PART - B

NOLER CHAR DEVELOPMENT PLAN

TABLE OF CONTENTS

Page No.

Page No.

FIGURE

PART-B
NOLER CHAR DEVELOPMENT PLAN

CHAPTER-1: INTRODUCTION

1.1 Background

Noler Char is a fairly stable and developed new char at the south-ward extension of accreted char lands in Southern Noakhali in the vicinity of Boyer Char. The char requiring empolderment as demanded by local people needs to be developed to provide, mainly protection to the agricultural land from saline tidal inundation/flood.

Land Reclamation Project (1978-1991) of the Government of Bangladesh developed Char Baggardona as a pilot multi-sectoral rural development project with Dutch Technical Assistance. As a continuation, Char Development and Settlement Project (CDSP) came in 1994, also with Dutch Technical Assistance, for implementation of Baggardona-II, Char Batir Teck, Char Majid, Char Maradona, Muhuri Char and Boyer Char under CDSP-I & II. Present Plan preparation (Part B – Noler Char Development Plan) is a part of "Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char under CDSP-III".

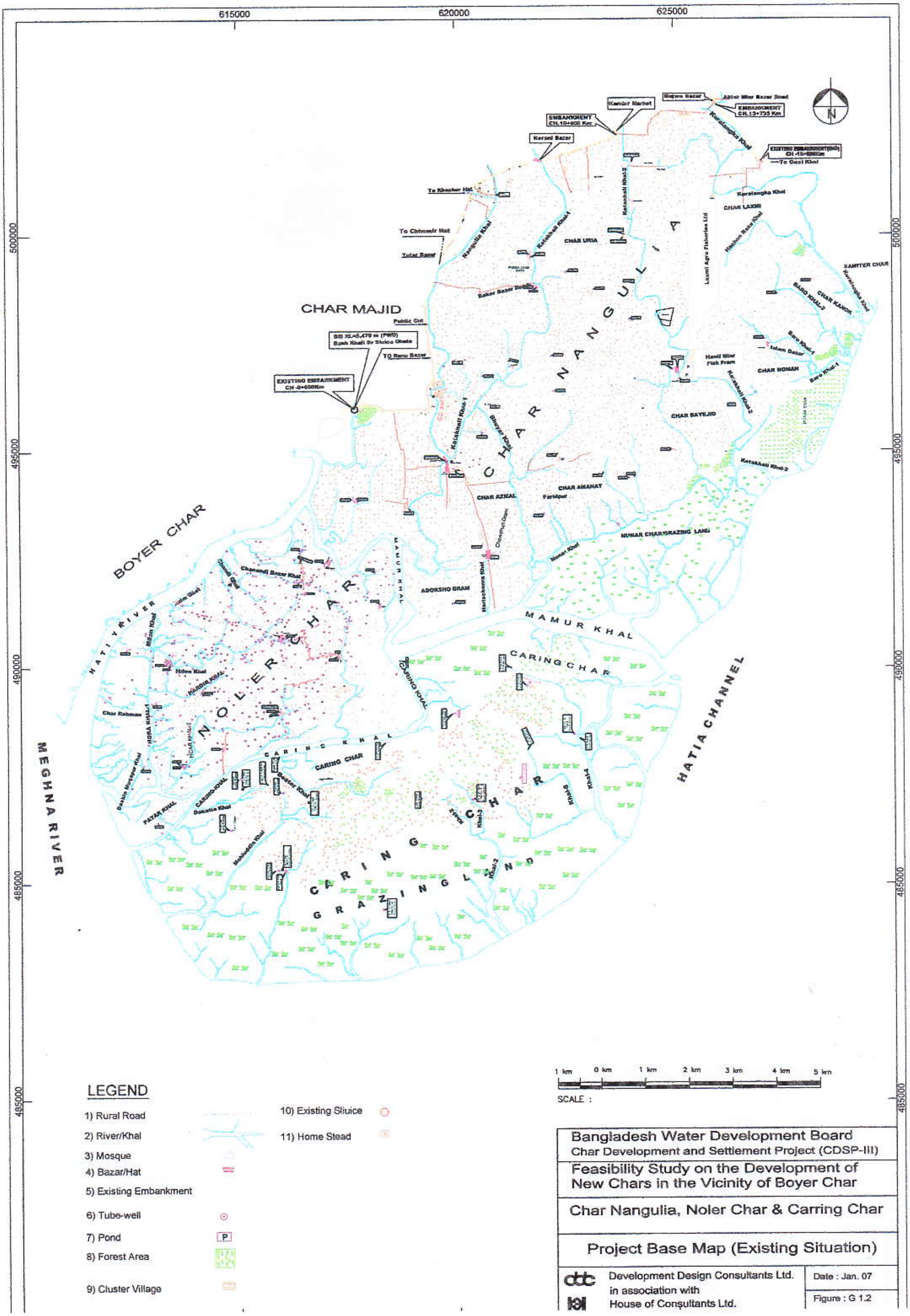
1.2 Plan Area

The Plan area falls in Hatiya, Upazila of Noakhali District. The Union is Chanandi in Hatiya Upazila.

It has a total land area of 2691 ha. Agriculture of the area is affected by saline tidal inundation/flood and soil salinity. The area is crises-crossed by numerous tidal channels and creeks. The plan area is shown in Fig. G 1.2.

1.3 Objective of the Plan

The main objective of the Development Plan is to provide protection of the area from saline tidal inundation/flood and land settlement to landless farmers and providing CDSP type rural development. The physical interventions would include peripheral embankment with drainage sluice, rural road including bridge/culverts, multipurpose Cyclone Shelter and sanitary and water supply facilities.



615000
620000
625000
500000
495000
490000
485000
CHAR MAJID
BOYER CHAR
CHAR NANGULIA
NOLER CHAR
CARING CHAR
CARING GRAZING LAND
MAMUR KHAL
HATIA CHANNEL
MEGHNA RIVER
HATIYA RIVER
CHAR URIA
CHAR LAXMI
CHAR BAYEJID
CHAR AMANAT
CHAR AZKAL
CHAR HOMAN
CHAR KAMOR
SAMITTER CHAR
ADORSHO GRAM
Katakhali Khal-1
Katakhali Khal-2
Baker Bazar
To Khasher Hat
To Chhomir Hat
Tatar Bazar
Public Cut
EXISTING EMBANKMENT CH -0+000Km
HATIA CHANNEL
LEGEND
1) Rural Road
2) River/Khal
3) Mosque
4) Bazar/Hat
5) Existing Embankment
6) Tube-well
7) Pond
8) Forest Area
9) Cluster Village
10) Existing Sluice
11) Home Stead
1 km 0 km 1 km 2 km 3 km 4 km 5 km
SCALE :
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)
Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char
Char Nangulia, Noler Char & Carring Char
Project Base Map (Existing Situation)
Development Design Consultants Ltd. in association with House of Consultants Ltd.
Date : Jan. 07
Figure : G 1.2

CHAPTER – 2: SUEVEY AND INVESTIGATION

2.1 Engineering Surveys

Engineering Surveys include Bench Mark Survey, Topographical Survey, River and Khal Survey and Embankment and Road Survey.

2.1.1 Bench Mark Survey

Bench Mark (BM) values have been carried to the permanent objects within the project area from the nearest available permanent Bench Mark (PWD).

One permanent BM has been set up by CDSP / BWDB at the Bashkhali sluice site in Char Majid Polder having a value of 5.479(m PWD). BM and TBM values of the study area are presented in table 2.1 and Map (Fig. G 2.1.1 in Enclosure-1, Annexure Volume).

2.1.2 Topographical Survey

BM set up by CDSP at the Bashkhali sluice in Char Majid Polder was connected by GPS measurement, with an accuracy below 5-10 cm per 100 km (both horizontally and vertically) to get the horizontal co-ordinates for accurate positioning in the study area and are used as control points for carrying out Survey for producing correct topographical maps.

Detail Survey was carried out in the areas of Noler Char. The existing features such as rivers/khals, river banks, ponds, roads, houses and mangrove areas, location of existing Tube-wells etc. have been taken by offset methods.

100m X 100m size grid surveys have been carried out in Noler Char. Land levels related to PWD levels at each grid have been taken, where abrupt changes of land profile have been found.

Topographical maps of Noler Char is presented in Fig.B 2.1.2 (Enclosure-1, Annnexure Volume).

2.1.3 Embankment/Road survey

Longitudinal and cross-section surveys were carried out for the existing roads of Noler Char. The proposed flood embankment cum feeder road along with the proposed internal road network system empoldering Noler Char were also surveyed.

For the long section, spot levels along the centre line of the alignment of proposed embankment/road have been taken at 100m intervals or closer, depending on ground profile. Levels at closer intervals have been taken to represent the actual profile of depressions, raised grounds and khals crossing the embankment/road alignment.

For proposed embankment/road, cross-sections have been taken at 100 m intervals or closer, depending on ground profile and extending over 10m or more and at 10m apart or closer at abrupt changes depending upon field condition with spot levels. Three cross-sections have been taken for a khal crossing the embankment/road alignment, one along the deepest level of khal and the other two along the banks of the khal.

The list of Embankment and Road surveyed is given in Table B 2.1.3.

Table B 2.1.3 : List of Embankment and Roads Surveyed

Sl. No.	Description of Embankment/Road	Length (Km)
1	**Embankment :** Proposed embankment cum feeder road:	
	(a) Sea dyke from off-take of Caring khal with Mamur Khal to Millon khal (outfall), Ch. 0.00 – 13.00	13.00
	(b) Millon khal (outfall) to off-take of Caring khal (Interior dyke), Ch. 13.00 – 22.50.	9.50
2	**Road :** Proposed Road From :	
	(a) Islam Bazar – Proposed Embankment (via Thanar hat & Saddam Bazar)	4.75
	(b) Thanar Hat – Proposed Embankment (Madrasha Bazar)	2.35
	© Azim Ghat to Thanar Hat	2.60
	(d) Killar Bazar to Saddam Bazar Road (via Bangla Bazar)	3.72
	(e) Bangla Bazar to Chairman Ghat (via Bhumihin Bazar)	1.96
	(f) Thanar Hat to Channdi Ghat	2.07

2.1.4 River and Khal Survey

Longitudinal and cross-sectional surveys were conducted for existing drainage channels/khals and rivers.

For longitudinal profile, the spot levels of the existing river or channel beds and banks have been taken at 500m interval in the case of main channel or river and 100m intervals in the case of branch or small channels. The survey started from the outfall of the channel proceeding towards upstream.

The cross-section of existing channels has been taken at 500m and 100m intervals or closer depending on ground conditions in the main and branch channels. All cross-sections were made perpendicular to the longitudinal alignment of the channel at point of survey. The cross-section covered the full width of the channel and extended up to 30m on either bank side. The list of drainage channels surveyed is given in Table 2.1.4.

Table 2.1.4 : List of Drainage Channels/Khals Surveyed.

Sl. No.	Name of Drainage channels/khals	Length (Km)
1	Daskin Musapur Khal	1.500
2	Hoar Khal-1	5.000
3	Hoar Khal-2	5.400
4	Hardir Khal	2.000
5	Million Khal	6.000
6	Chadni Ghat Khal	2.425
7	Mannan Mosque Khal	2.250
8	Adarsho Gram Khal	1.850
9	Caring Khal	9.100

2.1.5 Presentation of Survey Data

Field survey data have been processed using the computer packages. The Survey data have been presented as below:

- Longitudinal profiles of proposed embankment in Noler Char, existing embankment of Char Majid were plotted to the scale of 1: 200 vertically and 1: 25,000 horizontally. The design levels have also been drawn on it.
- Existing rivers, channels and khals, profiles of bed along with design bed were drawn.
- The profiles also show the locations of all the existing roads, khals and structures and the names of all proposed structures with the individual chainages in km.

- Cross-sections were plotted to the scales of 1:200 vertically and 1:500 horizontally.

Survey results are presented in Annexure Volume, Enclosure – 1 (Embankment: Fig. B.5.2.1, Fig. B 5.2.1a, Drainage khal : Fig. B 5.2.3/1-8).

2.2 Agriculture Survey

Noler Char has a project area of 2691 ha and net cultivated area is 2011 ha and an estimated 4690 households (hh). Crop production (Agriculture) in Noler Char mainly suffers from tidal inundation/flooding and salinity. So, the task of the study is to solve the harmful flooding and desalination of the South Western part.

2.2.1 Objectives

The major objectives of agricultural component mentioned in the TOR are as follows;

- to determine land types, soil characteristics, land suitability and land use under pre and post Project situation.
- to identify major crops, area under each crop, yield, cropping intensity and production at pre and post Project condition;
- to analyze land tenure system and socio-economic conditions of the farmers;
- to estimate crop damage due to flooding, water-logging and salinity;
- to assess the present support services (extension credit and market);
- to develop/suggest intervention to remove the constraints including field days and demonstration.

2.2.2 Scope

The study analyzed the land suitability and land use for crop production under pre and post Project situation. The report covers farm size, land tenural system, present crops grown, cropping intensity, area, yield, input use and costs of inputs and output prices, constraints of crop production, crop damages due to flooding, water-logging, salinity and socio-economic conditions of farmers, availability of support services such as extension, credit and marketing facilities. The report also covers farmers' food security and employment situation.

The future projections of increasing cropping intensity, yield and productivity are based on the analysis of the present situations in the adjacent areas and on the assumption that the major constraints of crop production will be removed and support services are improved and strengthened.

2.2.3 Method and Approach

In order to collect relevant information on landuse, socio-economic condition of farmers and constraints of production, primary data was collected from household sample survey and group discussion with farmers using a structured format and a cheek list. Group discussion was conducted using a cheek list by the Consultant to estimate farmers perception on crop damages due to salinity, flooding and water-logging. The household sample survey was conducted by an enumerator following a practical briefing by the Consultant how to elicit farmers opinions and fill up the questionnaire.

Household Survey. Households were not stratified as landless, marginal, small, medium and large farmers as it was reported that each household has about 1.5 acre (0.61 ha) land in Noler Char. About two percent households (1.6%) were selected randomly from the different wards of Union Parishad. First, the enumerator explained to the farmers the purpose of the survey and the household heads and other members became interested to provide information. The questionnaire was lengthy and it took about two hours to

complete one questionnaire. The discussion was held in or around the households or in market places. Each Ward of an Union Parishad has several Samaj/Villages. From each village of a Ward, households samples were selected randomly proportionate to the number of the total household of the Ward with the help of village leaders.

Information on family size, farm size, land tenurial system, food availability for the family per year, season wise land use, sources and share of annual income, cultivation resources, labour availability, employment of family member, credit, extension and homestead agro-forestry were collected through the household survey.

Group Discussion/Meeting. Five group discussions having 5-8 farmers per discussion were held in Noler Char to collect information on the farmers perceptions on season wise area affected and extent of crop damage due to salinity and abnormal tidal flooding. From such group discussion proportionate areas under different seasons, crops, yield, cost of production for each crop, inputs rates, prices and farm gate prices of the farm outputs were also collected.

Farm Walks/Transect Walks. Farm walks or Transect were used to determine land, soil types, observe crops, agro-forest trees and talk to farmers in the fields or village road. These helped farmers to talk informally on land, soil types, their field problems and tidal flooding. Farmers reported three land types such as high land, medium land and low lands with corresponding soil types of Duas (loam), Kada duas (clay loam) and Kadamati (clay or silty clay). Farmers also reported that salinity increases starting from high land to lowland.

Household survey, group discussion and farm walks helped clarify some information, cross checking and validation of information.

2.2.4 Land and Soil Types

The land and soil types of Noler Char are briefly described below :

Land Types. The study area Noler Char falls within the AEZ 18, the Young Meghna Estuarine flood plain. The flood plain lands are classified by MPO and FAO on the basis of flood regime, i.e. the depth and duration of flooding. During Group Discussion and Farm Walks information on depth of flooding was collected. Most of the land types (50%) in Noler Char fall within medium high land (F1) class which is flooded between 30-90 cm depth during the peak monsoon. However, some lands close to the canals, the homestead areas, markets roads and other infrastructures are built by raising land which is above normal flood level (>30cm is classified as (Fo). Some area fall within medium low land (F2) is flooded between 90-180 cm depth of water.

The present land types of the Noler Char area were estimated by topo survey for 1:10 year return period for monsoon season are 28% , 52%, 15% and 5%) as Fo, F1, F2 and F3 respectively (Table 2.2.1). With project condition land type will improve with reduced flood depth.

Table : 2.2.1 Land types of the Project Area (ha) in Noler Char

Land Type	Present Condition			With Project		Remarks
	Flooding depth (cm)	Area (ha)	(%)	Area (ha)	(%)	
Fo (High Land	0-30	771	28	2203	82	infrastructure, etc.
F1 (Medium High Land)	30-90	1389	52	292	11	
F2 (Medium Low Land)	90-180	401	15	139	5	
F3 (Low Land)	> 180	130	5	57	2	Khals, etc.
Total		2691	100	2691	100	

Source : Study Estimation

Soil Types and Salinity. The detail soil survey and analysis of Boyer Char are available. Noler Char is adjacent to Boyer Char. Land topography and soil types as determined by visual examination of Noler Char are very close to Boyer Char. Examination of canals and recently excavated ponds, showed no

distinct soil horizon developed. Horizons are undifferentiated and less compacted.

Table 2.2.2 : Soil Characteristics of Noler Char

Land Types	Flooding depth (cm)	Texture	Salinity	Drainage Classes
Fo (Highland)	0-30	Loam	Slightly Saline	Moderate
F1 (Medium Highland)	30-90	Clay Loam	Moderately Saline	Poor
F2 (Medium Lowland)	90-180	Clay	Strongly Saline	Poor

Source : Farm Walks and Group Discussion

Table 2.2.3 : Soil Salinity Level in Boyer Char

Salinity Class	Salinity Level (Ece:dS/m	% in Boyer Char (2001)	% in Boyer Char (2006, June)
Non-saline (So)	<2.0	0	0.5
Very slightly saline (S1)	2-4	1.25	2.3
Slightly saline (S2)	4-8	11.25	8.5
Moderately saline (S3)	8-12	40.0	?
Strongly saline (S4)	12-15	32.5	23.6
Extremely saline (S5)	> 15	15.0	65.1

Source : SRDI, CDSP (2001 and 2006) and DDC.

Soils of (Fo) lands are loam to silty loam, slightly saline, crops in three seasons (Aus, Aman and Rabi) can be grown and the land and soils are intensively cropped. Soils of F1 lands are silty clay loam to clay loam, moderately saline, two crops (T. Aman during Kharif-II and Rabi season) are grown. Soils of F2 lands are silty clay to clay usually strongly saline and single T. Aman crop is grown during the Kharif-II season.

2.2.5 Land Suitability and Land use

Land suitability is determined considering the ecological requirements and limitation of crops under specified production system such as rainfed, irrigated, traclifional or modern management. Land suitability has to be assessed considering agroclimatical and individual soils for each crop in each growing

season. Combining the agroclimatical and soil suitability, land suitability classes for each crop has to be made. Five suitability classes linked to the attainable yields are as follows (FAO/UNDP, 1988).

Very suitable (VS)	:	80% percent or more of maximum attainable yield (MAT),
Suitable (S)	:	60-80 percent MAT
Moderately suitable (mS)	:	40-60 percent (MAT)
Marginally suitable (MS)	:	20-40 percent (MAT)
Not suitable (NS)	:	Less than 20% of (MAT)

However, research/experimental results on attainable yields for different crops under specific land and soil conditions are not available. So, it will not be possible to classify the lands of Noler Char for different crops under the above classes.

The agricultural potentials of the flood plain soils are determined by hydrology and soil properties. The common soil types in Noler Char are silty loam to clay loam; low in organic matter, nitrogren and phosphorus and have poor structural stability. However, there is annual silt deposition from tidal flood which enrich the soil to some extent.

In Noler Char crop production is limited due to salinity in dry Rabi/Aus season. In the dry season, soil salinity increases by capillary rise from slightly to strongly saline ground water. Aus rice in Kharif-1 season is affected at germination and seedling stages in March-April when salinity reaches its peak level. However, from May onward, salinity starts decreasing due to rain and problem for Aus rice is reduced. During T. Aman season (July-December) there is little problem due to salinity but tidal inundation damages the crop. Rabi crops are restricted by salinity at all stages of its growth in the dry season.

Tidal flooding is affecting crop production and degrading the environment. Aus rice is less affected compared to T. Aman and Rabi crops by tidal flood. Higher water depth at transplanting and tillering stages affects the growth and yield of

T. Aman. After the harvest of T. Aman, Rabi crop cultivation starts, Rabi crop planting is delayed upto January as lands remain wet and not suitable for Rabi crop seeding and planting. So, intervention to remove tidal inundation/floods and salinity are needed to make soil suitable for crop production.

Land use. Present land use for specific crops and cropping patterns is determined by dry/Rabi season salinity, soil moisture condition, monsoon rain, tidal flood and water-logging.

Noler Char has project area of 2691 ha and 75% net cultivated area (NCA), 40.% single, 40%, double and 10% triple crops area. Land use are shown in Table 2.2.4. Current fallow/cultural waste has been considered to be 10% of NCA.

Table 2.2.4 Present, Land use for Crop Production in Noler Char

Sl. No.	Name of the Char	Total Project Area (ha)	Area under Settlement, Water bodies, Infrastructure, etc. (ha) and (%)	Net Cultivated Area (ha) and %	Single Crop Area (ha) & %	Double Crop Area (ha) & %	Tripple Crop Area (ha) & %
1	2	3	4	5	6	7	8
2	Noler Char	2691	680 (25.27%)	2011 (75%)	804 (40%)	804 (40%)	201 (10%)

Source : Household Survey

2.2.6 Farmers Perception on Crop Damages

Land suitability classification for each crop in different seasons are not available. Research/experimental data for different crops under specific land and soil conditions are also not available. Though some sporadic information on crop losses due to insect pests, dieses and post-harvest losses for rice are available. But no information on crop losses due to salinity, water-logging and tidal flooding in the Coastal Char lands of Bangladesh are available.

The Agricultural Expert met the farmers with the complaint that their crops are damaged due to salinity, water-logging and the tidal flood. The Agricultural Expert tried to assess the area affected, severity of damages due to salinity,

water-logging and the tidal flood in different seasons for different crops. For this purpose, a check list was used to collect information season wise area affected and severity of damages for Aus, Aman and Rabi crops. A group discussion having 5-8 farmers in three places in Noler Char was conducted. In each place farmers were asked to estimate the total area affected, extent of damage for Aus, Aman and Rabi crops due to salinity, water-logging and the tidal flooding. The average information from three places are shown in Table 2.2.5.

Table 2.2.5 : Farmers Perception on Crop Damage in Three seasons in Noler Char

Season	Area affected (%)	Severity of Damage (%)	Damage Index (%)	Remarks
Aus/Kharif-I	73	46	33	
T.Aman/Kharif-II	43	10	4.3	
Rabi	32	22	8	

Source : Group Discussion

2.3 Livestock Survey

There is no reliable data on the livestock population, per capita availability and their contribution to household economy, soil fertility, employment and use for agricultural operations. A sample survey was undertaken tb better understand the current management practices and the constraints in the production system and the scope of livestock sub-sector for future development in the context of small holder farming system. A comprehensive survey was undertaken in November 2006 to January 2007. A pre tested questionnaire containing both structured and semi structured questions were used and the responses from the surveyed households were recorded. The data collected were compiled and analyzed. Additional information was collected from the Hatiya Thana Livestock Office and Noakhali District Livestock Office of the Department of Livestock Services and others providing input services in the area.

2.4 Environmental Survey

Environmental survey on the Char Nangulia and Noler Char Development Study was conducted to –

- study the existing environmental situation of the project/study area,
- identify important Environmental Components (IECs) needing attention,
- help in assessing the impacts of development works/interventions in river hydraulics, morphology and water management etc. on environment and
- identify major impacts on existing environment and first identification of possible mitigation measure for the project area, utilizing experiences of CDSP activities.

The survey has been carried out according to guidelines set by GOB and Guidelines for Environmental Impact Assessment of CDSP Activities exploring the existing biodiversity.

Group Discussion has also been undertaken. The survey and the group discussions helped in carrying out an Initial Environmental Examination (IEEs).

CHAPTER- 3: PRESENT SITUATION IN THE PLAN AREA

3.1 Location

Noler Char is located on the south-eastern side of Boyer Char and south-western side of Char Nangulia. It is bounded by Hatiya River on the north-west, Mamur khal on the north-east and Caring khal on the south. The plan area falls within the BTM co-ordinates of about 485,500 – 493,500 Northings and 612,000 - 619,500 Eastings. Location of Plan Area is shown in Fig. G 1.2.

3.2 Physical Condition

The area is a fairly raised char land at southward extension by accreted land of Southern Noakhali. It gets saline tidal inundation through the tidal channels and creeks. Agriculture is impeded due to saline inundation and soil salinity. The area needs empoldering.

3.2.1 Topography

The plan area is on an average about 8 km long northeast - southeast and average 4 km wide northwest -southeast. Land level has a gentle slope north-south with higher levels on northern part. Average land elevation is about 3.0m (PWD). Maximum land of the area is within the elevation of 2.25m and 3.75m(PWD) covering about 88% of the Char Area. Area elevation relation is as below :

Elevation (mPWD)	Area(ha)
< 2.00	182
2.00 - 2.25	78
2.25 - 2.50	130
2.50 - 2.75	176
2.75 - 3.00	516
3.00 - 3.25	703
3.25 - 3.50	503
3.50 - 3.75	341
> 3.75	62
Total :	2691

3.2.2 Climate

The climate of Bangladesh is tropical, with a hot, humid summer (March to June), a rainy monsoon (June to September) with predominantly south-south easternly monsoon wind. The climate characteristics of the study area such as temperature, relative humidity sunshine hour and wind speed are based on Maijdee station. Maximum temperature stays between 34.0C to 35.3C during March-June period with the highest temperature experienced in the month of April and May. There is a significant fluctuation of minimum temperature varying between 9.5 C to 23.0 C. The lowest temperature is experienced in the month of January.

The range of average relative humidity is 73% to 88%. Humidity is the highest during June to October. The average wind speed varies between 1.5 m/s to 2.6 m/s with the highest speed occurring in the months of April, June, July and August. The sunshine hours from 3.0 hr/day to 8.2 hr/day with the minimum sunshine hour 3.0 hr. occurring in the month of July and the maximum sunshine hour 8.2 hr. in December.

The study area is often subject to severe cyclonic storm and vulnerable to tidal surges of the Bay of Bengal. Several major cyclones and tidal bores have crossed the area in the past. The peak cyclone risk times are September/October and April, the worst years being 1970, 1985 and 1991.

3.2.3 Soil

The area belongs to AEZ 18 Young Meghna Estuary Flood Plain and in Sub-region 18f – saline : Noakhali, Hatiya and Meghna Estuary Char land. General soil type is calcareous alluvium seasonally saline silty loam.

3.2.4 Hydro-morphology

The hydraulic and morphological conditions in the estuarine river and channels are quite complex and very dynamic in nature. The tides, river discharges, waves and storm surges are mainly responsible for the morphological development of channels in and around Noler Char. Major peripheral channels, Hatiya River and Mamur – Caring khal and part of the main internal channel like Hoar khal, Chanandi khal get morphological change in the form of gradual narrowing of

section and raising the bed level due to siltation. The present condition of channels can be seen in the long section and cross-sections (Enclosure-1, Annexure Volume).

3.2.4.1 Rainfall Analysis

Considering the different catchments area, data of the rainfall gauge station Ramgati (Station Id 375) from 1961 to 2002 have been used to determine the drainage requirement. A 5-day duration rainfall with 10-years recurrence interval is taken as the design rainfall for computation of drainage modulus. Results of 5-day duration rainfall of different return periods, which present the results of the frequency analysis of 5-days accumulated rainfall of the project area in monsoon periods, are presented in the Table 3.2.4.1

Table 3.2.4.1 Frequency Analysis of 5-day Accumulated Rainfall (Monsoon)

Return Period / Station	2.33 Year Rainfall (mm)	10 Year Rainfall (mm)	20 Year Rainfall (mm)	25 Year Rainfall (mm)
Ramgati	340.65	591.61	699.67	733.94

3.2.4.2 Wind

The wind regime along the Bay of Bengal shows a typically seasonal variation between the dry season (November-March) and the monsoon season (June-September). During the dry season the prevailing winds are calm and offshore. The prevailing winds during the monsoon season are from the South-Southeast direction, with an average velocity of about 8-12m/s. During severe storms and cyclones, very high wind velocities can occur. The highest wind speed, reported during the April 1991 cyclone (CERP-II, 2000), is 62.5m/s, corresponding to 225 km/h. Most cyclones occur during April-May and September-November, which are the transitional periods between the dry season and the monsoon season.

3.2.4.3 Tides

Tides in the sea results from the gravitational pull of the moon, the sun and the planets and from local meteorological disturbances. Two tides will occur during each rotation of the earth, and that the spring tide will occur when the forces due to the sun and the moon appears to be in opposition to each other. Tidal rise and fall

of the water surface at the entrance of an estuary causes surface gradients which results in the propagation of a gravity wave into the estuary. The rate of propagation depends primarily on the depth of water and, in consequence, on the tidal range at the mouth. The tidal wave travels more slowly as the depth decreases and, consequently, the wave form becomes distorted as it travels inland.

The water level variation is dominated by a semi-diurnal tide with a considerable variation from neap to spring tides. In the entire coastal area the variation of amplitude from neap to spring is from 0.6 to1.4 times the average amplitude (FAP-4).

According to the classification of tides proposed by Devies (1964) the tidal range in the study area can be classified as follows:

- South Bhola – Hatiya North : Meso-tidal-tidal range 2-4 m
- East Hatiya – Sandwip :Macro-tidal-tidal range > 4 m

The study area is uprotected and completely subject to tidal movement of the coastal waters. Coastal water at this location are mainly saline i.e. about eight months a year.

The maximum high-tide water level is about 6.5m above PWD and more during cyclone surges. The maximum current velocities vary from 0.1-4.0m/s in the tidal channels to about 0.2-0.5 m/s in the shallow areas on the mudflats and chars. During spring tide the flow velocities are normally higher than during neap conditions (MES II, June 2001). The tide deeply penetrates the area through the Hatiya River. The friction forces in the channel finally results in sedimentation during draining out of the tide.

The high water levels at spring tide outside the Char Majid Polder are 3.5m PWD and at neap tide 2 to 2.75m PWD (Polder Design and Development, Technical Report No. 13, 2004) during monsoon season. In dry season, water levels outside the Char Majid Polder are about 1.5m lower, as compared to the monsoon.

3.2.4.4 Waves

Wave models indicate that under the prevailing S – SE winds (with an average wind speed of about 8 m /s), the average significant wave height varies 0.6 – 1.5 m in the near shore zone to 0.1 – 0.6 m in the landward part of the project area. In the

dry season the waves are generally less than 0.6 m with peak periods of 3 – 4 seconds. During the monsoon season wave heights exceed 2 m with periods greater than 6 seconds.

Higher waves may occur mainly in the pre and post monsoon periods during cyclones. In a study carried out under Second Coastal Embankment Rehabilitation Project (CERP-11, 2000), the following estimates are given for the offshore wave heights (Table 3.2.4.4).

Table 3.2.4.4 : Offshore Significant Wave Height and Wave Periods

Return Period (Years)	2.5	5	10	20	50	100
Offshore Significant Wave Height Hs(m)	6.9	7.6	8.2	8.8	9.6	10.2
Offshore Significant Wave Period Ts(m)	11.1	11.7	12.2	12.5	13.1	13.6

3.2.5 Cyclonic Storm Surges

The coastal areas of Bangladesh are occasionally struck by severe tropical cyclones which generally originate in the form of a low pressure depression out at sea. They move northwards with well-defined circular wind fields which rotate in an anti-clockwise direction.

Flooding of coastal areas and off-shore Island by storm surge during a cyclone causes loss of lives and damages to properties. Available data on cyclonic storm surge height is very scanty. The displacement of water surface during a cyclonic storm surge also depends on tide. The displacement of water surface is the largest when the cyclonic storm surge reaches the coast during the time of spring tides. Such coincidence occurred during cyclones of November 12, 1970, December 10, 1981 and April 29, 1991.

The Multi-purpose Cyclone Shelter Programme (MCSP, 1993) has made a very thorough analysis of various aspects of the generation of cyclones surges and its penetration in-land. The yearly maximum wind speed (anywhere in the Bay of Bengal) was analyzed statistically revealing a relationship between return period and wind speed (Table 3.2.5a).

Table 3.2.5a : Cyclone Wind Speeds (source MCSP, 1993)

Return Period (years)	5	10	20	25	50	100
Wind Speed (km/h)	165	195	223	233	261	289

The storm surge height in the Meghna delta entrance is generally larger due to shoaling condition. Storm surge heights have been computed using a mathematical model in MCSP(1993). Estimated surge heights at the Chittagong to Noakhali sea coast for 20 years, 50 years and 100 years return periods with 90% confidence limits is presented below in Table 3.2.5b.

Table 3.2.5b : Estimated Surge Heights at Chittagong to Noakhali Coast with 90% Confidence Limits

Region	Surge Height (m)		
	20 years Return Period	50 Years Return Period	100 Years Return Period
Chittagong to Noakhali Coast	4.8 ± 1.0	6.5 ± 1.4	7.8 ± 1.8

The design surge height corresponding to given return period has been used for design of proposed infrastructure.

3.2.6 Salinity

Salinity intrusion is caused by the inflow of sea water during cyclones and lunar high tides and is the major constraint to agriculture development in the study area. The construction of embankments with adequate drainage facilities and adequate water management can reduce this problem. Serious crop damage occurs when standing crops are flooded by saline water.

Salinity data from LRP and MES indicate an enormous seasonal effect due to the influence of huge fresh water discharge from the lower Meghna River on the horizontal distribution of salinity in the estuary. During monsoon (June-September), nearly the whole estuary is filled with fresh water (salinity lower than 2 ppt (part per thousand).

Salinity level of water within the unprotected project area varies with the seasons; maximum values are reached in the pre-monsoon (April, May) and vary between 20-30m S/cm (12-19 ppt) which is more or less equal to sea water salinity (CDSP-II, Technical Report No. 13, May, 2004).

As per classification by MES, the land in this area is surrounded too long, more than three months, by saline water intrision. No irrigation of any importance is possible in this case. Soil salinity levels in the area fluctuates considerably within a year. During the monsoon (July – October) soils of the project area are slightly saline but remain below 5 to 10 d S/m. After the monsoon, from November onwards, soil salinity levels increase and reach a peak in March and April. High post and pre-monsoon soil salinity levels prevent settlers from cultivating crops in the Rabi and pre-kharif seasons (MES, FAP 5B, 1998).

With the construction of polders, Aus rice and Rabi crops can be grown without irrigation and improved yields of Aman rice can be ensured if soil salinity is sufficiently reduced.

3.2.7 Drainage

The general drainage pattern of the area is towards the south-west, while the land of the area slopes to the South. The Topographic map in Fig. B 2.1.2 (Annexure, Enclosure-1) shows the main drains.. Hatiya River, flowing south-west of the project area is the main drainage channel connected with the major internal drainage khals – Milon khal, Hoar khal-1, Hoar khal-2, Haddir khal, etc. receiving drainage of the project area. Drainage problems are not significant. But silt deposition in Hatiya River is there and caused problem to navigation.

3.2.8 Present Land Use

Noler Char

Noler Char has a present land area of about 2691 ha as found from the survey. Land under productive use are mainly in agriculture with about 76% but mostly mono cropped area with less productivity. Fallow land which can be brought under agriculture is about 10% of the area. Existing homestead covers about 6.5% and khal area 3.3%. Comparing to Char Nangulia, Noler Char is more developed. There

are 1616 Homesteads, 12 Bazars, 20 Mosques and 4 Primary Schools. Present household number as given by TA team is 4690. Present land use as per field survey is presented below :

Noler Char

Project Area	...	2691 ha
Cultivated/Cultivable Areas	...	2011 ha
Fallow Lands	...	278 ha
Fish Ponds	...	3 ha
Khals	...	87 ha
Homesteads	...	170 ha
Ponds/Ditches	...	100 ha
Roads	...	9 ha
Bazars, Schools, Mosques, Playgrounds	...	33 ha

3.3 Existing Infrastructures

3.3.1 Physical Infrastructure

Noler char appears to be well developed naturally with lesser drainage problem but not empoldered. The average ground level of the area is comparatively at a lower elevation than that of Char Nangulia. Noler Char is bounded by Mamur khal on the north, Caring khal on the east and south and to the west is Hatiya River.

There exists no permanent infrastructures i.e. roads, cyclone shelters. The whole proposed polder area is vulnerable to tidal inundation and cyclone disaster. The area is exposed to sea and needs protection by putting embankment.

3.3.2 Communication

There is no road network within the proposed polder area except a few footpaths connecting bazaars, mosques leading to ghats along the peripheral rivers (Hatiya and Mamur khal). Ferryboats are the only means of communication to proposed polder area from Boyer Char and Char Nangulia.

Accessibility is less in the Noler Char area as there exists no lateral roads linking any major road around the area. In recent times the population of Noler Char is rapidly increasing owing to onrush of settlements by migrants from different places.

The internal footpaths (roads) are in a very bad condition and accessibility in the monsoon period is problematic. Most of these footpaths are inundated during high tide twice a day in the monsoon period. Motor Cycles and Bi-cycles can ply within the area in dry season period.

3.3.3 Pond

In Noler Char about 3.8% of Char area is occupied by ponds and ditches. In every house there is a small pond/ditch to collect rain water for domestic use of house owner and also for cattle use. Ponds and ditches become dry during the pre-monsoon period and filled-up in rainy season. In comparatively low lying areas those are inundated by high tide. Small saline water fishes take shelter in those ponds and are caught by owner just after wet season before ponds are dried up.

3.3.4 Tube-wells & Toilets

There are 35 Deep Tube-Wells (DTW) in the Noler Char Polder area. The tube-wells are the main source of drinking water supply. Tube-wells are inadequate. Previously people were to use polluted pond/ditch water and to go far for collecting drinking water. DTW is the safe drinking water supply in the area. Drinking water crisis is mainly due to high salinity in surface and in ground water of shallow depth. Arsenic pollution within shallow depth of ground water is also problem in Noakhali Coastal Area. DPHE has conducted Arsenic tests on samples collected from DTW & STW in different Coastal areas in Noakhali Sadar Upazila. The Arsenic Test Results show arsenic content is nil in the samples of DTWs whereas Arsenic content is beyond tolerance limit (limit 0.05mg/litre, Bangladesh Standard) in 1/3 samples of Shallow tube-wells. Therefore, STW for drinking water supply should be avoided in the Char area.

Sanitation facilities in Noler Char is almost nil. Most of households are using kacha latrines. Very limited households are using single pit latrine supplied by NGO's.

3.4 Present Agriculture

3.4.1 Agricultural Seasons

There are three rainfall patterns associated with cropping seasons for non rice crops. Close to these three non-rice seasons, there are three distinct rice season having some overlapping periods and with its definite seasonal characteristics. The seasons and their limits, rainy season and crop growing periods are shown below.

Crop/Rice Season	Rainy Season	Time Period
Kharif-1/ Aus Rice	Pre-Monsoon Pre-Monsoon	April-June Mid March-July
Kharif-II/ T. Aman Rice	Monsoon Monsoon	July-October July-December
Rabi/ Boro Rice	Post Monsoon Dry Season	November-March December-May

3.4.2 Farm Size, Family Size and Land Tenure System in Noler Char

Farm Size. Farm size classification in Bangladesh is landless (0-.02 ha), marginal (0.02 – 0.4 ha), small (0.41-1.0 ha), medium (1.01 – 3.0 ha) and large >3.0 ha. During group discussion in Noler Char, farmers reported that each farm family was provided with o.60 ha i.e. 1.5 acre of land. Household survey showed the average land holdings is 0.51 ha consisting of the homestead 0.056 ha, pond area 0.075 ha and the cultivated land 0.38 ha. However, the range of cultivated land holding is 0.08-0.93 ha and the homestead and pond area range is 0.032 – 0.19 ha each (Annex-3, Table 3.1)

Annex-3, Table 3.1 : Average Land holdings of the Sample Farmers in Noler Char

Purpose of Land Use	Area in (ha)	Range (ha)	No. of Responses	%
Homestead	0.056	0.03-0.19	75	100
Pond (if any)	0.075	00-0.19	70	93
Cultivable Land	0.384	0.08-0.93	75	100
Fallow Land (if any)				
Orchard	Included with the homestead and pond area			
Agro-forest	Included with the homestead and pond area			
Total (ha)	0.51			

Source : Household Survey

Family Size. The household survey showed the average family size is 5.8 persons with a range of 3-17 persons. However, the average number of agricultural farm workers is 1.6 with a range of 1-5 per family. (Annex-3, Table 3.2)

Annex-3. Table 3.2 : Information on Households Member in Noler Char

	Total number	Average	Range
Total number of Member	437	5.8	3-17
No. of Agricultural labourer	121	1.6	1-5
No. of hh surveyed N = 75			

Source : Household Survey

Land tenure System. Household survey showed that 98% of the farm family possess land while 12% lease out land, 11% take lease and 34% cultivate land on share cropping. The share-cropping arrangement is on the 50% basis (Annex-3, Table 3.4).

Annex-3, Table 3.4 : Land Tenure System

Nature of ownership	No. of Response	(%)	Remarks
Own land	74	98	
Lease out	9	12	
Lease in	8	11	
Share-cropping	26	34	50% share basis

Source : Household Survey

3.4.3 Socio-economic Profiles of the Farm Family in Noler Char

Besides the socio-economic conditions described in the above section; some additional socio-economic conditions such as cultivation resources, sources and share of annual income, food security, farm employment and labour availability are described below :

Cultivation Resources. Household survey showed that only 33% farm family have bullock, plough and ladder for own land preparation from where 48% lease out bullock, ladder and plow and another 36% borrow bullock, plow and ladder for their land preparation. None of the farmers has power-tiller and sprayer. Surprisingly 80% of land preparation is done by Power-tiller (Table 3.4.2), hired from the machinery businessmen of neighboring settled areas.

Table 3.4.2 : Cultivation Assets of Farmers in Noler Char

Assets	Farmers		Lending (%)	Borrowing (%)
	No.	%		
Bull/Bullock	25	33	48	36
Plough	25	33	48	36
Ladder	25	33	48	36
Power Tiller	-	-	-	80
Sprayer	-	-	-	-
Weeder/Sickle	25	33	48	36

Source : Household Survey, N=75

Food Security. Only 9% of the farm family have 12 months food available and 12% of the family have only 3 months food and 45 and 35% of family have 6 and 9 months food available per year (Table 3.4.3) respectively.

Table 3.4.3 : Availability of Food for the Family Per Year

No. of months food is available	No. of Responses	%
3	9	12
6	34	45
9	25	33
12	9	9
Total :	75	100

Source : Household Survey

Employment of the Farm Family Member and Source of Income. Household survey showed that only 29% of the households have full employment in the farm while rest 79% has partly employment. Unemployment rate is 20%, i.e. on an average they become unemployed for 2.4 months in a year (Table 3.4.4).

Table 3.4.4 : Employment of Family Members of the Farmers

Nature of Employment	Responses	%	Unemployment Rate (%)	Av. Agricultural Labours in the Family
Fully Employed	22	29	-	-
Partly Employed	53	71	20 (2.4 months/per year	-
Total :	75	100		1.6 (1-5)

Source : Household Survey

Major source of farmers income are crops, small trading and labour selling. Seventy five percent farmers earn 39% of their income from the crops while 55 and 15 percent farmers earn 51% income from small trading and labour selling. Sixty eight percent and 55% farmers reported that they earn 4.5 and 3.5 percent income from fishery and livestock (Table 3.4.5).

Table 3.4.5 : Farmers Sources and Share of Annual Income in Noler Char

Sources	Av. Share (%) & Range	Responses (%)
Crops	39.0 (20-80)	100
Fishery	4.5 (2-10)	93
Livestock	3.5 (1-15)	90
Small Trading	51.0 (25 -75)	73
Labour Selling	51.0 (20-70)	20
Handicrafts	-	-

Source : Household Survey

Labour Availability for Agricultural Operations. The survey showed that 52% of the households have their own labourer for agricultural operation while rest 48% have to hire labourer from the local source. No migrated labour used is reported, rather during lean period, labour migrate to other areas for their employment (Table 3.4.9).

Table 3.4.9 : Labour Sources for Agricultural Operations in Noler Char

Source	No. of response	%
Own Labourer	39	52
Hired Labour	Local = 36	48
	Migrant = 0	0

Source : Household Survey

3.4.4. Present Cropping Pattern and Cropping Intensity

A farmer's decision to select a crop and cropping pattern is location specific, demand driven, depends on the availability of resources and support services. Food security is the prime concern to a farmer. Once food is secured economics and environment determine his choice of crops. Noler Char is dominated by single T. Aman crop (90%) during Kharif-II season followed by Rabi season crop (45%) and Aus/Kharif-I (15%). Table 3.4.1. Shows the present cropping pattern and cropping intensity as calculated from NCA (100%) and cropped area in Noler Char.

Table 3.4.1 : Present Cropping Pattern, Cropping Intensity in Noler Char

Name of the Char	Cropping Pattern	Net Cultivated Area (NCA) and %	Cropped Area (ha)	Cropping Intensity(CI)
Noler Char	**Single Crop**			
	Fallow–GM. -T. Aman 0 - 0 - 40	804 (40%)	804	40
	Double Crop			
	Fallow-Aus-T. Aman 0 - 5 - 5	100.5 (5%)	201	10
	Rabi-GM-T. Aman 35 - 0 - 35	704 (35%)	1408	70
	Tripple Crop			
	Rabi-Aus-T. Aman 10 - 10 - 10	201 (10%)	603	30
Total :	45 - 15 - 90	1810 (90%)	3016	150%

Source : Study Estimation

The future cropping pattern will remain more or less the same with the replacement of single crop area by double crops and increase of triple crop area. The major crops grown in Noler Char are shown below.

Boro/Rabi Season :

Pulses – Most common is khesari with little cow pea and Mungbean.
Oilseeds – Groundnut, Mustard and Linseed (Tishi)
Spices - Chillis, Onion, Garlic
Boro rice – Both local and HYV is absent

Aus/Kharif-1:

Aus – Local rice varieties are Saita, Boilam and HYV rices is China IRRI (Purbachi), BR-1 (Chandina) and BR-27

Kharif-II /T. aman :

Local rice varieties are Rajasail, Kajolsail, Gigaj and HYV rice is BR-23 and BR-II.

3.4.5 Homestead Agriculture

The average homestead area including ponds in Noler Char is 0.13 ha with a range of 0.064-0.38 ha. Homestead agriculture includes agro-forest and vegetables or kitchen garden. Survey showed that use of homestead is important to raise the

income, nutritional status of the family and environmental protection. Older households have more trees and vegetable crops than the new settlers. Almost every households have some kind of homestead crops.

The common homestead crops observed are Banana (100%), followed by Koroi (36%), Coconut (27%), Mango (17%), Mehogany (16%), Bambo (12%) and Jack Fruit (14%), in the sample household (Annex-3, Table 3.3). Homestead agriculture through proper planning managements and following the models developed by BARI could contribute to raise income, nutrition and environmental protection of the household and the char lands.

3.4.6 Present Level of Input Use and Management

The present use of inputs specially fertilizers in Noler Char is not optimum. Urea, TSP, some pesticides and power tiller is used in T. aman season. But very little fertilizer is used for pulses and oilseed crops except groundnut. For the common spice crops, Urea and TSP are used. Sulphur and Zinc are not found to be used. Majority of the farmers used their own saved seeds and some get the seeds from local markets and from the neighbors/relatives. The farmers lack cash for investment on inputs. A major part of the farmers are share croppers (34%) who are not much interested for investment on land (Annex-1).

Noler Char is newly settled and the farmers are resource poor and lack all kinds of support services including basic necessities of life like drinking water and health services. Among the inputs, locally produced seeds are used. Besides, human labour is used in different operations of crop production. Power tiller (80%) and animal power is used for land preparation.

3.4.6 Present Support Services (Extension, Credit and Marketing)

Support services such as extension services, credit and the marketing facilities to transfer new and modern technologies to the farmers, availability and access to production inputs such as quality seeds, fertilizers and the pesticides were examined in Noler Char. The extension services either from the GOB agencies such as DAE, DLS and DOF and the NGO's are almost absent in Noler Char. To increase production, income and employment opportunities of the farm household, support services need to be strengthened and improved.

Extension Services. The tasks of the extension services providers in GOB/NGO's and the private sectors are to train the farmers on modern and new technologies in the areas of crops, fisheries, livestock, homestead and agro-forestry and the income generating activities (IGA). The principles of the extension services and technology transfer is to assess the farmers needs and the resources of the farmers through involving the farmers, working in groups rather than individuals and targeting all farmers including women. The sources of extension services from any source at Noler Char is absent (Table 3.4.6).

Table 3.4.6 : Source of Support Services in Noler Char

Source of Services	Responses	
	No.	%
GOB (DAE/DLS/DFS)	0	0
NGO	0	0
Others (Seed/Fertilizer/Pesticide Dealers)	0	0
Total :	0	0

Source : Household Survey

Credit Support. Credit support for farmers is very important to adopt modern technologies in the field of crops, livestock, fisheries and small trading. The farmers in Noler Char are resource poor and do not have necessary agricultural assets and cash money. Sixty six percent household reported that they need credit. The source of credit is the money lender (74%), relative/neighbor (10%) and through the mortgage of the land (16%). No credit from Bank and the NGO's. The interest rate of the money lenders is 160% i.e. 6 mds of paddy per Tk. 1000 for one season (Table 3.4.7.).

Table 3.4.7 : Source and Interest Rate for Credit in Noler Char

Credit needs, Yes – 66%, No. - 34%

Source	Responses		Interest Rate (%)
	No.	%	-
Bank	0	-	-
NGO	0	-	
Money Lander	37	74	160% (6 mds of paddy per 1000 Tk.)
Relative	5	10	
Others (Mortgage)	8	16	
Total :	50	100	

Source : Household Survey

Marketing Facilities. Household survey showed that the farmers have local marketing facilities for all their inputs such as seeds, fertilizers, pesticides and their produces. Access to outside market may also be helpful for the farmers. (Table 3.4.8).

Table 3.4.8 : Responses on the Marketing Facilities of Agricultural Inputs and Outputs in Noler Char

Commodity	Local Market		Other Market	
	No.	%	No.	%
Rice	75	100	0	0
Pulses/Oilseed/Vegetables	75	100	0	0
Seeds/Fertilizer/Pesticides	75	100	0	0
Total : N = 75				

Source : Household Survey

3.5 Livestock

Livestock sector accounts for about 3.2 percent of GDP, and about 11 percent of agricultural GDP. The contribution of livestock of agricultural GDP is increasing over the years, providing about 20 percent employment of rural work force. In Bangladesh farming system - crop production and livestock are closely linked. In addition to providing part of draft power for crop production and rural transport the animals are major source of high quality protein in the diet. In the estuarine environment where tidal inundation, salinity and land erosion and accretion is a continuous phenomenon, vulnerability of farmers to natural disasters is prevalent, livestock production led to a strong element of risk aversion in farming systems and large animals are considered as an important hedge against risk. The large farmers often own large herds of buffalo or cow and put the animals in the natural grass pasture to grab the accreting land. Livestock and Poultry raising represent a reliable source of cash income for small farmers in the area.

3.5.1 Livestock Situation in the Project Area

Although the livestock sectoris dominated by large animals, more farmers especially the women and children are involved in small animal and poultry production. At the farm level, a small farmer operating about oneacre land typically owns (two heads of cattle, two goats and about ten poultry). Goat population is assumed to have increased significantly over the past few years of settlement despite recorded reports of mortality both in adult and young stock. For the poor settlers in the new land all

animals are important assets and aregenerally better able to acquire and manage small ruminants and poultry; as these are cheaper to purchase and easy to feed and can be reared using very little land and other resource. Under care of women and children small ruminants and small flocks of poultry are kept under scavenging system, supplemented with feeds made up of household wastes are significantly contributing in raising women's income and home nutrition especially of the children. Government considers livestock as a highly viable sectorfor employment generation for the rural landless, marginal households and the unemployed youths and to have direct impact on poverty alleviation and accordingly have given priority in the Sixth Five Year Plan 200207.

Table 3.5.1.1: Livestock Population.

Type of Livestock	Respondant households (%) Current holding (for >2yrs M/F)	Num-ber	Changes in stock in last 12 months						Income from sale (BDT)		
			No Bought	Purchase cost (BDT)	No sold	No born	Morta-lity	Net change	Animal	Milk	Eggs
Cattle >2Years	23 (30.66%)	33	9		5	2		6			
Cows number		26	7	28,500	3	2		6	36,100	11,400	
Bullocks number		7	2	12,000	2						
Buffaloe >2Years	17 (22.66%)	21	3	32000				3	15,000	9,000	
Male number		7									
Female number		14	3	32,000							
Goat/Sheep >1year	29 (38.66%)		3	1,400	21	25	01	6			
Does number		49									
Bucks/Rams											
Chicken> 6months (Pre-Layers)	72 (96%)	570	45	3600.	182	30					
Hens		485	35	2,800	82						11,300
Cocks		85	10	800	100						
Ducks > 6 monts(Pre-Layers)	69 92%)	332	38	2850	150	10					4,900
Males number		120	10	750	95						
Females		212	28	2,100	55	10					
Pigeon											
Other											

In the proposed Noler Char project area out of existing 4,690 households (HH) 75 HH were surveyed, 23 households (30.66%) recorded 33 cattle above 2 years, among them 26 cows and 7 bullocks indicate the preference of keeping females over the males and 17 (22.66%) households recorded 21 buffalo above 2 years, 14 female and 7 male. This again indicates to the preference of keping more females than males. Dependence on animal draft power is reducing with the gradual introduction of power tillers. 29 Households (38.66%) have 49 goats above 1 year, the survey recorded no sheep. 72 households (96%) rear 570 chicken above 6 months (485 hen and 85 cocks) in the backyard and 69households (92%) rear 332 ducks above 6 month (212 female and 120 male). It is seen that during last 12

months number of cattle increased by 6, buffalo by 3 and goat by 6 with 1 morality (Refer Table 3.5.1.1). Per capita availability of 0.144 (0.088 cattle and 0.056 buffalo), 0.13 goat and 2.4 (1.52 chicken and 0.88 ducks) as against national average of 0.26 cattle, 0.18 goat and sheep and 0.91 chicken and ducks as recorded in 1996 Agriculture and Livestock Census. Which indicates local farmers increased dependence on livestock and opportunities for free grazing in fallow land and mostly single cropped land that remain open for grazing during January to July and in the adjoining coastal forests during monsoon The per capita availability of cattle and goat is less than national average which can be increased with extension of technical services and micro credit facilities.

Table 3.5.1.2 : Estimated Livestock Population in Noler Char

Livestock Population in 2007

Households	Buffalo	Cattle	Goat	Sheep	Chicken	Ducks
4690	1313	2070	3049		35641	20909

The estimated livestock population of the project area is given in Table 3.5.1.2

Natural Feeds and Fodder :

The most common naturalgrass that grows with natural accretion of landmass is Uri grass (Oryza coarctata) and comes first, the farmers usually cut and carry them from the mud flat when the soil is soft and cannot bear the trampling by cattle. With further consolidation buffaloesare brought in by large farmers and grazed. If the land goes to the Forest Department (FD), the FD starts plantation with keora (Sonneratia oapetala) under the cover of Urigrass and do not allow grazing for three years till the planted materials are abovethe reach of the animals. However, the forest employees usually do not restrict cut and carry system unless the collectors do harm to the plantation . After 3 to 5 years the growth of the Urigrass subsides with the decline of salinity and replaced by Dhulgrass / Durbagrass (Cynodon dactylon) which grows with monsoon rain and the animals are grazed freely during monsoon and post monsoon months. The animals while in the forest also graze on other creepers, leaves of keora trees and any other palatable material available to the animals.

In June with start of monsoon rainfall a mix of free grazing and stall feeding is done. Again in pre winter months October– February most of the fields remain under rice and grazing area is very restricted. Animals aregrazed in failed rice crop fields and patches of fallow lands.

Table 3.5.2.3 : Feeds and Fodder Situation in the project area

Types of Livestock	Source of Grazing		Feed Sources			Source of Supply			Remarks
	Rainy Season July-September	Dry Season March-May	Cut and carry (for fattening)	Grown (Including under sown, Tk.)	Purchased (Total cost Tk.)	Private	DLS	NGO (Name)	
Cattle/ Buffalo	Tithered and stall fed	Open field	Limited	80,000	20,000	Private	-	-	No formulated concentrate is available
Goat/ Sheep	Tithered	Open field	Very limited	15,000	-	Private	-	-	"
Chicken	Scavange	Scavange	-	12,000	1,500	Private	-	-	"
Duck			-	10,000	500	Private	-	-	"
Pigeon									

Breed and breed characteristics of livestock species

Cattle: The predominant indigenous (deshi) animal is a small non-descript Bos indicus type, the mature body weight is between 125-200 kg. The slow growing, shy breeding animals average age at first calving is 45 months and have lactation period of about 7 months, the prolonged inter-calving period is about 38 months. No improved breed have so far been introduced in the area. The priority purpose of cattle was for draft power, particularly for cultivation of land but the scenario is fast changing with the introduction of power tillers in the area.

In the emplodered area with the increasing cropping intensity and the greater need for timeliness in land cultivation, the demand for draft power is increasing; to meet the demand cows are being harnessed to the plough. Small local breeds of cattle are preferred because they are adequate for local farm, easily housed within the limited homestead space and easily managed by women and children.

Under these circumstances milk, meat and hides are largely by products othe draft herd. However, inspite the high price of milk the average daily yield of milk is little over one litre per cow. Also the traditionalgrazing areas are going under the plough to produce rice which under the existing price structureare financially less attractive but with such a poor agricultural economy, survival is the prime motivating force.

Excluding the landless, the bulk of the estuarine households farm between one and two acre of land, much of it on a share cropping basis. To hire draft power for cultivation will cost between Tk (1500 to 2000) per acre per season but timeliness is so critical that hiring is a risky business. From this it can be seen that ownership of draft cattle is highly desirable, although they constitute a very high capital investment. To minimize the size of individual herd, whilst at the same time ensuring their continuity, systems of exchange exist between villagers. Recent introduction of power tillers and their easy availability on rent have greatly reduced dependency on draft animal, the surveyed households indicate preference for milk and meat animals. So far no initiative to introduce milk or meat breeds have been under taken by any public or private agency.

Buffalo: In the estuarine environment buffaloes are a preferred species as they are better adopted to plough the mud flats, consume coarser roughage that grows in the newly accreting chars and in the forests. They can tolerate more salinity than cows and are more resistant to disease. In the new estuarine chars the buffaloes are kept in large herd of 50 to 250 under care of herdsmen. The buffaloes found in the coastal region are Indian water buffalo type, mature body weight is 350-450 kg and are seasonal breeders and come in heat in post monsoon months with the increased availability of fodder in the chars and calve in spring. The average milk yield about 2.5 to 3 kg per day and lactation period is 7 to 8 months.

Buffalo milk contains more fat and solid not fat (SNF) than cow's milk and are preferred by local people for making ghee (clarified butter) and curd. There is scarcity of quality stud buffalo bulls and no improved breeding and management have been initiated in the area.

Goat: The major breed of goat is the Black Bengal. The breed is famous for its high prolificacy, tender meat and skin quality. The Black Bengal goat is well adopted to hot humid climate and produces twins and triplets and have the potential of being developed as "Broiler goat". The average live weight of adult goat is 16 to 18 Kg. goats are reared by marginal and landless households and children and women take care and considered an important activity in the existing integrated small holder farming system. The marginal households prefer goat rearing for it requires small capital investment, simple housing, easy management, graze on fallow lands after crop harvest, selectively

browse on weeds in weed infested and planted rice crop during mid stage or are tethered along the road sides, embankments. The goat can survive on tree leaves of number of species frequently seen in the estuarine villages. The goats mature at an early age short gestation period and generation interval. Goat meat fetches higher price than beef and the milk is easily digestible by children and the old. The kids are reared as households pets.

Marginal households with limited access to feed large ruminants but have the opportunity to obtain green grass and palatable leaves round the year and have idle manpower to look after may be promoted to take up goat rearing to augment the flow of side line income. Women groups mainly destitute and embankment/roadside plantation caretakers may be given preference to take up this activity. There is acute shortage of quality breeding bucks in the area, through project intervention this can be addressed benefiting the destitute women to earn an income by selling the services of the bucks.

Sheep: Sheep found in the coastal area are coarse wool type, small in size about 10-12 kg adult live weight and well adapted to the saline environment. In some coastal households they are preferred to goat for their selective browsing on the leftovers of cattle and buffalo and considered less menacing than goat. However, in the surveyed households no sheep was found. Preliminary information indicates ,that no effort was made to promote sheep in the area.

Chicken: In the project area most of the households rear chicken. Generally they live a scavenging existence, and seldom receive much supplementary feeding. The local "deshi" types is poor egg producer and lays 40-50 eggs in a year with a behavior of pronounced brooding. No impact of cockerel exchange programme with improved breed like Rhode Island Red or White Leghorn under taken by the Livestock Department. The indigenous deshi birds are small in body size of about 1-1.5 Kg and well adapted under scavenging condition and probably more resistant to prevalent common diseases and are better able to protect from predators. Commercial farms with improved breeds are non existent probably because of poor preventive coverage, non-availability of day old chicks, formulated feed and proper marketing network. The local birds are ideal for reproduction by natural brooding. However, in a semi scavenging model with artificial hatching and balanced feeding have

shown to increase income of smallholder poultry rearer in other parts of the country. No similar projects have been initiated in the study area.

Duck: Like chicken duck raising is widely practiced by the housewives in the area especially in the village areas, having large member of ditches that favour natural growth of fresh water snails and duck weeds. The area is ideal for duck raising on commercial basis but their number is not much because of shortage of natural feed during the dry months. The fresh water snails do not survive during the post winter salinity and this increase the cost of supplementary feeding. However, a few (Khaki Campbell) was seen in the project area foraging in the depressed part, the rearer reported less egg production due to natural feed scarcity. The flock size is reduced through sale of surplus duck at the end of monsoon season.

The ducks are preferred by housewives living around the fresh water pools, as they produce 100-150 eggs per year, more meat and are resistant to many diseases that affects the chicken.

Pigeon: Although the project village appears to have good opportunity to rear pigeon but it is seldom practiced. Simple project intervention to introduce and management practices like supplementary feeding and disease control expected to bring significant economic benefit to the women beneficiaries.

3.5.2 Constraints in Animal Production System

Seasonal shortage of fodder is the main constraint in animal production system in the project area specially when the crop lands are under rice cultivation and the animals are restricted to homesteads and in the villages. The poor farmers have little access to forest under growths for grazing and the distant accreting lands. No formulated concentrates are available for supplementary feeding especially during high monsoon when the animals are tied in the homesteads.

Table 3.5.2.4 : Common Animal Diseases of Estuarine Area

Type of Animal	Type of disease		
	Bacterial	Viral	Parasitic
Cattle	Anthrax, Black Quarter, Haemorrhagic septicemia	Foot and Mouth Disease (FMD)	Paramphistomaides, Fascioliasis, Nematodes
Goat	Entero-toxaemia, Pluereo pneumonia (PPR), Anthrax	Goat pox	Fascioliasis, Haemonchosis, Trematodes
Sheep	Entero toxaemia	Sheep pox	Fascioliasis, Haemonchosis, Trematodes
Chicken	Fowl cholera, fowl typhoid	New Castle Disease Fowl pox	Ascaris, Coccidiosis
Duck	Duck Cholera	Duck plague	Coccidiosis
Pigeon		Pigeon pox	Coocidiosis

Source: Department of Livestock Services, Personal Communication

Animal disease is another major constraint encountered by the farmers. The estuary receives all the washings of the upstream including the infected carcasses and the environment favours quick spread of disease organisms and causing high mortality in large and small ruminants. Among the infectious diseases Foot and Mouth Diseases is common which renders the work animals unfit for work in the ploughing season and also is responsible for many calf deaths, infertility and loss of milk production. According to Livestock Department field officials other bacterial diseases like anthrax, black quarter, haemorrhagic septicemia, enterotoxaemia and viral disease like goat pox, pluereo pneumonia, sheep pox etc. are occasionally seen in pockets. Newcastle disease, coccidiosis, fowl pox, fowl cholera, duck plague, duck cholera are seen in poultry and take heavy toll every year.

Parasitic infestation is common and the burden is high which largely affects animal productivity in terms of milk and meat production, delayed maturity and prolonged inter calving period, parasitic diarrhoea and poor utilization of scarce feed resources.

The ignorance of the farmers on the preventive and curative facilities that are now available in the townships is not utilized in the locality. The above facilities could easily be made available if the farmers are organized and oriented with the government and growing private veterinary service delivery system.

Table 3.5.2.5 Constraints in Livestock Rearing (Ranking in order of Importance)

Types of Livestock	Lack of Fodder (Season)	Lack of Water (Season)	Mortality/ Disease (Including predation)	Market Access	Cost of Feed	Lack of Access to Extension Services	Others Micro-credit	Remarks
Cattle/ Buffalo	Monsoon	Dry	Dry and Pre-winter	Monsoon	Dry	Round the year	Not available	
Goat/ Sheep	Monsoon	Dry		Monsoon	Dry	"	"	
Chicken			Pre winter			"		
Ducks		Dry	Pre winter			"		

However, the market access is not a problem as reported by the respondents. It appears that the cattle traders frequently visit the aea and buy the surplus stock, milk is sold locally and the peddlers collect the eggs and chicken regularly from the household and the adjacent market places. The farm gate price offered by the middle men are often satisfactory to the households.

During monsoon the peddlers visit less frequently as it is more difficult to move in the village due to bad road and aggregation of animals and driving them to market places is inconvenient for traders. The settlers receive little less price for increased aggregating and transfer cost to the distant markets. Provision of micro credit is one of the key issues raised by many respondent and requested for liberal micro credit delivery system for small bolder livestock raisers.

Mitigation of Constraints:

Table-3.5.2.6 : Technical Input Services

Type of Livestock	Vaccination		De-worming	Source of Service			Breeding Services	
	No of dose used	*Type	No. of dose used	Private (Tk)	DLS (Tk)	NGO (Tk)	Natural Cost (BDT)	Artificial Insemination (Cost) (BDT)
Cattle/ Buffalo	500	FMD, BQ	200	700	-	-	-	-
Goat/ Sheep	900	HS,PPR	-	900	-	-	-	-
Chicken/ Ducks	285	RDV,Duck Plague	-	285	-	-	-	No cock exchange

- FMD-Foot and Mouth Disease, BQBlack Quarter, HS-Haemorragic septicemia, PPR-Pluro pneumonia, RDV-Ranikhet / Newcastle disease vaccine.

The above Table 3.5.2.6 explains the dark picture of almost non availability of technical input services from both public and private service providers. A few quacks on demand provide some inputs and the quantity is far from satisfactory. No livestock development can be envisaged without bridging this wide gap. Project intervention need to address this on top priority basis.

Development Options ;

Seasonal shortage of fodder can be largely mitigated through introduction of leguminous fodder crops like salt tolerant varieties of kheshari and cowpea in the farming system in the dry season. Establishment of multipurpose trees in thevillage plantation schemes which can be used as protein leaf bank and also meet the fuel wood requirement of the households. The small and marginal farmers who are shy to use the under utilized forest under growths can be promoted to use the resource through group approach. The other feeds and fodder improvement canbe achieved through popularizing urea treatment of straw and feeding urea molasses mineral blocks which have shown promising results in the north and central regionof the country. Salt free drinking water facilities for buffaloes can easily by made by simple rain water collection devices and their maintenance during the dry season.

Introduction of routine preventive vaccination against common prevalent diseases would reduce mortality and deworming would increase livestock growth and farmer's profitability, facilities of other inputs like improved bulls and bucks can be introduced to increase genetic potential and productivity of the animals. Small scale solar powered cool chain facilities can be introduced through the NGOs promoted Rural Livestock Extension Workers to preserve vaccines, drugs and semen. Semen preservation in liquid nitrogen and its extension to the project village is feasible, this will solve the key constraint of genetic improvement of cattle. '

In the chicken and ducks similar approach to ADB financed Participatory Livestock Development Project with suitable improved breeds of chicken and duck may be adopted for organized promotion of day old chick rearing, formulated feed supply and improvement of chicken and egg marketing network. However, it is assumed that introduction of cross breed like Sonali may not sustain in the long run. The learning of PLDP and other livestock development projects need to be considered prior to adventure of any intervention in poultry sub-sector.

Simple rural hygienic milk processing can be introduced by installation of diesel/wind power operated milk chilling vats and can be integrated with national milk marketing

network though the NGOs or Dairy Co-operatives. Quality and high value hygienic milk products like Ghee, Cheese, Yoghurt etc can be produced and marketed to distant markets. The secondary markets have good demand for quality processed products and the market is rapidly expanding.

Farming System Development Options

Livestock are well integrated into the existing farming system of the estuarine region. The strategies attempting to increase animal performance must take into account both the complementary and competitive relationships between crops, trees and livestock in these systems. Farmers make few crop decisions without considering the demands for feed for their livestock.

In the estuarine area the small and marginal farmers operate with a very small resource base. This means that they have to be more dependent on the positive interactions resulting from crops livestock relationship and are in a less flexible position to adopt innovations. Negative interactions like free ranging of chicken and damage to home garden or free ranging of goats and cattle and damage to young field crops resulting in conflicts among neighbors are often inevitable and need careful considerations for planning changes in the system. However, the profitable use of accreting landmass and its natural vegetation is made through raising livestock till the salinity declines and are suitable for other higher value crop production. In the study village many of the respondents reported failure of rice crop due to water logging and increased salinity. These household can benefit from investing in livestock till the drainage congestion is removed.

It is expected that the new settlers would be served by NGOs and would include in their line of activities beneficiaries group formation, awareness building, savings mobilization and utilization of credit facilities. The NGOs are also likely to include home gardening, crop, livestock and fisheries development through group approach.

In the livestock sub-sector main activity of the NGOs would be to develop man power through organizing farmers training with cooperation of Livestock Department in specific line of activities and creation of a cadre of Livestock Field Workers and Women Poultry Workers who would undertake extension activities at the grassroots level on participatory approach and on self help basis. The

farmers would be motivated to bear the inputs cost and service charge of the workers. DLS with cooperation of NGOs and participation of farmers all the inputs like vaccines, drugs, feed, and day old chicks, artificial insemination would be channeled through these workers.

Through project intervention the productivity of the existing herd of cattle, buffalo, sheep goat chicken and ducks are expected to be improved and reduce the preventable mortality and morbidity. Gradual introduction of more productive animals with the increased inputs availability and farmers skills to rear the improved stock will be a practical proposition in near future. The effect of project intervention on livestock is given in the Table 3.5.2.7

Table 3.5.2.7 : Mortality in Animal due to disease under village condition

Type of Animal	Mortality without Treatment (%)	Mortality with Preventive Care (%)
Adult cattle ***	5	3
Calf	13	8
Adult Buffalo	4	2
Calf	12	6
Goat*	8	3
Kid	24	14
Sheep	8	3
Lamb	24	14
Chicken	20	10
Chicken up to 8 week **	50	20
Duck	10	5
Ducklings up to 8 week	40	10

Source: * Production of Bengal Goat with limited amount of supplementation and anthelimentic drugs in selected regions of Bangladesh, SS Kibria.

** Semi-Scavenging model for rural poultry, holding, hans Askov Jensen.

*** DLS and personal experience

3.5.3 Livestock Production and Population Growth

Although no specific study was carried out in the project mauzas to determine the real growth rate but through farmers and field staff interview of the Livestock Department and study consultant's observation estimated the annual growth rate of different types of animal in the project village over the next 57 years is given in Table 3.5.2.8. The estimated growth in livestock can be further perfected with project interventions like deployment of sub technical manpower by the NGOs and linkage with the line department and the private service providers. The target beneficiaries have to agree to bear the cost of services and the communities willingness to adopt the project promoted options and sustain the interventions beyondhe project period.

Table 3.5.3.8 : Livestock Production and Population Growth

Type of Animal	* Growth Rate in 5 years (1983-84 to 1988-89) (%)	Annual Growth (%)	** Cyclone Shelter Preparatory Study (%)	Estimated Growth Rate Noler Char (%)
Cattle	- 1.7	-0.34	3.70%	2.8%
Buffalo	36.6	7.32	-	15%
Goat	39	7.8	1.50%	5.3%
Sheep	24	4.8	-	-
Chicken	26	5.2	21.1%	7.2%
Duck	13	2.6		5.0%

* BBS 1994 Survey on Livestock and Poultry in Bagladesh
** Cyclone Shelter Preparatory Study 1996 Supporting Volume 4 Livestock

Livestock and poultry survey of Bangladesh conducted in 1988-89 by BBS has estimated overall decrease of Bovines population by 1.03% of which cattle population decreased by 1.7% but the buffalo population increased by 36%. and the Goat population increased by 39% and sheep 24% respectively. The chicken population increased by 26% and ducks increased by 13% respectively over the census conducted in 1983-84 covering 5 years. The annual growth rate of the livestock sub-sector in 1994-95 was 9.5 percent which was one of the highest in the economy [1]. The production of milk, meat and eggs increase by an annual compound growth rate of 1.3 percent, 3.2 percent and 6.5 percent respectively between 1990-91 to 1990-95[1].

Table 3.5.3.9 : Estimates of growth in livestock population in Cyclone Prone area

Average number per household			Zone			
			West	Central	East	Overall
	1983/4 (census)	Bovines	2.43	1.52	1.54	1.70
		Ovines	0.84	0.78	0.79	0.80
		Poultry	7.72	7.61	8.09	7.79
	Fifth Five - year plan 1997-2001	Bovines	2.29	1.76	1.91	1.91
		Ovines	1.06	1.12	1.00	1.00
		Poultry	13.66	18.22	19.13	19.13
Increase in number per household(Avg. change per year)		Bovines	-1.10%	0.80%	1.25%	0.70%
		Ovines	0.10%	23.20%	-0.70%	1.30%
		Poultry	16.50%	21.60%	18.50%	19.60%
Increase in nr. of household			3.50%	2.00%	2.20%	2.20%
Increase in total number (Avg. change per year)		Bovines	2.30%	2.80%	3.70%	2.90%
		Ovines	3.60%	5.30%	1.50%	3.50%
		Poultry	20.50%	24.10%	21.10%	22.20%

Source: Cyclone Shelter Preparatory Study Stage 1
Feasibility phase draft final report supporting volume 4 Livestock
Sener Ingenieria Y Sistemas Sa, Spain, 1996.

[1] Fifth Five Year Plan 1997-2001

Similarly Cyclone Shelter Preparatory Study conducted a survey in 1996 in the cyclone prone coastal area and found 2.3 to 3.7% growth in bovines, 1.5 to 5.3% in ovine and 20.5 to 24.1% growth in poultry per year over the 1996 period. The above study covered wider coastal zone from east to the west. However, the east zone, which is largely identical with the project area have similarity with estimated growth rates except the poultry. The Cyclone Shelter Study included many small scale commercial farms operating in the main land along the Chittagong High Way and none of the organized farms exists in the study village. The poultry growth rate is assumed close to the findings of BBS survey, the growth rate is given in Table 3.5.3.8, and the Cyclone Shelter Preparatory Study findings is given in Table 3.5.3.9.

It was noted that the buffaloes are in better health than cows as the buffaloes can consume coarser roughage and tolerate more salinity. During monsoon and post-monsoon the cattle are reared in house and are stall fed. The farmers seldom spend money on improved feeding and the animals have to subsist only on rice straw and scraps of grasses in the embankment, pond dykes, village roads and bunds which is not enough for minimum maintenance. The animals loose weight and are easily attacked by disease. The situation further deteriorates if there is draught and delayed monsoon.

The small farmers do not send their cattle or buffalo in the forest for fear of theft or loss and their dependence on animal draft power for cultivation and other agricultural operations.

Table 3.5.3.10 : Estimated Livestock Population in Char Nangulia with increase of settlement (10% over present hhs)

Livestock Population in 2007 – 2012

Households	Buffalo	Cattle	Goat	Sheep	Chicken	Ducks
5160	1445	2269	3354	-	39212	22674

Table 3.5.3.11: Estimated Growth of Livestock Population in Noler Char with Project

Type of Livestock	Expected Growth Rate	PY-0	PY-1	PY-2	PY-3	PY-4	PY-5	PY-6	PY-7	PY-8	PY-9	PY-10	PY-11	PY-12
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cattle	2.8%	2269	2332	2396	2464	2532	2604	2677	2752	2829	2829	2829	2829	2829
Buffalo	1.5%	1445	1466	1488	1510	1533	1556	1556	1556	1556	1556	1556	1556	1556
Goat	5.3%	3354	3531	3716	3914	4122	4340	4571	4812	4812	4812	4812	4812	4812
Sheep														
Poultry	7.2%	39212	42035	45054	48269	51759	55484	59484	63758	68385	73287	78580	78580	78580
Duck	5.0%	22674	23807	24986	26233	27548	28932	28932	28932	28932	28932	28932	28932	28932

Note:

The consultants estimate of growth potential of cattle will continue for eight years and then the herd size will stabilize based on the carrying capacity of total land. The growth of buffalo population will continue for five years and will stabilize based on carrying capacity and cultivation of high value crops and availability of coarse roughage and reduced dependence of draft power. The goat population is likely to increase for seven years for increased interest of women in goat production and high profitability and fecundity. The poultry growth is expected to continue till tenth year for easy management and introduction of simple technology. The duck population will increase for five years and then stabilise for reduced area for free grazing and reduced availability of natural feed.

With project the main benefit will be increase in sideline income of the beneficiaries and expected to be above the national average of per smallholder households. The unemployed youths and the housewives will find more employment facilities remaining in the village. The livestock product consumers in the adjoining townships, rural growth centers and including Noakhali, Feni and Chittagong will get continuous supply of wholesome livestock products at a more competitive price.

CHAPTER- 4 : WATER MANAGEMENT OPTIONS

4.1 General

Char Nangulia and Noler Char, the two chars for development plans have been considered together for empoldering options. Char Majid drainage has been taken into account for preparation of the options.

The existing physical situation, environment, major constraints and problems of the study area, public demand and impact on adjacent projects have been carefully identified and studied for formulation of a comprehensive and balanced Development Plan.

Hazard due to saline tidal inundation/flood and drainage congestion are the main causes of problems to agriculture and of sufferings of the people living in the unprotected areas.

Considering the complex and dynamic situation and existing environment of the study area channels the consultants carried out detailed hydro-morphological investigations in the Hatiya river system. The consultants carried out detailed topographical survey in Char Nangulia, Noler Char, Caring Char, river surveys, land use survey, drainage studies etc. to prepare a balanced water management plan for the proposed study area. Mamur khal and Caring khal are the two hydro-morphologically important channels connected with and influencing Hatiya River hydro-dynamics. Lower Meghna River on the South-west and Hatiya Channel on the East are the two ultimate drainage outfall channels of the study area.

The average ground level of Char Nangulia is about 3.70 mPWD while the average ground level of Noler Char is lower and about 3.00 mPWD.

Knowledge was gained from local communities especially from those using local land and water resources through direct communication and field visits. Their views were considered on drainage congestion, tidal inundation/flood, saline water intrusion etc. in the study area. Based on this knowledge gained, need assessments of the project have been done.

The consultants investigated into possible options for solution of the related water management problems in the study area taking into considerations the external drainage situartion and dynamic morphological conditions of the tidal channels.

4.2 The Options

After thorough examination of the existing physical situation, environmental status, major constraints and problems of the area, public demand and status of the adjacent projects the consultants investigated the following possible options for formulation of a comprehensive and balanced water management plan for the project area.

- No intervention,
- Two polders (Char Nangulia and Noler Char Polders),
- One polder (Char Nangulia – Noler Char Polder), 2 Drainage Units,
- One polder, 1 Drainage Unit, avoiding Hatiya River for drainage,
- One Polder, 2 Units, avoiding Hatiya River for drainage.

To arrive at a comprehensive and optimum solution of the drainage problem and flooding situation, drainage simulation model and GIS model developed by CEGIS were used and application runs of the models for different design events were carried out. The interventional options are presented in Figures G 4.2a, G 4.2b, G 4.2c and G 4.2d.

No Intervention Option

This option allows the present situation to prevail i.e. keeping the area as it is without water management interventions. If no Water Management interventions are taken up in the unprotected study area, regular saline water intrusion and tidal flooding and drainage congestion will remain as constraints to the optimum utilization of land, water and other natural resources. However, the diminishing development of land elevation will continue. The economic activities of the area will continue at present slower rate.

Figure : G 4.2a Water Management option - 1

Figure : G 4.2b Water Management option - 2

Legend

- Bazar/ Hat
- Azim Ghat
- Mosque
- Police Station
- Cluster Village
- Existing Sluice
- Proposed Sluice
- Paved Road
- Rural Road
- River/ Water Bodies
- Mangrove Forest
- Embankment (Existing)
- Embankment (Proposed)
- Khal

N

1 0 1 Km

January 2007

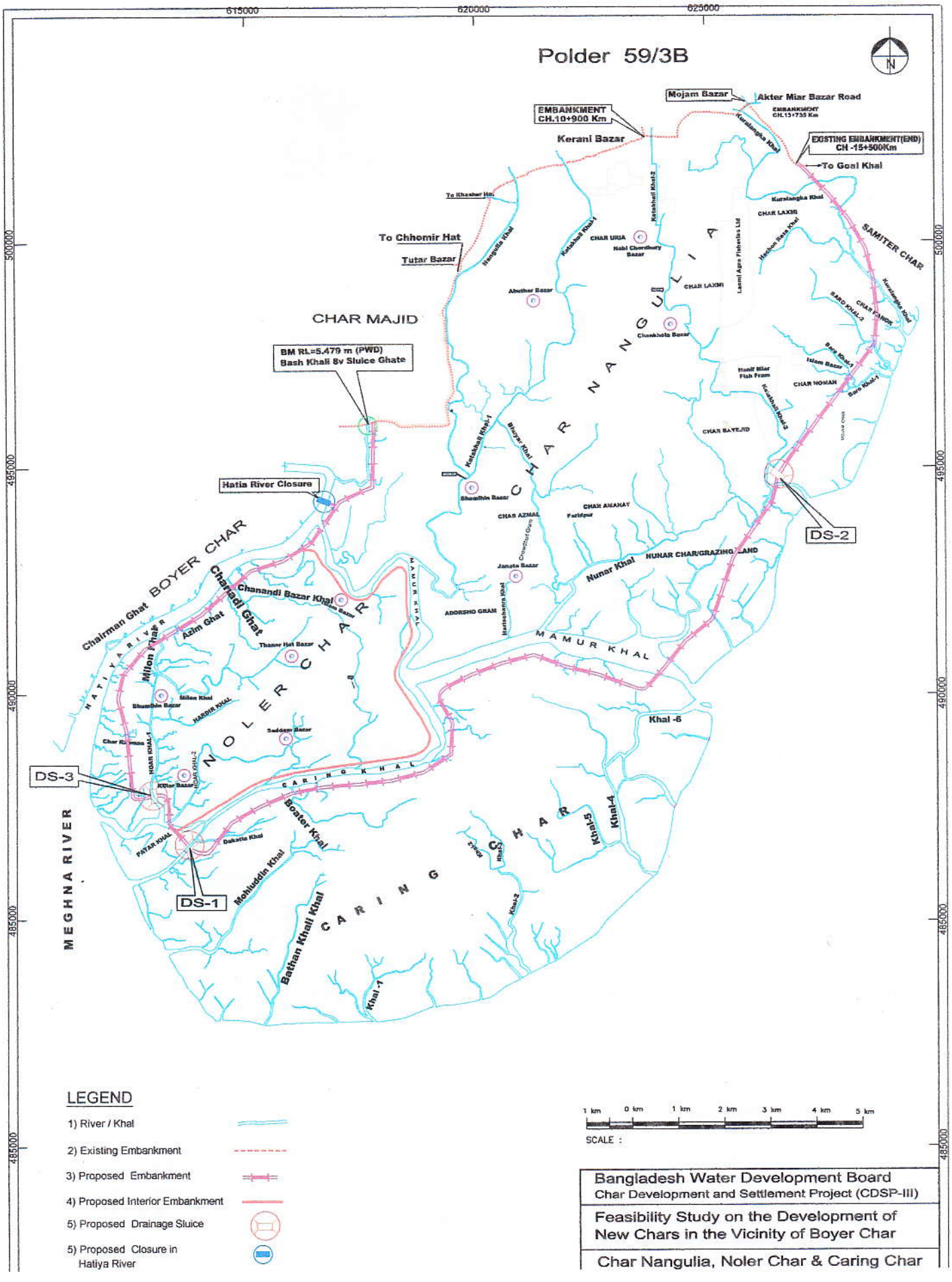
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia, Noler Char & Caring Char

CEGIS Center for Environmental and Geographic Information Services
On behalf of
Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Figure : G 4.2c Water Management option - 3


Polder 59/3B
615000
620000
625000
500000
495000
490000
485000
Mojam Bazar
Akter Miar Bazar Road
EMBANKMENT CH.10+900 Km
EMBANKMENT CH.13+735 Km
Kerani Bazar
EXISTING EMBANKMENT(END) CH -15+500Km
To Gosl Khal
Kuralangka Khal
To Khasher Hat
To Chhomir Hat
Tutar Bazar
Hangulia Khal
Ketakhali Khal-1
Ketakhali Khal-2
CHAR URIA
Nabi Chordhury Bazar
CHAR LAXMI
Laxmi Agro Fisheries Ltd
Hashon Saza Khal
SAMITER CHAR
CHAR MAJID
Abuthar Bazar
Chankhola Bazar
BAND KHAL-2
CHAR PAMOR
BM RL=5.479 m (PWD)
Bash Khali Sv Sluice Ghate
Bara Khal-2
Islam Bazar
Hanif Miar Fish Fram
CHAR NOMAN
Bara Khal-1
Ketakhali Khal-3
CHAR BAYEJID
CHAR NANGULIA
Hatia River Closure
Bhumihin Bazar
CHAR AZMAL
CHAR AMANAT
Faridpur
DS-2
Chairman Ghat
BOYER CHAR
Charkadi Ghat
Chanandi Bazar Khal
Azim Ghat
Thanar Hat Bazar
Janata Bazar
Nunar Khal
HUNAR CHAR/GRAZING LAND
MAMUR KHAL
ADORSHO GRAM
Hatiya River
Milon Khal
HARDIR KHAL
Bhumihin Bazar
Saddam Bazar
NOLER CHAR
Khal -6
DS-3
Kittar Bazar
HOAR KHAL-1
HOAR KHAL-2
CARING KHAL
Boater Khal
PATAR POOL
Dakatia Khal
MEGHNA RIVER
Mohiuddin Khal
Khal-4
Khal-5
CARING CHAR
Bathan Khali Khal
Khal-1
Khal-2
Khal-3
DS-1
LEGEND
1) River / Khal
2) Existing Embankment
3) Proposed Embankment
4) Proposed Interior Embankment
5) Proposed Drainage Sluice
5) Proposed Closure in Hatiya River
1 km 0 km 1 km 2 km 3 km 4 km 5 km
SCALE :
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)
Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char
Char Nangulia, Noler Char & Caring Char

Under this option, the existing situation in respect of drainage congestion will deteriorate, salinity will remain unchanged and most of the study area will remain flooded during high tidal flood.

Therefore, structural intervention for improvement of water management of the project area is essential and hence the option will not be discussed further.

Option-1 :

This option keeps Mamur khal and Caring khal open with the construction of (a) peripheral embankment for Char Nangulia Polder and a sluice at south-west corner of the polder discharging to Hatiya River and another sluice on eastern side to drain to Hatiya channel; and (b) peripheral embankment for Noler Char polder and a sluice near Milon khal outfall of this polder discharging to Hatiya River (Fig G 4.2a). The option will have the planed Cross-dam on Hatiya River at Ferry Ghat.

Option-2 :

This one-polder option is based on 2 drainage units 2 sluices approach. It will have one peripheral embankment around Char Nangulia and Noler Char area keeping Caring khal outside with 2 closures on Mamur khal one each near its confluences with Hatiya River and Caring khal and one sluice each for Char Nangulia and Noler Char drainage units both discharging to Hatiya River (Fig G 4.2b). Cross-dam on Hatiya River will be as planned at Ferry Ghat.

Option-3 :

This option will also have one combined polder with continuous peripheral embankment as of Option 2 but keeping Caring khal and eastern part of Mamur khal inside with one big sluice near the south-west end discharging to the Lower Meghna nearer to the out fall of Hatiya River (Fig. G 4.2c). It avoids Hatiya River as drainage outfall channel. Closure on Hatiya River may be at D/S of Char Majid out fall.

Option-4 :

The Option has been developed after the Technical Session on the study held on 25-06-07 in the Conference Room of BWDB, Dhaka (Proceedings given in Annexure Volume, Enclosure-3). It is a modified Option 3 with Noler Char as a separate drainage unit with a low height dyke on the other side of Caring khal and follow Mamur khal. Major Char Nangulia drainage will be effected through Mamur-Caring khals leading to a drainage sluice on Caring khal near to its outfall discharging to the Lower Meghna and another drainage sluice, like Option 1, will be on Khatakhali khal-2 to discharge to Hatiya Channel. Noler Char unit will have only one drainage sluice on Hoar khal to discharge also to the Lower Meghna. Option Map is given in Fig. G 4.2d. Closure on Hatiya River shall be at D/S of Char Majid outfall.

4.3 Discussion on Options

The four interventional options as already stated have been considered for Char Nangulia and Noler Char together taking into accounts the present hydro-morphological conditions of the major tidal channels of the study area - Hatiya River, Mamur and Caring khals, flow through them and tidal situation of the area. Option 1 keeps Mamur khal and Caring khal open with two polders and keeps Hatiya River as a drainage outfall channel; Option-2 closes Mamur khal, both sides with one polder and two drainage units and also uses Hatiya River as drainage outfall channel; Option-3 closes both Mamur khal and Caring khal with one polder and one drainage unit, and avoids Hatiya River as drainage outfall channel; and Option 4, actually a modified Option 3, also avoids Hatiya River as drainage outfall channel but having two separate units. The options and the points in favour and against are discussed to facilitate decision in favour of a specific option to prepare the development plans for the two chars accordingly.

4.3.1 Details of Option-1 :

There will be two separate polders – Char Nangulia and Noler Char Polders with individual peripheral embankment and drainage sluices keeping Mamur khal open as boundary external channel between them. With this option the cross dam on Hatiya River will be, as already planned, at Ferry Ghat to divert first drainage of Char Moradona through Boyer Char leaving Char Majid drainage as it is to drain to Hatiya

River since there is no problem of drainage in Char Majid. If required, Char Majid drainage may be diverted in future. This arrangement along with Char Nangulia drainage discharge and tidal discharge of the open Mamur khal is expected to help in channel maintenance of the Hatiya River for drainage.

Char Nangulia Polder will have the drainage sluice DS1 at the south west corner to discharge to Hatiya River and another sluice DS-2 on eastern side at Katakhali khal-2 outfall to discharge to Hatiya Channel. Mamur khal has been avoided as drainage outfall channel of Char Nangulia sluice due to its susceptibility to comparatively faster siltation. The silted up internal drainage channels Nangulia khal, Katakhali khal-1, Katakhali Khal-2, Bhuiyar khal and others will be re-excavated. Borrow pit channel for construction of embankment will be inside the polder to act as peripheral main drainage channel having required culvert/bridges at road crossings. Cross drainage inside will be effected through culverts on the internal roads.

Noler Char Polder will have the drainage sluice DS1 at the Milon khal outfall also discharging to Hatiya River. Here also borrow pit channel of embankment will act as peripheral drainage channel. Required culvert/bridges will be provided at road crossings of the drainage channels.

Positive Points of Option-1

1. Mamur khal and Caring khal are open to allow to continue natural tidal flow condition which will help maintain Hatiya River as out fall drainage channel of the area to discharge to Meghna River.

2. The two sluices in Char Nangulia will distribute drainage westward to Hatiya River and eastward to Hatiya Channel.

3. Construction of two large closures on Mamur khal as needed for one polder option will be avoided.

4. Nangulia drainage sluice (DS-1) discharging to Hatiya River will contribute to maintain Hatiya River channel.

5. Until diverted, Char Majid drainage will add to out-flow discharge of Hatiya River and help maintain the channel for drainage.

6. Peripheral embankments along Mamur khal will create facility to have east -west road communication of the polders.

Negative Points

1. Comparatively lesser siltation impact of Hatiya River than other Options.
2. Embankment length will be about 5.5 Km more.

4.3.2 Details of Option-2 :

The option will have a combined polder, **Nangulia-Noler Char Polder** with Char Nangulia and Noler Char Drainage Units. There will be one peripheral embankment for the two chars with two closures on Mamur khal, one near its outfall and the other at D/S of confluence with Caring khal. The polder will have two sluices, one for drainage of Char Nangulia Unit and the other for Noler Char Unit. A guide bund (dyke) on the southern bank of Mamur khal will separate the two drainage units. Eastern side embankment alignment will follow keeping eastern portion of Mamur khal and Caring khal out side the polder. Cross-dam on Hatiya will be as planned at Ferry Ghat with drainage diversion first of Char Maradona only leaving Char Majid Drainage as it is.

Positive Points of Option-2

1. Char Nangulia drainage sluice (DS-1) discharging to Hatiya River will contribute to maintain Hatiya River channel.

2. Until diverted, Char Majid drainage discharge will add to out-flow discharge of Hatiya River and help maintain the channel for drainage.

3. Closed Mamur khal is likely to be converted to a sweet water reservoir in futue.

4. Total embankment length is about 5.5Km less.

Negative Points

1. Closing of Mamur khal may likely to have uncertain morphological impacts including comparatively rapid siltation of Hatiya river leading to its dis-functioning as drainage outfall channel relatively early.

2. Two closures on Mamur khal.

4.3.3 Details of Option-3 :

This option will have a combined polder, **Char Nangulia-Noler Char Polder** avoiding Hatiya River as outfall drainage channel but one drainage unit. It will have one large drainage sluice on Caring khal at the southern end and discharge to Lower Meghna. Alignment of eastern side embankment will follow keeping eastern part of Mamur khal and Caring khal inside the polder which will be the main drainage channel leading to the drainage sluice. Cross-dam on Hatiya River may be at D/S of Char Majid out-fall to divert drainage of Char Majid, Char Maradona and also the area south of Char Majid through Boyer Char. This location of closure on Hatiya River will reduce embankment length of Boyer Char at Ferry Ghat end.

Positive Points of Option-3

1. One large polder with one sluice discharging to Lower Meghna River.
2. Likely siltation of Hatiya River will not affect drainage of the area.
3. The drainage sluice being nearer to the outfall River (Lower Meghna) there will be less problem of D/S siltation.
4. Closed Mamur khal and Caring khal may be used as sweet water reservoir in future.
5. Planned Boyer Char embankment length will be reduced by 1.5 km at Ferry Ghat end.

Negative Points

1. There will be no drainage distribution, char-wise. Accumulation of run off near the drainage sluice is likely to create temporary inundation near the sluice area due to lower land level in Noler Char.

2. Closing of Mamur khal may likely to have uncertain morphological impacts including rapid siltation of Hatiya river.

3. Two closures on Mamur khal and one on Caring khal.

4.3.4 Details of Option- 4 :

This option will also have a combined polder, **Char Nangulia-Noler Char Polder** but both the chars as separate units avoiding Baggardona/Hatiya River as drainage outfall channel. **Char Nangulia** will have the main drainage sluice (DS-1) nearer to the outfall end of Caring khal to discharge to the Lower Meghna. Like Option-3 alignment of eastern side embankment will follow keeping eastern part of Mamur khal and Caring khal inside the polder. Mamur khal - Caring khal will be the main drainage channel for Char Nangulia drainage leading to the Drainage sluice DS-1 (10V-1.5m x 01.8m). There will be another drainage sluice DS-2 (5V-1.5m x 1.8m) for Char Nangulia at eastern side on Katakhali khal-2 to discharge to Hatiya Channel. **Noler Char** will have one drainage DS-3 (7V x 1.5m x 1.8m) located at southern end of Hoar khal to discharge to the Lower Meghna river. Location of the proposed DS-1 and DS-3 will be at a minimum set-back distance of 1 km from the present coast line to provide safe distance against possible erosion and coast line migration at the outfalls of the sluices. The proposed Second Baggardona/Hatiya river Cross-dam will be at D/S of Char Majid out-fall instead of earlier one planned at Ferry Ghat. The river closure will be about 200m.

Positive Points

1. Hatiya River, susceptible to silting up in the long run, has been avoided as drainage outfall channel of Char Nangulia and Noler Char.
2. Noler Char being a separate drainage unit there will be no drainage accumulation.
3. Likely siltation of Hatiya River will not affect drainage of the area.
4. The drainage sluices being nearer to the outfall river Lower Meghna there will be less D/S siltation problem.
5. Planned Boyer Char embankment length will be reduced by about 1.5 km.
6. Closed Mamur khal and Caring khal are likely to act as sweet water reservoir.

Negative Points

1. Closing of Mamur khal and Caring khal may likely to have uncertain morphological impacts including rapid siltation of Hatiya river.

2. Two closures on Mamur khal and one on Caring khal.

4.4 Options Comparison

It is seen that all the four Options have individual points in favour for consideration. Positive and negative points of the Options have been discussed earlier. Comparison are made taking into account only the key positive and negative points.

Option 1 and Option 2, if compared first give that Option 1 has open Mamur khal a nd its tidal flow in addition to the drainage discharges of Char Majid, until diverted, and of Char Nangulia and is likely to impact favourably the channel maintenance of Hatiya River; and Option 2 will have less embankment length (by about 5.5 km) and scope of using closed Mamur khal as a sweet water reservoir. Considering anticipated more siltation impact of Hatiya River in Option 2 due to absence of Mamur khal flow, Option 1 is assessed to be favourable.

Option 3 has the strong positive point that it has only one drainage sluice discharging to Lower Meghna River but has a strong negative point that it creates drainage accumulation in Noler Char area. Comparing Option 1 and Option 3, Option 1 is considered favourable. The three Options (Options1, 2 & 3) were presented (Option 4 was not developed by then) in the Workshop held on 23.04.07 at Sonapur and Option 1 was accepted (Proceedings given in Annexure, Enclosure-3).

Option 4, developed after the technical session on the draft study report held on 25.06.07 (Proceedings given in Annexure, Enclosure-3), is a modified Option 3 with Noler Char as a separate drainage unit which eliminates the strong negative point of drainage accumulation in Noler Char..Like Option 3 it avoids Hatiya River but uses Lower Meghna River and Hatiya Channel as drainage outfalls of the sluices. If Option 1 and Option 4 are compared Option 1 has the risk of silting up of Hatiya River, the drainage outfall channel in the long run. So,Option 4 is favourable and considered as the selected option.

Although Option 4 was found to be the most viable option for the project area, the project model on flood depth was simulated for a number of scenarios.

The scenarios are :

- Existing condition for average, 5 & 10 year return periods, monsoon and post monsoon (Figures in Enclosure-1, Annexure).
- Option 1 for 10 year return period, monsoon (Fig. B 4.4/1),
- Option -2 for 10 year return period, monsoon (Fig. B 4.4/13),
- Option - 3 for 10 year return period, monsoon. (Fig.B4.4/14),
- Option- 4 for average year, 5 year and 10 year return periods for monsoon and post monsoon (Fig. B 4.4/15 – 20. Enclosure-1, Annexure).

From the simulation results it is found that the flooding situation at existing condition of Noler Char (10-year return period) give that 71% area is under F1 and below. But flooding condition for Option 1, Option 2 and Option 4 give about 20%, 20% and 18% areas are under F1 and below respectively. Considering other aspects, particularly avoiding Hatiya River and using Lower Meghna as drainage outfall Option 4 has been considered to be the best Option (Fig. B 4.4/1, B 4.4/2, B 4.4/13, 4.4/14 and B 4.4/15). Accordingly, Noler Char Development Plan has been prepared following Option 4.

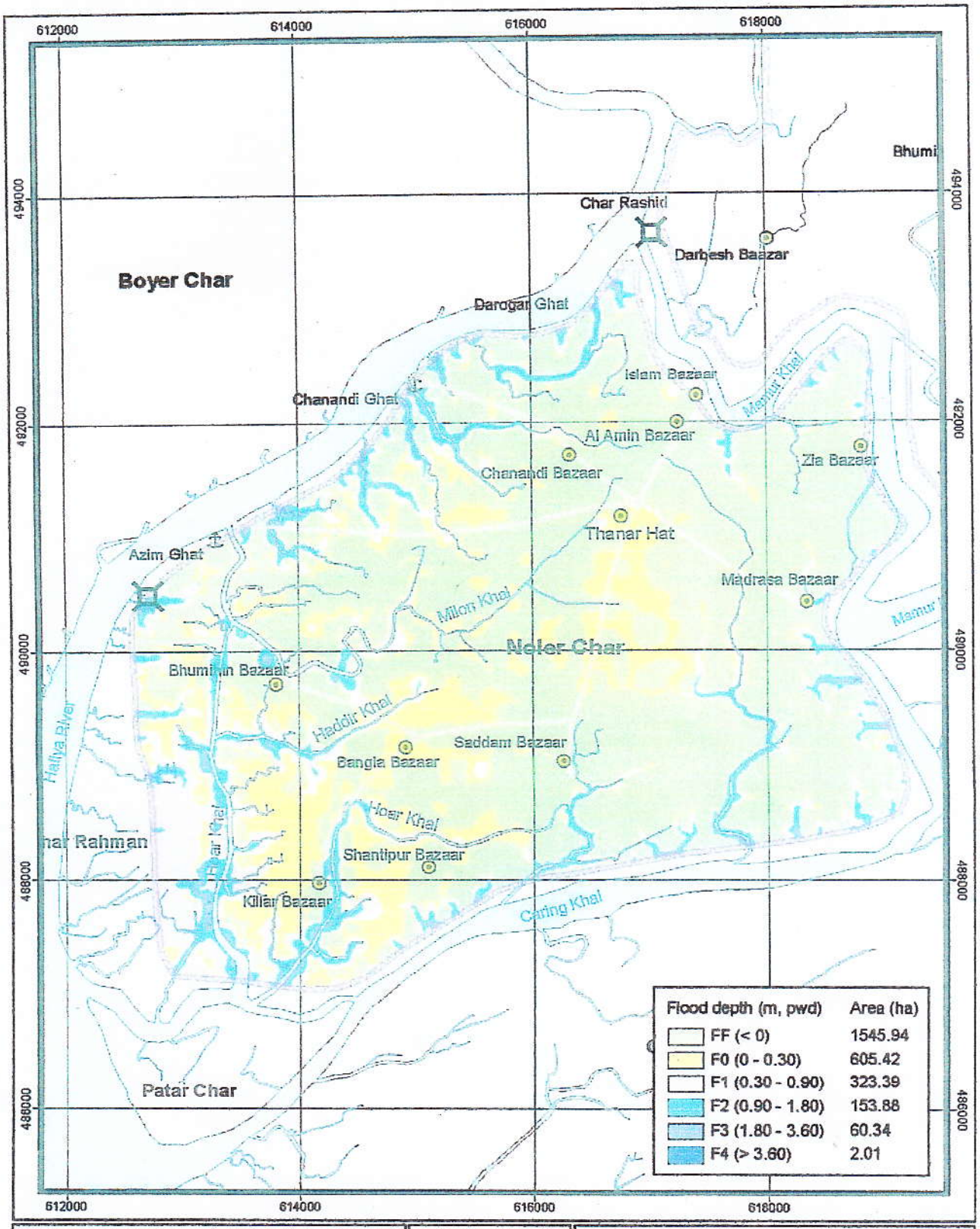


Figure : B4.4/1 Flood Depth Map (Option-1: 10 year return period - Monsoon)

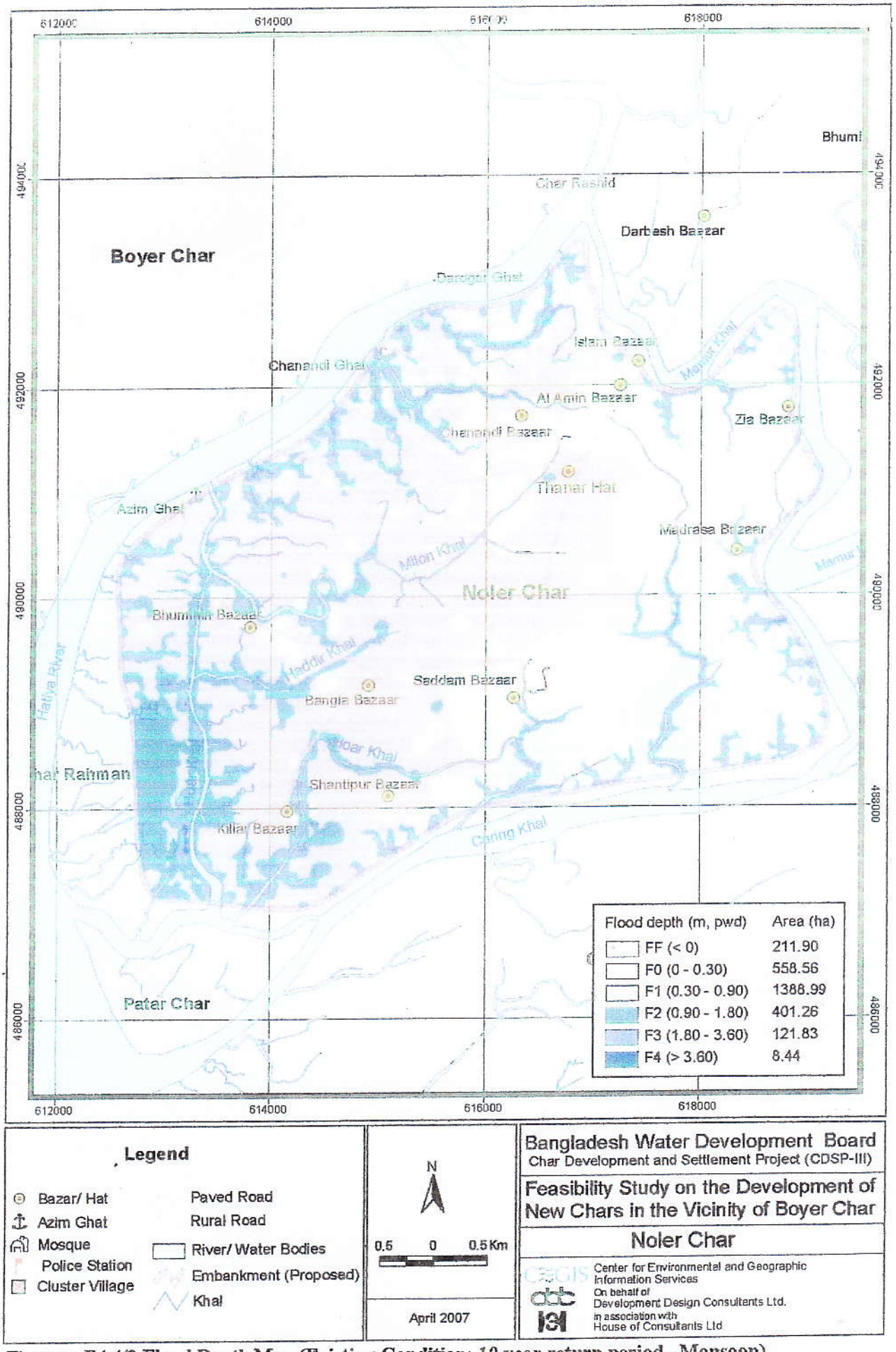


Figure : B4.4/2 Flood Depth Map (Existing Condition: 10 year return period - Monsoon)

Figure : B4.4/13 Flood Depth Map (Option-2: 10 year return period - Monsoon)


612000
614000
616000
618000
494000
492000
490000
488000
486000
Boyer Char
Char Rashid
Darbesh Bazaar
Darogar Ghat
Islam Bazaar
Chanandi Ghat
Mamur Khal
Al Amin Bazaar
Zia Bazaar
Chanandi Bazaar
Thanar Hat
Azim Ghat
Madrasa Bazaar
Milon Khal
Noler Char
Bhumihin Bazaar
Hatiya River
Heddir Khal
Saddam Bazaar
Bangla Bazaar
Hoar Khal
Shantipur Bazaar
Killar Bazaar
Caring Khal
Patar Char
Flood depth (m, pwd) Area (ha)
FF (< 0) 842.21
F0 (0 - 0.30) 839.57
F1 (0.30 - 0.90) 685.87
F2 (0.90 - 1.80) 236.38
F3 (1.80 - 3.60) 82.59
F4 (> 3.60) 4.36
Legend
Bazar/ Hat
Azim Ghat
Mosque
Police Station
Cluster Village
Paved Road
Rural Road
River/ Water Bodies
Embankment (Proposed)
N
0.5 0 0.5 Km
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)
Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char
Noler Char
CEGIS Center for Environmental and Geographic Information Services

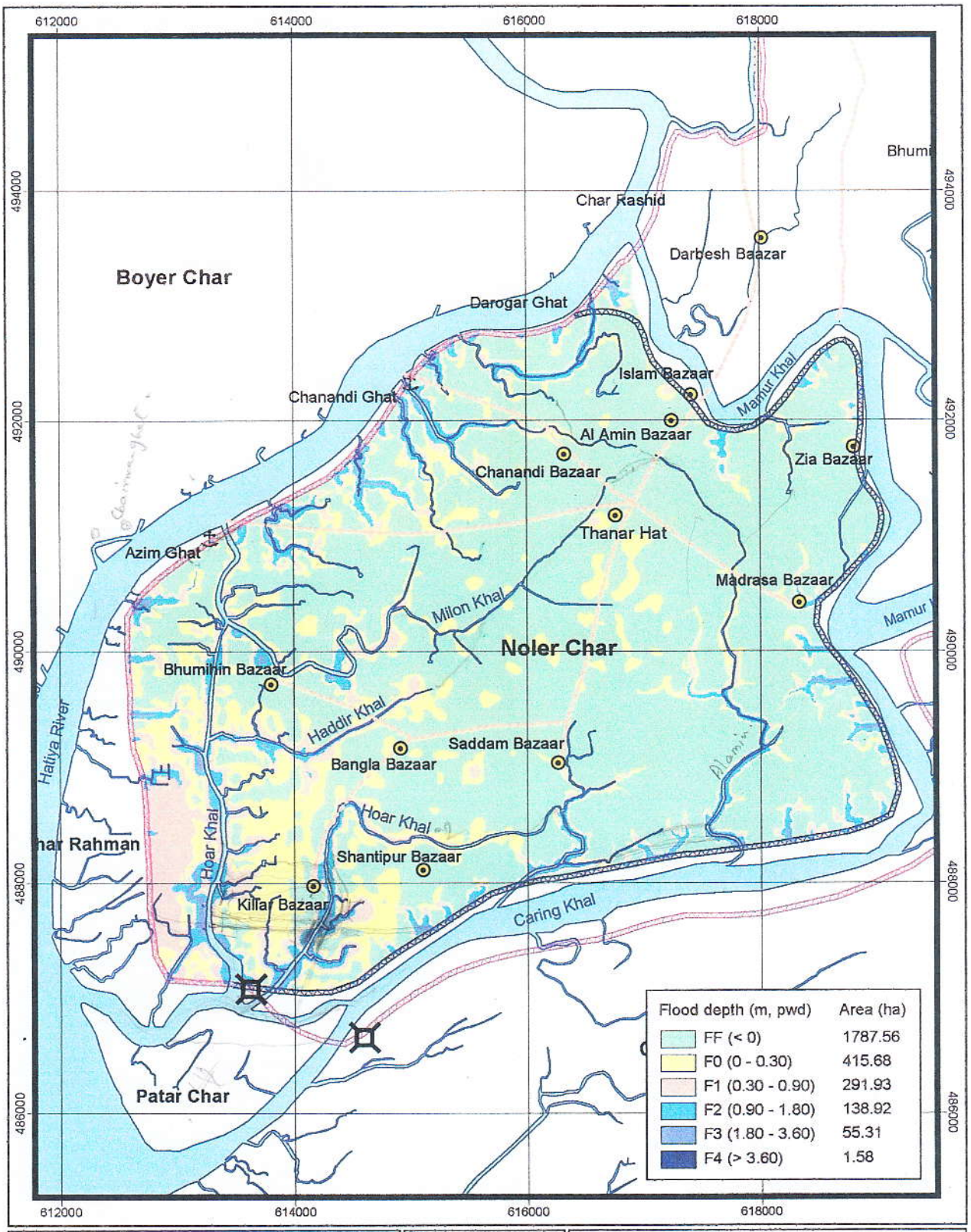


Figure : B.4.4/15 Flood Depth Map (Option-4: 10 year return period - Monsoon)

CHAPTER - 5 : PROPOSED DEVELOPMENT PLAN

5.1 General

In the newly accreted area development plan of new polder establishes the main pattern of physical infra-structures and the plan is determined by considering overall regional physical infra-structure of the nearby existing developed area and future requirement. The development plans are prepared for -

i) Water Management
ii) Communication
iii) Internal infrastructures

Proposed Interventions Map is given in Fig. G 5.1.

Water Management

Special care has been taken so that new empolderments do not in any way hamper the drainage of existing polders and or any unprotected land. The new system will integrate well with the existing drainage system of the area. Incorporation of fresh water source (surface/ground) has been considered for drinking. Further, future development has been left open.

Communication

Communication within the planned polders, between different polders and between new land and old land has been taken into account in the development plan and planned physical infrastructures. The transport of inputs into and outputs from the area, access of population to regional services and cyclone shelters has been considered during polder planning.

Internal Infrastructure

Internal Infrastructure like cluster village, rural roads with bridge/culvert, multipurpose cyclone shelters, ponds, tube-wells and latrine have been considered.

Long terms developments are also taken into consideration. There exists a long traditional reclamation and development activities of newly accreted land for agriculture in this area. The ongoing traditional land reclamation in Noakhali coast has been taken into account in the land development planning of the new polders.

5.2 Proposed Water Management Infrastructures

Embankment and Sluice

Embankments and Sluices along with drainage systems constitute essential structures necessary for achieving development of water management and agricultural production. Designs have been made following BWDB Standards and Practices

5.2.1 Embankment Cum Feeder Road

General

Design crest level is determined by providing free board over the design flood level. A rational determination of free board requires a determination of the height and action of waves. The height of waves generated by winds of the surface of a large body of water depends on the wind velocity, the duration of wind, the fetch length, and depth of water and the width of the water surface. After reaching and getting contact with the face of the embankment, the waves run-up move towards up in inclined planes and dissipate energy.

Level of Protection

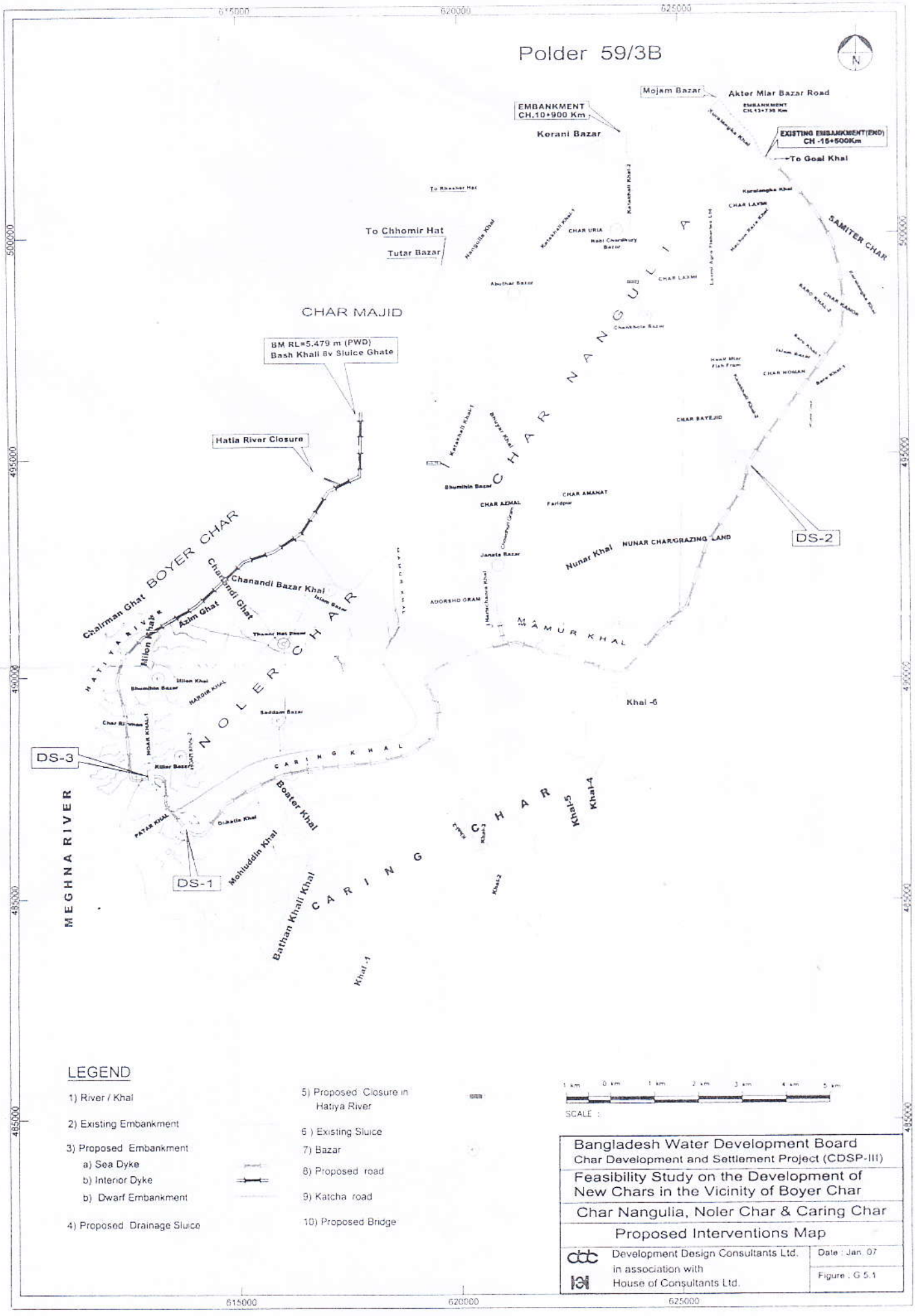
The level of protection is defined through the selection of hydraulic design conditions. These conditions are chosen on the basis of an optimization of the embankment design taking into account both technical and economical criteria. The design criteria are divided into monsoon conditions and the event of cyclone conditions as follows :

- For monsoon design condition the return period has been set to 5 years. No overtopping should occur at the significant wave height in this situation (only 13% of the waves should overtop).

- The return periods of cyclonic design conditions has been set to :

  - 20 years, where flooding due to wave overtopping of the sea/major river facing embankment should not result in average water depth in the polder exceeding 1.0m and crest should lower than the still water level of cyclonic storm surge.

- Climate induced sea level rise :
  - 5-10 mm rise per year as scenario for next 5-30 years.



LEGEND

1) River / Khal

2) Existing Embankment

3) Proposed Embankment
   a) Sea Dyke
   b) Interior Dyke
   b) Dwarf Embankment

4) Proposed Drainage Sluice

5) Proposed Closure in Hatiya River

6) Existing Sluice

7) Bazar

8) Proposed road

9) Katcha road

10) Proposed Bridge

SCALE :

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia, Noler Char & Caring Char

Proposed Interventions Map

Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Date : Jan. 07

Figure : G 5.1

Design Crest Levels and Slopes

Reduction of construction costs can be obtained by reducing the cross sectional area of the embankment either by lowering the crest levels and/or by applying steeper slopes.

Lower crests will for identical seaward slope lead to move frequent overtopping and hence to increase erosion damages to the crest and the inner slope. Too low crests will result in overtopping, which leads to considerable erosion to the inner slope.

Steeper seaward slopes will result in high velocities in the wave run-up and the slope will be subjected to wave erosion even during moderate monsoon conditions. For identical crest level the frequency and the amount of overtopping of the embankment will be increased.

Steeper inner slopes will be subjected to increased scour in overtopping situations and the geo-technical stability is not acceptable for steep countryside slopes.

For a given overtopping criteria, it can be demonstrated that a flat slope is more cost effective than a steep slope.

The crest levels arrived at for the CERP, Phase 2 embankment in May 1993 are listed below for comparison of the proposed polder in table.

Polder	Crest Level m(PWD)	Sea side slope
59/2, Ramgati	7.00	1:7
59/3B, Sudharam	7.60	1:7/1:5
59/3C, Companiganj	7.60	1:7/1:5
72, Sandip	7.0	1:7
73/1B, Hatiya	6.30	1:7

Considering the existing crest level of the embankment near Ramgati and adjoining polders (Boyer Char and Char Majid, it is recommended that crest level will be 7.00m (PWD), the sea side slope 1:7, country side slope 1:3 and crest width 7.30m for the proposed sea dyke. Crest width of interior dyke will be 7.3m with river side and country side slopes as 1:5 and 1:2 respectively. Dwarf embankment with crest level at 5.00m is recommended with 2:1 C/S and river side slope

The proposed cross-section and longitudinal profiles of the alignment of embankments and dwarf embankment of Noler Char is shown in Fig. B 5.2.1, Fig. B 5.2.1a and 5,2,1b respectively (Enclosure-1, Annexure).

For selection of alignment of the embankments, ground level, accretion and erosion of river bank, rate of coast line migration and protection of embankment from wave action by existing forest have duly been taken into consideration. Borrow pit will be provided inside so that it will perform the function of link channel for drainage leading to the respective drainage sluice.

The proposed embankment will protect the polder area against saline inundation during high tide and cyclonic storm surges. It will also protect human lives, cattles, crops and properties from damage due to cyclonic storm surge and flooding.

Closure

There will be five small and medium size closures on the khals crossing the proposed embankment.

5.2.2 Drainage Sluice

General

Drainage Sluices in tidal area are designed to drain the polder area up to design level. A tidal drainage sluice with suitable invert level and a flap gate at the river side is the most appropriate structure. To control the drainage flow and to maintain certain water level inside the polder, the drainage sluice is to be equipped with a vertical lift gate at the countryside where necessary.

Rainfall and Run-off

The drainage run-off is equal to the quantity of rainfall in the catchment reduced by evapo-transpiration, surface storage and infiltration into the ground. To estimate the drainage modulus of the drainage basin the method described in "Design Manual for Polders in South-West Bangladesh, Part 4, VOL. IX" with the assistance of Delta Development Project, Bangladesh-Netherlands Joint Programme under BWDB has been used.

To determine the drainage requirement rainfall frequencies have been worked out from the rainfall gauge station 375, Ramgati which is very close to proposed project site. A 5-day duration rainfall with 10-years recurrence interval is taken as the design rainfall for computation of drainage modulus. The same criteria were used in CERP, Phase 2 sluices planning and design in May 1993. It may be mentioned that the same criteria were also in CDSP-II. Results of frequency analysis is presented in Table 5.2.2a.

Water Level

Sluice size is calculated, based on the average design drainage discharge. During stages of design drainage discharge the polder water level may be assumed to be halfway in between the design drainage level (d.d.l) and maximum storage level (m.s.l) In monsoon period the design drainage level corresponds to the required water level in the rice fields.

The design drainage discharge through the sluice is to calculated at average tide condition of the river water. Average tide is defined as the average tidal amplitude ranging from M.H.W to M.L.W. at average river level for the considered time of the year.

Water level variations of the study area are mainly governed by tide as well as river discharge. Water level data for the stations 321, Hatiya and Banshkhali Sluice have been collected and analyzed as these are the nearest stations. A co-relation has been used to determine the design water level in project site Table G 5.2.2b (Enclosure 2. Annexure).

Drainage Routing

Drainage routing is carried out using 1 in 10 years 5 days rainfall amounts for the period of June-July following the criteria of 5% inundation of the incremental area in addition that can not be drained by gravity to greater depth than 0.30m for a period of 3 days. A co-related average year high water level and low water level during monsoon is considered as tail water level. Standard hydrological techniques are used in this analysis with the assistance of a number of computer programs. A computer simulation model is developed for design of drainage sluices in the coastal area by CERP, Phase 2 Engineers. Number of vents and invert levels of sluices are determined from several alternatives by the above Routing Program. Dimension of sluices at two different locations in Char Nangulia and one sluice in Noler Char Polder is covered in the Option- 4.

Char Nangulia and Noler Char lie in very active zone in southern Noakhali of Meghna Estuary. The outfall of Mamur khal which drains maximum area of Char Nangulia and a portion of Noler Char area along with tidal flows coming from the east falls in Hatiya River 8 km upstream of its (Hatiya River) outfall to Meghna River (Hatiya Channel). On the other side Caring khal which drains part of the area of Noler Char and Char Rahman and part of Caring Char falls in Hatiya Channel. Char Rahman at the southern end near

the outfall of Hatiya River, is being eroded which is also presently restraining the coastline forward movement towards south-west and lengthening of drainage path improving outfall condition of Hatiya River. For draining efficiently a 7-vent 1.50m x 1.80m sluice (DS-3) is proposed near the outfall of Caring khal with sufficient set back distance for drainage of Noler Char Polder. Plan and section of DS-3 is presented in Figure: B 5.2.2. Results of simulation of flood routing through sluices are presented in Table : B 5.2.2a (Enclosure-2, Annexure).

The particulars DS-3 is –

Vent Size	:	7 Vent – 1.5m x 1.8m
Sill Level	:	0.50 mPWD
Allowable Submergence	:	0.3m
Time of Drain out the access water	:	72-96 (max.) hours

5.2.3 Drainage Channel

Drainage channels have been designed considering the design procedures followed in "Design Manual for Polders in South-West Bangladesh, Part 4, VOL. IX " with the assistance of Delta Development Project, Bangladesh-Netherlands Joint Program under BWDB.The criteria followed for the drainage channels in the polders with some remarks are given below :

- the catchment area for individual channel has been delineated and measured with the assistance of computer;
- the same drainage modulus for sluices design has been considered for both the polders;
- the longitudinal slopes for the channels is considered 0.0001 - 0.0005m/m;
- the design bed width of the channel shall be such that the top width of design section remains within the existing top width of channel;
- the water level in the drainage channel at sluice point is the average of the high and low water level;
- the Manning's equation with roughness co-efficient of 0.035 and channel side slope 1:1.5 have been used to design the capacity of channels;
- the drainage time is taken 18 hours for all channels;
- the permissible velocity of flow should be within 0.90m/sec.

The design sections of the drainage channels/khals for Noler Char polder is furnished in Fig. B 5.2.3/1 to B 5.2.3/8 (Enclosure-1, Annexure). List of existing khals to be re-excavated are given in Table B 5.2.3.

Table B 5.2.3 : List of Existing khals proposed for Re-excavation of Noler Char

Sl. No.	Description of Rivers/Khals	Length (km)
1	Chanandi khal	2.425
2	Milon khal	6.000
3	Hoar khal – I	5.000
4	Hoar khal - 2	5.400
5	Adarshagram khal	1.850
6	Mannan Mosque khal	2.250
7	Haddir khal	2.000
8	Musapur khal	1.500
	Sub-Total :	**26.425**
9	Borrowpit khal-I (Islam Bazar to Daksin Musapur, Mamur khal – Caring Khal side)	12.3
10	Borrowpit khal-II (Islam Bazar to Daksin Musapur, Mamur khal – Hatiya River Side)	10.2
	Total :	48.925

5.3 Proposed Internal Infrastructure

The following internal infrastructures (Table : B 5.3) have been identified and assessed for Noler Char. Estimated numbers of household related infrastructures have been determined using number of households considering surveyed project area. Standard Design and Practices of LGED have been used.

Table B 5.3 Details of Internal Infrastructure of Noler Char

Sl. No.	Infrasturcture	Length /No.	Unit
1.0	Rural Roads (Type R-2)	17.45	km
2.0	Bridge (15m span)	1	Each
3.0	Culvert		
	3.1 Box Culvert, (1 Vent – 4m x 3m)	1	Each
	3.2 Pipe Culvert (0.6m dia)	8	Each
4.0	4.1 Multipurpose Cyclone Shelter	10	Each
5.0	Community Ponds	24	Each
6.0	Deep Tube-well	313	Each
7.0	Latrines	5159	Each
8.0	Public Toilet	12	Each
9.0	Pond Sand Filter Scheme	16	Each
10.0	Rain Water Harvesting Schemes	32	Each
11.0	* Market	12	Nos.
12.0	* Secondary School	1	No.
13.0	* Graveyard	4	Nos.

* Considered for provision of land for future development

5.3.1 Rural Roads

Rural roads will connect the cluster villages, farms, markets etc. with the feeder roads and embankment. The proposed rural roads are R2 type of LGED Standard (Fig. G 5.3.1). Its specification will be –

Crest width	-	3.7m
Side slope	-	2 : 1
Crest level	-	4.5m PWD

Long section is provided in Figure B 5.3.1 and Cross Section in Figure G 5.3.1(Annexure, Enclosure-1).

Table B 5.3.1 : List of Roads Proposed for Development of Noler Char

Sl. No.	Description Road	Length (km)
1	Islam Bazar to Saddam Bazar	4.75
2	Thanar hat to Azimghat	2.60
3	Saddam Bazar to Killar Bazar	3.72
4	Thanar Hat to Madrasha Bazar upto Mamur khal	2.35
5	Bangla Bazar to Chairman Ghat	1.96
6	Thanar hat to Chanandi Ghat	2.07
	Total :	17.45

The existing footpaths will be utilized in the proposed rural roads planning.

5.3.2 Bridge & Culvert

To minimize road crossing with existing channels new road alignment are selected parallel to the existing channels. Thus the number of bridge and culvert are kept minimum. Type design of bridges and culverts are given in Fig. G 5.3.2/1 to G 5.3.2/5 (Enclosure-1, Annexure). Location of Bridge/Box Culverts have been shown in Map (Figure G 4.4). For Cross drainage provision of 5 culverts have been kept and located at appropriate places.

5.3.3 Cluster Village

People are not interested to live in cluster village as expressed during field visit and meetings. They prefer to live in independent houses as they are living now.

5.3.4 Multi-purpose Cyclone Shelter

Emergency shelters have been provided to give high degree of security and safety for the people against tidal bore and cyclone. The cyclone shelter can also be utilized for other purposes like educational institutions, place of social gatherings etc. Total number

have been determined considering one cyclone shelter for each 500 households. Shelter sites are selected in densely populated areas preferably near the following important market places and other locations. The market places selected on discussion with the beneficiaries are (1) Madrasha Bazar, (2) Thanarhat Bazar, (3) Saddam Bazar, (4) Bangla Bazar, (5) Killar Bazar, (6) Bhumihin Bazar and (7) Chanundi Bazar in Noler Char. A typical plan of multi-purpose cyclone shelter is presented in Fig. G 5.3.4 (Enclosure-1, Annexure).

5.3.5 Tube-Well

One deep tube-well of average 400m depth for 15 families and one deep tube-well for each cyclone shelter, for each market (included with public toilets) and each mosque have been provided as per public demand during field visits and meetings. Provisions for Rain water Harvesting Scheme and Pond sand Filter Schemes. have been kept for locations where Deep Tube-wells are not feasible, about 10% and 5% of Tube-wells respectively.

5.3.6 Latrine/Public Toilets

One single pit Latrine is provided for each present family and for increased families during project period, 10% increased considered. Public toilets will be provided in large Bazars.

5.3.7 Ponds

Community ponds have been provided for each 200 households.

5.4 Cost of Civil Works

5.4.1 Cost Estimates of Water Management Infrastructures

For the proposed project (Option-1) assessments of the following water management infrastructures have been made :

- Sea dyke cum Feeder Road
- Interior dyke
- Drainage Sluices
- Drainage channels
- Borrow pit cum drainage channel

A summarized proposed water management infrastructures are presented in Table : B 5.4.1a.

Table : B 5.4.1a : Proposed Water Management Infrastructures in Noler Char

Sl.No.	Project Infrastructures	Unit	Quantity
1.0	Drainage Sluice		
	1.1 DS-1 (7-vent 1.50 m x 1.80 m)	No.	1
2.0	Embankment		
	2.1 Sea Dyke	Km	6.0
	2.2 Interior Dyke	Km	4.50
	2.3 Dwarf Embankment	No	13.25
3.0	Closure of khals	No.	5
4.0	4.1 Re-excavation of khal/Drainage channel (26.4 km)	Cum	52,810
	4.2 Re-excavation of Borrow Pit Channel	km	22.50

For the proposed water management infrastructures i.e. sea dyke, interior dyke, drainage sluices and drainage channels the unit rates have been based on standard schedule of rates of Feni O & M Circle, BWDB, 2006 and adjusted to 2009 cost.

Physical contingencies have been considered in the estimate by 10% of the total construction cost.

A summarized cost estimate of proposed water management infrastructures is presented in Table B 5.4.1b for Noler Char for year 2006-2007 and the expected escalated cost @ 10% increase per year is considered. Accordingly expected cost for the year 2009 is indicated in last column of the table.

Table B 5.4.1b : Cost Estimate of Water Management Infrastructures of Noler Char

Sl. No.	Project Infrastructures	Length/ No/Cum	Unit	Rate (Tk)	Amount as per schedule of 2006-07 (Tk. '000)	Expected escalated amount for the year 2009 (Tk. '000)
1.0	Drainage Sluice					
	1.1 DS-3 (7-vent – 1.5m x 1.8m)	1	Each	6,70,00,000	67,000	89,177
2.0	Embankment					
	2.1 Sea Dyke	6.0	Km	78,33,103	4,6999	62,556
	2.2 Interior Dyke	4.5	Km	68,71,231	30,921	41,156
	2.3 Dwarf Embankment	13.25	LS	5,30,000	7,023	9,347
3.0	Closures of khals	5	LS	-	5800	7,720
4.0	Re-excavation of khals/ Drainage Channel (26.4 km)	52,810	Cum	38.01	2007	2,671
				Total :	**1,59,750**	**2,12,627**

5.4.2 Cost Estimates of Internal Infrastructures

For the project development in Noler Char the following internal infrastructures have been proposed.

- Rural roads
- Bridge/culverts
- Multipurpose Cyclone shelters
- Community ponds
- Deep tube-wells
- Latrines

For Noler Char the proposed internal infrastructures such as rural roads, bridge/culverts, multipurpose cyclone shelters etc. the unit rates of LGED standard schedule of rate for the year 2006 of Noakhali Region have been used and Physical contingence have been considered in the estimate by 10% of the total construction cost. A summarized cost estimate of proposed internal infrastructures is presented in Table : B 5.4.2 for Noler Char.

Table B 5.4.2 : Cost Estimate of Internal Infrastructure of Noler Char

Sl. No.	Infrastructure	Length /No.	Unit	Rate (Tk)	Amount as per schedule of 2006-07 (Tk. '000)	Expected escalated amount for the year 2009 (Tk. '000)
1.0	1.1 Rural Roads (Type R-2)	17.45	km	490,000	8551	11381
2.0	Bridge (15m span)	1	Each	27,00,000	2,700	3,594
3.0	Culvert					
	3.1 Box Culvert, (1 Vent – 4m x 3m)	1	Each	10,00,000	1,000	1,331
	3.2 Pipe Culvert (0.6m dia)	8	Each	1,00,000	800	1,065
4.0	Multipurpose Cyclone Shelter	10	Each	64,66,000	64,660	86,068
5.0	Community Ponds	24	Nos.	3,00,000	7,200	9583
6.0	Deep Tube-well	313	Each	60,000	18,780	24,997
7.0	Latrines	5159	Each	2,000	10,318	13,733
8.0	Public Toilet	12	Each	6,91,030	7,212	9599
9.0	Pond Sand Filter	16	Each	1,79,944	2,879	3832
10.0	Rain Water Harvesting Schemes	32	Each	71,030	2,273	3025
				Total :	**126,373**	**1,68,210**

5.4.3 O & M Cost

Routine O & M cost has been assumed 1% of initial capital cost of the project. Item-wise yearly O & M cost has been considered as a percentage of initial capital cost as follows :

O & M cost of Drainage Channel	2%
O & M cost of Embankment	4%
O & M cost of Structure	2%

Cost of the emergency maintenance for restoration of Natural damage due to cyclone and tidal surge is estimated to be 4% of the initial capital cost of major infrastructures.

Item-wise estimated Yearly O & M costs are given in Tables B 5.4.2a and B 5.4.2b for water management and internal infrastructures respectively on 2009 year costs.

Table B 5.4.3a : Yearly O & M Cost Estimate of Water Management Infrastructures of Noler Char

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 cost	Estimated Cost (Tk. '000)
1.0	Drainage Sluices					
	1.1 DS-3 (7-Vent-1.5mx 1.8m)	1	Each	89,177	2	1784
2.0	Embankment					
	2.1 Sea Dyke	6.0	Km	62,556	4	2502
	2.2 Interior Dyke	4.50	Km	41,156	4	1646
	2.3 Dwarf Embankment	13.25	km	9,347	4	374
3.0	Closures of khals	5	LS	7,720	4	309
4.0	Re-excavation of Khal/ Drainage Channel (63.78 km)	52,819	Cum	2,671	2	53
			Total:	2,12,627		6,668

Table B 5.4.3b : Yearly O & M Cost Estimate of Internal Infrastructure of Noler Char

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 cost	Estimated Cost (Tk. '000)
1.0	Rural Roads (Type R-2)	1745	Km	11,381	2	228
2.0	Bridge (20m Girder bridge	1	-	3,594	-	72
3.0	Culvert					
	3.1 Box Culvert, (1- Vent 4m x 3m)	1	No.	1,331	2	27
	3.2 Pipe culvert (0.6m dia)	8	No.	1,065	2	21
4.0	Multipurpose Cyclone Shelter	10	No.	86,068	2	1721
5.0	Community Pond	24	No.	9,583	2	192
6.0	DTW	313	No.	24,997	2	500
7.0	Latrine	5159	No.	13,733	2	275
8.0	Public Toilet	12	No.	9,599	2	192
9.0	Pond sand Filter Schemes	16	No.	3,832	2	77
10.0	Rain water Harvesting Schemes	32	No.	3,025	2	61
				1,68,210		3,166

Yearly O & M cost comes as Tk. 6.668 million for Water management infrastructures and Tk. 3.166 million for Internal infrastructures with a total of Tk. 9.834 million.

CHAPTER 6 : DEVELOPMENT BENEFITS

6.1 General

The project will create ample scope of agricultural development through the proposed solution of the major problems of saline inundation/flood by constructing protection embankment and sluice and re-excavation of khals.

6.2 Agriculture with Project

A comprehensive solution of problem of salinity, water-logging and abnormal tidal flooding through the proposed interventions and providing land settlement and support services in Noler Char will bring positive impact on crop production and livelihood of the farmers of the char. The cropping intensity, yield, production and employment opportunity will be increased.

6.2.1 Rationale of Future Crop Production in Noler Char

Based on the review of other feasibility study reports on the coastal Char land, field surveys, discussion with farmers, extension agencies, environmental and socio-economic consideration of the study areas, future projections are planned under the options of the feasibility study. The planned cropping intensity will be close to the national cropping intensity, yields will be also increased and crop damages due to salinity, water-logging and tidal flood will be reduced.

6.2.2 Projected Cropping Intensity and Crop Diversity

The present cropping intensity in Noler Char is 150%. This is rather low compared to the national average of about 180%. The future cropping intensity of Noler Char is expected to increase to 165% in the 5th year and 180% in the 10th year of empoldering. In the 10th year the cropping intensity is expected to be stabilized. The increase of area i.e. intensity is expected in the Rabi and Kharif-1/Aus season only. In the Kharif-II/T. Aman season, the area or intensity is shown to be 90% at present and in future projection, the intensity will remain the same (Table-6.1). However, the area under HYV/T. Aman will increase to 30% from the present 5% only. Similarly, HYV area in the Aus season is expected increase to 15% from the present 2%. The intensity or area in Rabi season is expected to increase to 65% from the present 45%. It is expected that high value winter vegetable such as tomato cauliflower, cabbage etc. will

get its way in the production (Table 6.2). Present and With Project crop area information is given in Fig. G 6.2.2a and G 6.2.2b.

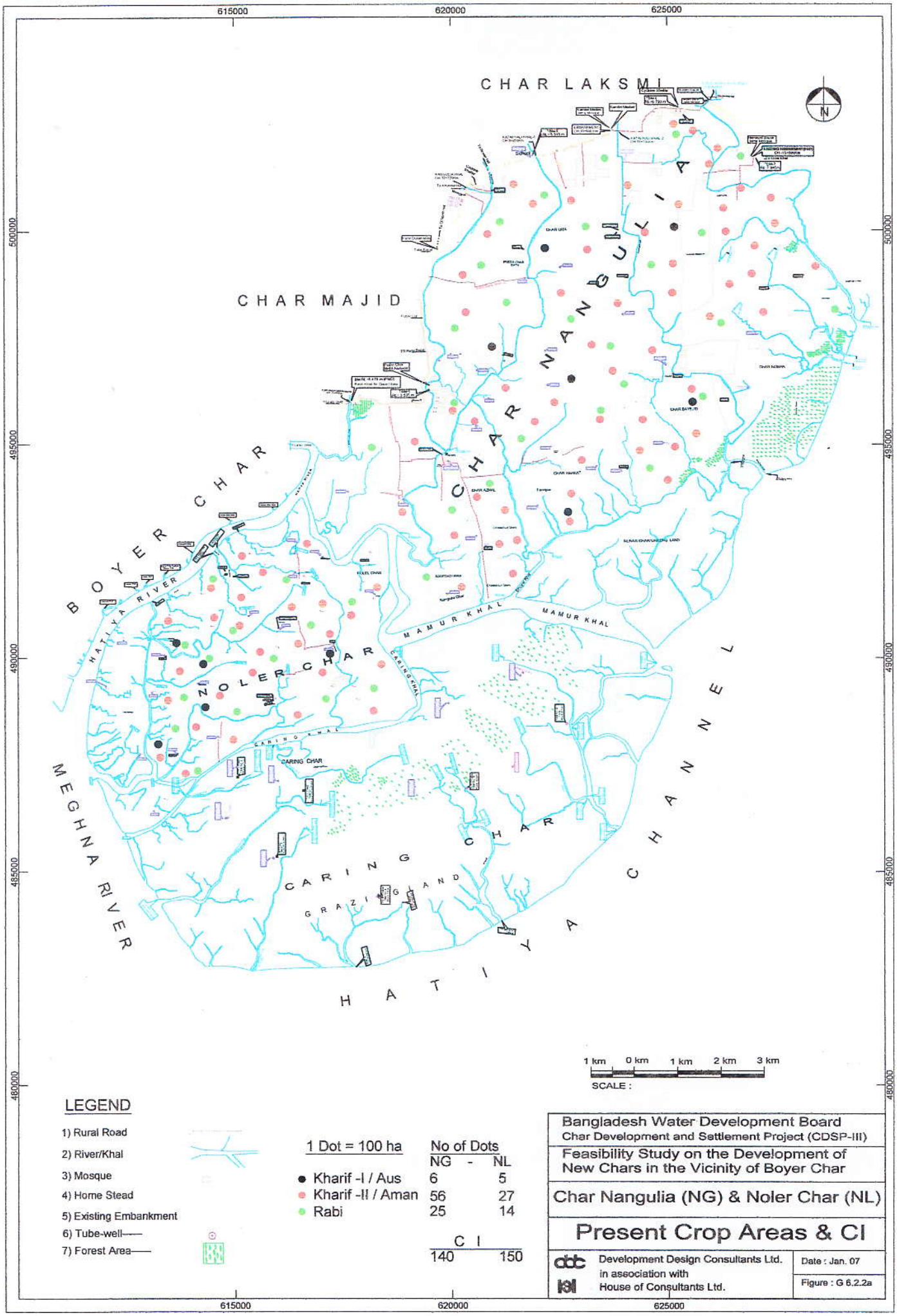
Table 6.1 : Present and Projected Cropping Intensities (%) in Noler Char

Name of the Char	Year after empoldering	Rabi/Boro	Aus/Kharif-1		T. aman/ Kharif-II		Total Intensity%
			HYV	Local	HYV	Local	
Noler Char	Base Situation (Present)	45	2	13	5	85	150
	5th year of empoldering	55	5	15	10	80	165
	10th year of empoldering	65	15	10	30	60	180

Source : Study Estimation-2007

6.2.3 Projected Yield and Production

Present yield rates for the major crops are low due to salinity and water-logging except rice. With the removal of salinity and drainage congestion crops yields are expected to rise. The anticipated production of different crops at full development stage are expected to be achieved after 10 years of project implementation. Projected area, yield and production of different crops with project situation are shown in Table6.2 and Annex-4. Future projection of crop yields was assessed in the light of average yield reported by BBS, yield obtained by CDSP's demonstrations, yield obtained by BRRI, BARI in their on- farm research trials. Projected yield will be easily achievable if recommended level of inputs such as quality seeds, fertilizers etc. are used and proper management of crops are provided.



LEGEND

1) Rural Road
2) River/Khal
3) Mosque
4) Home Stead
5) Existing Embankment
6) Tube-well
7) Forest Area

1 Dot = 100 ha

	No of Dots NG	NL
Kharif -I / Aus	6	5
Kharif -II / Aman	56	27
Rabi	25	14
C I	140	150

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

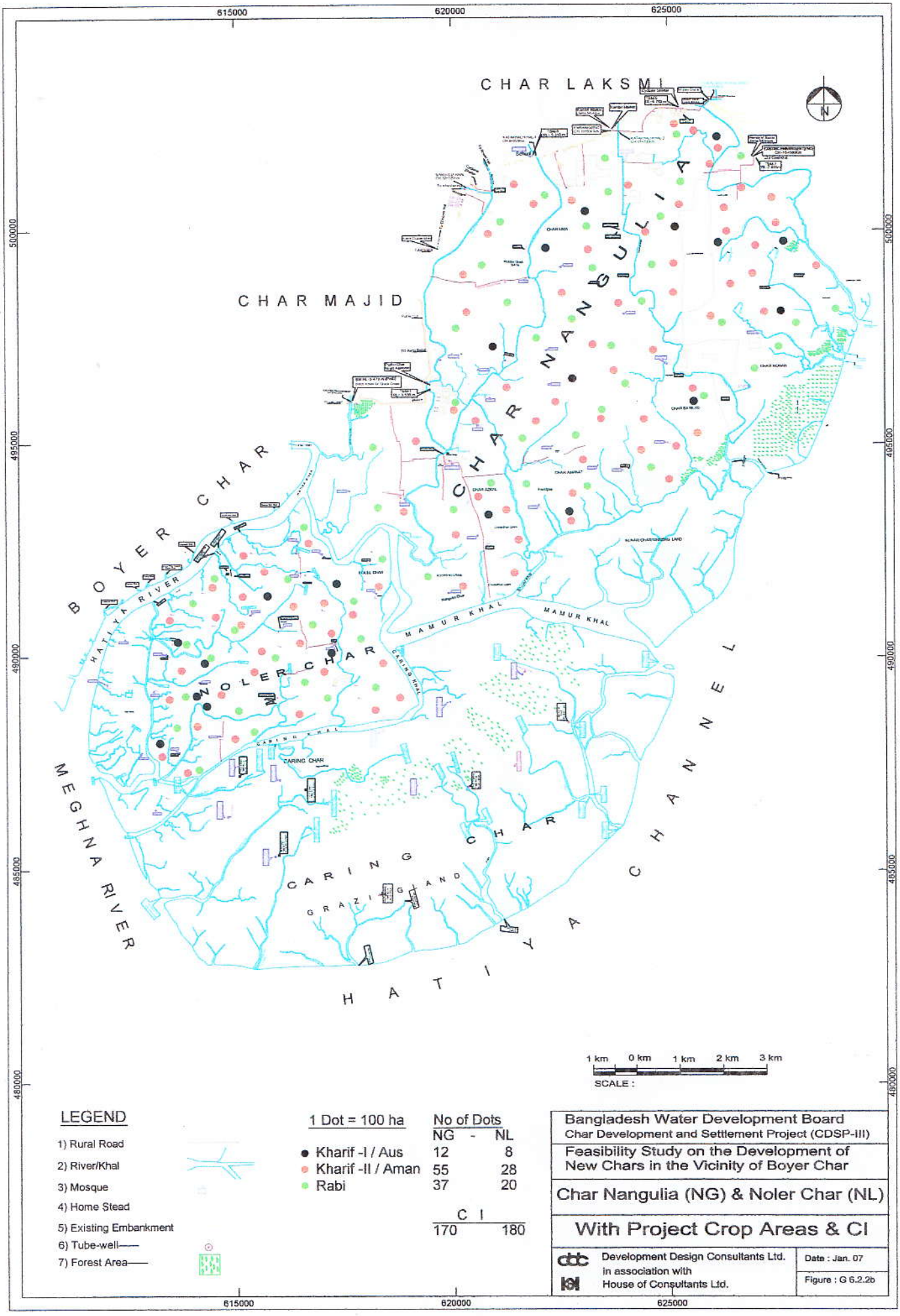
Char Nangulia (NG) & Noler Char (NL)

Present Crop Areas & CI

ddc Development Design Consultants Ltd. in association with House of Consultants Ltd.

Date : Jan. 07

Figure : G 6.2.2a



LEGEND

1) Rural Road
2) River/Khal
3) Mosque
4) Home Stead
5) Existing Embankment
6) Tube-well
7) Forest Area

1 Dot = 100 ha

No of Dots	NG	NL
Kharif -I / Aus	12	8
Kharif -II / Aman	55	28
Rabi	37	20

CI	
170	180

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia (NG) & Noler Char (NL)

With Project Crop Areas & CI

Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Date : Jan. 07

Figure : G 6.2.2b

Table 6.2 : Present and with Project Area (ha), Yield (T/ha), and production (tons) of different Crops In Noler Char

Crops	Crops Name	Present			5th year			10th year		
		Area (ha)	Yield (T/ha)	Production (ton)	Area (ha)	Yield (T/ha)	Production (tons)	Area (ha)	Yield (Tk/t)	Production (to
	1	2	3	4	5	6		7	8	9
Rice	Aus Local(13%)	261	1.5	391	258 (15%)	1.5	387	172 (10%)	1.5	258
	Aus (HYV) (2%)	40	2.5	100	86 (5%)	2.5	215	258 (15%)	3.0	774
	T. Aman Local (85%)	1709	1.7	2905	1377 (80%)	2.0	2754	1033 (60%)	2.0	2066
	T. Aman HYV (5%)	101	3.0	303	172 (10%)	3.25	559	517 (30%)	3.5	1809
	Rice Total :	**2111**		**3699**	**1893**		**3915**	**1980**		**4907**
	Rabi Crops (45%)				Rabi Crops (55%)			Rabi Crops (65%)		
Pulses	Khesari (40%)	362	0.86	311	331 (35%)	1.0	331	336 (30%)	1.0	336
Oil Seeds 26%	Ground Nut (10%)	90	1.3	117	95 (10%)	1.5	142	112 (10%)	1.8	201
	Mustard (8%)	72	0.4	29	95 (8%)	1.5	142	89 (8%)	0.8	71
	Linseed (8%)	72	0.4	29	76 (8%)	0.6	45	90 (8%)	0.8	72
	Oil Seeds Total:	**234**		**175**				**291**		**344**
Spices 24%	Chillies (Dried) (10%)	90	0.57	51	95 (10%)	0.65	62	112 (10%)	0.75	84
	Garlic (7%)	64	1	64	66 (7%)	1.25	83	78 (7%)	1.5	117
	Onion (7%)	64	1.5	96	66 (7%)	1.7	112	78 (7%)	2.0	156
	Spices Total :	**218**		**211**				**268**		**357**
Tubers	S. Potato (7%)	64	8	512	66 (7%)	9.0	594	112 (10%)	10	1120
Vege-tables 3%	S. Vegetables(1%)	9	3	27	28 (3%)	4.0	112	34 (3%)	4	136
	W. Vegetables(2%)	18	5	90	47 (5%)	5.0	235	78 (7%)	6	468
Grand Total :		**3016**		**5025**	**2839**		**5677**	**3099**		**7668**
By Products	Rice Straw (Aman only)			**3208**			**3313**			**3875**

Source : Household Survey, Group Discussion and Study Calculation

N.B : NCA : 2011 ha, CI = 150%, NCA : 1722 ha, CI : 165% NCA: 1722, CI : 180%

Note : Area for each crop is calculated from the net cultivated area (NCA) and the Cropping Intensity under the base situation, 5th and 10th year of empoldering (Table 6.1).

Example : Present Aus Local Area is 13%, NCA 2011 ha x 13% = 261 ha

Again for present Rabi Crops, NCA 2011 ha x 45% Rabi Crops = 905 ha.

For Khesari , 905 ha x 40% Kheshari = 362 ha. Similarly Area with the project situation is calculated from NCA 1722 ha x Area %.

Rice Straw : Grain straw Ratio for local rice is 1:2 and HYV rice 1:1

6.2.4 Homestead Agro-forestry

Noler char was partly a forested land. Erosion victims from Hatiya and other neighboring areas deforested it and settled there. The area is vulnerable to cyclones and tidal surges. In order to maintain a natural balance and partially protect the areas from the cyclones and tidal surges, planned homestead agro-forestry is essential.

The agro-forestry system has productive and service functions. The productive functions are provision of fruit trees, timber, fuel wood, fodder and service functions are environmental protection, partial protection from cyclone, tidal surges and shelter. The system may have multi-land arrangement of different planted species, specially in three layers for optimum use of land, air and light. The area is already growing different plant species but not well planned. CDSP may enter into arrangement with DOF, DAE and NGO for social and homestead agro-forestry services in the coastal char lands.

6.2.5 Support Services

To achieve the projected cropping intensity of 180% at the end of 10 years of poldering in Noler Char and increase of yield per unit area, support services need to be improved and strengthened. It will be important to reorient extension and technology delivery system and to train the extension/development staff to effectively handle the delivery of Knowledge Intensive Technology (KIT). A new mechanism should be established to strengthen research-extension-farmers linkages to deliver information, Knowledge and Technology packages based on participatory approaches. This calls for effective collaboration among CDSP, GOB extension agencies, NGO's and the private sectors.

Appropriate trainings will be vital in future to equip both the farmers and the extension agents with adequate information, Knowledge and Technology to tackle the need based production problems of the farmers in the new chars of the coastal areas. At present extension services are almost absent in the new chars.

Extension Services. At present extension services from GOB agencies, NGO's and Private Sector is absent. It was observed during group discussion by the Consultant that farmers are growing China IRRI (Purbachi) and Chandina (BR-1) in Aus season

and BR-22 in the T. Aman season. These HYV are not suitable for the coastal char lands. Farmers also reported that they face problems with these varieties. Recommended HYV rice varieties for the coastal area are BR-27 in Aus and BR-40 in the T. Aman season are also grown in limited scale. These happened due to lack of information and knowledge and lack of any extension service.

The CDSP has collaborative arrangements with GOB agency such as DAE for transfer of technologies and research organization such as BRRI, BARI and SRDI for new technologies and BADC for input supply. This arrangement should be made effective in Noler Char to achieve the projected targets in the crop sector.

Credit. Sixty six percent of the farmers reported that they need credit but no institutional credit is at present available. To adopt modern technologies and management, credit support is very important. At present, majority of credit requirement is met from the money lenders with high interest rate. In order to achieve the project targets institutional credit should be made available to the farmers.

Marketing Facilities. Noler Char is inaccessible by any means of transport which makes the agricultural inputs scarce in the local bazaar/markets. Yet the farmers do not consider the scarcity of inputs a problem for their agriculture. They can easily sale their produces in the local market also.

6.2.6 Production Benefit

Cropping Intensity and Land Use. Total Project Area of Noler Char is 2691 ha of which 2011 ha (74.7%) is the Net Cultivated Area (NCA). Base crop areas in three seasons is 3016 ha having 150% cropping intensity. With the project situation, NCA will be 1722 ha, a reduction of 14.37% of NCA due to infrastructure and development activities. Projected cropping intensities in the 5th and 10th years are shown as 165 and 180 percent respectively. In the 5th year total cropped areas for three seasons will be 2893 ha, still 5.8% below the base year. Total cropped area in 10th year with the Project will be 3099 ha, 2.75% higher than the base year. A summary situation of total cropped area (ha) production (tons) and changes (%)are shown below : (Table 6. 2.6)

Table 6.2.6: Total Crop Areas (ha), production (ton) and Changes of Areas and Production in Base, 5th and 10th year in Noler Char

Year after empoldering	Total Cropped area (ha)	% (-+)	Total production (tons)	%	Cropping Intensity (CI) (%)	Remarks
Base Year	3016	0	5233	0	160	
5th year	2839	- 5.8	5677	8.5	165	
10th year	3099	+ 2.75	7688	47	180	CI

In the 5th year, though total areas is reduced by 5.8%, there is 8.5% increase of total production due to favorable situation with the project and higher yield of different crops. In the 10th year, there is 2.75% increase of crop area and production increased by 47%. Total production of crops has been estimated to increase per year from present 5233 tons to 7688 tons from the 10th year. Total production of crops has been estimated to increase per year by 2455 tons from present 5233 tons to 7688 tons from the 10th year.

6.3 Other Benefits

In addition to the increased crop production and employment benefit there will be other direct extended and indirect benefits of the project.

Following benefits can be mentioned:-

- land security to landless through settlement,
- greater security of life against cyclone and tidal bores,
- increase of value of land and property due to prevention of tidal inundation and improvement of drainage and reduction of salinity of both water and soil.
- Increase in side line income from livestock.
- Improvement of road communication
- Scope for plantation on embankment and road slopes, and creation of mangrove forest outside embankment.
- Scope for culture fishery.

CHAPTER 7 : PLAN COSTS

7.1 General

Estimated cost of physical interventions has been prepared based on the current schedule of rates of BWDB and LGED. The Schedule of Rates of 2006-07 of Feni Operation and Maintenance Circle of BWDB and the Schedule of Rates, July 2006 of Noakhali Region of LGED are applicable and used for the preparation of Cost Estimates.

7.2 Development Plan Cost

Total plan cost includes costs of (a) Water management infrastructures and (b) Internal infrastructures.

A.	i.	Cost of water management infrastructure	...	Tk. 159.750 M
	ii.	Physical Contingency	...	Tk. 15.975 M
	iii.	**Sub-Total A (i + ii)**	...	**Tk. 175.725 M**
B.	iv	Cost of internal infrastructure	...	Tk. 126.373 M
	v.	Physical contingency	...	Tk. 12.637 M
	vi.	**Sub-Total B (iv + v)**	...	**Tk. 139.010 M**
	vii.	**Total A + B(iii + vi)**	...	**Tk. 314.735 M**

7.3 . Cost Escalation

Cost estimates have been prepared considering unit costs of work items for the year 2006-07. If implementation starts after elapse of say 3 years the escalated cost (C_E) after 3 years in 2009-10 considering yearly increase at 10% will be

$$C_E = C \times (1 + x)^n$$

$$= \text{Tk. } 314.735 \text{ M} \times \left(1+\frac{10}{100}\right)^3 = \text{Tk. } 314.735 \text{ M} \times 1.331$$

$$= \text{Tk. } 418.912 \text{ Million}$$

CHAPTER- 8 : ENVIRONMENTAL IMPACT STUDY

8.1 Methodology

CDSP/BWDB intends to conduct a detailed environmental study for the project according to Bangladesh Environmental Conservation Act of 1995 and Bangladesh Environmental Conservation Rules of 1997 and Guideline of CDSP/BWDB for Environmental Impact Assessment.

As such an Initial Environmental Examination (IEE) Report for this project is prepared on the basis of project interventions proposed following the ToR supplied by the project proponent (CDSP/BWDB).

The methodology recommended in FAP-16 guidelines for IEE and EIA and further detailed in ISPAN manual for EIA and Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) projects (February, 2005,WARPO) will be followed. Moreover, guideline for EIA as prepared by Department of Environment (DoE) for conducting IEE and EIA will be followed strictly.

A set of pre-designed checklist and questionnaire is used for collection of primary data and secondary information were collected from different govt. and non-government organizations to make an effective Environmental Report for the project.

8.2 Requirement for Initial Environmental Examination (IEE)

Projects under Flood Control category have to first conduct IEE which helps in understanding the potential extent of environmental changes and in finding ways to mitigate by considering the available information, or past experience or standard operating practices. The steps for conducting IEE are:

- Collection of baseline information in respect of the project and the environmental setting of the project and its site.
- Setting of boundaries of an IEE by identifying the significant issues.
- Selection of Important Environmental Components (IECs).
- Impact assessment, suggesting mitigation measures.

- In the event IEE of the project reveals that further investigation is to be carried out then the sponsors will have to carry out a detailed EIA.

8.3. Description of the Project

8.3.1 Project Area

The area consists of the following two main chars -

- Char Nangulia of about 9,040 ha of area.
- Noler Char of about 2,633 ha

8.3.2 Physical Interventions of the Project

The main interventions of the project are as follows:

- Construction of Embankment,
- Excavation/Reexcavation of Internal Drainage khals, and
- Construction of Sluice.

Besides, there will be some construction works for internal infrastructure development like:

- Internal road communication development,
- Bridge and Culverts,
- Multipurpose Cyclone Shelter,
- Tube wells and
- Latrines etc.

8.3.3 Basic Data of the Project

The basic data of the project are furnished in **Table- 8.3.3**

TABLE – 8.3.3
Basic Data of the Project

1.	Name of the Project:	Feasibility study on the Development at New Chars in the vicinity of Bayer Char (Char Nangulia and Noler Char).
2.	Project Executor:	Char Development and Settlement Project (CDSP)/Bangladesh Water Development Board (BWDB).
3.	Project Location:	• Char Nangulia, Shubarna Char and Hatiya Upazilas of Noakhali District. • Noler Char, Hatiya Upazila of Noakhali District.
4.	Area of the project:	• Char Nangulia of about 9,040 ha • Noler Char of about 2,633 ha and

8.3.4 Present Status of the Project

The project is now at the initial stage of development. The project area is mainly level saline tidal inundation/flood prone area. Land development will be the major requirement in the newly accreted char lands for the settlement of land less people.

8.4 Description of Environmental Baseline

8.4.1 Project Bounding

The primary requirement of Environmental Assessment Study is to delineate the geographical boundary of the "Project Area" and the "Impact Area". The "Project area" is the physical location of different components of the project while the "Impact area" encompasses the geographic extent of the significant environmental and socioeconomic impacts resulting from implementation of the proposed Project. It is recognized that the benefits of the proposed project will be considerably extended to the national scale. For the present IEE, the focus of the study will be limited to the area of Char Nangulia and Noler Char, within the 1 Km. on all sides has been considered for environmental analysis.

8.4.1.1 Hydro-Morphology

Tidal Inundation/Water Logging

The project area is comprised of medium low char land in tidal area. The land is mostly flooded by tidal inundation during the monsoon season. It gets inundated by the tidal flood of peripheral Hatiya River, Mamur khal and Caring khal and other small khals.

8.4.1.2 Soil Condition

Soil condition of the area is more or less plain alluvium seasonally saline land covered by silt residuum.

8.4.1.3 Air Quality

The project site is located beside the Bay of Bengal and in a rural setting without any kind of industrial activity. The air quality in existence may rightly be designated as normal not to warrant any concern for human health or environmental degradation. From visual inspection, this air appears to be clean.

8.4.1.4 Ambient Noise

The project area is quite noiseless, as there are no activities other than agricultural land cultivation in the area. So it was felt that the noise level at the base line situation in the project area is within the allowable limits of the standard set by DoE.

8,4.2 Land Use

8.4.2.1 Land use Pattern of the Area

Table-8.4.2.1 shows the land use pattern of the study area. The data shows that out of the total land 75% are cultivable land, 6% homestead and the remaining 19% consisting of khals, fallow lands, ponds, and rural infrastructures.

Table– 8.4.2.1
Land Use Pattern of the Land owned by Surveyed Households

Name of Chars	Land Use (Percent)			
	Cultivable land	Homestead	Others	Total
Noler Char	75	6	19	100
Char Nangulia	77	5	18	100

Source: Field Survey Database, 2006

Land use map of the project area is shown in Figure G'6.2.2b.

8.4.2.2 Present Cropping Practices

According to the soil resources use guideline, the cultivable lands of the project area have been classified as mainly high and medium high land. In the monsoon water depth exceed more than 30 cm. Present cropping patterns are shown in the following **Table – 8.4.2.2**

Table – 8.4.2.2
Land use Pattern of different Crops
Noler Char

Land type	Crop Area (%)	Type of Crops
Fo (High Land)	28	Homestead, Agro-forest, Aman
F1 (Medium High Land)	52	Aus, Aman, Rabi
F2 (Medium Low Land)	15	Aman, Rabi
F3 (Low Land)	5	Fisheries

Sources: Field Survey database 2006

Note : Natural capture fishery is there in the khals and low lands

8.4.2.3 Surface Water

The Hatiya River flows, up land and tidal, are mostly in south and southwestern directions. It is the main drainage artery and seems to be in rather stable conditions. The Mamur and Caring Khals, boundary tidal channels of he chars, are highly dynamic, shallow and unstable (seem to silt up). A branch of the river (Nangulia khal) was previously linked with this river. This is now silted up and it remains as a small drainage nala passing the project area. It now carries the rainfall runoff from its catchment and remains active and flowing in rainy season when there is plenty of rainfall. In other time of the year it remains dry. There has been no industrial effluent in this region to the river. Therefore, at the moment water pollution is not seen except that the water is saline during dry season and not suitable for agriculture. The project area is between 2-4m above the mean sea level. The land surface slopes gently towards the south.

8.4.3 Description of Environment

8.4.3.1 Physical Resources

Average monthly rainfall and evapotranspiration of Noakhali are shown below:

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	5	22	54	147	302	564	622	478	277	173	60	11	2717
ETO (mm/day	2.40	3.26	4.49	5.40	5.41	4.39	4.27	4.29	4.25	3.87	3.04	2.25	3.94

Relative humidity, temperature, wind speed and Sunshine hors of Noakhali are:

Items	Minimum	Maximum	Mean
Relative Humidity (%)	60	89	78
Temperature (0C)	10.9	35.5	25.8
Wind speed (m/s)	1.2	4.5	2.6
Sunshine (hrs/day)	3.0	8.2	6.7

Source: Agro-climate Survey of Bangladesh, FAO

8.4.3.2 Ecological Resources

Terrestrial Ecosystem

Natural ecosystem and species make many important contributions to human welfare. Yet these very important resources are seldom being used in ways that

will be able to meet the growing pressures of future high demands for both goods and services that depend upon these natural resources.

Terrestrial Fauna

The consultant collected information on terrestrial fauna of the project area during the field visit. Species of terrestrial faunas of the area are not so rich. Information of local fauna like : Venpu Bang, Pana Bang, Chika/Chucho, Badur, Pati Shial/ Shial, Indur, shalik, crow, dove, sparrow, Bok, Crane, Snipe, etc. were collected during the visit.

Terrestrial Flora

The consultant also collected information on terrestrial flora of the project area during the field visit.

These are local forest or lumber trees include Mehagani, Margosa(Nim), Shal etc. Fruit trees include Mango, Litchi, Lemon Tree, Guava, Betel Nut, Kolagach, Coconut and Palm trees. Estuarine flora Reeds like Kushla etc. Local weeds: Fern, Thankuni, gima, katchu etc.

Aquatic ecosystem

Aquatic Fauna and Flora

The consultant collected information on Aquatic fauna and Aquatic flora species during the field visit at the project area.

Few of the aquatic flora and faunas like: shaluk, kalmi, Helencha, water hyacinth, duckweed and Kuno Bang, Guishap, Kakra, Shamuk, Shrimp (diff. Species), Zhinuk etc. respectively exist in the area.

8.4.4 Gender Situation

Women of the project area are little bit different than the other parts of Bangladesh. They give efforts in and outside income earning activities in addition to their regular household chores. They work in crop field like seedbed preparation, transplanting, harvesting etc. They also do all types of post harvesting activities.

Women in the women headed households are passing their lives with economic hardship. They are looking for better income opportunities for their subsistence. They need financial and technical support from the Government for income generation. They hope that the project activities will make employment opportunity for them.

8.4.5 Aesthetic Values, Recreational Resources and Development

There are no area of aesthetic values in the project area. There exists a reserved forest of Forest Department in the vicinity of the area.

8.4.6 Historical/Archeological Relics

There are no Historical and archeological relics in the project area.

8.5 Screening of Potential Environmental Impacts and Mitigation Measures

Name of the Project	:	Char Nangulia and Noler Char .
Location (Upazila/Dist.)	:	Shubarna char and Hatiya Upazilas, Noakhali District.
Name of UP	:	Purba Char Bata and Chanandi Unions
Area of the Project	:	Gross area : 2691 ha Noler Char 8994 ha Char Nangulia
Population (2001 census)	:	.....

8.5.1 Description of Environmental Impacts

The project mainly consists of char areas. Environmental Impact of proposed project has been identified and summarized by the environmental specialist, which is shown in the following **Table No 8.5.1**

Table - 8.5.1

Description of Present Condition and Analysis of Possible Impact

Sl. No.	Selected IECs	Present Condition	Possible Impact
	Physical Environment		
1	Regional hydrological regime, flood pattern, etc.	Hatiya a tidal river with upland flow and Mamur and Caring tidal khals inundates the project area.	Condition of the area will be improved by preventing tidal inundation/flood.
2	Natural flushing	The Project area is having natural flushing in monsoon.	Implementation of the Project will control the Tidal saline inundation/flood and allow flushing out of salinity by monsoon rain.
3	Ground water table	not known	Ground water table will not be changed for Implementation of the Project.
4	Water quality	Saline during dry season.	Water quality will improve by controlling saline water intrusion.
5	Water logging and drainage	There is drainage congestion in the Project area	Water logging and drainage congestion will be improved.
6	Erosion and siltation	There is no erosion problem but siltation problem is there.	Internal channel siltation problem will be prevented, but at D/S of sluice siltation may continue.
7	Soil Characteristics/salinity	The soil in the Project area is silty loam and soil salinity is there.	Soil salinity will decrease progressively by monsoon flushing
Biological Environment			
1	Wetland and aquatic habitat	Wetland and aquatic habitat like Hatiya River, Mamur khal, Caring Khal etc. are major aquatic habitat.	Wetland characteristic inside protected area will change from saline towards sweet.
2	Terrestrial habitat	Terrestrial habitat exists but no ecological sensitive area are seen in the project area.	No impact on Terrestrial habitat will occur due to the Project implementation.
3	Natural and culture fishery	Natural and culture fishery resources in the area are existing.	Natural saline water fishery inside the project will be hampered by construction of sluice on khal, but there will be better scope to increase culture fishery.
4	Wildlife and biological diversity	Wildlife and biological diversity are not perceived in the Project area.	Wildlife and biological diversity will not be affected by the Project activities.
5	Unwanted aquatic weed and hyacinth	Unwanted aquatic weed and hyacinth are not significant in the Project area.	No impact on Unwanted aquatic weed and hyacinth in the Project area.
6	Natural forests	Natural forests perceived in the vicinity of the project area.	No impact on natural forests by the Project activities.
7	Tree plantation activities	Limited tree plantation activity perceived in the project area.	Project activity will create scope for tree plantation on the slopes of the embankment and creation of mangrove forest outside the embankment.
Social Environment			
1	Land Acquisition/land loss	No need for the project.	No land acquisition is needed. So no impact.
2	Agricultural development	Mainly T. Aman grows.	Agri. crop production will be

Sl. No.	Selected IECs	Present Condition	Possible Impact
			increased by about 2455 tons/year.
3	Road transport	No road transport except limited rickshaw is seen in the project area.	Road transport will be improved in the project area by the implementation of the project.
4	Employment scopes	Employment scopes in the area is limited	The Project will create scope for employment.
5	Health and nutrition	Health and nutrition facility is not good.	The Project will increase the Health and nutrition situation.
6	Community impact (Fishermen and other professional)	Limited fishermen in the project.	The project activity will create opportunity to rehabilitate the fishermen and other professional in fish culture, tree plantation and agricultural activities.
7	Culture and heritage	No culture and heritage location is seen.	Culture and heritage situation will be improved due to increased economy.

8.5.2 Impacts & Mitigation

Possible Impact and Mitigation measures were identified and describes in the following Table No 8.5.2.

Table 8.5.2

Summary Sheet of Potential Impacts & Mitigation Measures

Significant impact issue		Type of impact		Mitigation measure	Residual impact
		Beneficial	Adverse		
Physical Environment					
1	Regional hydrological regime, flood pattern, etc.	✔		Protection against tidal saline inundation.	
2	Natural flushing		✔	Timely gate operation of the sluice/regulator to allow natural drainage/flushing during monsoon to the extent T. Aman is not damaged.	Insignificant
3	Water logging and drainage	✔		Improvement through re-excavation of khals and construction of drainage sluices.	
4	Erosion and siltation		✔	Regular silt clearing at D/S of sluice are to be done under annual maintenance programmes, if siltation is a problem.	Insignificant
5	Soil characteristics/ salinity	✔		Improvement through prevention of saline inundation and leaching out of soil salinity through improved drainage.	
6	Wetland and aquatic habitat	✔		Improvement from saline environment.	
7	Natural and culture fisheries	✔		Better environment for culture fishery.	

8	Natural forests and plantation	✓		Increased scope on embankment slopes and berms.	
Social Environment					
1	Agricultural development	✓		Prevention of crop damage and scope for HYVs.	
2	Employment scopes	✓		Construction and O & M activities and increased agricultural activities.	
3	Health and nutrition	✓		Increased food production and increased income	
4	Community impact	✓		Land settlement programme for landless people.	
5	Culture and heritage	✓		Increased social contact between settled people.	

However, during the construction period some temporary adverse impacts are anticipated which are mainly: Noise pollution; Air pollution; Water quality; Waste disposal; Epidemic diseases etc.; Sanitation & health including latrines, urinals etc; Possible accidents; Safety measures;

Discussion of the anticipated adverse impacts follows.

Noise pollution

Impact:

There is little scope of generating noise in the project area. The construction of the embankment is generally performed manually by the local labors. Compaction of the embankment is usually done by the local labors by hand compaction. However use of rollers for better compaction would not create any hazards to the environment. In construction of regulators mixer machine and other construction equipments and vehicles will not generate any hazards to the environment. Usual noise at cyclone shelters will be generating when threat of cyclone is announced and people take shelter for a short period. So no adverse impact is anticipated in respect of noise.

Mitigation: *No mitigation measure is required.*

Air pollution:

Impact

Smoke: Smoke will generate at project site as the machinery's, equipments, & vehicles etc will be operating or moving over the roads during construction period of the project area. There will be some impact that is very much negligible. However no mitigation measure is required.

Dust: Dust will be generated at project site as machinery's, equipment's and vehicles will be used in construction of the embankment and regulator of the project for a very short time.

Mitigation: *No mitigation measure is necessary.*

Water Quality

Impact:

Surface water & Ground Water: There is little scope of affecting the surface or ground water by the disposal of wastes. Human waste of labors will create nuisance in the area but impact is not significant. However, there will be some impacts on surface water due to the project activities during the construction period. These impacts are temporal.

Mitigation:

Mitigation measure is not required.

Drinking Water

Impact:

During construction period, one or two deep hand tube wells would be provided for supplying of Arsenic free drinking water to the labors working at site. Usually, the labors carry food & drinking water with them from their own homes. Adverse environmental impact is not anticipated.

Mitigation:

Deep hand tube well would be provided at project site for drinking water & water will be tested before supplying to the laborers.

Waste Disposal

Impact:

Insignificant environmental impacts are anticipated due to waste disposal. There will be no significant office waste. Some concrete wastes may arise due to construction of regulators.

Mitigation:

Construction wastes should be dumped at the fixed place without spreading it scatteredly.

Disposal of human wastes may be accomplished through temporary latrines & urinals, which can be used as organic manure.

Epidemic diseases

Impact:

There will be labor camp in the project area for the construction works. However there will be local labors who will attend works in the morning & leave project site in the evening. For construction of embankment and regulators, contractor will provide temporary shed at the project site. Some labors of the contractor will stay in the night during construction period. As such, there may be outbreak of epidemic diseases at project site.

Mitigation:

During the epidemic diseases necessary measure will be taken up.

Temporary Latrines & Urinals:

Impact:

Temporary latrines and urinals will be provided at project site during construction period. Human wastes may be disposed of through temporary latrines & urinals.

Mitigation:

No mitigation measure is required.

Possible Accidents

There is possibility of occurring accident during construction stage since heavy earth moving equipment like dump truck, truck etc. may be deployed if contractor needs to carry earth from other area. In case of any accident, the nearby Upazila Hospital may be utilized. Safety measures arrangements is required at site

Mitigation:

No mitigation measure is required.

8.5.3 Public Opinion

In general, the local people's response to the project is positive. Most of the people who live in the project area have no objection towards the development of the project. Most of the people interviewed were not aware of any pollution hazard and also do not feel that the project would be the source of any hazard to them.

It may be mentioned here that the major expectations of the local people from the Project are increased crop production and creation of jobs for them. Some people will participate indirectly in various economic activities and support systems associated with the Project

A series of meetings held with the local people, Addl. Deputy Commissioner, Noakhali, District Livestock Officer, Noakhali and officials of the CDSP-III project.

It may be concluded that all of the stakeholders welcomed the proposed project for greater interest of the country. The farmers agreed to cooperate with the project authority and will participate in development activities.

8.6 Institutional Requirement and Environmental Monitoring Programme

An extensive monitoring program is not required. Timely operation of sluice gate will have to be done. The CDSP-III authority will arrange training to the farmer for O&M and timely regulator gate operations. The farmer will also be trained for IPM program.

However, the following parameters would be monitored as given in **Table 8.6.1.**

Table 8.6.1

Environmental Monitoring Parameters

Environmental Component	Parameter(s)	Sampling number/month
Erosion/siltation	Siltation at D/S of sluice to be removed	Under yearly maintenance programme
Natural Flushing	Timely gate operation of sluice	Occasional as required
Soil quality/salinity	Routine fertility analysis/Soil Salinity	Occasional during dry season.

8.7 Findings, Conclusions and Recommendations

Findings

The Project will not have any remarkable adverse impact on the environment. The project activity will increase the crop production of the area. The Project is recommended with the mitigation measures proposed in the **Table No. 8.5.2.**

Conclusions

After completion of the Project, production of crops will increase. The benefit from the crop production directly will go to the landowners. Others, especially the poor, will be benefited in terms of employment generation and easy availability of agricultural products. Moreover, the project will contribute to the Governments "produce more food" program.

Recommendations

The project is for the development of newly accreted char lands for settlement of land less people for agricultural development in the tidal saline inundation prevented and drainage improved lands. Being FCD type, EIA is generally required. But IEE conducted gives no remarkable adverse impact on the environment and s o the project is recommendable for implementation.

It is recommended that the Project can be implemented.

Table 2.4 Costs of water management infrastructure in Char Nangulia

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					%on 2009 cost	Estimated Cost (Tk. '000)
1.0	Drainage Sluices					
	1.1 DS-1 (9-Vent-1.5mx1.8m)	1	No.	104,816	2	2,096
	1.2 DS-2(5 Vent-1. 5m x 1.8m)	1	No.	59,895	2	1,198
2.0	Embankment					
	2.1 Sea Dyke	25.5	Km	237,170	4	9,487
	2.2 Interior Dyke	3.50	Km	25,976	4	1,039
3.0	Closures of khals	-	-			
	3.1 Major khals (Mamur/Caring)	3	LS	45,057	4	1,802
	3.2 Other khals	5	LS	7,498	4	300
4.0	Re-excavation of khal/ drainage channel (63.78 km)	915,066	Cum	46,291	2	926
4.1	Re-excavation of Caring khal	1,350,000	Cum	68,269	2	1,365
			Total:	594,972		18,213

Table 2.5 Costs of water management infrastructure in Noler Char

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					%on 2009 cost	Estimated Cost (Tk. '000)
1.0	Drainage Sluices					
	1.1 DS-3(7-Vent-1.5mx 1.8m)	1	Each	89,177	2	1784
2.0	Embankment					
	2.1 Sea Dyke	6.0	Km	62,556	4	2502
	2.2 Interior Dyke	4.50	Km	41,156	4	1646
	2.3 Dwarf Embankment	13.25	km	9,347	4	374
3.0	Closures of khals	5	LS	7,720	4	309
4.0	Re-excavation of khal/ drainage channel (63.78 km)	52,819	Cum	2,671	2	53
			Total:	2,12,627		6,668

- The estimated amounts of water management infrastructures have been compared with the cost of ongoing CDSP-III related structures and found justified considering required cost escalation.

for TL, CDSP-III
12.03.09
QCE, CDSP-III

C/S
18/3/09
PD-CDSP-III
BWDB, Dhaka.

Table 3.6 Cost estimate of internal infrastructure of Char Nangulia

Sl.No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 cost	Estimated Cost (Tk. '000)
1.0	Rural Roads (Type R-2)	37.77	Km	26,644	2	533
2.0	Bridge (20m Girder bridge	-	-	-	-	-
	2.1 20m span	3	No.	14,439	2	289
	2.2 15m span	3	No.	10,781	2	216
	2.3 10m span	2	No.	4,792	2	96
3.0	Box Cul vert, (1-Vent , 4m x 3m)	1	No.	1,331	2	27
	3.2 Pipe culvert (0.6m dia)	8	No.	1,065	2	21
4.0	Multipurpose Cyclone Shelter	17	No.	1,46,306	2	2,926
5.0	Community Pond	43	No.	17,170	2	343
6.0	DTW	607	No.	48,475	2	970
7.0	Latrine	9350	No.	24,890	2	498
8.0	Public Toilet	11	No.	8,799	2	176
9.0	Pond sand Filter Schemes	30	No.	7,185	2	146
10.0	Rain water Harvesting Schemes	60	No.	5,672	2	113
			Total:	3,17,549		6354

Table 3.7 Cost estimate of internal infrastructure of Noler Char

Sl.No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 Cost	Estimated Cost (Tk. '000)
1.0	Rural Roads (Type R-2)	1745	Km	11,381	2	228
2.0	Bridge (20m Girder bridge	1	-	3,594	-	72
3.0	Culverts					
	3.1 Box Culvert (1-Vent 4x3m)	1	No.	1,331	2	27
	3.2 Pipe culvert (0.6m dia)	8	No.	1,065	2	21
4.0	Multipurpose Cyclone Shelter	10	No.	86,068	2	1721
5.0	Community Pond	24	No.	9,583	2	192
6.0	DTW	313	No.	24,997	2	500
7.0	Latrine	5159	No.	13,733	2	275
8.0	Public Toilet	12	No.	9,599	2	192
9.0	Pond sand Filter Schemes	16	No.	3,832	2	77
10.0	Rainwater harvesting schemes	32	No.	3.025	2	61
			Total:	1,68,210		3,166

for TL, CDSP-III
12.03.09
SCE, CDSP-III

C/S 18/3/09
PD, CDSP-III
BWDB, Dhaka.

Recommendation of "Report Review Committee" on the Final Report of Feasibility Study on the Development and Settlement of new Chars; Char Nangulia, Noler char and Caring char, November 2008 for approval of the Board.

1. Background Information

1.1 Bangladesh Water Development Board (BWDB), by an Office order (Memo No-35/WDB (Sec)/Planning-1/Misc-3/2002 dated 03-07-2006; copy enclosed, Annex-A), formed a committee headed by the Chief Engineer, Design, BWDB, Dhaka to review and recommend about the Study Reports prepared by Consultants. The Terms of Reference (ToR) of the Committee may be seen in Annex-A.

1.2 Final Report was forwarded to the member-secretary of the committee by Chief Planning, BWDB, Dhaka vide U.O.no. 1025 dated 24 November 2008.

1.3 The report was prepared by Euroconsult Mott MacDonald, Dhaka.

1.4 Project Director, CDSP-III, BWDB, Dhaka under administrative control of ADG (Planning), BWDB, Dhaka represented the Board (the client) for conducting the study.

1.5 The Draft Final Report was discussed in a workshop on 14 January 2008, held at the BWDB conference room, Dhaka.

2. Activities of the Committee

2.1 The member-secretary received the Report on 26 November 2008.

2.2 (a) The member-secretary of the committee, being requested by the convener of the committee, communicated vide memo no. 1c-5/2006 (part-2)/366 dated 14 December 2008 the notice of meeting of the committee to discuss the report on 23 December 2008.

(b) Accordingly, the committee met on 23 December 2008 in the office room of the Chief Engineer, Design, BWDB, Dhaka & concerned Project Director, Executive Engineer from the field division were present in the meeting.

3. Observations of the Committee

3.1 The Committee observed that the comments, suggestions & recommendations made by the participants on the Draft Final Report of Feasibility Study on the Development and Settlement of new Chars; Char Nangulia, Noler char and Caring char, November 2008 in the meeting of 14 January 2008 have been properly addressed by the Consultants & concerned officials and incorporated in the final version of the Report.

3.2 The Committee discussed the report in the meeting (held on 23 December 2008) and the observation is presented in **Annex-B**.

4. Recommendations:

4.1 The Committee as per ToR opines that:

- প্রকল্পের মূল উদ্দেশ্যের সাথে সামঞ্জস্যতা ঃ The Final Report is consistent with the Objectives of the study (which is presented in the report).
- প্রদত্ত সুপারিশসমূহের বাস্তব ভিত্তি সমন্ধে ঃ The recommendations made in the study are realistic and implementable in the field.
- সমীক্ষা প্রতিবেদনের গুণগত মান প্রসঙ্গে ঃ The quality of the report is acceptable.

4.2 Under the above circumstances the Committee is recommending to accept the Final Report.

23/12/08

(Md. Fazlur Rahman)
Director, Planning-II
BWDB, Dhaka.
(Member-Secretary of the Committee).

২৩/১২/০৮

(Md. Naushad Ali)
Chief Engineer, Design
BWDB, Dhaka.
(Convenor of the Committee).

বোর্ড সচিবালয়
ওয়াপদা ভবন (৩য় তলা)
মতিঝিল বাণিজ্যিক এলাকা,
ঢাকা-১০০০।

ফোন: ৯৫৬৩৩ (অফিস)

Annex - A

একই স্মারক নং ও তারিখে প্রতিস্থাপিত

স্মারক নং-৩৫/পাউবো (সচি)/পরি-১/বিবিধ-৩/২০০১ তারিখঃ ০৩-০৭-২০০৬ ইং

দপ্তরাদেশ

পরিকল্পনা-১ পরিদপ্তরসহ, অন্যান্য দপ্তরের আওতায় নিয়োজিত বিভিন্ন পরামর্শক প্রতিষ্ঠান, ইনডিভিজুয়াল পরামর্শক, আই ডব্লিউ এম এবং সি ও জি আই এস কর্তৃক সম্পাদিত সমীক্ষা কাজ সমূহের চূড়ান্ত প্রতিবেদন অনুমোদনকল্পে পাউবোর বিভিন্ন বিভাগ ও দপ্তর হতে সমন্বয়ে একটি কমিটি গঠন করা হইলঃ-

১। প্রধান প্রকৌশলী, নকশা, পাউবো, ঢাকা। ঃ আহ্বায়ক
২। পরিচালক, পরিকল্পনা-২ পরিদপ্তর, পাউবো, ঢাকা। ঃ সদস্য-সচিব
৩। প্রকল্প এলাকার সংশ্লিষ্ট নির্বাহী প্রকৌশলী, পাউবো। ঃ সদস্য

কমিটির কার্যপরিধিঃ

ক) সমীক্ষা প্রতিবেদনের [illegible] পর্যালোচনা এবং [illegible] সুপারিশ সমূহ বাস্তবায়ন ও প্রকল্পের মূল উদ্দেশ্যের আলোকে সামগ্রিকভাবে বিষয়ে স্পষ্ট মতামত প্রদান।
খ) সমীক্ষার চূড়ান্ত প্রতিবেদন বোর্ডের পক্ষে যথাযথভাবে পর্যালোচনা ও নিরীক্ষা পূর্বক সর্বোচ্চ ৭(সাত) দিনের ভিতর বোর্ডের অনুমোদনের জন্য সুপারিশ প্রদান।
গ) বিবিধ।

বোর্ডের আদেশক্রমে

০৩.৭.০৬

(সামসুননেছা)
সচিব, পাউবো
ঢাকা।

স্মারক নং-৩৫/৮(১)/পাউবো (সচি)/পরি-১/বিবিধ-৩/২০০১ তারিখঃ ০৩-০৭-২০০৬ ইং

অবগতি ও প্রয়োজনীয় ব্যবস্থা গ্রহনের জন্য অনুলিপি প্রেরণ করা হইল।

১) প্রধান পরিকল্পনা, পাউবো, ঢাকা।
২) প্রধান প্রকৌশলী, নকশা, পাউবো, ঢাকা।
৩) প্রধান প্রকৌশলী, পাউবো (সকল)..... .....
৪) তত্ত্বাবধায়ক প্রকৌশলী, পাউবো (সকল)..... .....
৫) পরিচালক, পরিকল্পনা-১, পাউবো, ঢাকা।
৬) পরিচালক, পরিকল্পনা-২, পাউবো, ঢাকা।
৭) সি এস ও যুগ্ম মহাপরিচালক, পাউবো, ঢাকা।
৮) পি এ টু অতিরিক্ত মহাপরিচালক-পরিকল্পনা, পওয়া-১, পওয়া-২, পাউবো, ঢাকা।

৩/৭/০৬

(এ টি এম আবদুল বারী)
উপ-সচিব (পরিকল্পনা)
পাউবো, ঢাকা।

Annex-B

Feasibility Study on the Development and Settlement of new Chars; Char Nangulia, Noler char & Caring char: Final Report November 2008, done by Euroconsult Mott MacDonald, Dhaka

Compliance Report on the Objectives of the Study

Sl. No.	Objectives (as required in the ToR)	Compliance (as reported in the Report)
A.	**Comprehensive development plan for Nangulia Char & Noler Char**	
	1. Establishing baseline conditions	
	► Water management & Land suitability :	
	➢ Basic topographic map of present situation	Chapter-1, Fig-1.1, Page- 4
	➢ Basic drainage map of present situation	Chapter-2, Fig-2.1, Page- 8
	➢ Map of present salinity situation	Page-75
	➢ Flood map	Page-74
	➢ Identify bottlenecks & develop interventions	
	• Design of optimal internal drainage system to avoid bottlenecks	Chapter-2, Article-2.4.3, Page-14
	• Embankment heights	Chapter-2, Article- 2.4.2, Page-13
	➢ Drainage, salinity & flood maps with interventions	Chapter-3, Fig-3.1, Page-18
	➢ Land suitability map	Page-75
	►Population and settlements :	
	➢ Household Census	Chapter- 1, Article-1.4.2, Page-5
	➢ Occupation	Chapter- 1, Article- 1.4.3, Page-5
	➢ Migration Pattern	Chapter- 1, Article-1.4.5, Page-6
	➢ Income	Chapter- 1, Article- 1.4.6, Page-6

9-6

	➢ Food situation	Chapter- 1, Article- 1.4.6, Page-6
	➢ Land titles	Chapter- 4, Article-4.4, Page-27
	➢ Tenancy	Chapter- 4, Article-4.4, Page-27
	➢ Existing level of services	Chapter- 3, Article- 3.2, Page-17
	➢ Desired level of services	Chapter- 3, Article-3.3, Page-17
	▶ **Land allocation :**	
	➢ GOB policy on land distribution & existing claims on land	Chapter- 4, Article- 4.3, Page-26
	▶ **Agriculture and livestock :**	
	➢ Existing cropping pattern and yields	Chapter-5, Article- 5.3.2, Page-31
	➢ Existing livestock situation	Chapter- 5, Article-5.5.1, Page-34
	➢ Analyze agricultural practices	Chapter- 5, Article- 5.3.3, Page-32
	➢ Identify main bottlenecks	Chapter- 5, Article- 5.3.4-5.3.5, Page-32
	▶ **Aquaculture and Fisheries :**	
	➢ Map of existing actual activities with special focus on regional aquaculture	Chapter- 6, Figure-6.1, Page-39
	➢ Identify possibilities for small scale aquaculture	Chapter- 6, Article- 6.3.1, Page-40
	➢ Identify constraints for small scale aquaculture	Chapter- 6, Article-6.2.4, Page-40
	2. Identification of possible interventions	Chapter-3, Article- 3.3, Page-17
	3. Analysis of costs & impacts of interventions	
	➢ Costs and benefits of proposed interventions	Chapter-3, Article- 3.4, Page-21
	➢ Costs and benefits of proposed land settlement	Chapter-4, Article- 4.5, Page-28
	➢ Costs and benefits of agriculture and livestock development	Chapter-5, Article- 5.7, Page-37
	➢ Costs and benefits of aquaculture and fisheries development	Chapter-6, Article- 6.4, Page-43
	➢ Costs and benefits of forestry development	Chapter-7, Article- 7.5, Page-48
	➢ Costs and benefits of institutional development	Chapter-8, Article- 8.5, Page-55
	➢ Social impacts	Chapter-9 , Article-9.3, Page-59
	➢ Environmental impacts	Chapter-9 , Article-9.4, Page-60

9-7

	4. Formulating the development plan, setting priorities & timetables & making an overall assessment of the impacts (feasibility study) ➢ Land distribution plan ➢ Development plan for infrastructures ➢ Development plan for agriculture and livestock ➢ Development plan for aquaculture & fisheries ➢ Plan for social forestry on roads, embankments etc. ➢ Development plans and management system for shore and social mangrove forestry for applying public participation and process ➢ Support the delineation of administrative bodies and their involvement in the implementation of the development plan ➢ Plan for involvement of NGO's/LGI's ➢ Outline of sustainable structure of local committees for land and water management ➢ Overall costs and impacts ➢ Priorities and timetables	Chapter- 4, Article- 4.4, Page-27 Chapter-3, Article- 3.3.2, Page-21 Chapter-5, Article- 5.4.1 & 5.6, Page-33 & 36 Chapter-6, Article-6.3, Page-40 Chapter-7, Article-7.4.1, Page- 47 Chapter-7, Article-7.4.1 & 7..4.2, Page-47 & 48 Chapter- 8, Article- 8.2.2, Page-51 Chapter- 8, Article- 8.3, Page-53 & Page-76 Chapter- 8, Article- 8.4, Page-53 & Page-76 Chapter-9, Article- 9.1, Page-56 Page-78
B.	**Preliminary development plan for Caring Char** **1.Topography & Water management :** ➢ Basic topographic map of present situation ➢ Basic drainage map of present situation ➢ Map of present salinity situation ➢ Flood map ➢ Assessment of accretion rate	Chapter-1, Fig-1.1, Page- 4 , Chapter-2, Fig-2.1, Page- 8 Page-75 Page-74. Data are shown in article 5.2.1 (page-29) Page-79
	2. Further reconnaissance on living conditions	Chapter-5, Article- 5.3.3, Page-32 Chapter-6, Article- 6.2.3, Page-40 Chapter-7, Article- 7.2, Page-46

9-8

	3. Forestry : ➢ Development of plan for establishment and management of a forestry	Chapter- 7, Article- 7.5.1, Page-49
	4. Interventions : ➢ Identify and plan for immediate interventions	Chapter-3, Article- 3.3.2, Table-3.5, Page-21
	5. Environmental impacts	Chapter-9, Article-9.4, Page-60
	6. Social impacts	Chapter-9, Article-9.3, Page-59
C.	External drainage situation : ➢ Identify all possible interventions ➢ Make a screening and selection of most promising ones ➢ Further analyze the selected promising solutions ➢ Make a comparison between these promising solutions in support of decision making by the BWDB	Chapter-2, Article-2.3.2, Page-11 & Page-80 Chapter-2, Article-2.3.3, Page-11 & Page-80 Chapter-2, Article-2.3.3, Page-11 & Page-80 Chapter-2, Article-2.3.3, Page-11 & Page-80

6-6

23/12/08

G M Shamsur Rahman
Project Director
CDSP-III
BWDB, Dhaka.

23/12/08
(মুহঃ ফজলুর রহমান)
পরিচালক
পরিকল্পনা পরিদপ্তর-২
বাংলাদেশ পানি উন্নয়ন বোর্ড, ঢাকা।

23/12/08
প্রকল্প প্রকৌশলী,
ডেল্টাটেক, বাপাউবো,
ঢাকা।

Sediment Management Plan for Hoar Khal and Caring Khal

Sedimentation is likely to occur at the outfall of the Haor Khal and Caring khal during the period from late September to June. The following measures will be followed after implementation of the project.

(i) Initially the depth of sedimentation would not be significant, which can be in the range of 30 to 50 cm. An operation rule for operation of the gate will be followed to generate eroding velocity at the downstream stretch of the Hoar Khal and Caring Khal. In the beginning of October only two gates/one gate of each regulator will remain open instead of all the gates of the regulators to obtain sufficient head difference of water between upstream and downstream. Eventually the stream power will be higher to transport the incoming sediment load further downstream from the outfall of the Khals. Even, if any sedimentation occurs that would be very less. This mechanism of sediment management would be effective from October to November. However, it will reduce the depth of sediment deposition.

(ii) A monitoring system would be followed to find the sedimentation rate and its exact location by cross section survey with 500m spacing in the Haor Khal and Caring Khal. A lead channel having the capacity of 2m X 1.5m would be developed at the silted reach based on monitoring results before the onset of monsoon. At the onset of monsoon the remaining loose/unconsolidated sediment deposition will be removed and required drainage condition would be developed due to huge onrush of fresh water.

01-3-09

Team Leader-Acting
Char Development & Settlement Project
Dhaka.