NGOs to help women in marketing their handicrafts?	Yes.
G.27	88. Page G 2.-36 para 7 When read with para 8 one may get confused. In para seven there appears to be no interest of women on wage earning job, but para 8 gives an impression that women needs motivation for work. This needs clarification.	It is being said that wages offered by rich families are insufficient motivation. However BRDB and NGOS succeed by offering better rewards.
G.28	89. Page G 20-38 Para 2 Is BRDB's self claimed success story is needed here? What is needed is a balanced evaluation of BRDB projects.	Such an evaluation was not possible with the resources available.
G.29	90. Page G 2-38, para 3 Comilla Model is much older than a quarter of century. It began in early sixties.	Yes, but the publication referred to here describes a quarter of a century of experience.
G.30	91. Page G.2-39 While making an evaluation of Comilla project one must take into account that the institution was founded and run by Dr Akhtar Hamid Khan, a earthwhile Member of CSP/ICS bureaucratic system. His success was in his personal commitment, dedication and personal dream, added with his personal influence on the civil service. he got a significant amount of support that he needed for initiating, implementing and running the project.	Agreed. Similarly support of committed personnel is required for success of most projects (See comment G.9).
G.31	92. Table G.2-30 Why so many NGOs are concentrating on Sudharam?	It is one of the poorest areas.
G.32	93. Page G.3.1 section G.3.1 para 3, line 1 Which guideline? Is it the GPP.	No. The guidelines referred to here are those attached to the ToR for the study.
G.33	94. Page G.3-2 section G.3.2 Public participation under the official auspicious is not a new concept in this land. Since really 50s the UN initiated urban community development projects and later in early sixties Comilla Academy based their project implementation process on the principle or peoples right to decide on projects that affects their life.	Perhaps this should be rephrased as "Public participation as proposed for the FAP ...."

Comment Nr	Comments from FPCO	Replies and action
G.34	95. Page G.3-3 bullet 2 Were the people asked if they have done anything regarding water related problem? If so, what did they really do about it?	No
G.35	96. Page G 3-7 Did the local BWDB officials attend any of these people's participatory meetings? It is they who are expected to run the project on the principle of people's participation.	No. at this stage the consultants wanted opinions not affected by presence of officials.
G.36	97. Page G 3-8, section G 3.4.4 To what extent local MPs are involved in and are motivated to the cause of regional flood problem.	Only five MPs of the region attended the meeting.
G.37	98. Page G 4-3, para 5 A point to ponder, particularly, the issue of formation of project committees.	Agreed. It is important. Practice is more difficult than establishing a methodology.
G.38	99. Page G 4-16 para 3 The suggestion as given here is vague. It needs elaboration.	This is elaborated in the main report, chapter 13 and 14.

Comment Nr	Comments from BARD	Replies and Action
G.39	This study observes that this project area has a high density of population, low level of education, poor housing and sanitation, skewed income distribution and acute poverty. The consultants made references to various studies to include that the traditional social structures have been supplanted by multiple ties of clientatlism, but Samaj linkages are still used as an important instrument for mobilising support in local level politics. They have also observed a patron-client relationship to have been existing in the area and this is manifested in the mechanism of land transfer, share cropping and other economic transactions. Special emphasis was given to Women's Profile' It was observed that the women have a fairly large number of roles to play. They have a major role in post-harvest operation. Poorer among them have been working in various NGOs and different projects.	No reply required
G.40	With regard to public participation in the planning process, the Consultants met the local people in three rounds in nine meetings to elicit public opinion about the project.They also had a seminar at BARD with the Member of Parliament of the region. The local people indicated, among other things, the problems of poor drainage during the monsoon and lack of irrigation water during the Boro season. Reexcavation of local 'khal' both for irrigation and drainage was suggested at all locations.	NO reply required
G.41	With regard to perception of benefits from these projects it was indicated that the project would help raising cropping intensity and production and reducing flood damage. It was also envisaged that it would help initiate a process of socio-economic development. It was suggested that the institutional framework must be appropriately chosen to avoid mis-management and poor quality of work.	No reply required

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Comment Nr	Comments from BARD	Replies and Action
G.42	There should be no difference of opinion on the issue of developing appropriate institutional framework for the implementation of any project of this type. We agree with the suggestion that in areas where no such institutions are existing, they should be built and developed during the detailed design phase as part of the people's participation components. The local government institution which have not been adequately touched upon in this study may play an important role in mobilising local resources, including labour, and planning of micro-level smaller schemes. Similarly, if villages samaj is identified as an important non-formal institutions it will be to the benefit of this project if some measures for its involvement in planning and development are incorporated in this scheme. It has been observed that such projects suffer from lack of proper maintenance after their initial start. There should be some measures to capture a part of the incremental benefit for maintenance of the structures. The local beneficiaries may be encouraged to form their own associations for the purpose.	The main report, chapter 8 described local government institutions as well as Annex G. The proposals for participation at implementation and O&M stages are given in Annex G and also in chapters 13 and 14 of the Main Report where proposals for beneficiary group formation and for cost recovery are included. No action required
G.43	Given the existing socio-economic conditions of the rural women and the anticipated changes in their roles as a result of the implementation of the project it is necessary to devise appropriate organisational and technological measures for their greater and more meaningful participation in the development process of the area.	Proposals are made for this and the continuing peoples participation programme envisaged should ensure that this occurs.
G.44	The experience of BARD, BRD, Grameen Bank and other NGOs may be useful in this respect.	Agreed.

7. Annex H - Envrionmental Impact Assessment Volume 7

Comment Nr	Comments from FPCO	Replies and action
H.1	Vol 7. Annex-H has been a good report given the time and resource constraints mentioned in the forward. It has been however agreed in the forward that the present work is not a full scale EIA. Why?	Because the project schedule and resource limitations precluded a full year of data collection.
H.2	Once again I wish to clarify the same old thing that I had been pressing i.e. Ecology standing alone in a report means little or nothing to a professional or decision maker and may kindly be avoided. What is the difficulty in following the EIA guideline which supersede Environment part Multicriteria Guideline for Project Assessment is not yet clear to me. In one hand the consultants complain of inadequate resources to produce a credible EIA report, and on the other hand they tend to waste time and energy in unnecessary for reports.	The GPA guidelines suggest separate annexes for SIA and E.A and the role of EIA is to produce an integrated assessment. If this now not intended then perhaps the GPA should be suitably amended? All the information in Annex D is reqyured so there is little saving by combining with another Annex.
H.3	Generally speaking the Table of Contents contain most of the important aspects expected to be covered. One point is not clear to me as to why H.5.2 Environment Management Plan should be a subsection under H.5 Impact mitigation and Environmental Management Plan. EIA Guideline clearly delineates that mitigation, enhancement, residual impacts, contingency plan all forms part of Management plan and should be viewed as such. Details of public participation could not be traced in the report. Environment Project has been very well presented particularly the surface water Flood Zoning, river morphology, land capability soil types, population, landlessness, literacy, agricultural activity etc.	Public participation is dealt with in detail in Annex G and is summarised in the main report. Thank you.
H.4	The report received disproportionate weigthage to Fisheries compared to Fuel, fodder and live-stock. The scanty treatment of this very important aspect undermined the quality of the report. EMP has not adequately addressed these issues as well. Present availability, future scenario with population growth and how much and to meet those needs are absolutely absent in quantitative terms unlike fisheries. Some important items like economic activities present and future in transportation, growth/ trading centers. agro-industrial growth, imperatives and impediments of human resources development etc, have not been covered at all.	It is considered that the relative importance and weightage is probably about right for reasons fully explained in the report. The agricultural Annex E described the increased quantity of straw expected. The other aspects are also discussed in other volumes.
H.5	One fact may be adequately made clear that EIA is a feasibility level initiative. Based on EIA outcome decision on further work-detail design part is expected to be taken up.	Agreed No action required.

Comment Nr	Comments from FPCO	Replies and action
H.6	Appendix H. IV and Appendix H.V are good additions. Water quality data on a spread sheet standing alone without the consultant's interpretation did not mean much in a number of past reports reviewed. However, the interpretation could have been elaborated and their impacts over time could be assessed.	The interpretation is included in the report. Impacts over time are impossible to assess at this time. No action required.
H.7	**P H 2-8** Writing up in the lower part - however balanced the inorganic fertilizer applications are made, high productivity can only be achieved by ensuring organic fertilizer in the soil (percentage varies for different soils and crops) - Ref BARC Study.	Agreed No action required
H.8	**P H.2-18, sub-section H.2.3.8.** Livestock why introduction of power tiller should raise issues concerning agricultural sustainability is not all clear to me.	Power tillers use fossil fuels whereas livestock use renewable resources. However this is not serious as is stated in the report. No action required.
H.9	**P H.2-21 Sub-section H.2.4.1.** It appeared to me that there is a settle reference to Ganges barrage and it is not clear to me how that initiative is going to have external influence on the project under review.	There is no reference to Ganges barrage but only reference to possible future projects in India. No action required.
H.10	**Fig H.3.16** Environmental Rating Matrix of proposed intervention appeared to me in some places as wishful thinking. Why due to project implementation groundwater availability and drinking water supply should slightly deteriorate ? Is it that the prolonged impounding will be taken care of ? Why fuelwood should be severely affected but fodder should slightly improve. Is due to more HYV? Quite questionable. Forestry and fuelwood instead of such a dismal picture should improve really.	The matrix shows no differential between the future without project situation and the with project state for groundwater. Fodder is improved by additional crop residue production. However this is not so for fuelwood. The slight decline (not severe) is due to increased land clearance with intensification of agriculture.
H.11	**P H.5-3 Section H.5.2** Why an EMP is not normally considered justifiable until a firm commitment has been made to undertake further study (the following step after feasibility is detailed design) is not understandable to me. Resource constraint is one aspect but EMP should not carried out until receiving commitment is an un-acceptable statement. From all the impacts and analysis presented in this report, I would tend to conclude that the proposed project intervention is quite desirable.	Agreed The penultimate sentence will be deleted.
H.12	A very exhaustive Bibliography has been annexed though there are still more publications remain to be mentioned, which will always be so.	Agreed No action required.

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8. Annex I - Engineering - Volume 8

Comment Nr	Comments from FPCO	Replies and action
I.1	1. The entire area South of the Comilla-Daudkandi road upto Noakhali in the North-South direction and from the Meghna to India border in the east west direction is hydraulically inter related. Therefore it is not clear as to how an area like the NN project can achieve full drainage benefit without being interfered from other areas. Will the Consultant explain the present and the future hydraulic condition in the entire area with the special context of the NN area.	The entire sub-regional drainage system as described in the comment has been included within the South East Regional Model (See Figure B.2.10 of Annex B, Hydrology and Hydraulic Modelling), and the interactions within this drainage system are therefore fully represented. However, the model results have only been studied in detail and converted to flooding characteristics within and adjacent to the project area (a portion of the lower Little Feni basin and areas north of the Dakatia was also studied), as shown in Figure B.4.2 in Annex B. The effects of the proposals on the area north of the Dakatia River are small, whilst it was concluded from model runs that the interaction between the project area and the Little Feni basin was negligible (Section B.7.5 of Annex B).
I.2	2. **Page 1.1-4 sl (1) Figure 1.1.4** It appears that the consultant did not comment on the differences in land levels in the sample Area 3 between the Land Level Data base and the Sample Area survey specially for the land above 3.75 m. The reason for the apparent difference may be explained.	The differences in land levels for sample Area 3 were actually viewed more in terms of a discrepancy in net cultivable area and were discussed under the next item (ii) on page I 1-4. The 16% increase in NCA between the land level database (pre 1969) and the 1992/93 sample area survey is almost certainly spurious, arising from local difficulty in interpreting the non-arable areas from the 1:30000 aerial photography (see section I.1.1.2). If the curves in Figure I.1.4 were adjusted so as more or less to equalise the NCA, the apparent descrepancy in elevations would be much reduced.
I.3	3. **Page 1.1-11, 1st para** The consultant has proposed a regulator on the Noakhali Khal. It is necessary to explain the possible morphological effect of the structure in the downstream. As in case of other structures in coastal area whether this will also be blocked by siltation and if so what is the remedial measure and whether this can be economically justified.	See reply to comments M.17 and M.39.

Comment Nr	Comments from FPCO	Replies and action
I.4	4. **Page 1.1-12 sec 1.1.4** In this section the consultant has tried to establish, after analysing the salinity data used in the NWP I and II, that there is a clear declining trend in salinity level during the dry season. What the consultant has told here emphatically has been told cautiously in NWP-II (Ref Page 3-37 para 2 and 3). Even in this section (1st sentence) the consultant has accepted that there is little data available to draw a definite conclusion. That the NWP-II analysis cannot be fully relied upon may be proved from the Table 3-20 (NWP-II Vol 1), where it has been shown that the salinity at Chandpur has been increased by 33% from NWP-I to NWP-II in April while those of Ilshaghat, Dhulia in the down stream have decreased by more than 20%. How these can be justified. It is probably because of these anomalies the NWP-II has concluded that the maximum salinity are related to factors other than changes in discharge. Therefore, it needs further study and data collection before drawing any definite conclusion. It is may be further added that the location of Rahmatkhali is about 10 km upstream of Ilshaghat. Therefore, salinity of Rahmatkhali should be lower than Ilshaghat. This section may be re-written according to the above discussion.	The NWP data for Ilshaghat (up to 1989) has been supplemented by an additional 3 years of data from the same station together with data for 1991 and 1992 collected by SWMC downstream of Rahmatkhali Regulator. The additional data confirms the downward trend in salinity since 1976, which the consultant feels is quite convincingly portrayed in Figure I.1.22. It should be noted that apart from the SWMC data, these are instantaneous peak salinities, and the average will be much lower. With reference to the salinities at Chandpur increasing from 180μs/cm to 240μs/cm between NWP I and NWP II both these levels are comparable with the background conductivity level in the Brahmaputra River ("Southwest Regional Plan, Supplement E, Saline Intrusion and Tidal Hydraulics", quoted in "Technical Note on Salinity Conditions in Lower Meghna Estuary, SWMC 1991). This small increase (60μs/cm) in what is in any case a very low level of salinity is therefore insignificant compared with the decreasing trend further downstream. The Consultants trust the above discussion adequately clarifies the matter without the need for rewriting the section.
I.5	5. **Engineering Cost** Engineering costs are in general, found to be responsible	Noted. Thank you.

Comment Nr	Comments from FPCO	Replies and action
I.6	6. **1.4-5 Sl(II)** It is stated that the stilling basin is dropped down to 4.5m to increase the Froude Number to 4.5. It is necessary to explain how lowering the stilling basin level will increase this Froude Nr. What is the effect of the Tail water depth and how this will work in this particular case.	The finer details of the hydraulic design are probably more appropriately left to the detailed design stage. However a brief explanation is given here. Under condition of high tailwater depth, no hydraulic jump will occur, and energy dissipation will be by turbulentt mixing. In this case, consideration of Froude number is not important. The critical design situation was considered to be when the tailwater level is low enough to permit a jump to form (greater head-loss, more energy to dissipate). For a stable jump, with optimum energy dissipation, the Froude number of the incoming jet should exceed 4.5, and one way of achieving this is by increasing the fall from gate sill to stilling basin floor - i.e. dropping the stilling basin. Another important consideration is that the tailwater depth should be adequate to retain the jump within the basin under all conditions - again this can be achieved by lowering the basin floor.
I.7	It is further stated that the floor thickness were determined by finding the uplift pressure from Khosla etc. In this case question arises whether the floor is designated as mass concrete or re-inforced. In the latter case the structure as a whole will withstand this hydrostatic pressure making it cheaper.	The observation on uplift pressures is quite correct. However, the mass concrete floor thickness shown in Figure I.4.6 does not seem unusual for a structure of this type. There are difficulties in both the design and construction of a major structure like this in reinforced concrete as a rigid monolith (or more economically, as a flexible structure on a flexible foundation), but this option may certainly be examined at the detailed design stage, although it may not necessarily be cheaper. No action required.
I.8	7. **Page 1.4-16 sl (II) Drainage and Figures 1.4.14 & 1.4.15** Figure 1.4.14 and Figure 1.4.15 shows that there is a significant improvement of flood phase under without and with project condition. This can be achieved even without closing the inflows from the Dakatia. It is necessary to elaborate how they can be achieved without closing the inflow from the Dakatia.	The modelling and Hyrodynamic analyses are described in Annex B in detail. However it may be briefly stated that the main improvements are in the southern parts of the project area gradually diminishing to the north. The drainage through Rahmatkhali regulator creates a gradient across the area but reduces flood levels on the Dakatia only slightly thus only slightly increasing Meghna inflows at peak high tides.

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Comment Nr	Comment from BARD	Replies and action
I.9	We agree with the Consultant that the existing minor irrigation facilities are not sufficient to improve the cropping intensity in the project area and that emphasis should be given on surface water irrigation by developing the existing khals and channels. However, most of the re-excavation works will need manual labour which can be provided by local organisation like the Union Parishads, Co-operatives and NGOsd. The importance attached to thee institutional arrangement for beneficiary participation at the design stage can hardly be over emphasized.	Agreed. This matter has been discussed in some detail in Section G.4.5 of Annex G and the Main Report (Chapters 11 to 14).
I.10	The suggestion for taking representation from the concerned central and local government agencies and their officials, and also from elected public representatives and disadvantaged groups at the PCC deserves special consideration. Participation of local people/ institution will help mobilize local resources and will generate employment for the local people.	Noted and agreed.
I.11	It is our experience that this kind of project suffers from lack of proper maintenance. There should be provisions for involving the beneficiary groups for maintenance of work through proper training and supervision. These operation and maintenance works can be done through cost-recovery system. Though this system will be a burden for the poor beneficiary group, it will be helpful for the sustainability of the project. However, for this sustainability the farmers of the project area must be organised in cooperatives or similar other groups and training programmes should be organised for these. Government, non-government and local agencies may be encouraged to come forward with their resources for successful implementation of the project.	These aspects are also discussed in Section 14.3 of the Main Report and Section G.4.5 of Annex G. No action required.

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9. Annex J Economics - Volume 9

Comment Nr	Comment from FPCO	Replies and Action
J.1	The Report has broadly followed much in herewith Gumti Phase II Feasibility Study, the approach outlined in GPA (1992). However, the Report Suffer from similar deficiencies as these of Gumti Phase II Report, in addition to some additional mistakes. These are noted below:	
J.2	(a) The Report is a feasibility study of the Noakhali North Drainage and Irrigation project but one gets a misheading idea in the very first sentence of Report where it refers to Gumti Phase II project area. This effects utter carelessness on the part of the consultants and needs correction right away.	Editing error. This will be corrected.
J.3	(b) GPA has presented two estimates for shadow wage conversion for unskilled labour - 0.75 for unskilled labour used in crop production and 0.65 for unskilled labour employed in project construction. The consultants, however, mentions (page J-1-1) only same conversion factor has used for economic evaluation of both project costs and farm income. This needs clarification.	The reference item 10 on page J 1-2 will be changed Both rates have been used as per GPA. See table J.2.1 for agricultural costs and table J.2.2 for construction costs.
J.4	(c) It is not understood., as mentioned in page J.1-3 of the Report. why quantitive estimated of such parameters as increments in crop production and decline in fish catches gives indication of the order of indirect benefits and costs. Clearly, they represent direct benefit and cost of project intervention.	The text will be amended to clarify the points.
J.5	(d) It is not clear why the financial prices of agricultural products and inputs as recorded. In Table J.2.1 are identical of those recorded for Gumti Phase I study. Since these prices re locations specific reflecting local demand and supply conditions, one would expect them to differ for the projects - Noakhali North and Gumti Phase II - as these are located in different area. This needs clarification.	The two projects are not far distant from each other. As stated data were collected from three producer markets and two wholesale markets and the results were not consistently different, so as to justify use of different prices. No action required.
J.6	(e) It is not understood why Gumti Phase II appears at the top of Table J.2.10 of the Report as dealing with feasibility study of Noakhali North Project. Also, it is not clear whether the BBS yield figures are representative of the project area. If so, then they should differ from those of the Gumti Phase II, which actually does in the two reposts. However, in J.2.11 of the Reports, the BBS yield figures (average of 1989-91) do not differ in the two Reports. Why this so?	The "Gumti Phase II" label is an error and will be removed. The yields used in the budgets do differ. The BBS figures are wrong in Table J.2.11 and will be corrected to conform with those in Table J.2.10.

Comment Nr	Comment from FPCO	Replies and Action
J.7	(f) The consultants should have elaborated while describing the estimation of both crop and non-crop damage due to flooding how they have actually devised the annual expected value of flood damage using flood frequency analysis as outlined in GPA.	See reply to comment E.15. The consultants consider that the best use has been made of the available data (primary and secondary). Additional explanatory sentences have been added to the text. No action required.
J.8	(g) It is not clear why the cropping pattern changes as recorded in Table J.4.1 where estimated for two cases - 10 years and 30 years, when this does not meat any differences at all in the figures. This needs clarification.	This table is a standard output from the economic model devised for both the Gumti Phase II and Noakhali North Studies. In the case of Gumti Phase II, private sector minor irrigation development gives rise to different cropping figures at 10 and 30 years, but this does not apply in Noakhali North. The surplus columns have now been deleted.
	Comments from BARD	
J.9	It appears from the consultant's observations that the project will establish a sound irrigation and drainage system in the project area. This will help change cropping pattern and increase cropping intensity. But other crops like vegetables, oil seeds and pulses are important consumption and each crops which need to be considered for a balanced crop diversification programme.	See reply to BARD comment on Annex E (E.40) Agriculture.
J.10	Construction of flood control embankments/ drainage work will divide the flooded area and reduce fish production. Ultimately landless and poor fishermen will be rendered unemployed. Alternative employment opportunities for these people may please ne indicated. it will be useful if some alternative scopes for productive investment of the fund received as compensation can be identified. Similar issues like expansion of market, increase of employment for overall development of project areas etc. may also be considered before implementation of the project	These aspects are described in Section 11.5.1 of the main report, but in any case it should be noted that the proposed project does not involve building embankment.