Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Water Resource Planning Organisation

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6

DAMPARA WATER MANAGEMENT PROJECT

FEASIBILITY STUDY
ANNEX E: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN
FINAL REPORT

March 1997

SNC • LAVALIN International
Northwest Hydraulic Consultant

in association wit

Engineering and Planning Consultants Ltd
Bangladesh Engineering and Technological Service

Canadian International Development Agency

2

49

COVER PHOTO: A typical village in the deeply flooded area of the Northeast Region. The earthen village platform is created to keep the houses above water during the flood season which lasts for five to seven months of the year. The platform is threatened by erosion from wave action; bamboo fencing is used as bank protection but often proves ineffective. The single *hijal* tree in front of the village is all that remains of the past lowland forest. The houses on the platform are squeezed together leaving no space for courtyards, gardens or livestock. Water surrounding the platform is used as a source of drinking water and for waste disposal by the hanging latrines. Life in these crowded villages can become very stressful especially for the women, because of the isolation during the flood season. The only form of transport from the village is by small country boats seen in the picture. The Northeast Regional Water Management Plan aims to improve the quality of life for these people.

Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Water Resource Planning Organisation

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

DAMPARA WATER MANAGEMENT PROJECT

FEASIBILITY STUDY
ANNEX E: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN
FINAL REPORT

March 1997

SNC ♦ LAVALIN International
Northwest Hydraulic Consultants

in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services

Canadian International Development Agency

Canadian International Development Agency | Agence Canadienne de developpement international | **ENVIRONMENTAL ASSESSMENT SCREENING REPORT** | **2**

This form must be completed when a screening is required under the *Canadian Environmental Assessment Act*. Where more space is needed, separate sheets will be used and attached to this form. A copy of this form must be sent to the Public Registry Co-ordinator, c/o the Environmental Assessment and Compliance Division (CIDA). The Screening Report will be made available to the public through the Public Registry.

THIS SECTION TO BE COMPLETED BY CIDA

Project Title:_____ Project no._____ 'FEAL no._____
CIDA Officer:_____ Title:_____
Branch:_____ Telephone no:_____
' The FEAL no. is the Federal Environmental Assessment Index number, to be obtained by the Public Registry Co-ordinator in the Environmental Assessment and Compliance Division (CIDA)

THIS SECTION TO BE COMPLETED BY THE ORGANIZATION RESPONSIBLE FOR THE PREPARATION OF THE SCREENING REPORT

Responsible Officer:_____ Name of Organization:_____
Telephone no:_____

1. What is the scope of the project for the purpose of this environmental assessment:, i.e. all the components of the project to be assessed?

The Dampara Water Management Project was identified in the Northeast Regional Water Management Plan as one of the key components for realizing enhanced production in seasonally flooded areas. The pre-feasibility investigation considered channel re-excavation (using dredgers) and embankment.

Main components of the proposed project include the following:

- construction of a 29.7 km full flood embankment along the Kangsha right bank from Jaria to Meda;
- re-sectioning of 2.01 km of Caritas Road by Naterkona;
- use of existing two regulators at the outfall of Kalihar and Balia Channels;
- construction of three small drainage outlets south of Naterkona Village and one drainage outlet at the outfall of Mohespatti Khal;
- re-excavation of 9.6 km of Dhalai Channel; and,
- construction of 20 LLP inlet structures.

2. Describe the adverse environmental effects that are likely to result from the project:

Loss of open-water fishery, loss of wetland habitat and wetland-dependant wildlife, potential social conflict, lifestyles of some fishers and farmers permanently lost, nutritional levels of the poorest may deteriorate.

a) Describe the environmental components that are likely to be affected by the project:

- surface water quality
- open water fish production
- wetland production
- social harmony
- lifestyle
- navigation

b) Describe any change that the project may cause on the environment, including any affect of any such change on health and socioeconomic conditions, physical and cultural heritage, the current use of lands and resources for traditional purposes by aboriginal persons or any structure, site or thing that is historical, archaeological, palaeontological, or architectural significance:

1) Surface water quality may deteriorate due to water being blocked by the embankment
2) Open water fish production will be severely adversely affected, resulting in job loss for fishers
3) There will be significant loss of seasonal wetland and some loss of perennial wetland resulting in an overall loss of wetland production
4) Agricultural production is expected to increase significantly due to timely plantation, reduction in flooding losses and use of HYV
5) Culture fisheries are predicted to show increases as security on the floodplain leads to greater investment
6) There are also mixed impacts on social harmony. Some social relations will be improved i.e., between the Kangsha Project residents and the Dampara Project residents. However there are other areas that may become disputational. For example, relations may deteriorate between different user groups within the project boundaries and between those inside the project and those left out of the embankment alignment.
7) Homestead and public infrastructure will experience increased security and protection. Life in the project area will become more secure and reliable leading to more investment and a better quality of life
8) Flood protection will increase women's income opportunities by relieving them of the burden of annual flood preparedness and post-flood cleanup. It will also increase security of the homestead, permitting more home-based income generating activities (IGAs) for women
9) The embankment will hamper navigation on Kalihar *khal.*

c) Describe the environmental effects that may occur as a result of accidents or malfunctions:

1) Social conflict may occur over the building or use of the embankment and drainage regulators
2) Embankment failure will result in the loss of many of the gains made by the project through crop loss, etc.

d) Describe cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out:

The project will have an impact on neighbouring projects to the east. These projects will be rehabilited and the threat of embankment cutting will be reduced significantly.

e) Describe how the environmental conditions may impact on the project:

An exceptionally high or flash flood might overtop the embankment leading to embankment failure.

f) Other relevant matters (i.e. purpose of the project, alternatives to the project, alternatives to carrying the project, transboundary effects):

The project needs intensive community organisation if the project is to function as conceptualised. There is a reliance on community-based bodies to maintain and operate the embankment and the drainage regulators in order to enhance the fishery and maintain surface water quality.

g) Information sources:

- ☐ **Class Screening**
- ☐ **Previous Environmental Assessment**
- ☐ **Environmental Studies**
- ☐ **Site Reconnaissance**
- ☐ **Environmental assessment report prepared by another organization (specify)**
- ☐ **Traditional or Community Knowledge**
- ☐ **Consultation with Recipient Country**
- ☐ **Consultation with CIDA technical advisors**
- ☐ **Consultation with other experts**
- ☐ **Other(s)** Primary sources - Surveys by NERP

Most of the information was collected from the field from primary sources. Data on bio-physical resources were collected through survey. People's perception were obtained through a series of public consultation meetings. Community Organizers (COs) of NERP are working for more than a year and were well accepted by the communities. Information collected by the COs was transmitted to the multidisciplinary team members through continuous dialogue in the field and in the Dhaka office.

A semi-detail land use survey was carried out using 1:3960 scale *mauza* maps, which were digitized by NERP AutoCAD team and different maps were prepared in different scale. The land use survey also included detail information on agriculture and irrigation. Much of these information have been automated in computer data banks.

3. Describe proposed measures to mitigate significant adverse environmental effects:

The only significant adverse impact associated with the pre-construction and construction stages of the project is the acquisition of land for the embankment. Fifty-one hectares will be needed and will be permanently removed from production. It is proposed that the embankment lands be used for gardening and grazing area, also any losses from production due to embankment-construction are exceedingly minor when compared to the projected production gains that the standing embankment will bring.

The process of land acquisition could also be problematic for the community. Community organisation and the their inclusion in the selection of the final alignment of the embankment should ease the process.

The project is designed to function with a controlled flushing and flooding programme. If executed as proposed this programme will somewhat mitigate impacts on the open water fishery. Since most fish

migration occurs in the April to June period, the drainage regulators will be opened at this time to allow fish to migrate to the floodplain. This will also mitigate some of the adverse impacts on the wetlands. The controlled flooding and flushing can mitigate problems associated with surface water stagnation and groundwater recharge.

Community organisation, capacity-building and the Total Village Development Programme will help to alleviate some of the expected conflicts arising from use of the drainage regulators.

4. Taking into account the implementation of mitigation measures, characterize the residual environmental effects (e.g. magnitude, extent, duration, frequency, and reversibility), in consideration of the ecological and socioeconomic context of the project area:

The most serious residual impact will be the losses to the open water fishery. Despite interventions, the decrease in seasonal wetlands will significantly reduce the numbers of fish. Another serious residual impact is the potential for social disputes over the operation of the project. In a dispute between fishers and farmers over the use of the regulators chances are that the farmers, with their economic clout, will win, thereby undermining the controlled flooding programme.

5. a) Was an opportunity given to the public to examine and comment on the screening report and other records related to the environmental assessment of the project?

☐ **No** ☐ **Yes,** **Public notice given on**_____**(date)**

Public input deadline_____**(date)**

No formal written notice was issued as more than 80% of the area residents are illiterate. However, a public participation process was initiated and continued during the project development process. Local residents will be actively involved in project implementation and, operation and maintenance.

b) Describe the nature of public participation and any public concerns regarding the project:

According to NERP guidelines, a public consultation process was initiated with the explicit objective to ensure public participation from the planning stage of the project. Formal and informal meetings with different groups were held to solicit the perceptions of the people. Formal and informal meetings with different groups were held to solicit the perceptions of the people.

Separate meetings with groups of poor and landless women were arranged in Naterkona, Purbo Moudam and Letirkanda in an attempt to understand their livelihood patterns, their survival strategies and their social status. The process of data collection was highly participatory and included informal methods that required socialization within the community.

Further comments:

ACRONYMS AND ABBREVIATIONS

ASA	Association for Social Advancement
ASP	ammonium sulphate
BADC	Bangladesh Agricultural Development Corporation
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
CBMS	community-based management system
CIDA	Canadian International Development Agency
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
cm	centimetre
CO	Community Organizer
DAE	Directorate of Agricultural Extension
DANIDA	Danish International Development Agency
DOF	Department of Fisheries
DOL	Directorate of Livestock Services
DPHE	Department of Public Health Engineering
DSSTW	deep set shallow tube well
DTW	deep tube well
EIA	environmental impact assessment
EMP	environmental management plan
FAP	Flood Action Plan
FCD	flood control and drainage
FCDI	flood control, drainage and irrigation
FFW	Food for Work
FPCO	Flood Plan Coordination Organization
FW	future with project
FWC	Family Welfare Centre
FWO	future without project
FWV	Family Welfare Visitor
ha	hectare
HTW	hand tube well
HYV	high yielding variety
IGA	income generating activity
IEC	important environmental components
IUCN	International Union for the Conservation of Nature
LGED	Local Government Engineering Department
LLP	low lift pump
m	meter
MCH	mother and child health
Mm^3	million cubic meters
MTW	medium tube well
NERP	Northeast Regional Water Management Project (FAP 6)
NGO	non-governmental organization
O & M	operation and maintenance
PCC	project coordinating committee
PRA	participatory rural appraisal
RD-12	Rural Development-12

RRA	rapid rural appraisal
SSP	single super phosphate
STW	shallow tube well
TW	tube well
UNICEF	United Nations International Childrens' Emergency Fund
UP	Union Parishad

GLOSSARY

aman	monsoon rice crop
aus	pre-monsoon rice
beel	floodplain lake that may hold water perennially or dry up during the winter season
boro	dry season irrigated rice crop
chon	native grass
haor	depression on floodplain located between two or more rivers, which functions as a small internal drainage basin
ikor	native grass
jalmohals	government owned open water fishing ground
kantha	quilt made of old cloth
khal	channel
khas	government-owned land.
mauza	lowest level of government land revenue jurisdiction with enumeration of indivisual plots
pajubon	grasslands
parishad	council
samity	cooperative society
taka (tk)	unit of currency, 1 US $ = 40 taka (approx.)
thana	geo-administrative unit under a district comprising several unions
union	geo-administrative unit under a thana comprising several villages
union parishad	elected local government council at the union level

TABLE OF CONTENTS

List of Tables

List of Exhibits

APPENDIX A: TABLES

LIST OF FIGURES

E.1. PROJECT SETTING

E.1.1 Background

The Dampara Water Management Project Feasibility Study was conducted in the second stage of the Northeast Regional Water Management Project (NERP). In the first stage, NERP carried out pre-feasibility studies for four projects in the Upper Kangsha floodplain area. The Dampara Project is one of the four component projects of the Upper Kangsha River Basin Development Project (Figure 1) taken up to feasibility-level study including a full scale Environmental Impact Assessment (EIA).

The Dampara Water Management Project lies northwest of Netrokona Town; it is located between latitudes 24°56' and 25°03' north and longitudes 90°23' and 90°39' east. It is bounded by the Kangsha River to the north, the Phulpur-Purbadhala Road to the south, the Kharia River to the west and the BWDB's Kangsha River Project's west embankment to the east (Figure 2). The project covers a gross area of 15,000 ha spread over the Purbadhala and Phulpur *thanas*. About 12,525 ha is available for cultivation.

E.1.2 Rationale and Objectives for the Project

The Dampara Project area is located in a flash flood zone of the Kangsha River and is regularly flooded by overspill from the river. Bank overspills are triggered by rainfall in the river's catchment, most of which is located to the north in India. Flooding damages transplanted *aman* crops, ponds, homesteads and infrastructure. In some areas *boro* rice is occasionally damaged by pre-monsoon rainfall runoff due to drainage congestion.

The flooding situation has worsened with the development of the Kangsha River Project to the east. The Kangsha Project area was once the floodway for the Dampara area. Now, when the Kangsha overtops its banks, the water is trapped by the Netrokona-Durgapur road that serves as the western embankment of Kangsha River Project. People living in the flooded area, when in distress, cut open the road, flooding the Kangsha Project area and damaging the project's crops and infrastructure. The vital road communication between Netrokona and Durgapur is disrupted due to the cuts and Netrokona town is also threatened by the flood waters. Figure 3 shows the Kangsha Project.

The general objective of the proposed project is to allow the Dampara area some measure of flood protection for crops. Population growth in the area requires an increase in agricultural production. There is no scope for increasing winter crop production through areal expansion, but flood protection will allow significant increases in monsoon crop production. More specifically, the proposed interventions seek to:

- protect crops, fish ponds, homesteads, and infrastructure from Kangsha River flooding;
- protect the Netrokona-Durgapur road;
- provide flood protection for Netrokona town; and
- make the Kangsha River Project fully functional.

E.1.3 Methodology for Environmental Impact Assessment

NERP multi-disciplinary team members, conducting the feasibility study and the EIA of the Dampara Project, reviewed the pre-feasibility reports before proceeding to collect primary data. Several reconnaissance surveys were undertaken which helped to identify the important environmental components and formed the basis upon which subsequent data collection methods were developed. These methods included rapid rural appraisal (RRA), participatory rural appraisal (PRA), a baseline household survey, a semi-detailed land use survey and both formal and informal consultations with the area residents. Extensive discussion also took place at different stages of the EIA. Discussions were held with local government institutions, with *thana* officials, with BWDB engineers and within the EIA team.

The EIA tasks were dealt with under four major resources: water, land, biological and human. The methodologies used for the collection and the analysis of data on the various resources is contained in Chapter 1 of the main report.

E.1.3.1 General Evaluation

Based on a detailed survey, the NERP team developed an environmental baseline description for the study area. For the EIA, the study area was divided into two parts: the project area and the impact area. The impacts of project actions were assessed through data analysis, the MIKE 11 Hydrodynamic Model and relevant maps, output and tables.

The assessment began by establishing an environmental trend for a "future-without-project" scenario, by assuming that past trends will continue into the future. This was followed by developing a second scenario under the projected "future-with-project" conditions. The impacts of the project were predicted by assessing the difference between the two scenarios, considering the likely changes in the water, land, biological and socioeconomic environmental components.

Map analysis outputs were used for the quantification of spatial impacts, particularly regarding agriculture. Having identified the impacts of the project against a defined future of thirty years (being regarded as the lifetime of the project), a series of recommendations on mitigation, enhancement and monitoring measures for environmental management are proposed.

E.1.3.2 Assessment and Scoring

The methodology described in the EIA Manual (ISPAN, April 1995) for project impact assessment and scoring was used in this study. The EIA guidelines (FPCO 1992a) suggest scoring the impacts. The impact assessment of specific important environmental components (IECs) was done by individual subject specialists. When an impact could not be quantified, qualitative judgement was used based on expert experience.

The complex nature of the environment does not easily lend itself to any single methodology for rating impacts. The scoring method of impact assessment was attempted but the results varied significantly according to who was assigning the scores. Though it was found deficient, scoring allowed for the clear identification of the most significant impacts.

E.1.3.3 Assessment and Impact Description

The presentation used in this report is a combination of the recommended methodologies. Though a matrix was initially used as an assessment tool, it was ultimately found not sufficient to address the impacts. Impacts occurring during the pre-construction and construction phases were largely minor and temporary in nature. Including these in the general assessment tended to exaggerate the importance of these impacts. Therefore, they are dealt with largely in Chapter 8 - the Environmental Management Plan. A combination of text and tables is used for the impacts of the completed project and the residual impacts. All impacts have been quantified where possible.

E.1.4 EIA Team

The EIA team was assembled by NERP and comprised a group of expatriate consultants advising Bangladeshi professionals from a variety of academic backgrounds. The multidisciplinary team included a water resource engineer and a sociologist as full time members. Inputs were made by other NERP professional staff from the fields of agronomy, hydrogeology, mathematical modelling, fisheries' biology, wildlife biology, botany and economy. The EIA specialist was supported by an EIA advisor.

E.1.5 EIA Budget and Level of Efforts

Data and investigations required for the feasibility study coupled with some extra efforts by the team members provided most of the data needed for the EIA. The work started in July 1994 and continued until December 1995 when both the feasibility report and the EIA report were prepared. Consultation with local people continued throughout the period of EIA. Total level of effort by the team members besides the time spent for the feasibility study was estimated to be ten to twelve person-months.

E.1.6 Relationship to Project Feasibility Study/Report

The feasibility study and the EIA were conducted simultaneously. This report is a stand-alone appendix of the Dampara Water Management Feasibility Study. Its companion volumes: Appendices A through D and the main report were published together in May 1996.

E.1.7 Scope and Format of Report

The format of this report generally follows that laid out in Chapter 6 of FAP-16's *Manual for Environmental Impact Assessment* (ISPAN, 1995). Chapter 2 provides an outline of the future of the project area without any interventions. It also looks at proposed interventions and provides a rationale for the choice of the project. Chapter 3 describes the project in detail and provides the schedule for implementation for the different phases of the project activities. The environmental baseline survey is described in Chapter 4. Chapter 5 looks at the environmental impact of the different activities associated with project implementation. Chapter 6 details the cumulative impacts of the project. Chapter 7 covers the consultation process. Finally, in Chapter 8, the environmental management plan is detailed, the residual impacts of the projects are listed, and the cost of the EMP is provided for incorporation in the economic analysis of the project.

E.2. PROJECT ALTERNATIVES

E.2.1 No Project

The Dampara Project Feasibility Study proposes a series of interventions to mitigate flood damage and to address other issues in the project area. The interventions include the construction of an embankment along the right bank of the Kangsha River from Jaria to Meda, the re-excavation of Dhalai Channel and other necessary measures that may be identified as the project develops. Whether action is taken, changes in the biophysical and socioeconomic environment of the project area are inevitable.

Under the future without project (FWO) scenario, it is predicted that the flooding situation will steadily deteriorate. Continued deforestation in the watershed area, lack of international cooperation in water resource and environmental management and misuse of water resources will continue to aggravate problems regarding water surplus in some seasons and water scarcity in others.

In the FWO, increasing floods are predicted to result in a general decrease in cereal food production by 17 percent annually in the next thirty years. It is predicted that vegetable and wheat crops will increase however, therefore overall cropping intensity is expected to remain approximately the same.

Though the growth rate of the Dampara population is predicted to decrease, the population of the project area will still more than double before zero population growth can be achieved, perhaps around the middle of the next century. By 2015 CE the population will increase by about one third (40,000 people) compared with the 1996 population. This will add about seven or eight thousand families. By this time more than two thirds of all the people in the project area (perhaps 20-25 thousand households) will be landless.

The impacts of population growth will be many. Demand on the land will come from the need for more agricultural production, living space and infrastructure development. An additional 152 ha will be converted to homestead lands if the same population density (people/ha of homestead) is maintained, further reducing agricultural productivity. These conflicting demands will create tremendous pressure on the existing system of agricultural production and will ultimately lead to famine in severe flood years.

The BWDB's two neighbouring FCD projects: the Kangsha and the Thakurakona, will continue to suffer as long as there are no flood control measures in the Dampara Project area. With the need for more production in the Kangsha and Thakurakona project areas to satisfy the demands of the growing population, conflict will increase between the Dampara area people and the people of those two project areas. Population growth will increasingly be dealt with through out-migration, most typically to over-crowded urban centres.

Observations of past fish production suggest an annual decline of 3 to 5 percent. This decline is due to overfishing, disease, increasing sedimentation, the absence of overwintering grounds and the deterioration of water quality due to increased pesticide use.

Existing grasslands are predicted to disappear under pressure to convert them to more economic uses. More land will come under orchard, bamboo grove and plantation agriculture to meet growing needs for fuel and other forest products.

Wetlands have experienced increasing deterioration through human action, typically, conversion to agricultural land. Wildlife populations are declining drastically due to habitat alteration and human predation. These trends are predicted to continue.

Since the development of the Kangsha Project to the east, more homestead and agricultural lands in the Dampara area have been subject to flooding. The large disparity in flood protection between the two areas has created significant social tension; it ultimately leads to the cutting of the Kangsha Project's west embankment by Dampara residents in every flood year.

Local authorities will continue to construct flood control schemes. Some of these will be unplanned, uncoordinated and constructed without proper study. The damage and suffering under false protection are greater than under 'no project' conditions since people adjust their livelihoods and cropping patterns to the promised project conditions.

E.2.2 Project

Additional food and employment are greatly required in the area. The greatest scope for increasing food production in the area is to protect the t. *aman* crop from flood damage. In public meetings, people strongly favoured engineering interventions - particularly the construction of an embankment - to manage floods. It is concluded, therefore, that a viable engineering scheme is needed for the area's socioeconomic development. However, the project must be sensitive to environmental considerations.

E.2.3 Alternatives

Two large project-oriented alternatives were considered for intervention in the area. Since the main water management problem is flooding from the Kangsha River, the interventions were focused on containing flood flows within the river banks. The two proposed solutions were channel dredging and an embankment.

Removal of Kangsha & Thakurakon guest?
(since these are the cause of the flooding)

E.2.3.1 Alternative One

The first alternative considered was dredging the Kangsha channel. Effects of channel dredging were modelled with the MIKE-11 hydrodynamic model using 1991 data. The increase of the channel's cross-section by 300 m^2 over a distance of 40 km from Jaria towards downstream would require the removal of 12 Mm^3 of bed material. The excavation of the channel material would result in an increase of channel area by 25 percent and reduce flood depths in the project area by approximately 0.4 m during peak flood conditions.

Approximately 300 dredger-months would be required to complete the work (assuming 18" dredgers were used, operating ten hours/day and twenty days/month). With five dredgers operating twelve months of the year, the work could be completed in a minimum of five years.

E.2.3.2 Alternative Two

The second alternative considered was the construction of an embankment along the right bank of the Kangsha River. About 29.7 km of embankment from Jaria to Meda is required to prevent Kangsha flood spills. Flood routing analysis for the 1991 hydrological conditions indicates that an embankment would lower water levels in the project area by more than 0.86 m at peak flood conditions.

Figure 4 shows the project flood depths after proposed interventions

E.2.4 Selection of Alternatives

Effectiveness and costs

With channel dredging, the decrease in flood levels was considered marginal and the cost would be very high. Assuming a unit dredging cost of 120 Tk/m^3, the cost would be Tk. 1,440,000,000 (USD 25,000,000). As siltation is an on-going process in the Kangsha, maintenance dredging would be required to maintain any gains made. Annual upkeep costs are estimated at Tk. 180,000,000 (USD 3,200,000). Other considerations are the time required to implement the project, the potential displacement of people from the river's edge and the question of dredging spoil disposal.

The cost of the embankment would be comparatively low, in the order of Tk. 11,400,000 including the costs of appurtenant structures. The construction could be completed in two working seasons. Ongoing annual maintenance costs were estimated at Tk. 228,000.

Based on this analysis, clearly dredging would not provide a feasible or sustainable solution to monsoon flooding in the Dampara Project area.

Public Consultation

Though the overwhelming majority of people at the public consultation meetings were strongly in favour of the embankment, two main concerns were raised about embanking the Kangsha. They are:

- increased flooding on the north floodplain (the opposite bank of Kangsha River), and
- the depletion of fishery resources.

Those who favoured the dredging option were people from the left bank of the river. These people would receive no protection from the embankment option, but some protection from river dredging.

There is significant apprehension that an embankment on the right bank of the Kangsha River will raise water levels on the left bank floodplain. An analysis by hydrodynamic model reveals that the intervention will raise water levels by a scarcely noticeable five centimetres for two-year flood conditions. The figure for a twenty-year flood will be ten centimetres. It appears, therefore, that the impacts of the Dampara Project embankment on the Kangsha River left bank will be small and, for the most part, difficult to detect. Two dangers remain. The first is that if a large flood occurs soon after the Dampara embankment is constructed, people on the left bank may infer that the additional flooding they experience is caused by the embankment. The second is that even though the increase in flooding for areas outside the Dampara embankment will be small, there

will be a large disparity in the flooding situation between the area inside the embankment and that outside. This could cause significant tension between the "outsiders" and those inside the project area.

Impact on Fisheries

Eighty percent of the area's fish are produced in open water. The critical time for open-water fisheries is the pre-monsoon when fish migrate primarily from the Kangsha to the floodplain for spawning. In post-project conditions, migration routes through the Kalihar and Balia channels will be impeded by the 5-vent regulator at the Kalihar outfall and the 10-vent regulator at the outfall of the Balia.

Obstruction of the flow of the river on to the floodplain in the April-June period by the project interventions would have a considerable negative impact on fishery resources. Therefore, the project is conceptualized to keep the floodplain open to the Kangsha and other boundary rivers and to allow flooding during the pre-monsoon season (see project concept in the main report). This will significantly reduce the impact of the embankment on fisheries.

This plan was discussed with the fishing community at Berha Village (a fishing village) where engineering interventions and the project were strongly supported. It was also felt that the excavation of selected *beels* would increase the extent of overwintering grounds and act as fish sanctuaries, thus enhancing fish resources in the area.

E.2.5 Recommendation

Based on the technical analyses and public consultation, this study recommends the construction of an embankment along the Kangsha River right bank from Jaria to Meda and the re-excavation of the project's drainage channels and *beels* wherever necessary.

E.3. PROJECT DESCRIPTION

E.3.1 Project Overview

Though flooding is the main problem in the Dampara area, this study also identified drainage and irrigation as water resource issues to be addressed. The following sections outline steps taken and interventions proposed to deal with the three problem areas.

E.3.1.1 Interventions in Flood Problems

In response to the area's flooding problems, this project proposes the construction of a 29.7 km embankment from Jaria to Meda along the right bank of the Kangsha River. Field surveys suggest that there are no spills west of Meda. The proposed embankment will connect with the existing Kangsha Project embankment that ends near Jaria.

The guidelines of the FPCO recommend using existing roads for embankments wherever possible. Around Netrokona Village, there are two roads that could potentially be used for embankment purposes - one to the north of the village and the other to the south. The north road (Caritas Road) is close to the river, but it is not safe for use as an embankment. The south road leaves the entire village on the river side. The development of a third embankment between the two roads is opposed by the people of the village. Since they have already relinquished land for the two roads, they are not prepared to give up more land for an embankment.

This study, therefore, recommends the development of the southern road as part of the embankment for the project. To prevent flooding of the village, it is proposed to re-section Caritas Road to serve as an embankment. As well, three small drainage regulators will be installed on the southern road embankment to allow drainage of the village. This proposal was agreed upon by the people of the village.

Currently there are two drainage regulators in the project area: one at Khatuair on the outfall of the Kalihar Channel and the other at Chorerbhita on the outfall of the Balia Channel (see Figure 3). This study examines the adequacy of these two structures for draining their catchments. Mohespatti Beel is an isolated *beel* and drains to the Kangsha through Mohespatti Khal. It is proposed to construct a small drainage outlet at Mohespatti on the outfall of that *khal*.

E.3.1.2 Interventions in Drainage Problems

Young *aus* and *boro* crops are damaged by drainage congestion caused by pre-monsoon rainfall-runoff. Kalihar, Balia and Dhalai are the three major drainage channels of the project area. Analysis was carried out to check the adequacy of these three channels to discharge rainfall-runoff without damaging crops. It was found that the Kalihar and Balia channels adequately drain their respective catchments but the Dhalai Channel needs re-excavation along a stretch of about 9.6 km.

E.3.1.3 Interventions in Irrigation Problems

According to NERP's 1995 land use survey, about 94 percent of the cultivated land is covered by winter crops which are partially to fully dependent on irrigation. Both groundwater and surface water, where available, are used for irrigation. Surface water is very scarce. Of the 74 Mm^3 of

water needed for irrigation, only two Mm^3 are available as surface water in the area's channels and *beels*. People of the area have requested more surface water for irrigation because it is cheap and easily accessible. They proposed that surface water be augmented by enlarging the Kalihar and Balia channels.

Channel enlargement is not an attractive option for the augmentation of irrigation water. Kalihar and Balia channels are adequate for draining their respective catchments (see Annex A); enlargement would be justifiable for irrigation use only. An increase of channel sections by 50 percent will increase the surface water availability by only 0.50 Mm^3 - a negligible amount. Enlargement will induce siltation in the channel thus requiring expensive annual maintenance. Also, since there are many homesteads located on the banks of Kalihar Channel, enlargement will displace many people.

E.3.1.4 Proposed Project Interventions

The main components of the proposed project include the following:

- construction of a 29.7 km full flood embankment along the Kangsha right bank from Jaria to Meda;
- re-sectioning of 2.01 km of Caritas Road by Netrokona;
- use of existing two regulators at the outfall of Kalihar and Balia Channels;
- closing off the Kalihar Channel at regulator site and excavation of the diversion channel;
- construction of three small drainage outlets south of Netrokona Village and one drainage outlet at the outfall of Mohespatti Khal;
- re-excavation of 9.6 km of Dhalai Channel; and,
- construction of 30 LLP inlet structures.

Figure 5 illustrates the proposed project interventions

E.3.2 Preconstruction Phase

E.3.2.1 Preconstruction Activities

The pre-construction phase activities are listed in Table 3.1. The construction of the embankment requires a topographic survey on the proposed alignment and land acquisition before floating the tender. To finalise the land acquisition plan, a cadastral survey will be conducted. The embankment alignment will be finalised with the help of community leaders. The topographic survey will be conducted on the final alignment to estimate the earthwork for tendering.

Table 3.1 Pre-construction Phase

Pre-construction phase activities
Fish migration and recruitment study
Socioeconomic baseline survey
Cadastral survey
Survey of proposed alignment
Community organisation
Final design and cost estimate
Preparation of tender documents
Floating of tender
Award of contract
Land acquisition

Embankment Design

The main purpose of the embankment is to protect the agriculture of the area. The design of the embankment layout is a key to the success of this project. The final alignment must be both technically safe and socially acceptable. Local preference is for an alignment close to the river's edge, but river morphology requires that the embankment be as far as possible from the river. The final alignment needs to be negotiated with the communities with the help of locally-based planning committees developed under the Community-Based Management System. Wherever possible it should follow and make use of existing roads

Community Organisation

The organisation of the project coordination committee (PCC) and sub- project coordination committee (Sub-PCC), as described in Chapter 10 of the main report, should begin as early as possible in the pre-construction phase. Close links with the community and the building of an institution to provide those links will simplify project activities and will be necessary for the execution of important components of the EMP.

Items that could be included in discussions with the community include:

- Selecting the final embankment alignment
- Siting of drainage outlet structures
- Accommodating those outside the embankment alignment
- Capture fisheries improvement and management
- Wetland management

Land Acquisition

About 51.0 ha of land will be required for the Jaria - Meda embankment. No land acquisition will be required for Caritas Road improvement. To reduce land acquisition, earth for construction will be obtained from landowners through the payment of royalties.

Of all the pre-construction tasks, land acquisition is the most complex and time-consuming. The spatial extent of the embankment will require the participation of possibly hundreds of landowners. Experience from the Small-Scale Flood Control Drainage and Irrigation Project (SSFCDI) suggests that the process of land acquisition could take up to a year. The participation of the community in final embankment alignment could ease the land acquisition process.

E.3.3 Construction Phase

E.3.3.1 Construction activities

The construction of the embankment and the re-excavation of the channel (see Table 3.2) are the main activities in the construction phase. Excavation and placement of the material will be done

through manual earth moving techniques. These tasks may be contracted out or may be executed through the FFW program.

Construction of the small drainage outlet structures will be the responsibility of the contractor. Local labour will be used whenever possible.

Enhancement Activities

The construction stage represents a period of capital inflow into the project area and an opportunity to deliver benefits to the poorest sector of the community. Therefore, the main consideration at this stage is to ensure that local landless people benefit from the project through employment opportunities and other training programmes provided during construction. Details are provided in section E.8 of this annex.

Figure 3.2: Construction Phase Activities

Construction Phase
Embankment construction Pre-section survey Labour camp Excavation Placement of material Slope stabilization
Drainage structure construction Labour camp Excavation Foundation Superstructure
Drainage structure rehabilitation
Road re-sectioning and paving
Channel excavation Pre-section survey Excavation Spoil disposal Spoil rehabilitation
Monitoring of work progress and quality
Construction-phase enhancements Training programmes for workers Guidelines for local contracting and hire Savings and credit programmes

E.3.3.2 Hazards

In the construction phase hazards may arise from either social discord or worksite accidents.

Social discord may result in confrontation or clashes during the construction period. During the pre-construction and construction phases, material, equipment and other resources will be brought into the project area. The level of stress experienced by the communities will increase. Conflict may arise from the following sources:

- from those who may be opposed to the embankment project, i.e., those left outside the alignment or residents from the left bank;
- through misunderstandings between the community, the contractors, the labourers and other agencies;
- pre-existing conflicts amongst and between villagers that can flare up over new resources brought into the area and under situations of community stress.

On any construction site there is potential for accidents. Though there are no substantial hazards associated with manual excavation and earth moving, work-place safety should be addressed.

E.3.3.3 Schedule of Works and Logistics

Three years are required to implement the project. The work should start preferably in November. Pre-construction activities should be completed in year one. Construction activities would start in year two and be completed in year three. An itemized implementation schedule is shown in Table 3.3.

Table 3.3: Implementation Schedule

Activity	Year of Construction		
	1	2	3
Preconstruction Activities			
Surveys	100		
Implementation Document	100		
Land Acquisition	70	30	
Construction Activities			
Construction of Embankment		50	50
Re-excavation of Channel		50	50
Construction of Structures		50	50
Mitigative Measures		40	60

E.3.4 Operation and Maintenance Phase

E.3.4.1 Operation Activities

The BWDB will assume initial responsibility for overseeing the operation and maintenance of the project. It is expected that the Sub-PCCs will be responsible for organising the maintenance and will ultimately be responsible for the operations of the project. The Sub-PCCs will require a concerted effort in capacity-building in order to fulfil its roles and responsibilities. Though the relationship between the BWDB and the Sub-PCCs must be organised, it is expected that the BWDB will provide support to the community for as long as possible (a minimum of five years). Most of the O & M activities listed in Table 3.4, however, will be ongoing after the final project phase.

Operation and Maintenance Manual

An operation and maintenance manual will be developed for the whole project based on negotiations between the Sub-PCCs and the BWDB. The manual will be produced within the framework of an action research methodology. The manual itself will constitute the outcome and record of the negotiations and will clarify the roles and responsibilities for each party. This method will allow substantial community participation in manual preparation.

Maintenance

The approach to maintenance will be worked out in collaboration with the Sub-PCCs. It is assumed that the committee will have a mandate that is larger than the mere maintenance of the infrastructure, and will include aspects of the total village development programme outlined in the EMP.

It is considered beyond the scope of this document to prescribe how the community will arrange the maintenance. However, an assumption is made that maintenance will involve the participation of the landless poor. One method adopted in other projects has been to exchange access to embankment land for maintenance services rendered.

Table 3.4: Operations-Phase Activities

Operations phase
Preparation of O & M manual
O & M of drainage regulators Controlled flooding program
Embankment maintenance Erosion control Filling of holes and breaks
Drainage channel maintenance
Environmental Monitoring Groundwater monitoring Hydrologic monitoring Socioeconomic monitoring Fisheries monitoring
Identification of necessary changes
Operations-phase enhancements Extension and credit facilities Training for fishers Training for farmers

Environmental Monitoring
Ideally the line departments of the Government of Bangladesh should take over monitoring and enhancement activities in the operations phase. But with possible exception of BWDB, these agencies are at present not equipped to do it. Furthermore, some body must assume overall responsibility for the execution of monitoring programme. The only practicable way is to assess this responsibility to a Bangladeshi consulting company who will carry on this work before, during and after project implementation.

E.3.4.2 Hazards

The hazards related to the standing embankment are embankment failure and failure of the drainage regulators. It is vital that contractors follow proper engineering guidelines during embankment construction and that the Sub-PCCs follow maintenance guidelines in the O & M phase. Prevention of embankment failure due to human actions such as embankment cutting is more difficult to achieve. There are many variables involved in such actions, most of which will not be under the control of the executing agency.

Attenuation of drainage regulator failure can also be achieved through adherence to engineering and maintenance guidelines.

E.3.5 Overall Project Schedule and Logistics

Training and capacity development
In the two years post-construction, the Sub-PCCs will take over responsibility of project operation and maintenance. An important part of the development of a long-term consciousness about maintenance and management of a project such as this, is that the Sub-PCCs will need some degree of support for many years. This is a contentious point since funding agencies are reluctant to provide long-term funding for projects after they are nominally completed.

The problem with a short support period is that it does not allow the local management system a sufficient range of experience. Other than construction defects, only a small range of problems can be experienced over short period, especially in the first year after construction. Unless the management system can be supported throughout the time it is encountering a large range of problems, it is unlikely to become competent. The minimum length of time required for such support is five years, and some monitoring is probably required for ten years.

E.4. DESCRIPTION OF THE EXISTING ENVIRONMENT

E.4.1 Physical Environment

The Dampara area is located on a low-lying floodplain. Most of the land is used for agricultural purposes. All of the land area has, to some extent, been altered by human activities and most is intensely used by humans or their domestics. This chapter describes in detail the environment of the Dampara area.

E.4.1.1 Atmospheric Environment and Climate

The area has a tropical monsoon climate characterised by abundant rainfall during the monsoon season followed by a cool winter period and a dry hot summer. There is no climatological station within the project area. The nearest station is Mymensingh, the location of which is shown in Figure 1.

Monthly maximum temperatures vary from about 32.2 to 34.7°C with the highest temperatures occurring between March and October. Minimum temperatures range from 9.8 to 15.9 °C and occur between November and February. Increased cloud cover during the June to September period prevents extremes of temperature.

The length of the cool winter period is 50-90 days. Average minimum temperatures are below 15 °C. In the summer period there is an average of 0.5-5 days when maximum temperatures are above 40 °C.

Rainfall distribution shows an increasing trend from the southwest (2800 mm/year) to the northeast (3400 mm/year). Annual potential evapotranspiration, computed at Mymensingh, is 1506 mm. The lowest monthly amount occurs in December (87 mm) and the highest occurs in April (162 mm).

E.4.1.2 Aquatic Resources

Surface Water

There is a significant surplus of surface water in the monsoon season but scarce in the dry months. The disparity of surface water availability leads to a large variance in river discharges in the region. For example, the discharge of the Kangsha River at Jaria varies from 0.0 m^3/sec to 1430.0 m^3/sec (Table 4.1).

Table 4.2 shows the dependable surface water availability for different return periods in the Kangsha at Jaria. The figures are ten-year averages for the first ten days of January, the second ten days and the third ten days. Data from Sarchapur and Netrokona have only been collected for a few years. The time span is too short to make frequency analysis, therefore, Table 4.3 gives only the mean values of the available data at these two stations.

92

Table 4.1: River Discharge

River	Station	Period of Record	Years of Record	Mean Daily Discharge (m^3 /sec)		
				Historical Maximum	Historical Minimum	Range
Kangsha	Sarchapur	1991-93	3	294.0	0.0	294.0
Kangsha	Jaria	1964-93	30	1430.0	0.0	1430.0
Mogra	Netrokona	1991-93	3	285.0	0.0	285.0

Table 4.2 Kangsha River at Jaria - Surface Water Availability 1961-93

Return Period	Dependable Surface Water Availability (m^3 /sec)									
	Jan			Feb			Mar			Apr
	I	II	III	I	II	III	I	II	III	I
2-yr	42.6	35.0	29.4	23.0	21.0	18.1	16.2	14.3	15.6	14.6
5-yr	28.9	28.1	21.9	15.8	14.0	12.1	10.7	9.7	9.0	9.0
10-yr	26.2	24.0	19.1	13.9	10.5	9.7	9.1	7.7	6.2	7.2

Table 4.3: Kangsha River at Sarchapur and Mogra River at Netrokona Surface Water Availability 1991-93

Station	Dependable Surface Water Availability -Mean Value (m^3 /sec)									
	Jan			Feb			Mar			Apr
	I	II	III	I	II	III	I	II	III	I
Sarchapur	13.6	13.8	8.4	7.0	5.5	5.3	4.4	2.9	3.8	3.2
Netrokona	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

According to the data collected at Sarchapur, the Kangsha River becomes almost dry during the winter period even under average conditions. Field observation showed no flow down to the Nitai confluence. Therefore, all of the dry-season flow of Kangsha River at Jaria is received from Someswari River through Shibganj Dhala. The upstream reach of the Mogra River along the project area also becomes dry.

In the dry season a small quantity of surface water is available in *beels* and drainage channels. Area residents construct cross-dams on the Kalihar and Balia channels to impound water for

irrigation. Through the damming of the channels, about 2.0 Mm^3 of water is made available for irrigation. This amount is insignificant when compared to the 74.0 Mm^3 required for irrigation in the project area.

Figure 3 shows area *beels* and channels.

Groundwater

Groundwater is the major source of water for irrigation and for domestic use. In the winter season about 10,872 ha is under *boro* that is entirely dependant on irrigation. The irrigation requirement for the *boro* crop is estimated at 73 Mm^3 (Annex A). The available surface water in *beels* and channels is 2 Mm^3, the demand for groundwater for irrigation therefore, is 72 Mm^3. Modes of groundwater withdrawal are presented in Table 4.4.

Table 4.4: Irrigation Mode and Irrigation Area

Irrigation Method	1990-91		1992-93	
	Number	Irrigated Area (ha)	Number	Irrigated Area (ha)
STW	328	1 525	631	2700
DSSTW	22	8	4	2
DTW	50	678	204	2 946
MOSTI	12	3	18	5
Total	412	2 214	857	5 653

According to DPHE/UNICEF *Rural Water Supply and Sanitation Programme 1992-95*, the groundwater consumption for domestic purposes in rural areas is 12.5 litres per person per day. Figures from the 1991 census show an area population of 112,772. The total groundwater consumption for domestic purposes would therefore be about 0.0016 Mm^3. This is not considered significant in comparison to the figures for agricultural use. The present annual groundwater use for this project, therefore, has been calculated to be 73 Mm^3.

The potential recharge in the area is about 818 mm or 123 Mm^3 (see Annex A). Seventy-five percent of the potential recharge, equivalent to 92.0 Mm^3, is assumed to be available for irrigation and other purposes. A 25 percent reduction from the total recharge figure was made to compensate for uncertainties in the model calibration and in the input data.

Table 4.5: Development of Tara Pumps

Year	Number of pumps
1992	166
1993	222
1994	304
1995	408

In the dry season, there is extensive irrigation in the area. According to NERP's 1995 land use survey, about 94 percent of the cultivated area is irrigated in the dry season (Annex B). Both ground and surface water are used. About 97 percent of the area's irrigation water comes from groundwater sources.

There is apprehension that groundwater reserves will be depleted and that the area will suffer water shortages in future. Available groundwater is estimated to be 92.0 Mm^3 which is greater

than the present use (74.0 Mm^3). Since 94 percent of the project's cultivated land is already under a winter crop, there is little room for increasing the area under irrigation. It is predicted, therefore, that demand for groundwater will remain relatively stable and supply appears plentiful.

Another concern is that domestic water supply suffers due to the withdrawal of groundwater. Suction mode hand tube wells (HTWs) are widely used for withdrawing groundwater for domestic use. But large scale groundwater withdrawal for irrigation lowers the water table, resulting in many HTWs failing during the irrigation season.

To cope with the situation, the Department of Public Health Engineering (DPHE) and UNICEF are gradually replacing the HTWs with forced-mode Tara pumps. As seen in Table 4.5, there has been a gradual increase in the number of Tara pumps under the DPHE/UNICEF programme. By August 1995 there were 408 Tara pumps in the area. Since one pump can service approximately 100 persons, more than 36 percent of the project's population is served by Tara pumps.

E.4.2 Biological Environment

E.4.2.1 Terrestrial Environment

Terrestrial Flora and Habitats

The major habitat patterns in the Dampara project area are homestead vegetation, bamboo orchard, crop field vegetation, grassland vegetation and roadside vegetation. No natural forest exists in the project area.

Homestead Vegetation: Homestead vegetation is the single most important plant community in terms of diversity. It occupies about 700 ha of the project area. This vegetation generally includes two types of plants: those cultivated for their economic value and those that are self propagating. Homestead forests are not as diverse as natural forests since only economic species are cultivated. Despite this, there is significant variation in the composition of homestead vegetation. The most common species are koroi (*Albizzia sp.*), mango (*Mangifera indica*), mandar (*Erythrina sp.*), khathal (*Artocarpus heterophyllus*), jam (*Syzygium sp.*), boroi (*Zizyphus mouritiana*), and bamboos belonging to two or three species. Homestead forests also play an important role in providing shelter for many wildlife species.

Besides supplying food, fodder, medicine, fuel and other household requirements, trees are the major source of timber and renewable biomass energy. Most of the tree species grown in homestead platforms are highly to moderately vulnerable to flood water. Flood-insensitive species comprise less than 2 percent of the total. Annual return from an average homestead platform is about Tk. 7,000.

Plantation and Orchard: Bamboo orchards are the most important of the economic plantations in the Dampara Project area. The area covered by bamboo grove is about 104 ha with a value of about Tk. 837,000 per hectare or Tk. 87 million for the project. The annual return from these plantations totals Tk. 130,000 per hectare or Tk. 13.5 million for the total area.

Cropland and Open Woodland: Crop field vegetation extends over 12,525 hectares or 83.5 percent of the project area. This area is largely used for rice monoculture. Areas at the edge of the crop fields and between the cultivable plots provide important cover for smaller animals. Solitary trees or shrubs amid the vast tracts of cropland provide perching and roosting place for

raptors and other insectivorous birds. The open woodland mostly comprises koroi (*Albizzia* sp.), mandar (*Erythrina* sp.) and jarul (*Lagerstromia* sp.) Predominant trees are listed in Table 4.6.

Table 4.6: Major Tree Species According to Their Canopy Coverage Area.

Tree species	Present in % of Ultimate Sample Unit as a major tree cover (<5%)	Canopy coverage % of area covered	Tree species	Present in % of Ultimate Sample Unit as a major tree cover (<5%)	Canopy coverage % of area covered
Albizia procera	15	1.60	*Lagerstromia speciosa*	12	0.96
Aphanamixis polystachya	15	1.25	*Mangifera indica*	40	7.30
Areca catechu	21	3.96	*Streblus asper*	35	3.96
Artocarpus heterophyllus	45	5.08	*Syzyzium cumini*	25	3.32
Bambusa sp.	51	9.28	*Syzygium fruticisum*	15	1.75
Caryota urens	24	2.85	*Bombax ceiba*	12	0.89
Ehretia acuminata	12	0.57	*Uha*	29	3.50

Roadside Vegetation: Excepting for the Syamaganj-Jaria Road, roadsides are generally without trees. Recently, planting has been undertaken on some portions of the Purbadhala-Phulpur Road. All other roadside trees are privately owned. Some roadsides and other degraded and encroached areas have been brought under the people participated afforestation program. Under this programme several exotic species like eucalyptus (*Eucalyptus* sp.) and sonail (*Cassia* sp.) are planted.

Grassland: In the past, the greater Dampara area supported localised tracts of grassland comprised of the grass varieties *chon, ikor*, etc. These were commonly known as *pajubon*, and were favourite hunting spots. The *pajubon* were visited by a variety of game birds in addition to larger game such as deer, tigers and elephants.

Most of the *pajubon* have now been converted to cultivable land. Grasslands are concentrated in the eastern part of the area, notably in the areas surrounding Kusmai, Singadingha, Kuma and Panisana *beels*. They cover a total area of about eight hectares and are used as common grazing land. Some grasses grown in these lands are used commercially for thatching and fencing purposes. Some grasslands are supported on limited areas on the banks of the major rivers in the project area. These riverine grasslands are unique and support specialized fauna and flora.

Fallow land: Fallow lands are areas that are usually left out of crop production due to some physical constraints. These areas provide space for grazing and habitat for several plant and wildlife species.

Terrestrial Fauna

A total of 161 terrestrial species was observed within the project area (see Table E.A.1). Of these, 133 species preferred homestead and open woodland areas while twenty-eight species preferred grass or fallow land habitats.

Amphibian species favour wetlands and the marginal drier areas. Some species, like the kaloula frog (*Kaloula pulchra*), prefer the cool, damp habitat of the bamboo grooves. Like other wildlife species the population dynamics of the amphibian is directly related to habitat alteration and changes in the water regime.

Among the reptiles, the yellow land tortoise (*Indotestudo elongata*) is the only terrestrial chelonian known to occur in the area. This species is very rare and on the verge of extinction. It is included in the *Red Data Book* (IUCN, 1994), the schedules of the *Convention on International Trade in Endangered Species of Flora and Fauna* (CITES) and the Bangladesh Wildlife Act (1973). Among lizards, the monitor lizards (*Varanus bengalensis* & *V. flavescens*) are threatened. Both species are listed on CITES I. Other lizard species, like the garden lizard (*Calotes versicolor*) and the wall lizard (*Gecko gecko*),are also declining.

Changes in the hydrological regime, conversion of land for agricultural purposes, habitat alteration due to development activities and exploitation of wildlife for commercial purposes have all had deleterious effects on populations of local fauna. The resulting ecology has favoured certain species while impairing others. For example, changes due to agricultural expansion have favoured the propagation of rodents that, in turn, has supported an increase in the raptor population, particularly the crested serpent eagle (*Spilornis cheela*). Table E.A.2 lists project area bird species and occurrence.

Among birds dependent on a terrestrial habitat, the most common are the subspecies of drongos and mynas. These species thrive in the altered habitat. Conversely, frugivorous (fruit-eating) birds and grassland-dependant birds (warblers, etc.) are experiencing population decline due to the lack of fruit-bearing trees and grassland habitat.

Commercial exploitation of economically important species like the common otter (*Lutra lutra*), the bengal lizard (*Varanus bengalensis*), the rat snake (*Ptyas mucosus*) and the bull frog (*Rana tigerina*) is widely practiced. Local people, particularly tribal groups, are engaged in the collection of local species. These are either sold locally or transported to Dhaka from where they are shipped overseas.

The negative effects of habitat alteration have had the greatest impact on the mammal population, particularly the large mammals, which have been totally wiped out. The medium and small mammals are struggling to survive. In view of the current situation, a wildlife management plan is desperately needed for the region.

Biodiversity

Several species listed in the IUCN *Red Data Book* (1994) occur within the project area, making the area internationally important in terms of biodiversity conservation. These species include the bengal fox (*Vulpes bengalensis*), the smooth Indian otter (*Lutra perspicillata*), the lesser adjudant stork (*Leptoptilos javanicus*), Pallas's fish eagle (*Haliaeetus leucoryphus*) and the yellow monitor lizard (*Varanus flavescens*).

In addition, other species found within the project area are listed in CITES. Those listed are the common otter (*Lutra lutra*), the peregrine falcon (*Falco peregrinus*), three fresh water turtles (*Aspideretes hurum*, *Kachuga tecta* and *Lissemys punctata*), the monitor lizard (*Varanus bengalensis*), the rat snake (*Ptyas mucosus*), the binocellate cobra (*Naja naja*) and the bull frog (*Rana tigerina*).

E.4.2.2 Freshwater Environment

Wetlands and Types of Aquatic Habitats

Wetlands are a young and dynamic form of landscape. The geographical and temporal extent of wetlands is governed by the timing and duration of inundation or soil saturation events, flow regime, chemical and particulate concentrations and soil characteristics. Wetland conditions range from perennial aquatic lowland to seasonally dry uplands.

The Dampara Project area supports two types of wetlands: permanent and seasonal. Permanent wetlands include rivers, canals, perennial water bodies and fish ponds. Most of the perennial water bodies lie in the eastern area of the project and most of them are in Purbadhala *thana*. The major perennial water bodies are the Kuma, Rajdhala, Pakhla, Doba, and Kusmai *beels*.

Both the seasonal and the perennial *beels* are connected by a network of channels to the Balia and Kalihar rivers which serve as the main supply and drainage route. Human encroachment has reduced this network by encroaching on the banks and impounding the flow. Now, except in the flood season, some wetlands have lost connection to their main channels, notably, the Rajdhala, Padma and Painsa *beels*.

The total area of permanent wetlands is 590 hectares, or 3.84 percent of the project area. Of this area, 120 ha are under fish ponds (1085 in number), 415 ha under rivers and 175 ha under perennial *beels*. Figure 3 shows the perennial wetlands and canal networks inside the project area. Wetland area decreases during the dry season when only the deepest pockets retain water.

Seasonal wetlands are supported on most of the land area. All of the F1, F2 and F3 land areas are the seasonal wetlands. F0 land is above the average flood level. The actual extent of seasonal wetlands varies from year to year depending on flooding intensity. In a 1:2 year average flood depth map, the area under seasonal wetland totals 12,330 ha. Seasonal wetlands are important as feeding areas for fish and other aquatic animals. They provide connections to other wetlands allowing wildlife to migrate in search of food and provide a substratum for some species to lay eggs.

Aquatic Flora

Ecology and plant community: The wetland habitat is characterized by anaerobic conditions, which inhibits normal plant growth. A group of plants known as hydrophytes, adapted to withstand these conditions, colonizes wetland habitats. Length of hydroperiod, soil type and flood tolerance are keys to vegetation development and community dynamics.

Aquatic flora in the Dampara Project area can be divided into communities based on a set of environmental conditions. The communities are as follows:

- submerged plants;
- free-floating plants;

- rooted floating plants;
- sedges and meadows; and
- marginal vegetation.

Of all the wetland plant communities in the project area, the submerged plant community is one of the most prevalent. It is found in both permanent and seasonal wetlands. Almost all these plants are monocotyledons from closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonaceae. These plants begin their growth period with the rise of the water level and persist as long as water is present. The species composition of this community differs between the permanent and the seasonal wetlands. Jhangi (*Hydrilla*), and goisa (*Najas*) are the most common in perennial *beels* while ghechu (*Aponogeton*) and panikola (*Ottelia*) are dominant on the seasonal floodplain.

The free-floating plant community is also very common in the project area. It is abundant in the perennial water bodies with enclosed habitats like the Kuma, Padma and Doba *beels*. Kochuripana (*Eichhornia crassipes*) is the single most dominant species followed by tentulpana (*Salvinia*), kutipana (*Azolla*) and khudipana (*Lemna*). Many fish ponds also support this type of vegetation.

The rooted floating community is a dominant plant type in some wetlands. It is abundant in perennial wetlands and in deeply flooded seasonal wetlands. The short growth period in shallow seasonal wetlands renders them scarce in this habitat. The plant community comprises about fifteen species. Dominant families are Nymphaeaceae and Menyanthaceae. At the species level Nymphaea and Nymphoides are the most abundant and common.

Sedges and meadows are ecotones consisting of amphibian plants. This community has the highest species diversity among all the wetland plant communities and thus, is one of the most important in the project area. The dominant families in this community are Cyperaceae and Gramineae. At the species level, mutha (*Cyperus*), joina (*Fimbristylis*), and chisra (*Scirpus*) are common in all the *beels* as well as on the seasonal floodplains. In some wetlands, dhol kalmi (*Ipomoea fistulosa*) and kechur (*Monochoria hastata*) are also very common. Generally this vegetation type occupies the water margins and moves with water level fluctuations.

Marginal plants are not defined as a community. Rather, they are a composition of both wetland plants and small dry land herbs occupying surrounding saturated soil. The composition of the marginal plants depends on the degree of waterlogging and the flood tolerance of each species. Cyperaceae are the dominant family followed by many other unrelated plant families ranging from Amaranthaceae to Gramineae.

Abundance and distribution: Distribution and relative abundance of wetland plants are largely dependant on the condition and the position of a particular wetland. In the Dampara area wetlands are generally shallow and have very little water remaining in the dry period. These conditions are adverse to abundant plant growth. The physical characteristics of wetlands change with the water regime. This has a direct impact on the flora and fauna that inhabit or depend on the wetlands. The fluctuation or changes in the population dynamics of the biological diversity define the biomass productivity of the wetlands.

The project area can be roughly divided into two sections according to flood depth and the presence of perennial water bodies. In the eastern section, where flood depths are greater and most

of the perennial wetlands are situated, aquatic plants are greater in number and diversity. The most highly diverse aquatic ecosystems are found in the Kuma and Doba *beels*. Both *beels* contain some unique and rare species like padmo (*Nelumbo nucifera*) and makhna (*Eurayle ferox*). Moreover, both of them have a very high percentage of vegetation coverage on their water surface.

In the western portion of the project area, where the land is much higher and very few perennial water bodies exist, water plants have little scope to prosper. Most of these wetlands are used as a source of irrigation water in the winter. This practice destroys the seed beds and inhibits regeneration.

A list of major plant species and their relative distribution is provided in Table E.A.3.

Growing period: Most of the wetland plant species are sensitive to and governed by seasonal water level fluctuations. Most of the channels in the project area are without vegetation in the monsoon. After the recession of the water level, plants begin to surface.

In the permanent *beels* plants can survive and regenerate through the year, though the growth period occurs from May to October only. In seasonally flooded areas, the rhizomes and seeds remain buried under the soil during the dry season and start sprouting with the arrival of water. As water level increases, they multiply and expand their vegetative growth, attaining their highest level just after the peak flood. When the water starts receding most of these plants flower and fruit very quickly, thereby assuring offspring in the next year. Most of these species have rhizomes and can also reproduce vegetatively.

Utilization: Due to the lack of adequate wetland plant products, human use of aquatic plant products remains very low. Wetland plant products are minimally used for food, medicine, fuel, fodder and thatching materials. Wetland plant products, currently used by humans, are grouped as follows:

- starch food
- other vegetables
- fodder and forage
- medicine
- thatching and mat making
- fuel
- fisheries' habitat
- bio-fertilizer

Table-E.A.3 shows the known uses of each species in the project area.

Aquatic Fauna

A total of 104 species of aquatic fauna was observed in the project area. Of these, sixty-eight species are totally dependent on wetlands (*beels*, river, ponds), and thirty-six species are partially dependent on wetlands. The survey also showed a habitat preference for stretches abutting homestead backyards. There are little available aquatic habitats for faunal species. Wetlands are intensively exploited and the habitat is highly disturbed. Despite this, some species have adapted to the altered environment, and others have even flourished.

80

Among the amphibians, the skipper frog (*Rana cyanophlyctis*) is common - being found in most of the wetland habitats - and has been the most successful in adapting to the altered habitat. The common roof turtle (*Kachuga tecta*), the flat-shelled spotted turtle (*Lissemys punctata*) and the peacock soft shell turtle (*Aspideretes hurum*) are the most common of the reptiles. These freshwater turtle species face problems of migration during summer when water levels are inadequate.

The common aquatic snakes include the checkered keelback (*Xenochrophis piscator*) and the smooth water snake (*Enhydris enhydris*). The common lizards found within the project area comprise the common skink (*Mabuya carinata*) and the garden lizard (*Calotes versicolor*). Among other species that once were common but now are only occasionally seen are the monitor lizards (*Varanus bengalensis* and *V. flavescens*). These species prefer a habitat with or near water.

Aquatic and water-dependent birds have been severely affected by habitat alteration. Wetland degradation has left virtually no sheltered place for waterfowl to roost or nest. Common, resident waterfowl like the lesser whistling ducks (*Dendrocygna javanica*) and jacanas (*Metopidius indicus*), have been intensely affected by habitat alteration.

Compared to adjoining eastern parts of the northeast region, migratory waterfowl are scarce. Among the migratory waterfowl, noteworthy are the shoveller (*Anas clypeata*), the northern pintail (*Anas acuta*), the garganey (*Anas querquedula*) and the coot (*Fulica atra*). The waders comprise the Mongolian plover (*Charadrius mongolus*), the grey-headed lapwing (*Vanellus cinereus*) and the golden plover (*Pluvialis fulva*) among others.

Wetland-dependent birds like kingfishers and other birds of prey have little scope for adaptation. Some species (mostly piscivores) have moved to areas more favourable to their needs. The only dominating raptor species is the crested serpent eagle (*Spilornis cheela*). Among the kingfishers, the storkbilled kingfisher (*Pelargopsis capensis*) was not seen though the existing habitat is supposed to support them. It was felt that this species had migrated elsewhere.

There are few aquatic mammals. There is evidence of the presence of the common otter (*Lutra lutra*) but the population is fast-declining. The freshwater dolphin (*Platanista gangetica*) is generally absent from the project area, though a few are seen in the Kangsha during the monsoon season.

E.4.3 Socioeconomic Environment

E.4.3.1 Social Development and Quality of Life

Institutional Considerations

The study area is under the administrative jurisdiction of Netrokona and Mymensingh districts. The largest proportion of the project population is in Purbadhala *thana* of Netrokona district (74%), followed by Phulpur *thana* (26%). *Thana* and district level administration and development programmes are implemented through a team of civil servants and professionals attached to respective departments and line ministries. Among these are:

- Department of Fisheries (DOF)
- Department of Livestock Services (DOL)
- Forest Department

- Department of Agriculture Extension (DAE)
- Directorate of Health and Family Planning
- Department of Education
- Department of Public Health Engineering (DPHE)
- Bangladesh Rural Development Board (BRDB)
- Directorate of Women's Affairs
- Department of Cooperatives
- Directorate of Youth Development
- Local Government Engineering Department (LGED)
- Bangladesh Water Development Board (BWDB)

The BRDB promotes a two-tier cooperative structure: a primary society at the village level and a federation of primary societies at the *thana* level. It promotes cooperative societies mainly among the farmers. Poor men and women, who had until now been covered by the BRDB are now being organized and monitored under the RD-12, another development programme introduced in the eighties.

As well as the administrative structure, there is a local government structure that has largely remained in the shadow due to a lack of necessary political clout and coherence. At the *thana* level, no local government body exists now. Previously there was a *thana parishad* headed by an elected Chair. At the union level, there is the *Union Parishad* (UP) which is the lowest-level local government unit. The UP have limited administrative and financial authority and functions as a window for all development activities implemented by different ministries/ departments. The UP are directly elected by the people and have a tenure of four years.

Bangladesh Water Development Board (BWDB) is the key agency in the water sector. The greater Dampara area is within the jurisdiction of the Netrokona Water Development Division under Mymensingh Circle. The NERP feasibility study on Greater Dampara Water Management Project is under the purview of the Directorate of Planning Schemes-I of BWDB. Its office is located in Dhaka.

There are several national and local NGOs that are active in the study area. They work with a "target group approach," the target audience being men and women belonging to the landless and other poorer strata. Village-based groups are the core of their institution-building process. Among the NGOs, only Caritas has a history of implementing water-management structures. The following NGOs have activities in the study area: Caritas, Grameen Bank, Association for Social Advancement (ASA), Bangladesh Rural Advancement Committee (BRAC) and Association for Socio-Econo-Cultural Advancement (SECCA).

Table 4.7 Land Ownership Pattern

Ownership	Size of holding (ha)	House-holds (%)	Cultivable land owned (%)
Landless	0	34.4	0
Small farmer	<1	43.9	22.2
Medium Farmer	1-3	17.2	45.4
Large farmer	>3	4.5	32.4
Total		100.0	100.0

Source: NERP Household Survey

Demographic and Social Context

The 1991 census calculates the population of greater Dampara to be 112,772. Population increased at an annual rate of 1.54 percent during the 10-year period from 1981 to 1991. The average household size is 5.13. There are 104 males per 100 females.

The extent of landlessness is high; 34 percent of households do not own any cultivable land and another 21 percent own less than 0.2 ha (Table 4.7). Most households are dependent on agriculture or farm labour. Seventy-one percent of farms are small (less than one ha) and 78 percent farms are owner-operated. Wage employment among women is very limited and their wages are lower than those of men. More than two-thirds of the households are indebted.

Public Health and Safety

The local public health infrastructure includes one government health centre-cum-hospital in Purbadhala *thana* headquarters and one Family Welfare Centre (FWC) in each union. The hospital is run by a team of health professionals (seven doctors and three nurses), and the FWC is run by an extension worker known as a Family Welfare Visitor (FWV). Seriously ill patients are referred to Mymensingh Medical College Hospital - about an hour away by road from the *thana* headquarters.

Records of the *thana* hospital show that people suffer mainly from worm infection, diarrhoea and skin diseases. More diarrhoeal patients come to the hospital in the post-monsoon period (October to January).

There are ninety-one persons per public tubewell on average. All people have access to tubewells for drinking water. While all the people drink tubewell water, more than four-fifths of the population use tubewell water for cooking, one-third use it for dish-washing and one-fifth use it for laundry and bathing.

E.4.3.2 Economic Development

Land Use

Current land use patterns in the project area are shown in Table 4.8. These figures are based on NERP's 1995 full-scale land use survey. The information was recorded in the field on 164 sheets of *mauza* maps at a scale of 1:3960.

Table 4.8: Current Land Use

Land Use	Area in ha	% of total area
Net cultivated land	12525	84
Homesteads	470	3
Ponds	120	1
Agro-forestry and homestead plantation	810	5
Infrastructure	485	3
Channel	415	3
Beel	175	1
Total	15000	100

The overwhelming majority of the land is used in agricultural production. Crop field vegetation extends over 12,525 hectares or 83.5 percent of the project area. Most of the agricultural land is used for rice monoculture.

Agriculture

The present cropping patterns according to land type and crop production have been furnished in detail in Annex B. As compiled from the land use survey, total cropped area is 24,424 ha, and the present cropping intensity is

195 percent. Rice dominates crop farming, accounting for over 95 percent of the cropped area (Table 4.9). Rape and mustard oilseeds are the major non-rice crops occupying less than 3 percent of the cropped area.

Rice is grown in a multitude of environments, representing five ecosystems. These are rain-fed upland (b. *aus*), rain-fed or partially irrigated (t. *aus*), deepwater (b. *aman*), rain-fed lowland (t. *aman*) and irrigated (*boro*). T. *aman* is the major crop in terms of area under rice. The crop is grown in the monsoon season and covers 44.9 percent of the total cropped area. *Boro* or winter rice occupies 44.1 percent of the total cropped area and *aus* or pre-monsoon rice occupies 6.3 percent. Deepwater *aman,* which is sown in the pre-monsoon season and harvested with t. *aman*, accounts for 0.3 percent of the total cropped area.

Both high yielding varieties (HYV) and local varieties of the three rice crops are cultivated. The HYVs account for 73 percent of the *boro* area, 32 percent of the t. *aman* area, and 11 percent of the *aus* area. The use of HYV predominates in the *boro* crop due to the decreased threat of flood.

Table 4.9: Area of Major Crops

Crop	Cropped area (ha)	% of total cropped area
Rice	23 359	95.6
Wheat	164	0.7
Jute	21	0.1
Oilseeds	666	2.7
Other	214	0.9
Total	24 424	100

Farmers practice sole-stand cropping for the major crops, and a system of mixed cropping for vegetable cultivation. Agricultural production technology is almost exclusively based on manual labour. The country plough, ladder, rake, hoe and sickle are the most important and sometimes the only agricultural tools. Exceptions are tube wells for irrigation and power sprayers for pesticides and fungicides.

Inputs: *Boro* rice is completely dependant on irrigation. Irrigation is also used for the *aus* crop in upland conditions. In the transplanted *aman* area, limited supplemental irrigation has been reported in drought years. Among the non-rice crops, wheat, oilseeds, vegetables and spices are partially irrigated in the dry season.

Seeds come from a variety of sources. Usually farmers save seeds from the harvested crop and sometimes exchange seeds with others. Seeds of HYVs or improved varieties are available at *thana* BADC seed centres. The centres distribute mainly rice and wheat seeds. However, jute, potato, rape, mustard, mung and other vegetable seeds are also available. The total amount of HYVs and improved seeds distributed to the farmers is reportedly lower than the average requirement for the cultivation of most crops.

Fertilisers are used mainly on the HYV rice crop. Nitrogen, derived largely from urea, is the most common and widely-used nutrient. Phosphate is second to nitrogen in frequency and total volume of use. The most widely consumed phosphate fertilizer is TSP. Potash is the third most widely used nutrient, and MP is the only source of potash. Other fertilizers include ASP, SSP, zinc sulphate and gypsum.

Pesticides are mainly applied on HYV rice; they are rarely used on local rice varieties. Mainly granular varieties of pesticides are used in the project area. Other pesticides include conventional pest complex, acaricide, fungicide and rodenticide.

Rape and mustard are the major non-rice crops. The crop accounts for 2.7 percent of the total cropped area. The other major non-rice crops, such as wheat, occupy 0.9 percent of the total cropped area, jute 0.1 percent and vegetables and spices 0.9 percent. A small area is used for the production of other non-rice crops.

Livestock

There are no available figures on production or value of livestock in the project area. Livestock are kept mainly by women. There are some grasslands in the eastern part of the project area used for common grazing land. In times of flood fodder becomes scarce or unavailable and space to keep the animals is at a premium. Area residents are often compelled to sell livestock at depressed prices.

Open Water Fisheries

Many good *beels* and migratory routes like the Kalihar and Balia channels have made the study area a rich open water fishery. There are twenty seasonal and ten perineal *beels* in the study area. Rajdhola, Kuma, Paniana, Pakhla, Singa Singa, Atla, Dudhgara, Dangai, Padma and Kanigang are perineal *beels* (Figure 3), though a few of these have very limited water areas in dry season. Only 0.1 percent of the area remains under water during the dry season. The open water fishery is limited during this time.

More than 71 percent of the floodplain is inundated in the wet season. There are 6000 ha of very shallowly flooded land, 3179 ha of shallowly flooded, 2250 ha of medium flooded and 681 ha of deeply flooded land in the project area. In the wet season the shallow floodplains and paddy fields are very productive. Plankton, nekton, benthos and other aquatic organisms are abundant in these areas. Because of this abundant food supply, small fishes, fry and fingerlings of larger fishes, are also abundant. Floodplain residents breed in the inundated floodplain. About 95 out of 155 species (see Table E.A.4) found in northeast region were observed within the study area. Several species are uncommon and some are becoming rare.

Fish population and species diversity are directly related to the hydrological cycle. During the pre-monsoon smaller fish start their migration toward the shallow floodplain from adjacent perineal wetlands like the Doba, Pakhla and Paniana *beels* and the Kangsha River. Riverine fish species migrate to *beels* and the floodplain just after wetlands get water connection. The main migratory routes are the Kalihar and Balia channels. Kangsha bank overspills have a major influence on fish recruitment and breeding in this area.

Though production varies depending on water depth, total annual open water fish production of the Dampara area is 446 metric tons. There are twenty-eight fish markets in the study area, 1212 fisher households and three fishers' societies. Annual sales from fish markets total 500 tons and annual consumption is 592 tons.

Settlements

The greater Dampara project includes ninety-two *mauza* and covers parts of twenty-two other *mauza*. The settlements in the Dampara are quite old. Along the Kangsha River settlements are quite dense thinning into the centre of the area.

According to a survey undertaken in May 1995, there are 516 households with homestead land located between the Kangsha River and the proposed dyke alignment on the section from Naterkona to Bisradpur (for Netrokona, the existing UP dyke has been considered as the

alignment; otherwise, the number of households would be more). The total amount of homestead area owned by these households is about 35 ha. It has been found that of those who possess a homestead outside the dyke alignment, 29 percent are landless (own no cultivable land), another 10 percent have cultivable land only outside the dyke alignment. Forty-eight percent possess cultivable land both outside and inside the dyke alignment and the rest, 13 percent, possess cultivable land only inside the dyke alignment (see Table 4.10).

Table 4.10: Land Ownership Status of Households Having Homestead Outside the Dyke

	HH	Home-stead area	Agricultural land ownership							
			Only inside the dyke		Only outside the dyke		Both sides			Landless house-holds
			HH	Area	HH	Area	HH	Area (inside)	Area (Outside)	
Khatuair	19	2.16			2	0.88	12	36.00	11.04	
Gangerbera	24	2.72			5	0.52	18	16.67	4.52	1
Letirkanda	118	16.52	26	75.34	22	9.14	46	106.33	36.31	24
Sonaikanda	19	2.09	5	8.28	2	0.58	3	1.82	1.06	9
Kapasia	15	3.04					15	40.04	6.41	
Giriasha	60	6.87	10	11.82	2	1.10	31	59.06	8.17	17
Ghagra	72	7.07	10	8.20	2	0.32	20	12.63	7.89	40
Bainja	7	1.20			6	6.00	1	0.25	0.50	
Roghurampur	15	2.45					15	14.42	3.78	
Dampara	24	4.38	4	14.00	4	2.97	12	7.81	6.29	4
Purbopathera	37	8.81	2	3.50	4	0.60	15	35.21	12.86	16
Pathera	25	12.11	3	5.45			20	37.68	15.11	2
Kashimala	27	7.62	1	1.00	1	0.50	20	55.00	19.85	5
Projapotkhila	7	1.03	2	0.80			2	2.50	0.26	3
Moheshpatti	5	1.11					3	3.00	0.82	2
Bisharadpur	17	5.50			2	0.50	12	17.30	13.85	3
Total	516	85.80	67	129.67	52	23.11	247	448.34	150.66	150
% (HH)	100		13		10		48			29

Note: land areas are in acres

Industries

There are some industries located in the market places. The biggest industrial unit in the area is the *Jagorani Biri Factory* (Table 4.11). This is located in Purbadhala *thana* and employs 105 workers. Other industrial units are operated on a smaller scale. Among these are a rice mill with a paved platform (for parboiling, drying and husking), an ice plant, a saw mill (for timber), an oil mill, etc. There is only one operational handloom in the area. There are a few bakeries and rice-husking mills (for husking of rice and crushing of wheat) in the market places.

Only male labourers are engaged in these units, except in rice mills where female labourers are engaged for the parboiling and drying of rice. The production of household utilities with bamboo and cane, *kantha* making, net making, etc., are all homestead-based activities. While kantha is made by women only, other activities are done by both women and men. Boat-building is performed by individual carpenters on contract basis.

Table 4.11: Industry in Dampara

Industry type	Location	Number
Biri Factory	Purbadhala	1
Rice mill	Purbadhala	2
Ice plant	Jaria	1
	Purbadhala	2
Saw mill	Purbadhala	1
	Jaria	3
Oil mill	Purbadhala	1
Handloom	Hogla	1

Infrastructure

Road, rail and drainage infrastructure is shown in Figure 3.

Road Infrastructure: There are about 12.0 km of metalled and 76.0 km of unmetalled motorable roads in the project area in addition to many kilometres of village roads.

Almost all the motorable roads run north-south leading either to Phulpur or Purbadhala, the two *thana* centres of the area. All these roads were constructed under Food for Works Programme. Now the Local Government Engineering Department (LGED) is taking over some roads for further development. The LGED has a programme to connect all the growth centres of the area by metalled roads. Details of the road infrastructure are given in Table 4.12.

Table 4.12: Road Infrastructure

Name of Road	Type	Length			Culvert	Res. Agency
		From	To	km		
Purbadhala-Jaria	Metalled	Purbadhala	Jaria	12.	4	R & H
Subtotal	**Metalled**			**12.**	4	
Purbadhala-Phulpur	Unmetalled	Purbadhala	Phulpur	30.	16	LGED
Purbadhala-Ghagra	Unmetalled	Kaldura	Ghagra	11.	3	UP
Purbadhala-Guatala	Unmetalled	Hogla	Guatala	10.	2	LGED
Jaria-Ghagra	Unmetalled	Jaria	Ghagra	11.	-	UP
Phulpur-Guatala	Unmetalled	Baola	Guatala	6.0	2	LGED
Phulpur-Bilasati	Unmetalled	Balia	Bilasati	4.5	3	UP
Phulpur-N.Patti	Unmetalled	J.Pur	N.Patti	3.5	2	UP
Subtotal	**Unmetalled**			**76.**	**28**	

Railway: In the project area, there are nine kilometres of metre gauge railway line between Purbadhala and Jaria with six railway bridges. It is a part of Mymensingh-Shymganj-Jaria section of railway line, the north terminal point being at Jaria. Before road development, it was the only route in the northern area for the transport of passengers and cargo. Even to-day, it is the dependable route especially during floods when the Purbadhala- Jaria Road is cut or breached. All incoming and outgoing country boats that connect the different growth centres of the area with Jaria coordinate their schedule with the trains' arrivals and departures.

Existing Drainage Infrastructure: In the project area, there are two existing drainage regulators: one of 5 vents on Kalihar Nadi at its outfall at Khatuair, and one of 10 vents on Balia Nadi at its outfall at Chorerbhita.

In the neighbouring Kangsha Project, there are seven regulators at different locations. Particulars of regulators in both projects are given in Table 4.13. The vent size of all regulators is 1.52 m x 1.83 m.

Table 4.13: Existing Drainage Regulators

Regulator	Channel	Location	Vent	Invert Level (m, PWD)
Dampara Water Management Project				
R-1	Kalihar	Khatuair	5	5.13
R-2	Balia	Chorerbhita	10	4.27
Kangsha River Project				
D-1	Lauri	Trimohoni	4	4.27
D-2	Lauri	Pachh	3	4.57
D-3	Lauri	Singa beel	3	4.57
D-4	Lauri	Saidpur	3	4.27
D-5	Balua Khali	Pukhira	1	4.88
D-6	Balua Khali	Dighjan	1	4.88
D-7	Balua Khali	Kamalpur	1	5.18

Navigation

Navigation is seasonally and geographically limited within the project area. Of the three main drainage channels, there is water transportation in only the Kalihar Khal during the monsoon season (late June to October).

Balia Khal runs over low lands and *beels*. The homesteads are far from this channel making it difficult to reach and unattractive for navigation. Dhalai Khal flows over high land. Road development using low bridges has rendered this channel non-navigable.

Kalihar Khal connects the project's interior with Jaria and Jhanjail, situated across the Kangsha River from one another. Jhanjail is an important market, operating on Saturdays and Wednesdays. Jaria is a landing centre with a railway terminus and road connection with Netrokona and Mymensingh.

During the monsoon season two mechanized boats ply this channel on market days (Saturday and Wednesday) and one boat on non-market days. They travel between Jaria-Jhanjail and the project area with passengers and merchandise. Non-mechanized country boats also ply this channel. Non-mechanized boats carry mainly cargo to and from the project area. The findings of the NERP 1995 boat traffic survey on this route are given in Table 4.14.

Table 4.14: Estimated Annual Traffic Through Kalihar Channel

Inflow				Outflow			
Boats		Traffic		Boats		Traffic	
NMB	MB	Cargo (ton)	Passengers	NMB	MB	Cargo (ton)	Passengers
843	193	280	8000	713	193	780	7400

The main water transportation in the area takes place on the Kangsha River that borders the project area on the north. This transport route is also seasonal. People living on or near the banks of this river use the waterway extensively. Jaria, Jhanjail, Kapasia, Gagra, Porakandulia and Goatala are some growth centres situated on the banks of the river. A NERP 1995 field survey revealed that fertilizers, petroleum, oils, lubricants, cement, mild steel rods and other manufactured goods are imported to this region from Bhairab Bazaar, Ashuganj, Narayanganj, etc. and items like paddy, timber, oilseed, etc. are exported from this area on mechanized boats. Estimated volume of the export and import traffic is 10,560 tons.

E.5. ENVIRONMENTAL IMPACT ASSESSMENT

E.5.1 Assessment Methodology

The assessment methodology suggested in the FAP-16 EIA Manual (April 1995) was followed with some adaptations to match the specific set of conditions in the Dampara Water Management Project. Important environmental components (IECs) were identified through the process described under scoping (section E.5.1.1.). The impact of each set of activities during pre-construction, construction, operation and maintenance phases on different environmental components was assessed. The following aspects were considered while assessing the extent of impacts of these activities on individual IECs:

- value of the IEC in terms of rarity, economic value, importance for health, etc.
- magnitude of change (low to high)
- scale of the change (site specific, local, regional, national)
- frequency of occurrence
- duration (short, mid- or long-term)
- reversibility (through mitigation or natural processes)
- probability (unlikely, likely, unavoidable).

E.5.1.1 Scoping

A scoping process was carried out to identify the important environmental issues to arise from the project and the important environmental components (IECs). The IECs and related environmental issues were evaluated in terms of distribution, quantity, quality, seasonality and socioeconomic and/or ecological importance.

Scoping was carried out during two work sessions involving individuals from different technical disciplines related to the Dampara Project. The first session attempted to identify the various environmental components that would be affected by the project and the related issues. These issues are related to various aspects of the project including the stage of project development.

Initially a matrix was used to identify impacts and an attempt was made at rating and scoring. The matrix proved deficient, however, in respect to the multiplicity of components, the various stages of implementation, the IECs and the nature of the related impacts. As stated before, there is a concentration of impacts associated with the standing embankment. The matrix underemphasised these aspects and overemphasised impacts related to the project phases.

A scoring methodology was used for the matrix. Attempts to simplify the environmental impacts, however, inevitably allow significant levels of subjectivity to enter the process. Eventually a trade-off between biodiversity and the social environment was agreed upon.

There is little of the Dampara area that has not been significantly altered by human activity. As population increases and pressure on the existing system of production grows, biodiversity will decrease regardless of interventions. Further conversion of wetland habitat to agriculture is just one example. If the social impacts are not adequately accounted for, all other aspects of the environment will suffer.

Though the impacts associated with pre-construction and construction phases are temporary and, generally, minor, there is significant latitude for enhancement measures. Because of the capital inflow into the project area at this time, there is opportunity to deliver some project benefits to the landless and women of the area. Because of these considerations, the two stages are addressed more thoroughly in section E.8 - the environmental management plan (EMP).

The IECs identified for the Dampara Project are as follows:

- groundwater quantity
- surface water quality
- soil quality
- open water fish production
- wetland production
- agricultural production - crop field
- agricultural production - agro-forestry and homesteads
- culture fisheries
- public health
- social harmony
- homestead and public infrastructure
- security and reliability
- neighbouring development projects
- women's opportunities
- employment
- lifestyle
- navigation

The major impacts identified through the scoping exercise include:

- improved agricultural production
- loss of open water fishery
- reduction in biodiversity
- changes in lifestyle for fishers
- social conflict between those inside project and those outside
- loss of property and livelihood
- improved culture fishery
- social conflict between fishers and farmers
- increased security and reliability
- employment opportunities gained and lost
- protection of homesteads and infrastructure
- sanitation improvement
- nutritional changes (improvement for some but reduction for others)
- psychological stress reduction

E.5.1.2 Bounding

Physical Bounding

For purposes of the EIA, the physical boundary of the study area is extended north of the river to the extent of the additional flood waters, because of the effects of the embankment (Figure 1).

The south and west boundaries are defined by the extent to which land would be relieved of flooding because of the embankment. The eastern boundary extends to the eastern limit of the Thakurakona project area. The boundary extends this far to take into account the positive effects that the project will have on both the Kangsha Project and the Thakurakona Project.

Temporal Bounding
In consideration that the positive effects of the project and the impacts on river morphology would conceivably last for the predicted lifespan (30 years) of the Project, the temporal boundary was set at thirty years after the completion of the embankment.

E.5.2 Quantification of Impacts

In the following sub-sections, Project impacts have been quantified and tabulated where possible. Project impacts are also described qualitatively and is given in the Appendix (Table E.A.4).

E.5.2.1 Impacts Associated with the Physical-Chemical Environment

Groundwater Quantity **(-)** Groundwater recharge will be negatively affected by the reduced flood depth in the project area. This could potentially lower the water table and affect water availability for irrigation and domestic uses. To quantify the impact, WARPO, at NERP's request, ran its Recharge Model run using 1988 hydrological conditions. The projected recharge reduction was 6 percent. The output is given in Table 5.1.

Table 5.1: Recharge under 1988 Hydrological Conditions With and Without Project

Project	Recharge (mm)												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
Without	3	1	1	11	74	112	137	137	137	121	60	24	818
With	2	1	1	11	74	112	121	129	132	118	47	18	766

After project implementation, the available groundwater will be 86.2 Mm^3. The demand for groundwater is approximately 73.0 Mm^3, thus even with reduced recharge rates, the groundwater supply will be sufficient to meet the foreseeable demand of the area.

However, area residents rely solely on groundwater for domestic purposes. The No. 6 suction mode hand tubewells are widely used for withdrawal of groundwater for that purpose. These hand pumps cannot operate beyond 7.0 m of suction head. The reduced recharge of groundwater and subsequent lowering of the water table will put many hand tubewells out of operation.

Surface Water Quality **(-)** Floodwater from rain and water that will occasionally overtop the embankment, will be confined by the embankment especially if drainage regulators are not operated and maintained properly. This can cause stagnation which could lead to public health problems and endanger aquatic species. Proper operation and maintenance of the regulators will help reduce the impact on the quality of surface water, particularly in terms of stagnation.

***Soil Quality*(-)** The free flow of river water over the floodplain contributes to soil quality in many ways. It flushes harmful chemical build up, deposits silt and provides a habitat for fish and other life forms that ultimately contribute to the organic enrichment of the topsoil. The embankment will stop these processes and may, over the long term, affect the capability of the soil.

E.5.2.2 Impacts Associated with the Biological Environment

Open Water Fish Production **(-)** Ninety-five of a total of 155 fish species (see Table E.A.4) found in the Northeast region are observed in the Dampara project area. Several of these species are uncommon. The fishery development of the area is dependent on several seasonal factors on the floodplain: unimpeded migratory routes, sufficient water depths, and aquatic vegetation for food and shelter.

Table 5.2 : Floodplain Fisheries Production

Habitat	Flood Depth (m)	Without Project			With Project		
		Product'n (kg/ha)	Area (ha)	Product'n (tons)	Product'n (kg/ha)	Area (ha)	Product'n (tons)
Flood-plain	0-.3	10	6000	60	10	9000	90
	.3-.9	29	3179	92	29	1042	30
	.9-1.8	107	2250	241	107	603	65
	>1.8	44	681	30	44	487	21
Subtotal			12110	423		11132	206
Drainage Channel		104	220	23	85	220	19
Total			12330	446		11352	**225**

The embankment will restrict migration and recruitment of fish from the Kangsha River into the Dampara area. Reduced floodwater will disrupt the connections between *beels*, and some *beels* will become isolated. This, combined with the general reduction in flooding and wetland habitat will reduce the number of fish and it is possible that the total number of species will also decline. It is projected that the open water fishery production will suffer a reduction of 221 tons/year (Table 5.2).

It is not known to what extent migration from the Kangsha River will be restricted. There is no indication as to which species, if any, would be lost from the area. This is a highly significant potential impact. In the project's monitoring phase floodplain species composition should be monitored carefully to determine the necessary project adjustment.

Wetland Production **(-)** A study of the wetlands in the Northeast region showed that there were no wetlands of either international or national importance within the project area. The area has no *haors*, but is characterized by a large floodplain that is seasonally inundated and contains many *beels* that are locally important for their economic and biodiversity values.

As the hydrological regime of the area changes and habitats become less varied, the area's biodiversity will be weakened. There is no mitigation for wetlands lost because of the reduction of floodwater. A tradeoff for flood protection will be made with the alteration and loss of wetlands, and the subsequent loss of wetland-dependent wildlife species.

The seasonal wetlands provide the basis for the fisheries production of the area. Wetland vegetation provides important shelter for many migrating fish species. Diminished flood waters will also encourage more rice cultivation that will reduce the regeneration of wetland vegetation. The project will affect the seasonal wetlands by reducing water surface area. Winter wetland area will decrease by 8 percent from 860 ha to 787 ha and summer wetland area will decline by 30 percent from 2048 ha to 1438 ha.

The permanent wetland vegetation of the project area is currently in a highly degraded state. Approximately five hectares of perennial wetland areas will be eliminated even without project due to expansion of cultivation in the low areas. Significant changes could develop in the depths of the *beels* due to reduction of flooding. The permanent *beels* in the Dampara area are already very shallow; further reduction in water depths will render the area uninhabitable for many aquatic flora and fauna.

The wetlands of the Dampara area provide a habitat for at least 104 wildlife species, several of which are in the IUCN *Red Data Book* and others listed with CITES. Habitat reduction could greatly affect wetland species that are sensitive to hydrological changes. In some instances species can probably adapt to drier conditions and to conditions of increased human activity. It is not known to what extent different species, individual populations and wildlife communities as a whole, will be affected, but some rare species like padmo (*Nelumbo nucifera*) and makhna (*Eurayle ferox*) will likely be lost.

E.5.2.3 Impacts Associated with the Socioeconomic Environment

Agricultural Production - crop field **(-)** In total, twenty-five ha of crop land will be taken for embankment construction. The production loss has been considered when estimating benefits from the project interventions for these lands.

It is estimated that 77 ha of land will be converted to pond cultivation. This conversion may only be partially attributed to the establishment of the embankment. At least some pond development would be a normal occurrence as land owners realize greater profits from culture fishery relative to those from agricultural production. Total rice production equivalent losses represented by these lands would be 380 metric tons per year.

Agricultural Production - crop field **(+)** The project will reduce floodwater and protect 12,292 ha of crop land (FW) from flood damage. This will yield 8,848 metric tons of rice crops per year. Farmers who normally may avoid establishing crops during the monsoon due to the high risk of flood damage will now be encouraged to establish crops, thus increasing the total area under crop production. As well, wetlands that have been drained will be cultivated. This will increase non-rice production (mainly mustard), yielding 1,315 metric tons/year. The net economic benefit to the farmers will be Tk 38.7 million per year (Table 5.3).

Table 5.3: Annual Crop Production and Economic Benefit

Item	Unit	Present	FWO	FW	Net Increment	
					(FW-FWO)	Adjusted [1]
Rice production	tonne	68,300	67,260	77,200	9940	8848
Wheat production	tonne	330	440	463	23	21
Non-cereal production	tonne	2680	3,110	4560	1450	1294
Net economic benefit	mtk	117	117	150	43.50	38.70

[1] see Annex D for detail

Agricultural Production - agro-forestry and homesteads **(-)** According to NERP's 1995 land use survey, there are 200 ha of land under homestead plantation and 30 ha under agro-forestry in the flood prone area. Twenty-six hectares of this land will be appropriated for embankment construction. The result will be that twenty-four hectares of homestead plantation and two hectares of agro-forestry land will be lost.

Agricultural Production - agro-forestry and homesteads **(+)** The project will have substantial positive impacts on homestead plantation and agro-forestry by offering increased security against flooding. About 98 percent of homestead trees are vulnerable to flood damage. Because of this flood sensitivity, people are reluctant to plant saplings in their homesteads. Increased flood protection is predicted to result in increased tree plantation.

In the flooded zone, the estimated present annual production per hectare of homestead lands and agro-forestry is Tk. 100,000 and Tk. 152,000 respectively. A survey in the project's non-flooded area reveals that annual production from the same categories of land is Tk. 130,000 and 170,000 respectively. Despite the loss of production from 26 ha of homestead lands, the net benefit from project development will be Tk. 3.1million (Table 5.4). The net economic output will be Tk. 2.35 million per year (see Annex D).

Table 5.4: Homestead Plantation and Agro-Forestry

	Scenario	Area (ha)	Production (Tk.000/ha)	Total Production (MTK)	FW-FWO (MTK)
Homestead Plantation	FWO	200	100	20	2.9
	FW	176	130	22.9	
Agro-Forestry	FWO	30	152	4.6	0.2
	FW	28	170	4.8	
Total					3.1

The embankment will eliminate the threat to livestock and forage during flooding and will allow livestock owners to maintain animals to maturity and sell when market conditions are favourable. Flood protection may encourage a general increase in livestock production. Livestock protection, increased production and favourable marketing conditions will improve household incomes.

Open Water Fisheries (-) At present more than 80 percent of the area's fish production comes from area's floodplain. The floodplain fishery is an important socioeconomic environmental component because of the many professional and subsistence fishers that depend on it for survival. It is expected that many fishers will lose their lifestyle and that the nutritional levels of families of subsistence fishers will drop.

Wetland production (-) The annual economic productivity of the wetland areas has been estimated at Tk. 300 per hectare. Therefore the total annual economic loss of wetland productivity will be Tk. 0.20 million (Table 5.5).

Table 5.5: Wetland Production

Category	Scenario	Area (ha)	Production (Tk. 000/ha)	Total Production (MTK)	FW-FWO (MTK)
Winter Wetland	FWO	860	0.300	0.26	(-) 0.02
	FW	787	0.300	0.24	
Summer Wetland	FWO	2048	0.300	0.61	(-) 0.18
	FW	1438	0.300	0.43	
Total					(-) 0.20

Culture Fisheries (+) At present there are 120 ha of pond in the project area. Eighty-five hectares are in flood-free areas and the remaining 35 ha are flood-prone. Project interventions will allow the flood-prone fish ponds to achieve full production.

A secondary effect on culture fisheries will be an increase in land suitable for pond development and culture fish production. It is predicted that an increase of 60 ha of ponds will be developed over a ten-year period and this will represent a total increase in fish production of 41 tons/year. In the FWO scenario, it was estimated that 15 ha would be converted to pond for fish culture in the non-flooded area, therefore the project will cause new ponds to be dug in an additional area of 45 ha. The existing ponds (35 ha) in the flood-prone area will gain full production by year three and new ponds (45 ha) will be developed and achieve full production within thirteen years after project development.

In some ways the development of culture fisheries will compensate for the reduction in open water fisheries. However, with the open fishery where the production is available to the poor, culture fish production belongs to the land owner and the produce is sold in the marketplace. Moreover, compared to the species diversity of open water fisheries, culture fisheries tend to focus on a few economic species.

Public Health-sanitation (+) The state of sanitation will improve with flood protection. Presently, most people do not build pit latrines because of the expense lost during the flood. Under improved conditions, water-seal pit latrines would be easy to maintain. After homestead protection, women will have fewer problems fetching water even during the flood season. Thus, the use of tube-well water for all domestic purposes will be increased. Diarrhoeal and other waterborne diseases are generally more prevalent during times of flood. Flood control will provide easy access to both

latrines and potable water and will decrease the incidence of waterborne disease.

Table 5.6: Floodplain and Pond Fish Availability (per yr) over Project Life

Project Life	Floodplain Fishery Product'n and Benefit				Pond Fishery Product'n and Benefit			
	FWO	FW	Net Increase	Net eco.output	FWO	FW	Net product'n	Net Eco-output
year	ton	ton	ton	mtk	ton	ton	ton	mtk
1	433	433	0	0	105	105	0	0
3	408	207	(-) 201	(-) 7.2	108	114	6	0.4
10	329	168	(-) 161	(-) 5.7	118	152	34	1.1
13	301	153	(-) 148	(-) 5.2	118	171	53	1.6
20	243	124	(-) 119	(-) 4.1	118	171	53	1.6
30	179	91	(-) 88	(-) 2.8	118	171	53	1.6
Av./yr	288	161	(-) 134	(-) 4.7	115	156	41	1.2

Public Health-sanitation **(-)** The degeneration in surface water quality due to drainage problems from the embankment could lead to an increase in vector-borne diseases such as malaria and encephalitis.

Public Health - nutrition (+) With flood protection, homesteads are protected and homegardens, which provide the family with a variety of vegetables, will no longer be inundated. Homegardens could expand providing families with a greater variety and quantity of food.

Public Health - nutrition **(-)** Fish is the major source of animal protein for the rural poor and their health could deteriorate because of the loss to the open water fishery. Production increases from the culture fishery will not be available to the poor, and will not replace the free-access commodity of the open fishery.

Social Harmony **(-)** There are three potential sources of social discord regarding the embankment. The first may come from those on the river side of the embankment, the second from those on the left side of the river and the third may occur between fishers and farmers over the operation of the drainage regulators.

From Netrokona to Bisharadpur, an estimated 516 households are presently living between the proposed embankment alignment and the Kangsha River right bank. Their total homestead area is 35.14 ha. This includes a mosque and a graveyard on 0.81 ha of land in Kapasia village. Many people living in these villages have no land in the project area. They will not be benefitted from the project and may resist the building of the embankment. They may believe they will be disadvantaged by its presence. Though water levels will only rise by 5 cm (10 cm in the 1:20 year flood years), the disparity between the two areas during times of flooding will be obvious. Resistance may emerge as construction disruption, embankment breaching, political interference, and physical skirmishes. Education on the effect of the embankment, and a fair resettlement and

compensation for damage due to homesteads and crops because of additional flood waters, will lessen the possibility of conflict.

The water level will rise in the left bank area by five centimetres and ten centimetres respectively for 2-yr and 20-yr flooding conditions. This rise will not change the cropping pattern of that area. But during flood time, left bank people will observe a difference - in their side there is flooding and on the opposite bank there is cropping. This may lead to resentment and become an object of social contention between the people of two banks.

There are conflicting interests between farmers and fishers over the use of water resources especially during the monsoon season. According to the project concept, the regulator gates will remain open until the end of June to allow fish to migrate from the Kangsha River. Those who are dependent on the fishery for at least part of their livelihood, may attempt to break the embankment or keep the regulators open to ensure the maintenance of the fish habitat. Farmers may want to keep the gates closed so that they can cultivate *aus* crops in the lower lands. Thus, a conflict between fishers and farmers could develop.

Social Harmony **(+)** The people of the Dampara Project area cut open the Kangsha Project's western embankment when they are flooded. This becomes an object of contention between the residents of the two areas. The project embankment will close the source of flooding in the Dampara area and, as a result, social conflict between the Dampara residents and the Kangsha residents will be alleviated.

Homestead and Public Infrastructure (+) Homestead and public infrastructure will be protected from flood damage. One of the benefits of flood protection is direct: the reduction of costs involved in rebuilding and repairing after recession of flood waters. The project will protect 12,400 households and benefit 65,000 people. The direct benefit as estimated from damage control up to a 1:20 year flood situation is Tk. 1.95 million per year. The estimate is made from a damage frequency curve and the mathematical expectation of annual flood damage based on the data collected from the project area (see Annex D: Economics).

The indirect benefits include the reduction of human suffering, inconvenience and improvement in the quality of life for women by allowing them to pursue home-based activities with more security. Such activities as homestead gardening, livestock keeping post-harvest processing, bamboo and cane product-making, net-making, quilt-making and daily chores will be eased by flood protection. Women from the poorer stratum are likely to benefit more from platform protection since the economic significance of the homestead is higher among the poor. Transportation networks will be protected allowing the movement of goods and people throughout the area in all seasons.

Security, Reliability and Psychological Stress **(+)** With a significant reduction in flood frequency and levels, farmers and others will feel more secure and their investment reliability will be higher. Psychological stress related to crop losses, debts and money lending will be reduced.

Neighbouring Development Projects **(+)** Increased security for the Dampara area residents will increase the security of the neighbouring projects described in section E.1.2. This, in turn, will lead to increased crop production and the other benefits of the project being extended to the neighbouring projects.

Women's opportunities **(+)** The project will simplify the role of women in several ways. Firstly, the project will generate many jobs, at least some of which will be available to women. The income will allow women to make investments and become more self reliant, thus increasing self esteem. Secondly, flood protection will encourage and allow more home-based income generating activities (IGAs) for women, in turn permitting women to be more economically independent. Thirdly, the alleviation of flooding will ease the personal and economic burden of caring for themselves, their home and their families during the monsoons.

Employment **(-)** Employment and income loss will come from two sources: floodplain fisheries and wetland products. The floodplain fishery production loss will reduce fishery employment by 127,000 person-days per year (Table 5.7). This will affect mainly the professional fishers who have no other skills. Most fishing is carried out by part time fishers who also farm or work as farm labourers. Their income will be significantly affected and since many are subsistence fishers, they will be required to seek alternate sources of income for their survival. With a smaller resource to share some will abandon fishing and look for other sources of income.

Wetlands provide the raw materials for many IGAs. People gather starch food, vegetables, fodder and forage, medicine, thatching and mat-making materials, fuel and bait from wetland areas. These common property resources are important to the poor who depend on income and food from wetland products. Generally, fodder and building materials are collected by men and food and medicinal materials are collected by women. The employment impact would be a loss of 1300 person days per year based on the assumption that harvesting of wetland products require two person days/ha/yr.

Employment **(+)** Reduced flooding will provide several job opportunities in the culture fisheries and the agricultural sectors. Direct job opportunities will result in increased socioeconomic benefits to families and communities. Increased pond fish production will create 4,000 person-days per year. Considering that 127,000 person days will be lost from the open water fisheries there will still be a net loss of 121,000 person days in the fisheries' sector.

The project will generate 340,000 person-days of new employment for agricultural labourers (Table 5.7). Woman labourers who work in harvesting and post-processing activities will also benefit from increased employment opportunities. In Bangladesh woman make up 9 to 16 percent of the total agricultural labour. Assuming that woman will share 10 percent of the increased employment, the project will generate 34,000 person-days for woman in the agriculture sector.

Table 5.7: Employment

Sector	Present ('000 pd/yr)	FWO ('000 pd/yr)	FW ('000 pd/yr)	Net Increment ('000 pd/yr)	
				(FW-FWO)	Adjusted [1]
Agriculture Labour	3074	3028	3407	379	340
Fisheries - Floodplain - Pond	446 12	288 13	161 17	-127 4	-127 4
Wetland	5.8	5.8	4.5	-1.3	-1.3

[1] see Annex D for details

Note: NERP field survey finds that, on an average, one man can catch one kg of fish in the floodplain and 9 kg in the pond in a day.

Lifestyle (-) Many fishers dependent on the open water fishery will lose their lifestyle.

Navigation **(-)** Within the Dampara Project area navigation is seasonal and very limited. Only in the Kalihar Channel is navigation possible. The project interventions entail the closure of this channel at its outfall at Khatuair.

The closure will require the transhipment of cargo across the drainage structure. The 1995 NERP boat traffic survey indicated that the inflow and outflow of cargo through this route totals about 1060 tons. Calculated at a rate of Tk. 25/ton, the transhipment cost is estimated at Tk. 26,500 annually. This cost has been treated as project's disbenefits.

E.5.3 Impacts Affecting the Boundary Regions

An additional area of 300 ha on the north side of the river will be inundated by the 10 cm rise of flood level (in the 1:20 year flood) because of the embankment. As well, an area of 35.14 ha between the embankment and the river will be subjected to this additional flooding. The exact impact of the additional flood water on agricultural activities and production is unknown, but they are not expected to be of any significance.

The Kangsha Project, covering an area of 11,000 ha east of the Dampara Project, was developed by the BWDB in 1990. Before project development, this area was a floodway for the Dampara Project area. The embankment that now blocks the floodway is regularly cut during the monsoon by the now-flooded Dampara residents. Once the Kangsha Project is flooded, people of that area cut open the Netrokona-Baroari Road, (the common embankment of the Kangsha and Thakurakona Projects) leading to the flooding and damaging of crops of that project.

Since the proposed project interventions will protect the Dampara Project area from flooding, the cutting of the Kangsha and Thakurakona Projects' embankments will cease. The gross area of these two projects is 14,200 ha. Though not quantified, crop production and employment benefits in proportion to those in the Dampara Project will be derived from these two areas.

E.5.4 Information Deficiencies and Requirements

Biodiversity

Studies should be carried out to determine the species composition of the migratory populations and the species that are likely to migrate via the regulators. Reference should be made to the effects of similar embankments on other fisheries in the country. Through monitoring it can be determined which species enter the floodplain and the *beels* and, if any are denied this access. Fisheries and water management could mitigate this impact by ensuring that regulators are operated on a schedule that would favour migration of the species of concern.

Monitoring of the wetland wildlife populations, their composition and dynamics, will provide a clearer picture of the effects that the flood reduction will have on wildlife species, particularly those indicated above on the Red Book list and CITES list.

Groundwater

Though the effects of reduced groundwater recharge are expected to be minimal, the number of HTWs that will be rendered inoperative is unknown. A study should be done to learn how widespread the effects of the 6 percent recharge reduction will be on the domestic water supply.

E.6. CUMULATIVE IMPACTS

E.6.1 Cumulative Impact Assessment Methodology

Cumulative impacts result from actions that are added to others of the past, present and the future, caused by multiple human activities and/or natural events that are either repeated or occur in combination.

Information on past as well as present activities going in and around the proposed project area were obtained from different sources. In respect of activities upstream across the border in India, data gaps had to be filled under certain assumptions. Cumulative impacts were assessed by integrating the impact of project interventions along with the impact of these other activities.

E.6.2 Potential Non-project Impacts Combined with Project Impacts

E.6.2.1 Regional Impacts

The only significant cumulative impact for the area is the loss of open water fish habitat and production. The Kangsha project area and the Thakurakona area to the east are protected from floods. Presumably these areas once had larger open water fisheries. The Dampara project further reduces the region's open water fish habitat and production. The reduction of the Dampara open water fishery adds to the continual loss of this important fishery of Bangladesh. In addition, the wetland biodiversity of the country is increasingly weakened through the continuous development of flood control structures.

E.6.2.2 Worldwide Climate Change

Increasing trends in rainfall over the past thirty years have led to worsening flood conditions. It is not known whether these trends are an indication of a permanent, anthropomorphic, world-wide climate change or part of a large-scale natural trend.

E.6.2.3 Upper Riparian Activities

Continued deforestation in the watershed regions especially in the Meghalaya hill regions will lead to increasing flooding in the downstream reaches.

E.6.2.4 Others

The quantification of individual impacts often diverts attention from the larger picture. Flood mitigation structures focus on solving symptoms of greater and more global problems. As such they cannot be perceived as a complete solution, merely a temporary measure to avert suffering. If appropriate measures are not implemented, measures that will solve the initial problems, the suffering is merely delayed.

Population growth

A significant environmental problem in Bangladesh is population growth. The embankment will increase the capacity of the production system to feed more people. The most significant factors

affecting the birth rate are levels of urbanisation, level of education of women and the degree to which women work out of the house. The Dampara area has none of these in its favour. Thus, one cumulative result of the project could be an increase in population growth.

Increased risk

Increased security will result in further development of the floodplain. In fact, the intent of the project is to encourage this aspect. Infrastructural and other developments on the floodplain will therefore be further exposed to risk in case of embankment failure, embankment cutting or unusually severe flooding conditions.

Increased use of biocides

It is predicted that the embankment will encourage farmers to invest more heavily in crop production. Ultimately this will lead to the cultivation of more HYV crops in the area. Increased use of pesticides required by the HYV crops could lead to pesticides leaching into and contaminating surface and groundwater systems.

Crop biodiversity

There is a concern that with the increase in HYV rice cultivation, local varieties will eventually disappear from the area thus removing a valuable germplasm that could have certain qualities required later.

E.7. PROJECT SCOPING AND THE CONSULTATION PROCESS

E.7.1 Public Consultation

E.7.1.1 Public Meetings with Local Residents

Within the framework of NERP, a public consultation process was initiated with an explicit objective to ensure people's participation right from the planning stage of the project. More specifically, this was aimed at improving the study taking into account opinions from the people of the impacted area. While undertaking household surveys, knowledgeable persons and community leaders were identified and contacted. They were invited by NERP to voice their opinions about water-related problems of the area and possible solutions.

Two such meetings were held, one at Ghagra on 4 August 1994 and another at Shadhupara on 27 November 1994. The Ghagra meeting was attended by ninety-nine persons from twelve villages belonging to two unions. The Shadhupara meeting was attended by sixty-two persons from nine villages belonging to five unions (see Table 7.1).

Separate meetings were arranged for the community representatives to disseminate the project idea and to get their opinion on project-related issues and problems. Chairs and Members from concerned *Union Parishads* (UP) attended these meetings. Two such meetings were held. One meeting took place at Jaria on 5 August 1994 attended by fourteen community leaders from Jaria and Ghagra unions. The other meeting was held at Shadhupara on 25 November 1994 attended by twenty-six community leaders from Hogla, Agia, Purbadhala, Balia and Baola unions.

Proceedings of all four meetings have been prepared by NERP in *Bangla* and were distributed among the people who attended these meetings.

E.7.1.2 Meetings with Special Interest Groups and NGOs

Formal and informal meeting with different groups were held with the primary objective to understand the peoples' perceptions regarding relevant issues. Discussion mainly centred around problems of the area and suggested solutions.

One meeting was held at Netrokona in February 1995 attended by eighty people representing different socioeconomic strata. The main issue discussed was the dyke alignment along the right bank of the Kangsha river and its likely impact on the local people, particularly those who would be left outside the dyke.

After the fixation of the tentative dyke alignment, attempts were made to consult the people having homestead land outside the proposed alignment. Group discussions were held in seventeen villages along the proposed dyke alignment from Netrokona to Bisradpur (see Table 7.2). The main purpose of these talks was to learn the nature and extent of impact because of the construction of a dyke, and to have an understanding about issues related to safety and maintenance of the dyke.

Table 7.1: Attendance in Public Meetings

Meeting place	Persons attended			
	Village	Male	Female	Total
Ghagra	Ghagra	18	0	8
	Sankiduari	11	1	12
	Giriasha	10	2	12
	Letirkanda	10	4	14
	Khatuair	12	0	12
	Netrokona	9	14	23
	Jaria	0	1	1
	Chandraghona	1	0	1
	Tutia	2	0	2
	Kapasia	2	0	2
	Sonaikanda	1	0	1
	Khuilajuri	1	0	1
	Sub-total	77	22	99
Shadhupara	Purbo Moudam	17	0	17
	Kharchail	3	4	7
	Chuchaura	12	0	12
	Birampur	2	0	2
	Kalihar	11	3	14
	Hatdhala	3	0	3
	Purbadhala	1	0	1
	Meghshimul	4	0	4
	Agia	2	0	2
	Sub-total	55	7	62

Separate meetings with groups of poor and landless women were arranged in Netrokona, Purbo Moudam and Letirkanda to know about their situation, livelihood pattern and survival strategies, as well as their status in the existing social milieu.

A meeting with the *Jaria Nadi Nitimala Samity* was held at Gujakhalikanda on 17 October 1994. The meeting was attended by twenty-five members of the *samity*. Discussion centred around the impact of the Kangsha River Project on fish resources in the *Jaria Nadi* and the functioning of the *samity*.

Table 7.2: Public Consultation Along the Dyke Alignment

Village	Para	Total households in these para/village	Households outside dyke alignment	Persons consulte d
Netrokona	Noluapara, Charpara, Majhpara	433	?	10
Khatuair	Purbopara, Madhyapara	73	19	5
Gangerbera		83	24	11
Letirkanda	Majhpara	63	55	6
	Purbopara	103	38	7
	Poshchimpara	40	25	4
Sonaikanda		135	19	11
Kapasia	Uttarpara	56	16	8
Giriasha	Uttarpara	81	60	10
Ghagra	Kulupara, Rajpara, Dhobapara	144	36	9
	Purbopara	37	16	9
	Charpara	200	20	5
Bainja		140	7	8
Roghurampur	Charpara	15	15	3
Dampara	Purbopara	75	24	8
Purbopathera		150	37	7
Pathera		215	20	7
Kashimala		50	27	12
Projapotkhila		28	7	7
Mhoheshpatti		95	5	5
Boratia		42		11
Bisradpur		73	17	6
Netrokona				60

A meeting with the members of fishers' community was arranged in Barha village on 16 February 1995. Discussions were held on possible impact of flood control infrastructure on fish resources and migration of fish.

Meetings were also held with local staff members of NGOs having activities in the project area. Among these NGOs are ASA, SECCA, Caritas and Grameen Bank. Talks with senior management staff of Caritas and ASA were held in Dhaka. Information on their on-going activities and process of community organization was sought from these NGOs. Only Caritas is involved in dyke construction on an *ad hoc* basis if there are requests from the community.

E.7.1.3 Summary of concerns

Water-related problems and issues, as described by those who attended these meetings are summarized as follows:

(a) Problems and issues:

- Flood water comes suddenly from the hills;
- Flood water affects *aman* crops;
- In the dry season, there is scarcity of water for irrigation, and for drinking. The *khals* and rivers dry up. *Boro* fields are affected. Boat transportation is disrupted;
- Rivers have been silted up. These cannot drain much water. As a result, flood water spills the banks during the monsoon;
- Floods damage houses, homestead gardens and trees;
- Cooking, keeping poultry and livestock becomes extremely difficult;
- If the tube well goes under water or becomes inoperative, the sufferings of women are multiplied;
- One area is benefitted by the embankment, while another area on the other side suffers;
- Drainage regulators are not effective;
- Flood water now stays longer than before as the drainage is obstructed by roads and embankments, particularly by the Syamaganj-Jaria road-cum-embankment;
- People cut the embankment to save their houses and crops;
- Fish resources have declined after the construction of a drainage regulator at Chorerbhita and the closure on the *Jaria Nadi*;
- The incidence of fish disease has increased due to the deterioration of water quality as a result of the use of agro-chemicals by farmers.

(b) Suggested measures:

- The rivers that are silted up should be re-excavated to help irrigation;
- Expansion of the Kalihar drainage regulator is needed;
- A flood protection embankment should be constructed along the right bank of the Kangsha;
- The Kangsha, the Atrakhali, the Shibganj Dhala and the old Someswari should be re-excavated;
- An embankment along the left bank of the Kangsha is needed to protect the area in the north, so that the people of that area would not oppose the idea of an embankment along the right bank;
- Necessary measures should be taken against river erosion;
- The embankment should be built nearer to the bank so that displacement effects could be

minimal;

- Ring culverts should be constructed so that high embankments do not hamper the use of LLPs;
- Those who will lose their land should be compensated;
- Instead of making an embankment, the mouth of the Shibganj Dhala should be closed;

E.8. ENVIRONMENTAL MANAGEMENT PLAN

E.8.1 Introduction

The purpose of this environmental management plan (EMP) is to provide specific action plans that will be carried out during development and operational phases of the project to manage the impacts as discussed in Chapter E.5 so as to reduce their affects to an acceptable level and make the project environmentally friendly. The plan also includes project monitoring that is necessary to ascertain whether measures taken for reducing the impacts are adequate and also to see whether there occurs any other unanticipated impact. An enhancement programme has also been included in this plan to increase the benefits of the positive impacts resulting from project development. The management plan includes the following four work packages or components:

- Environmental Protection Plan
- Contingency (Disaster Management) Plan
- Environmental Enhancement Plan
- Monitoring Plan

Each component has been further divided into elements. The Work Breakdown Structure diagram is shown in Exhibit 8-1. The effects of some impacts will be reduced in part by mitigation and in part through compensation. To show the total measures taken for those impacts, the compensation plan, a component of the environmental management plan, is addressed with the mitigation measures under environmental protection plan. (The mitigation measures are elements of the environmental protection plan).

Implementation of the environmental management plan linking the different agencies to implement the plan is outlined in Section E.8.6. Training and technical assistance needs are also addressed in that section. The final two sections of this chapter relate to residual impacts and EMP costing.

E.8.2 Environmental Protection Plan

The environmental protection plan includes a specific mitigation plan that will be executed to prevent deterioration of the environment by the project intervention. Compensation, where possible, will also be provided to the affected people. Responsibilities of various agencies have also been assigned to implement the mitigation and compensation plans. The protection plan is described below by project phase (pre-construction, construction and operation-maintenance):

E.8.2.1 Pre-construction

The activity which has the most significant impact in the pre-construction phase is the selection of embankment alignment and acquisition of land for embankment construction as the affected people will likely resent the project.

a) Impact: Social Stress and Conflict Arising from Land Acquisition

Social stress and conflicts are anticipated from the affected landowners during the land acquisition process. The extent of the land required for the embankment could conceivably involve the participation of hundreds of landowners, thus increasing dramatically the risks of conflict.

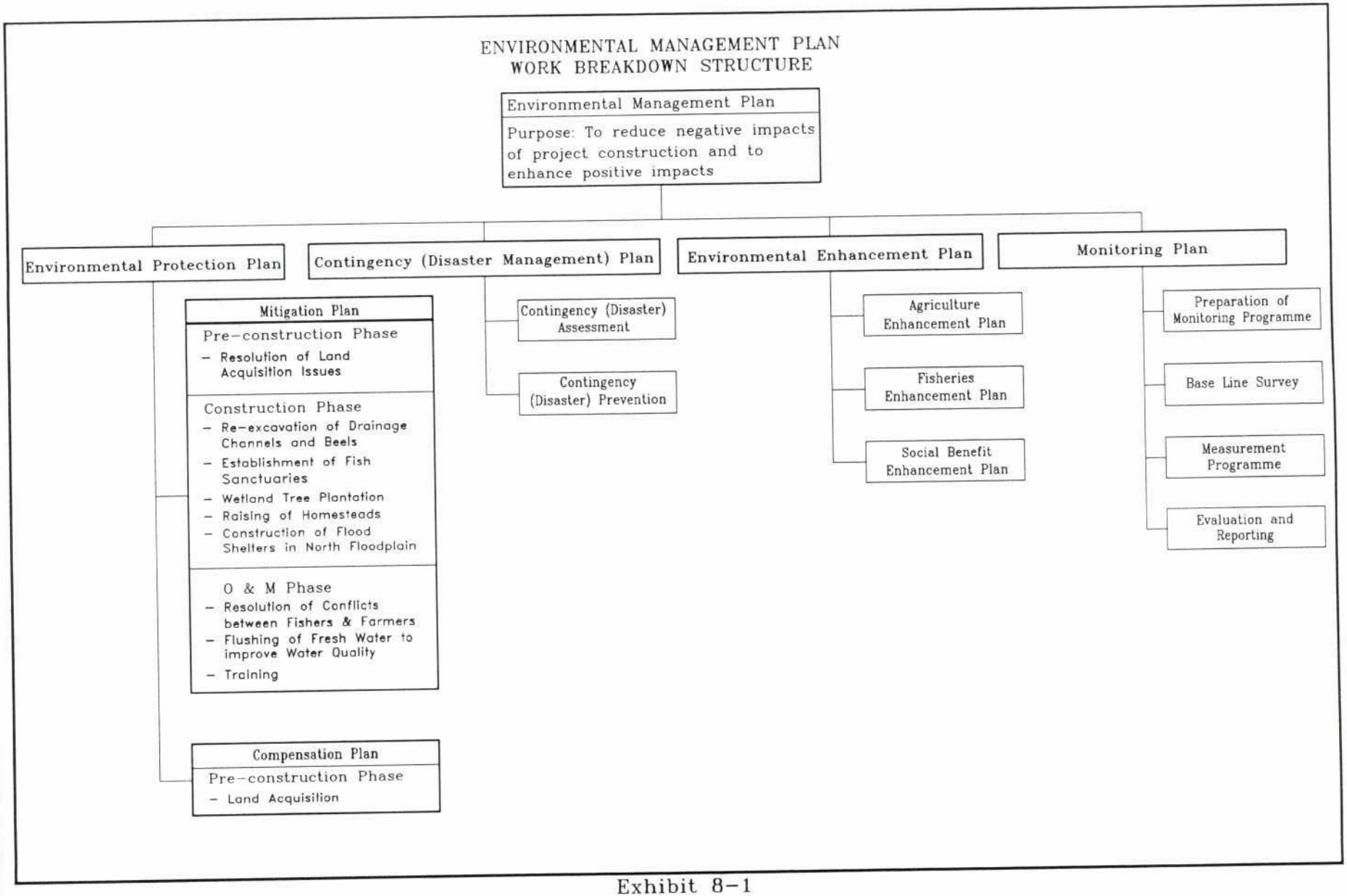

ENVIRONMENTAL MANAGEMENT PLAN
WORK BREAKDOWN STRUCTURE
Environmental Management Plan
Purpose: To reduce negative impacts of project construction and to enhance positive impacts
Environmental Protection Plan
Contingency (Disaster Management) Plan
Environmental Enhancement Plan
Monitoring Plan
Mitigation Plan
Pre-construction Phase
- Resolution of Land Acquisition Issues
Construction Phase
- Re-excavation of Drainage Channels and Beels
- Establishment of Fish Sanctuaries
- Wetland Tree Plantation
- Raising of Homesteads
- Construction of Flood Shelters in North Floodplain
O & M Phase
- Resolution of Conflicts between Fishers & Farmers
- Flushing of Fresh Water to improve Water Quality
- Training
Compensation Plan
Pre-construction Phase
- Land Acquisition
Contingency (Disaster) Assessment
Contingency (Disaster) Prevention
Agriculture Enhancement Plan
Fisheries Enhancement Plan
Social Benefit Enhancement Plan
Preparation of Monitoring Programme
Base Line Survey
Measurement Programme
Evaluation and Reporting

Exhibit 8-1

Mitigation: Community participation will be ensured in the selection of final embankment alignment, as well as adequate compensation for land and its timely payment. This will ease the land acquisition process.

No land will be acquired for borrow areas, thus limiting land acquisition to the minimum required for the embankment. Earth for embankment construction will be purchased from the landowners.

Compensation: Landowners will be provided with a choice of compensation packages including cash value for land, alternate land elsewhere or a combination of cash and land. Each landowner will receive land that will be equivalent in value to the land being expropriated and/or cash in hand that reflects the current market value of the land. Payment will be made in one instalment immediately upon signing by the landowners.

Responsibility: BWDB will be responsible for acquiring land for project implementation. The Consultant will organize the formation of an embankment committee (see Section E.8.6) who will work with the community to select the final embankment alignment with BWDB and the Consultant.

The PCC (see Section E.8.6) will ensure adequate compensation to the affected landowners in cash or land. The earthwork contractor will be responsible to purchase earth for embankment construction by paying royalties to the interested landowners. BWDB and the Consultant will check the suitability of earth.

b) Impact: Loss of Livelihood due to Land Acquisition

After the land is acquired, although some people will have enough land to continue farming, some poor farmers who are mainly dependent on the acquired land for their livelihood will suffer. Even some families may have to take compensation and leave farming all together.

Compensation: Though yet unidentified, it is not unlikely that a few hectares of poor farmers' lands will be acquired. The following compensation measures will be taken:

- allocate nearby *khas* land to the affected persons;
- if not enough *khas* land is available, purchase some on behalf of the affected families;
- employ the affected families in project's construction and O&M activities; and,
- lease the embankment land to these families.

Responsibility: The Embankment Committee will identify the poor affected families. It will try to exchange the poor person's acquired land with land from rich farmers through consultation. The PCC will try to allocate *khas* land (if available nearby) to the affected families. BWDB will give them priority for employment in the project construction works. The embankment committee who is supposed to be responsible for project's O&M will lease them the embankment land for home gardens, grazing or tree plantation and employ them in the project's O&M works.

92

E.8.2.2 Construction

The impacts such as *loss of agricultural production in the borrow pit area* and *conflicts between outside labourers and local labourers* occurring during construction phase are fairly minor and temporary and are not dealt with in the EIA due to their low scoring during the screening exercise. It is expected that adequate measures will be taken during project construction to reduce or eliminate these impacts.

The most significant impacts will occur during the operational phase of the project. However, most of the mitigation measures are to be taken during the construction phase to make the project environmentally friendly.

a) Impact: Reduced Groundwater Recharge due to Reduced Flooding

Mitigation: Though the present analysis shows that the recharge will still exceed groundwater withdrawal, it is to be noted that all recharge estimates are approximate. An essential component for a more refined evaluation of the resource is a comprehensive system of groundwater monitoring.

Groundwater levels are currently monitored in three places in the project area. This monitoring will continue after project construction. If groundwater resources show signs of stress, the following mitigation measures will be adopted:

- flush in river water to the project area to the extent that standing t. *aman* crops for whose protection the project is mainly developed is not damaged. This measure will not only increase the recharge but will also help fisheries, wetland resources and water quality within the project area;

- motivate farmers to diversify crops from rice to suitable non-rice crops that require less irrigation water and consequently withdraw less groundwater.

Responsibility: BWDB is currently monitoring groundwater levels at three places in the project area and will continue to do so in the future also.

b) Impact: Domestic Water Hand Tube Wells Rendered Inoperative

Due to reduced groundwater recharge, the groundwater level will likely go down rendering domestic water hand tube wells inoperative.

Mitigation: The standard HTWs which will run dry will be replaced with forced mode Tara pumps that can operate up to 15 m of head. Already DPHE replaced more than 400 HTWs with Tara pumps in the area.

Responsibility: The quantification in terms of number and location of the hand tube wells that will be affected specifically by the project interventions will require a full scale groundwater study. Due to this information deficiency, this project cannot implement the mitigation measures and thus considers it as a negative impact in the project evaluation. (It is to be noted that DPHE has been replacing the inoperative HTWs).

c) Impact: Reduction in Floodplain Fisheries Production

Losses to floodplain fisheries production and fisheries employment can be mitigated to some extent through increased intensive culture fisheries. But culture fisheries cannot compensate for the nutritional intake of occasional fishers and cannot maintain fish biodiversity or fishers' incomes. It is therefore suggested that floodplain fisheries be maintained and enhanced as much as possible.

Mitigation: Since the crucial time for migration and recruitment is in the April-June period, the project is designed to keep the floodplain open to the Kangsha and other boundary rivers and to allow flooding during the pre-monsoon season (see project concept in the main report). This operational program will significantly reduce the impact of the embankment on open water fisheries.

The main reason for reduction of the fisheries production is reduction in water surface area and change in habitat. One way to mitigate this loss is to increase the fish population density in the remaining water area. In this context, this project intends to increase the population density by taking the following measures:

1. Re-excavate Selected *Beels* to Develop Fish Sanctuaries

Fish production in the area is poor largely due to the absence of overwintering grounds. Area *beels* are naturally shallow; the practice of draining the *beels* to catch the remaining fish destroys the recruitment cycle.

Under the project, five *beels* will be re-excavated to develop overwintering grounds. The fish stock in these *beels* will help natural recruitment, increase floodplain fish production and fish biodiversity. The five *beels* are Paniana, Kharchail, Kuma, Doba and Dudhgara Beels (Figure 3). They have been chosen based on the following criteria:

- availability of *khas* land (government land);
- good connection with two main drainage channels - Kalihar and Balia;
- cluster of *beels* around the selected *beels*.

The developed *beels* will be declared as sanctuaries. Currently, there is no *beel* sanctuary in the Kangsha Basin. This initiative will act as a pilot scheme to prove the effectiveness of this intervention for the enhancement of the fishery resources in the project area.

2. Re-excavate Internal Channels

Many *beels* have been cut-off from the major fish migratory routes (Kalihar and Balia channels) due to the siltation of connecting channels. Some channels identified during a field reconnaissance survey were the Atla, Kanigang and Koityakhalir *khals* in the Kalihar Basin and the Chankhali, Bishkakoni and Nowgaon *khals* in the Balia Basin (Figure 3). Under the project, these connecting channels will be cleaned to facilitate fishes to migrate and graze in the floodplains.

3. Declare River and Drainage Channels as Fish Sanctuaries

The project is largely dependent upon the Kangsha River for fish recruitment into the project area. The only two migratory routes between the project and the Kangsha are the Kalihar and Balia Channels.

Under the project, the Kangsha River reach from Jaria to Ghagra and three kilometres of both the Kalihar and Balia channels upstream of their outfall will be declared as fish sanctuaries. This measure will help increase broodstock survival in the Kangsha River and will facilitate migration to the project's floodplain for breeding and grazing.

4. New Fisheries Management Policy

The application of a new fisheries management policy formulated by Department of Fisheries will protect fish stocks and provide a livelihood for fishers with limited resources. The policy proposes a set of twelve strategies and measures to achieve these objectives. Very important to the floodplain fisheries of the Dampara area are the followings:

- Biological management of *jalmohals* by providing fishing rights to genuine fishers and gradually replacing the existing leasing system;
- Community-based integrated development approach for artisan fisheries with improvements in technology, processing, marketing and distribution facilities;
- Formulation and application of a well-defined land and water policy to avoid wasteful resource conflicts, and
- Effective measures against the dumping of industrial and other wastes into the open water system and the use of agricultural biocides having long residual effects.

Responsibility

Beels and Internal Channel Re-excavation. The Consultant will organize a 'Beel and Drainage Channel Management Committee' (see Section E.8.6). BWDB will work with this Committee to re-excavate the selected beels and channels. The work will be carried out as per specifications to be provided by the Department of Fisheries. The contract will be given to the LCS. The Beel and Drainage Committee will ensure that no one will catch fish in the excavated *beels*.

Fish Sanctuaries. Fish sanctuaries established for the above-mentioned Kangsha River and Kalihar and Balia Channel reaches will be guarded by the fisheries community and will be monitored by the Department of Fisheries. Such fish sanctuary exist in the Updakhali River near to the proposed site and is reported to be functioning well.

New Fisheries Management Policy. The implementation of a 'New Fisheries Management Policy' is the responsibility of the Department of Fisheries.

d) Impact: Reduction in Wetland Production

Project interventions will reduce the depth of flooding and areal extent of inundation and impact the wetland dependent flora and fauna directly.

Mitigation: Per hectare plant production will be enhanced by planting wetland based commercial plants such as *Murta* (Clinogyne Diohotoma) and wetland trees and by protecting the planted areas from grazing and premature cutting. Limitations on the cutting of plant materials to replacement levels will be achieved through public education. Thus, under the project, a non-formal education programme will be conducted for the public in the field of conservation.

The re-excavation of *beels* and channels in connection with fisheries mitigation measures will also help to improve wetland production.

Responsibility: The consultant will organize the 'Beel and Drainage Channel Management Committee' to implement the mitigation measures through landless people dependent on this resource. The Committee will also be entrusted to manage the property. The consultant will arrange non-formal education for the public in the field of conservation.

e) Impact: Social Conflict

Project implementation is expected to generate the following three types of conflicts:

1. Conflict between those left outside the embankment (living between Kangsha River and the project embankment) and project residents;

2. Conflict between people living on the north floodplain (on the other bank of the Kangsha River and opposite to the project) and project residents; and,

3. Conflict between fishers and farmers. (This will be resolved in the O&M phase and as such has been addressed under O&M in Section E.8.2.3).

1. Conflict between those left outside the embankment and project residents: Although the "outsiders" may not experience worse flood situations than they have previously suffered, the disparity between them and those living inside the embanked area during times of flooding will be obvious, especially when their homesteads are under water. Those who have no land in the protected area will resent this non-equitable state of affair. The safety of the embankment is the key to the success of this project and its safety depends largely upon these people who will be living alongside it.

Mitigation: The community, including those outside the embankment, will be involved in the selection of the final embankment alignment. This measure will promote understanding of the final alignment and mitigate negative feelings about being left out. Moreover, those "outsiders" who have no lands in the project area will be given benefits by way of raising their homesteads, thus integrating them with the project development.

As surveyed by NERP and given in Annex C, about 29 percent of households having homestead outside the dyke alignment do not possess any agricultural land. Another ten percent of these households have all their agricultural land outside the dyke alignment. Thus the project will not

benefit 39 percent of these households. To bring them under the project umbrella, their homestead areas will be raised above the 20-yr flood level with project funds.

Responsibility: Consultants will work with the Embankment Committee to identify the beneficiaries of this component. BWDB will implement the work through LCS.

2. Conflict between people living on the north floodplain and project residents: Though the project embankment will not alter the cropping patterns on the northern floodplain, during flood time, people from that area will observe a difference - there is flooding on their side and on the opposite bank there will be cropping. This may become an object of social contention between the people of two banks.

Mitigation: To reduce sufferings of the north floodplain people during flood time, this project will upgrade ten schools located in the worst flood affected areas to be used as flood shelters. Poor People will be trained in income generating activities like fish culture in cages. Also people living on the north floodplain will be made aware that Dampara Project construction will not bring about any significant hydrological change in their area.

Responsibility: The Embankment Committee, in consultation with the people of the north floodplain area will select ten schools which are flooded annually. BWDB in consultation with the Ministry of Education will upgrade and raise the schools' plinths above the 20-yr flood level.

The Consultant will organize training for cage fish culture. Poor people living along the banks of the Kangsha River will be given training for cage culture in the flowing water of the River. The Embankment Committee will arrange consultation meetings in that area and will try to impress upon the north floodplain people that the Dampara Project construction will have little impact on flooding in their area.

E.8.2.3 Operation and Maintenance

Most of the impacts that will occur in the operation and maintenance phase will be mitigated in the project's construction phase (Section E.8.2.2). However, during the O&M phase, the main issue will be potential conflicts between different user groups over resource management.

a) Impact: Conflict Between Fishers and Farmers

It is anticipated that there will be conflicts between fishers and farmers over the use of water resources especially in the early monsoon when the regulator gates will remain open to allow fish migration to the project area. Farmers may want to close the gates to expand *aus* cultivation in the low areas and fishers may want the gates to remain open for more fish migration.

Mitigation: The Regulator Committee (see Section E.8.6) formed from both farmers' and fishers' communities will operate project's regulator gates according to the needs of both the communities.

Responsibility: The consultant will organize the committee to be elected from both fishers' and farmers' communities. The consultant will also prepare a regulator operating manual and train the committee members on operation of the regulators according to the needs of both the communities.

b) Impact: Stagnation of Water Trapped by Embankment (Water Quality)

While the embankment will be in operation, rain water will stagnate within the project area causing problems to public health and endangering aquatic species.

Mitigation: When needed, water will be flushed into the project area through the regulators to clear out stagnant water.

Responsibility: The consultant will train the Regulator Committee to monitor the surface water quality in the project area and to operate regulators properly to flush in river water.

E.8.3 Contingency (Disaster Management) Plan

E.8.3.1 Contingency (Disaster) Assessment

Because of the nature of the project, the scope of potential disasters is limited. The potential for disaster rests largely on embankment failure, social clashes, construction-site accidents and, to a lesser extent, regulator break-down.

Embankment failure may be caused by faulty construction, poor maintenance or public cuts. Failure of the embankment will likely result in the loss of benefits generated by the project. The building of the embankment will enhance the perception of security on the floodplain. Once the embankment is in place, it is anticipated that more investment will be put in the protected area and development will take place. Thus, an embankment failure will have far greater consequences than current flooding.

Social discord may result in clashes during the construction period or public cuts after completion. During the pre-construction and construction phases, material, equipment and other resources will be brought into the project area. The level of stress experienced by the communities will increase. Existing conflicts among villagers can be exacerbated under these conditions. There is also the potential of causing new conflicts through misunderstandings between the community, the contractors, the labourers and other agencies.

At any construction site there is also the potential for accidents. Though there are no substantial hazards associated with manual excavation and earth moving, work-place safety should be addressed.

It is likely that during the life of the project the regulators will fail. Depending on the season and the nature of the malfunction, it may be disastrous for the protected area. For example, it is possible that a gate fails when the river is in spate. Inundation of the project area may result from such a failure. Minor gate failures may result in reduced flushing or prevent fish migration.

E.8.3.2 Contingency (Disaster) Prevention

The possibility of embankment failure can be reduced in several ways. It is vital that contractors follow proper engineering guidelines, it is therefore important, to monitor construction activities to ensure proper compaction of earthworks and grading. Adherence to maintenance guidelines is also important to ensure proper operation of the regulators and to prevent embankment failure. The structure should be checked regularly for repairs. This will ultimately be the responsibility

of the Regulator Committee, but external monitoring of the maintenance programme should take place for at least two years after construction.

Prevention of embankment failure due to human actions such as cutting by "outsiders" or people living on the other side of the river are more difficult to prevent. There are many variables involved in such actions, most of which will not be under the control of the executing agency. The provision of flood-protected housing for "outsiders" will help in this matter. In addition, monitoring the response of "outsiders" during and after the first few monsoon seasons will prove important in evaluating the likelihood of future action by them.

Social discord will be mitigated through several measures. During the pre-construction phase, community organization including the participation of the community in alignment design, education programmes regarding decisions taken and the compensation plan will promote community acceptance of the project. Measures for mitigating potential conflicts during the construction phase have been dealt with under section E.8.2.

Contractors, with the assistance of the Consultant, will be responsible for providing a work-site safety programme to prevent work-related accidents.

E.8.4 Environmental Enhancement Plan

E.8.4.1 Agriculture Enhancement Programme

After the construction of FCD interventions, the project plans to implement the following activities to further increase agricultural production:

- development and organization of a special training programme to farmers related to selection of crops and cropping patterns, crop production and management practices, and new/improved technology which will be best suited to the improved agro-hydraulic conditions;
- information exchange between farmers and the project implementation agency on drainage patterns, irrigation water supply and water management;
- establishment of demonstration, multi-location testing and pilot production programme to motivate farmers to adopt new cropping patterns and new crop varieties;
- special training to extension workers on changed agro-hydrologic conditions brought about by FCD interventions;
- guidance on the efficient use of agricultural inputs including fertilizers, manures, pesticides and irrigation water for sustainable agricultural production with emphasis on integrated pest management (IPM);
- creation of local farmers' groups and associations which will assist in timely identification of farmers' needs, constraints to agricultural production, transfer of information and technology and water management; and,
- establishment of strong linkage between farmers, extension workers and other agencies

providing support services in the project area.

Responsibilities: The Directorate of Agricultural Extension (DAE) will be responsible for implementing the plan. The extension workers under the guidance of thana level supervisors will consult the progressive farmers, local leaders, NGOs and other concerned agencies to organize extension activities, identify demonstration sites and establish a demonstration farm and provide training to the selected farmers. The Consultant will coordinate the programme.

E.8.4.2 Fisheries Enhancement programme

As DANIDA has been working with the Department of Fisheries to increase fish production in the area's ponds, the project will limit its activities to increase fish production in the area's open waters only.

The main objective of the open water fishery enhancement plan is to diversify fishery activities and reduce dependence on traditional floodplain fishery resources. There is increasing pressure on these resources due to the increase of landless people. The project will implement the following enhancement programmes to increase fish production, generate employment for poor people and increase their incomes:

a) Shallow Floodplain Aquaculture

Many areas of the floodplain are shallowly flooded and remain inundated for three to four months of the year. These shallowly flooded areas are very rich in plankton and benthos but their productivity for fisheries is relatively low (only 10 kg/ha) due to long migration routes, obstruction by roads and other problems. To increase the fish productivity in the shallow floodplains, the project will implement a pilot scheme (because the concept is new) near Baora village by the side of the Purbadhala-Jaria Road by introducing basic aquaculture management practices. The selection criteria for the site are:

- it is away from the main drainage system;
- currently it has low productivity;
- it is bounded on all sides by roads and homesteads; and,
- there is a small depression so fish can take shelter when the water level decreases.

The drainage inlets will be closed by fish nets and the outlets by a small drainage structure with fish net designed to maintain water in the upstream pool. Fingerlings will be released at the onset of the monsoon season and could be harvested in winter.

The fisheries community of Baora Village will be mobilised to culture fish in the selected floodplain site. As the scheme is a pilot scheme, 50% of the cost will be borne by the project.

b) Support to Diversified Fisheries

Under the programme, training will be provided to the poor people of the project area in the following fields and pilot schemes will be established:

- fish hatcheries;
- freshwater prawn culture in paddy fields and ponds;
- cage culture;
- freshwater pearl culture in paddy fields and ponds.

The focus of the programme will be to encourage and to support the formation of small enterprises within the scope and ability of poor and landless people.

Fish Hatcheries. With flood control interventions in the area, culture fishery will increase significantly. It is estimated that about twenty small hatcheries will be needed to supply the future needs for fry and fingerlings.

Under the programme, support will be provided to establish two low cost fish hatcheries in the private sector, typically costing Tk. 20,000 to 30,000 to establish. On farm training will be provided to help local people adopt production and management methods.

Freshwater Prawn Culture in Paddy Fields and Ponds. Prawns are a high value crop that can be cultured in paddy fields and ponds. The purpose of this initiative is to prove the feasibility of such a crop and to transfer this knowledge to the area people.

One pond and one floodplain area near Jaria will be selected for a pilot program. The owners will be given training and assistance in securing funding as an incentive to start the program. Training in the development and management of prawn farms will also be available to other interested parties.

This initiative will include the establishment of a prawn hatchery in the private sector if the prawn culture proves to be viable.

Cage Culture. Many poor people living along the bank of the Kangsha River have no ponds for culture fishery. To provide these people with income and an additional food source, this initiative will train and motivate them to practice cage culture.

Freshwater Pearl Culture in Paddy Fields and Ponds. Natural pearls are a high value crop. Under the programme, pearl mussels will be cultured in two ponds near Jaria to demonstrate and test the idea for the conditions that exist in the area and to transfer culture techniques to the people of the area. The pond owners will be given training and assistance in securing funding as an incentive to start the program.

Responsibilities: The consultants will work with DOF to implement this component of the fisheries enhancement programme. For floodplain culture fishery, fishing rights from farmers who own the floodplain land will be obtained by paying royalty to the owners.

In the 'Support to Diversified Fisheries' programme, the consultants will provide training to the interested parties and DOF will provide assistance in securing funding as an incentive to start the programme.

E.8.4.3 Social Benefit Enhancement Programme

The project will benefit mainly the landowners and to some extent the agricultural labourers. But people of other social groups will not receive direct benefits. It is necessary to target a wider spectrum of people, especially landless poor and women within the project boundary. In part this is in keeping with the stated objectives of the GOB and CIDA to improve equity; it will also help to make the project acceptable to all. To accomplish these objectives the project will implement the following village development programme as part of project development:

a) Water Supply and Sanitation

Sixteen HTWs will be installed, one each in the 16 villages over which the embankment will pass. The poorest households will be provided with the tubewells. The women-headed households and households affected by the land acquisition will be given preference.

Sanitation is practically non-existent. Less than 5 percent of the area population use sanitary latrines. To remedy this situation, the project intends to provide all landless households in Jaria and Gagra Unions, the worst flood affected area, with water sealed latrines (one slab and three rings) of DPHE standard. These two unions account for 33% of the project population, and 34% of them are landless. Based on 1997 projected population, 2,700 households would constitute the beneficiary group.

Responsibilities: The Embankment Committee will identify the beneficiaries. DPHE will execute the work. The consultant will co-ordinate the work.

b) Livestock and Poultry Development

The program includes training of selected women, preferably from the poorer stratum, in livestock and poultry vaccination. Each women will be provided with a flask and other necessary tools. In total, 25 women will be trained, one for roughly 1,000 households.

Responsibilities: The consultant will organize the programme through the Livestock Directorate

c) Women's LCS in Project Construction and Maintenance

At least one-fifth of the earthwork should be executed by women workers. To perform the task it is assumed that about 60 LCS, each having 40 members will be required. The package includes necessary social mobilization and formation of LCSs, training, registration and monitoring.

Responsibilities: The consultant will work with the Social Welfare Directorate to organize the women LCS to accomplish the task.

d) Education

Under this program, ten non-government primary schools will be provided with the necessary education material including some furniture, stationeries, scientific equipments and books.

Responsibilities: The consultant will identify the schools in consultation with the local committees and BWDB will release the fund at the Consultant's recommendation.

e) Social Forestry

The program includes plantation of trees along the embankment/road. Under this program, 10,000 saplings will be planted and cared by the women LCSs who will enjoy the benefit.

Responsibilities: The consultants will organize the women LCSs in consultation with the Embankment Committee and train them. In agreement with BWDB, the Embankment Committee will grant the space to LCSs for plantation.

E.8.5 Monitoring Plan

The development of the monitoring plan is an important step in the environmental assessment process in order to evaluate the accuracy of the impact assessment and the effectiveness of the mitigation measures and in order to identify any unanticipated change which would result from project implementation. These changes need to be evaluated and the project adjustment accordingly to mitigate any unforeseen impacts. Careful planning should be done to ensure that the monitoring plan considers only the important factors - remembering that time, personnel and funds are limited. Considering these aspects, the changes in the following sectors will be monitored:

- hydrology;
- water quality;
- groundwater level;
- fisheries resources;
- agricultural production;
- socio-economic changes; and,
- wetland dependent flora and fauna.

The task includes identifying and carrying out pre-project baseline survey if required; preparing post-project monitoring plan, conduct a measurement programme, and evaluate and report for project adjustment.

As part of the disaster prevention plan, the reaction of "outsiders" to the flood situation and their feelings towards the embankment will be monitored. This monitoring will take place during and after the first few monsoon seasons.

Social monitoring will include the reintegration of fishers and the effects of the embankment on the condition of landless and women.

Responsibilities

Ideally the relevant GOB agencies should carry out the monitoring. But with the possible exception of BWDB, these agencies are at present not in a position to carry out this task. Furthermore, someone must assume overall responsibility for the execution of the monitoring programme. The only practical solution is to assign this responsibility to a Bangladeshi consulting company who will carry on this work before, during and after project implementation.

The Monitoring Consultant will be responsible for monitoring of project performance for the first two years, evaluate the project performance based on the data of these two years and develop a system for a long term monitoring. The relevant GOB agencies and local committees will then take over and continue with the long- term monitoring.

The Monitoring Consultant will prepare an inception report including a workplan within two months of the commencement of the project and submit it to CIDA and BWDB for approval and proceed with the activities accordingly. The Consultant will also keep liason with the relevant GOB agencies and the local committees so that they can carry out the work after completion of the Consultant's term of reference. Table 8.1 shows the breakdown of the monitoring phase and the agencies responsible for short and long term monitoring:

Table 8.1: Monitoring Sectors and Implementation Responsibilities (Short and Long-Term)

Monitoring Sector	Responsibility	
	Short Term	Long Term
1. Hydrology	Consultant	BWDB
2. Water quality	Consultant	Beel Management Committee
3. Groundwater level	BWDB	BWDB
4. Fisheries resources	Consultant	DOF/Beel Management Committee
5. Agricultural production	Consultant	DAE
6. Socio-economic changes	Consultant	Social Welfare Directorate
7. Wetland flora and fauna	Consultant	Beel Management Committee

E.8.6 Implementation of Environmental Management Plan

E.8.6.1 Institutional Arrangement

Under the existing institutional arrangement, Bangladesh Water Development Board is the sole organization involved in planning, design, implementation, operation and maintenance of water management projects in Bangladesh. Its main focus is to control floods by structural interventions and it hardly implements any mitigation measures to reduce impacts caused by project interventions on other water related resources. However, under this project, the mitigation measures as discussed in the EMP will be implemented as an integral part of the project development through coordination of three bodies (PCC, Sub-PCCs and Consultant). The organization chart is illustrated in Exhibit 8-2. This organization chart is a component of the Project Organizational Chart shown in Exhibit 10-3 of the Main Report.

a) PCC

The implementation of the EMP requires a multidisciplinary team approach. Accordingly, it is proposed to form a project coordination committee (PCC) with officials from relevant government agencies and local representatives from different social groups. It is also proposed that an elected representative from the area people should head this PCC. Accordingly, the Member of Parliament from Purbadhala Thana will become the chairman of the PCC. However, by this time, if a person elected by the area people heads the thana council, he then will become the chairman of the committee. The Sub-Divisional Engineer, BWDB, Jaria will be the member-secretary. Fisheries Officer, Agricultural Officer, Asstt. Engineer, DPHE, Social Welfare Officer, Livestock Officer of Purbadhala Thana and three representatives each from three Sub-PCCs (see below) will be the other members of the Committee.

INSTITUTIONAL ARRANGEMENT FOR EMP IMPLEMENTATION

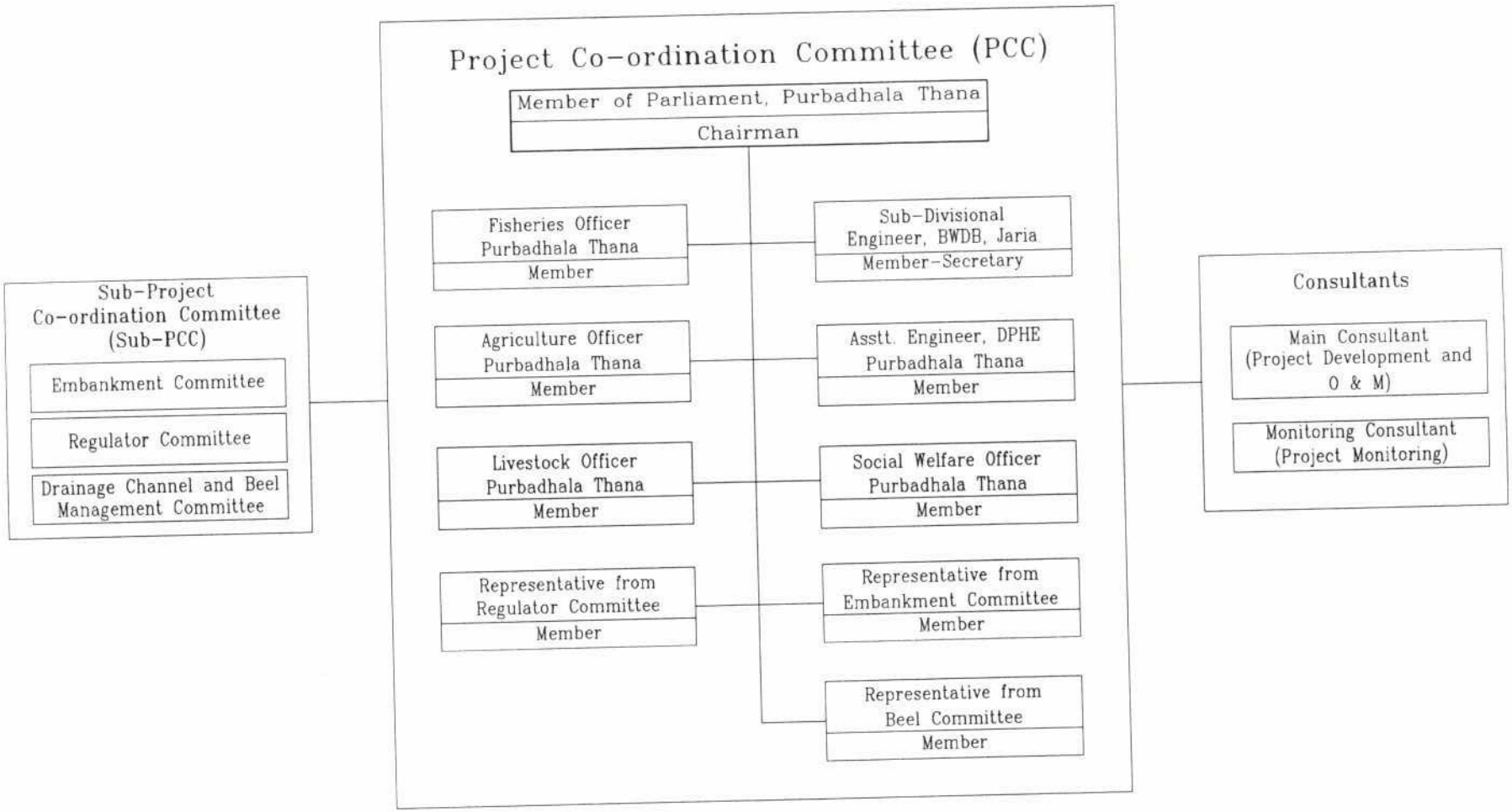


Exhibit 8-2

b) Sub-PCCs

Three local committees (Sub-PCCs) organised around "three technically rational water management structures" will be formed to integrate the local people in the project development and management. These committees are:

- embankment committee;
- regulator committee; and,
- drainage channel and *beel* management committee.

In order to be effective, the members of the sub-committees will be individuals directly benefiting from the interventions, otherwise, as has been found in the Pilot Dredging Project carried out by NERP, their effectiveness would diminish should they include members who do not have immediate interests at stake. The Consultant will organize these committees and their members will be elected from the following sectors of the population:

Embankment Committee: The main beneficiaries of the embankment are the land owners and those having access to land. So, this committee will include mainly farmers/landowners from low, medium and high lands.

Regulator Committee: Though the drainage regulator is a component of the embankment, its operation directly affects fishery and wetland resource user groups. So, this committee will include farmers, fishers and wetland resource users.

Drainage Channel and Beel Management Committee: The main beneficiaries of the embankment are farmers, fishers and wetland resource users and members of this committee will be selected from these groups.

It is expected that in the long run Sub-PCCs will be entrusted with the use and maintenance of the project infrastructures and the BWDB's role will be limited to seeing that Sub-PCCs uses the infrastructures in the intended manner.

C) Consultants

There will be two consultants - the Main Consultant and the Monitoring Consultant. The Main Consultant will be responsible for activities related to project development and O&M. The Monitoring Consultant will be responsible for monitoring project performance and evaluation, and recommend necessary project adjustments.

Responsibilities

BWDB will control funds and will release them to other ministry officials as per budget allotment. The respective officials will work with the relevant local committees and perform their tasks according to the responsibilities assigned to them as discussed in Section E.8.2. The officials will remain responsible for their performance to the PCC as well as to their line ministries.

The consultants will be directly responsible to BWDB and coordinate the EMP works and programmes with PCC and Sub-PCCs.

E.8.6.2 Training and Technical Assistance Needs

Need Assessment
Various social groups will require significant support in terms of training and technical assistance for optimal, equitable and sustainable development and management of area's water related resources to improve their socio-economic conditions.

The Sub-PCCs who will be entrusted with the use and maintenance of the project infrastructures will require training in embankment maintenance, operation and maintenance of regulators, disaster prevention and water quality.

Farmers will need training in the field of selection of crops and cropping patterns, crop management practices and new technologies best suited to the changed agro-hydrological conditions taking place due to project development.

Fishers will need training for improved management of area's *beels* and channels for open water fisheries enhancement and also for diversified fisheries activities such as cage culture, hatchery management and, prawn and pearl culture in paddy fields and ponds.

Area's landless people particularly poor women need training in income generating activities such as livestock and poultry vaccination and plantation and management of social forestry. A non-formal education programme in the field of conservation is also necessary for the area people to conserve and enhance wetland dependent flora and fauna.

Responsibility
The Main Consultant will be responsible to organize the training programmes for the area's different social groups in co-ordination with the relevant GOB agencies.

E.8.6.3 Implementation Schedule

The EMP Implementation Schedule is given in Exhibit 8-3. This schedule details the EMP work schedule given in the Project Master Schedule (Exhibit 10-4) in the 'Main Feasibility Report'.

Project implementation is assumed to last three years starting in November 1997 and continue for another two years for operation and maintenance, and monitoring. Mitigation and Compensation Plans will be implemented in the first three years as an integral part of project development. Contingency, Enhancement and Monitoring Plans will be developed and carried out during the last two years.

EMP IMPLEMENTATION SCHEDULE

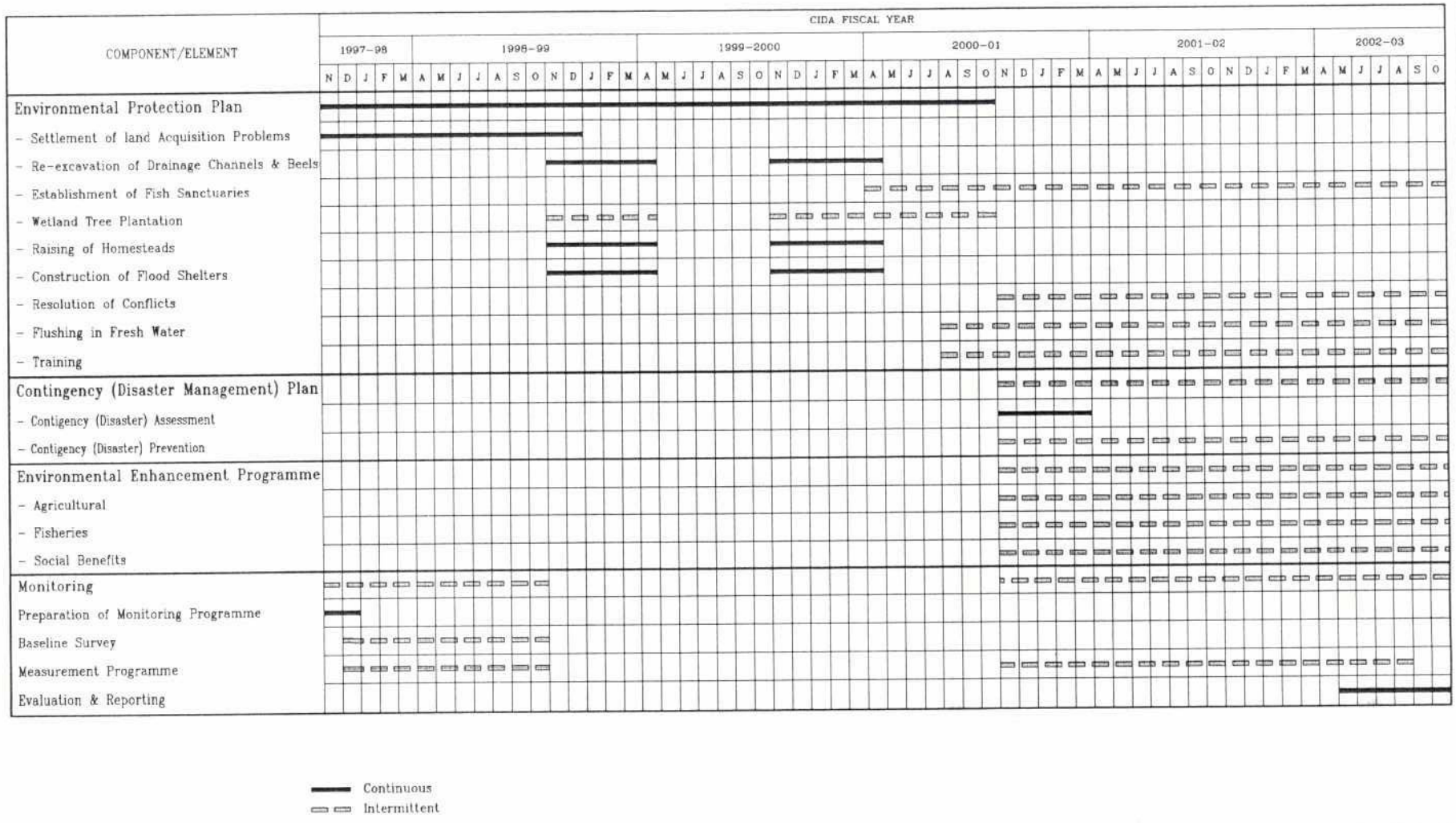


Exhibit 8-3

E.8.7 Residual Impacts

Despite mitigation of negative impact and enhancement of positive ones in the floodplain fisheries, there will still be significant losses of seasonal wetland habitat, migration routes and open fisheries production. Permanent wetland habitat will also be reduced, resulting in the possible loss of wetland wildlife species of international importance. Many fishers and some farmers will permanently lose their lifestyles. The loss from the open fisheries, will result in a deterioration of the nutrition levels of the poorest.

There is concern that even after mitigation some measures described in the EMP, especially those regarding the use of the drainage regulators for controlled flooding and flushing, may prove socially unsustainable. This could lead to conflicts between fishers and farmers. Also lapses in community organization over project maintenance will impair the positive impacts of the project and of the mitigation and enhancement measures.

E.8.8 Cost Estimate

E.8.8.1 Mitigative Works

1. Fisheries Mitigation Programme

a) Re-excavation of Beels
Excavated area: 5.0 ha.
Excavation depth: 2.0 m; Volume of earthwork: 100,000 m^3
Cost: Tk 14.1 x 100,000 = Tk 1,410,000

b) Cleaning of Internal Channels: Tk 200,000 (L.S)

c) *River Sanctuary:* Katha letting and operational cost : Tk 390,000 (L.S)

Total: Tk 2000,000

2. Wetland Mitigation Programme

Plantation of commercial wetland trees: Tk 400,000 (L.S)

3. Raising of Homesteads and School Plinths

Total no. of households between river and embankment: 516
No. of households to be raised: 516 x 0.39 = 202
Average household area: 0.08 ha.
Total area: 202 x 0.08 ha = 161,600 m^2
Assume 1.0 m to be raised; total earthwork = 161,600 x 1.0 m = 161,600 m^3

Cost: Tk 15.20 x 161,600 = Tk 2,456,000 (say)

Flood Shelters: Cost Tk 484,000 (L.S)

Total: Tk 2,940,000

E.8.8.2 Environmental Enhancement Plan

1. Agricultural Enhancement Programme

The cost for strengthening agricultural extension activities is estimated at Tk. 400,000 (see table below). The programme is scheduled for two years. It will cover two crop seasons and two sites in each year.

Table 8.2: Agricultural Enhancement Programme Cost

Item of Work	Cost (Tk)
1.Multi-location testing of new/improved production and management practices and technology under new agro-hydraulic condition (Tk.15,000×2×2x2)	120,000
2. Demonstration of practices and technology (Tk.15,000×2×2x2)	120,000
3. Pilot production (Tk.10,000×2×2x2)	80,000
4. Management	80,000
TOTAL	400,000

2. Social Enhancement Programme

Table 8.3: Social Enhancement Programme Cost

Particulars	Cost (Tk)
Water supply: Installation of 16 HTWs @ Tk 6,000 each	96,000
Sanitation: Supply of 2,700 water seal latrines @ Tk 500 each	1,350,000
Livestock and poultry: Vaccination training for 25 women extension workers	30,000
Women's LCS: Operational cost	100,000
Education: Supply of furniture, scientific equipment etc. to 10 schools	224,000
Social forestry Plantation of 10,000 saplings	200,000
Total	2,000,000

3. Fisheries Enhancement Programme

a) Floodplain Aquaculture Programme
Proposed area: 6 ha.
Fry/Fingerlings: 60,000; Cost: 360,000
Food and fertilizer: Tk 50,000
Two year programme and 50% to be borne by the beneficiaries
Project cost: Tk 510,000

২৩

Table 8.4: Fisheries Enhancement Programme Cost

Particulars	Cost (Tk)
1. Floodplain aquaculture programme	510,000
1. Fish Hatcheries: Training and Management	150,000
2. Prawn Culture: Training and Management	150,000
3. Cage Culture: Training and Management	90,000
4. Pearl Culture: Training and Management	100,000
Total	1000,000

E.8.8.3 Monitoring Programme

Cost for collection of data and their analyses have been included with the monitoring consultancy cost (see Main Report).

E.8.8.4 Cost Summary

Table 8.5: Mitigation and Enhancement Cost Summary

Measure	Item	Cost ('000 Tk)
1. Mitigation	a. Fisheries Mitigation Programme	2,000
	b. Wetland Mitigation Programme	400
	c. Raising of Homesteads and School Plinths	2,940
Subtotal		**5,340**
2. Enhancement Programme	a. Agricultural Enhancement Programme	400
	b. Social Benefit Enhancement Programme	2,000
	c. Fisheries Enhancement Programme	1,000
Subtotal		**3,400**
Total		**8,740**

APPENDIX A

TABLES

Table - E.A.1. Wildlife Species of the Dampara Project Area
(excepting fishes and birds)

Species / scientific name	English name	Status[1]	habitat and (breeding period)
AMPHIBIA :			
Bufo melanostictus	Common Toad	VC	Very common & widely distributed (Mar-June)
Kaloula pulchra	Kaloula Frog	UC	Moist, cool homestead areas with lot of cover (May-Aug)
Rana limnocharis	Cricket Frog	C	Common in the wetland margins (Apr-Aug)
Rhacophorus maculatus	Tree Frog	UC	Forests and marginal areas (Aug-Oct)
REPTILIA : CHELONIA :			
Indotestudo elongata	Elongated Tortoise	R/E	Forests
LACERTILIA :			
Calotes versicolor	Garden Lizard	S	Homesteads (Mar-Apr)
Gekko gecko	Wall Lizard	UC	Homesteads & swamp forests (Aug-Oct)
Hemidactylus frenatus	Common Lizard	VC	Homesteads (Apr-Jun)
Hemidactylus brooki	House Lizard	C	Homesteads (Apr-Jun)
Mabuya carinata	Common Skink	UC	Homesteads, swamp forests (Mar-May)
Varanus bengalensis	Bengal Lizard	UC-T	Homesteads, forests (Jun-Sep)
Varanus flavescens	Yellow Lizard	S-T	Homesteads, forests (Jul-Aug)
OPHIDIA :			
Ahaetulla nasatus	Common Vine Snake	UC	Forests, homesteads (Aug-Nov)
Amphiesma stolata	Striped Keelback	UC	Wetland edges, homesteads (Mar-Apr)
Bungarus caeruleus	Common Krait	S-T-E	Forests, cultivable land (Jun-Aug)
Bungarus fasciatus	Banded Krait	C-T	Wetland margins, homesteads, commercially exploited (Jun-Aug)
Elaphe radiata	Copperhead Trinket Snake	S-T	Foothills, forests, homesteads (Feb-Apr)
Lycodon aulicus	Common Wolf Snake	UC-T	Homesteads (Sep-Nov)
Lycodon jara	Yellow Wolf Snake	UC-T	Homesteads (Dec-Feb)
Naja kaouthia	Monocellate Cobra	UC-T	Wetland margins, homesteads, commercially expolited (Apr-Jun)
Naja naja	Binocellate Cobra	S-E	Forests and drier areas. Commercially exploited (Apr-Jun)

[1] VC: Very Common; C: Common; UC: Uncommon; S: Scarce; R: Rare; T: Threatened; E: Endangered; K: Indeterminate.

Oligodon arnensis	Common Kukri Snake	S	Forests, cultivable land (Sep-Oct)
Oligodon albocinctus	Whitebarred Kukri Snake	R-K	Forests (Sep-Nov)
Ophiophagus hannah	King Cobra	R-E	Forests, cultivable land in the foothills
Ptyas mucosus	Rat Snake	S	Wetland margins, getting rarer (Apr-Jun)
Typhlina bramina	Common Worm Snake	UC	Forests, homesteads
Typhlina porrectus	Slender Worm Snake	UC	Forests, homesteads
MAMMALS :			
Bandicota indica	Bandicot Rat	C	Homesteads and croplands (Mar-May, Aug-Oct)
Bandicota bengalensis	Mole Rat	VC	In and around homesteads, croplands and swamp forests (year round)
Callosciurus pygerythrus	Irrawady Squirrel	C	Forests, homesteads
Canis aureus	Jackal	C-T	Homesteads, forests, high ground near wetlands (Aug-Oct)
Cynopterus spinx	Short-nosed Fruit Bat	UC	Wetlands and homesteads (Feb-Mar) (Aug-Oct)
Felis viverrina	Fishing Cat	UC-E	Homesteads, forests, wetland margins (Apr-Jan)
Felis chaus	Jungle Cat	R-E	Present occurence uncertain (Aug-Nov)
Herpestes auropunctatus	Small Mongoose	C	Homesteads, croplands
Hespereptenus tickellii	Tickell's Bat	VC	Widely distributed (Aug-Oct)
Hystrix indica	Indian Porcupine	UC	Forests
Lepus nigricollis ruficaudatus	Rofoustailed Hare	UC-T	Once abundant, presently restricted to forests (Oct-Feb)
Manis crassicaudata	Indian Pangolin	R-E	Forests (Jan-Mar)
Megaderma lyra	False Vampire	C	Homesteads, wetlands (Mar-May)
Mus musculus	House Mouse	C	Homesteads and croplands (year round)
Mus booduga	Field Mouse	VC	Homesteads and croplands (Feb-Apr, Aug-Oct)
Pipistrellus coromandra	Indian Pipis-trelle	VC	Widely distributed (Aug-Oct)
Pteropus giganteus	Flying Fox	VC	Few roosts in the homestead and forests (Aug-Oct)
Rattus rattus	Common House Rat	VC	In and around homesteads (Mar-May, Aug-Oct)
Rousettus leschenaultii	Fulvous Fruit Bat	C	Widely distributed (Nov-Mar)
Suncus murinus	Grey Musk Shrew	VC	Homesteads, wetland margins
Sus scrofa	Wild Boar	UC	Used to be abundant, pest on crops. Forests
Viverra zibetha	Large Indian Civet	S-T	Homestead, forests (May-Jun)

Viverricula indica	Small Indian Civet	R-E	Homestead, forests
Vulpes bengalensis	Bengal Fox	UC-E	Few recent observations

Table E.A.2: List of Birds, Status and Habitat Preference

Scientific name	**English name**	**Status**[2]		**Habitat preference**
Accipiter badius	Shikra	C	Resident	Open wooded country.
Acridotheres ginginianus	Bank Myna	UC	Resident	River banks
Acridotheres tristis	C Myna	VC	Resident	Open country and towns.
Acridotheres fuscus	Jungle Myna	C	Resident	Open and lightly wooded ares.
Acrocephalus dumetorum	Blyth's Reed Warbler	VC	Resident	Throughout in scrub and trees.
Acrocephalus stentoreus	Clamorous Reed Warbler	C	Resident	Throughout in waterside scrub, reeds.
Aegithina tiphia	C Iora	C	Resident	Throughout in wooded areas.
Alauda gulgula	Oriental Skylark	C	Resident	Open country, sandy rivers.
Alcedo atthis	C Kingfisher	VC	Resident	Throughout wherever there is water.
Anas querquedula	Garganey		Migratory	Wetlands
Anas acuta	Northern pintail		Migratory	Wetlands
Anas clypeata	Shoveller		Migratory	Wetlands
Anthus rufulus	Paddyfield Pipit	C	Resident	Grassy areas, incl. paddy fields.
Anthus richardi	Richard's Pipit	C	Migratory	Throughout in open country.
Anthus roseatus	Rosy Pipit	C	Migratory	Near wetlands and river banks.
Apus affinis	House Swift	C	Resident	Less c over open areas.
Aquila nepalensis	Steppe Eagle	R	Migratory	Open country incl. wetlands.
Aquila pomarina	Lesser Spotted Eagle	C	Resident	Throughout in open country near water.
Artamus fuscus	Ashy Swallow-Shrike	C	Resident	Throughout in open woodland.
Athene brama	Spotted Owlet	C	Resident	Throughout in wooded areas, homesteads.
Aviceda leuphotes	Black Baza	UC	Resident	Forests and woodland.
Bubulchus ibis	Cattle Egret	VC	Resident	Widely distributed, associated with cattle.
Cacomantis merulinus	Plaintive Cuckoo	C	Resident	Open wooded areas.
Caprimulgus macrurus	Large-tailed Nightjar	C	Resident	Throughout in open wooded areas.
Centropus sinensis	Lesser Coucal	C	Resident	Scruby areas, homesteads.
Ceryle rudis	Pied Kingfisher	C	Resident	Throughout on wetlands, rivers.
Chalcophaps indica	Emerald Dove	UC	Resident	Well wooded country.
Charadrius mongolus	Mongolian plover	UC	Migratory	Wetlands adjoining paddy fields, grasslands
Chloropsis aurifrons	Gold-fronted Leafbird	UC	Resident	Woodland and forests.
Circus cyaneus	Hen Harrier	S	Migratory	Open country.

[2] VC: Very Common; C: Common; UC: Uncommon; S: Scarce; R: Rare; LC: Locally Common

Circus melanoleucos	Pied Harrier	C	Migratory	Open country, also near water.
Circus spilonotus	Eastern Marsh Harrier	S	Migratory	Open country near water.
Circus aeruginosus	Western Marsh Harrier	C	Migratory	Open country near water.
Cisticola jUCidis	Zitting Cisticola	C	Resident	Throughout in grassy areas, paddy fields and water margins.
Clamator jacobinus	Pied Cuckoo	C	Summer visitor	Well wooded areas.
Columba livia	Rock Dove	VC	Resident	Widely distributed.
Copsychus saularis	Magpie Robin	C	Resident	Throughout woodlands and scrub.
Coracias benghalensis	Indian Roller	UC	Resident	Throughout in open country.
Coracina novahollandiae	Black-faced cuckoo-shrike	C	Resident	Wooded areas, forests.
Corvus macrorhynchos	Large-billed Crow	VC	Resident	Widely distributed.
Corvus splendens	House Crow	VC	Resident	Widely distributed.
Cuculus varius	C Hawk-Cuckoo	C	Resident	Homesteads, woodlands.
Culicicapa ceylonensis	Grey-headed Flycatcher	C	Local migrant	Forests, woodlands.
Dendrocitta vagabunda	Rufous Treepie	C	Resident	Open wooded country.
Dendrocygna javanica	lesser whistling duck	UC	Resident	Wetlands
Dicrurus aeneus	Bronzed Drongo	LC	Resident	Forest, woodlands.
Dicrurus nacrocercus	Black Drongo	VC	Resident	Widely distributed.
Dinopium benghalense	Black-rumped Flameback	C	Resident	Throughout in open wooded areas.
Elanus caeruleus	Black-shouldered Kite	C	Resident	Throughout in open country, incl. wetlands
Erithacus svecicus	Bluethroat	C	Migratory	Srcub near wetlands.
Eudynamys scolopacea	C Koel	C	Resident	Homesteads, woodlands.
Falco subbuteo	Northern Hobby	R	Migratory	Wooded country.
Falco tinnUCulus	Eurasian Kestrel	UC	Migratory	Open country including wetlands.
Falco peregrinus	Peregrine falcon	UC	Resident	Open wooded country incl. wetlands
Ficedula strophiata	Red-throated Flycatcher	C	Migratory	Throughout in wooded areas.
Fulico atra	Coot		Migratory	Wetlands
Gyps bengalensis	White-rumped Vulture	C	Resident	Throughout over open country, incl. wetlands.
Gyps indicus	Long-billed Vulture	UC	Migratory	Open woodland.
Halcyon smyrnensis	White-throated Kingfisher	C	Resident	Throughout in wetlands with trees.
Haliastur indus	Brahminy Kite	C	Resident	Throughout in open country, near water.
Halieetus leucoryphus	Pallas's Fish Eagle	UC	Resident	Wetlands and large rivers.
Hirundo rustica	Barn Swallow	C	Migratory	Throughout in open country.
Hirundo daurica	Red-rumped Swallow	C	Migratory	Throughout in open country.

Hypothymis azurea	Black-naped Monarch	C	Resident	Well wooded areas.
Ichthyophaga ichthyaetus	Grey-headed Fish Eagle	C	Resident	Throughout in wetlands.
Ixobrychus cinnamomeus	Cinnamon Bittern	C	Resident	Wetlands and adjoning paddy fields, grasslands.
Ixobrychus sinensis	Yellow Bittern	C	Resident	Wetlands and associated homesteads, grasslands.
Jynx torquilla	Eurasian Wryneck	C	Migratory	Open country, woodlands.
Lanius cristatus	Brown Shrike	VC	Migratory	Widely distributed.
Lanius schach	Long-tailed Shrike	C	Resident	Open, lightly wooded and scruby areas.
Leptoptilos javanicus	Lesser Adjudant Stork	S	Resident	Wetlands and adjoining areas.
Lonchura puctulata	Scaly-breasted Munia	C	Resident	Throughout open country.
Lonchura malacca	Chestnut Munia	LC	Resident	Throughout in open country.
Megalaima haemacephala	Coppersmith Barbet	C	Resident	Throughout in wooded areas.
Megalaima lineata	Lineated Barbet	C	Resident	Well wooded areas.
Megalurus palustris	Straited Warbler	C	Resident	Open grassy areas, near water.
Merops orientalis	Green Bee-eater	C	Resident	Throughout in open country.
Merops leschenaultii	Chestnut-headed bee-eater	C	Local migrant	Open woodland.
Metopidius indicus	Jacana	R	Resident	Wetlands
Milvus migrans lineatus	Black Kite	C	Migratory	Throughout in open country.
Milvus migrans govinda	Pariah Kite	C	Resident	Throughout in open country and urban centres
Mirafra assamica	Rufous-winged Bushlark	C	Resident	Open grassland, scrub and paddy fields.
Monticola solitarius	Blue Rockthrush	UC	Migratory	Open wooded country.
Motacilla citreola	Yellow-hooded Wagtail	C	Migratory	Near water.
Motacilla cinerea	Grey Wagtail	S	Migratory	Throughout near running water.
Motacilla alba	White Wagtail	VC	Migratory	Open areas, often near water.
Motacilla flava	Yellow Wagtail	C	Migratory	Open areas near water.
Nectarina zeylonica	Purple-rumped Sunbird	C	Resident	Widely distributed.
Nectarina asiatica	Purple Sunbird	LC	Resident	Throughout in wooded areas.
Ninox scutulata	Brown Boobook	UC	Resident	Well wooded areas, forests.
Nycticorax nycticorax	Night Heron	C	Resident	Widely distributed.
Oriolus xanthornus	Black-hooded Oriole	C	Resident	Forests and wooded areas.
Orthotomus sutorius	C Tailorbird	VC	Resident	Throughout in scrub.
Pandion haliaetus	Osprey	UC	Migratory	Wetlands.
Parus major	Great Tit	C	Resident	Throughout in wooded areas.
Passer domesticus	House Sparrow	VC	Resident	Throughout near human settlement.

Pelargopsis capensis	Storkbilled kingfisher		Resident	Throughour in wetlands
Pericrocotus cinnamomeus	Small Minivet	UC	Resident	Open wooded areas, forests.
Phoenicurus ochruros	Black Redstart	S	Migratory	Open woodlands, near homesteads.
Phylloscopus inornatus	Inornate Warbler	C	Migratory	Throughout in homesteads.
Phylloscopus collybita	Eurasian Chiffchaff	C	Migratory	Throughout in wooded areas.
Phylloscopus fuscatus	Dusky Warbler	C	Migratory	Throghout in scrub and trees.
Picoides macei	Fulvous-breasted woodpecker	C	Resident	Throughout in wooded areas.
Picoides canicapillus	Grey-capped woodpecker	C	Resident	Throughout in wooded areas.
Picus canus	Grey-headed woodpecker	C	Resident	Forest, woodland.
Ploceus philippinus	Baya Weaver	LC	Resident	Open country often near water.
Pluviais fulva	Golden plover	UC	Migratory	Wetlands and adjoining paddy fields, grasslands
Prinia hodgsonii	Grey-breasted Prinia	C	Resident	Open grassy areas and scrub.
Psittacula krameri	Rose-ringed Parakeet	VC	Resident	Widely distributed.
Pycnonotus jocosus	Red-whiskered Bulbul	C	Resident	Throughout in well wooded areas and scrub.
Pycnonotus cafer	Red-vented Bulbul	VC	Resident	Open scrub, wooded areas.
Rhipidura albicollis	White-throated Fantail	UC	Resident	Well wooded homesteads, forests.
Rhopodytes tristis	Green-billed Malkoha	UC	Resident	Well wooded areas.
Riparia paludicola	Plain Martin	C	Resident	Large rivers.
Riparia riparia	Sand Martin	C	Migratory	Open country, near water.
Saxicola torquata	Stonechat	C	Migratory	Throughout in open country.
Spilornis cheela	Crested Serpent Eagle	C	Resident	Open wooded country, incl. wetland margins.
Streptopelia orientalis	Oriental Turtle Dove	C	Resident	Open wooded country.
Streptopelia decaocto	Collared Dove	C	Resident	Open wooded country.
Streptopelia tranquebarica	Red Turtle-Dove	C	Resident	Throughout in open wooded country
Streptopelia chinensis	Spotted Dove	VC	Resident	Open country.
Sturnus contra	Asian Pied Starling	VC	Resident	Widely distributed.
Sturnus malabaricus	Chestnut-tailed Starling	C	Resident	Open wooded country.
Tephrodornis pondicerianus	C Wood Shrike	C	Resident	Homesteads and wooded areas, incl. forests.
Treron phoenicoptera	Yellow-footed Pigeon	C	Resident	Forest and woodlands.
Treron pompadour	Pompadour Pigeon	C	Resident	Woodland, forests.
Treron bicincta	Orange-breasted Pigeon	C	Resident	Woodland, homestead and forests.
Trichastoma tickelli	Tickell's Babbler	C	Resident	Forests, woodlands.
Trichastoma abbotti	Abbott's Babbler	C	Resident	Woodlands, forests.

Turtoides earlei	Straited Babbler	LC	Resident	Scrub and woodlands.
Turtoides striatus	Jungle Babbler	C	Resident	Wooded country, scrub
Tyto alba	Barn Owl	UC	Resident	Open wooded, urban areas.
Upupa epops	Hoopoe	UC	Resident	Throughout in open country.
Vanellus indicus	Red-wattled Lapwing	C	Resident	Throughout in open country, near water.
Vanellus cinereus	Greyheaded lapwing	UC	Migratory	Throughout in open country, near water
Zoothera citrina	Orange-headed Thrush	UC	Resident	Open woodland, homesteads and forests.

Table E.A.3.: Wetland Plants and Their Uses

Utilization Codes : m- medicinal/narcotic/poison; c- ceremonial; ff- food: fruit & nuts; fs- food:starch/sugar/cereals; fv-food: vegetable; fu- fuel; sm- smoking/chewing; fp- feed plants/forage; ts- timber/structure; or- ornament /hedge; fb- fiber/thatching/wickerwork; bf- bio-fertilizer;
Habit codes: H - herb; S-shrub; A-nnual; Pe-Perennial.

Species	Family	Local Name	Habit	Use
Submerged				
Aponogeton undulatus	Aponogotonaceae	ghechu	H, Pe	fs, fv, m
Aponogeton appendiculatus	Aponogotonaceae	ghechu	H, Pe	fs, fv, m
Blyxa sp.	Hydrocharitaceae	shayala	H, A	fp,bf
Ceratophyllum desmersum	Ceratophyllaceae	jhangi	H, Pe	fp,fu
Hydrilla verticillata	Hydrocharitaceae	kureli, jhangi	H, Pe	fp,m,bf
Myriophyllum tuberculatum	Haloraceae	-	H, A	fp,m
Myriophyllum tetrandrum	Haloraceae	-	H, A	fp,m
Najas sp.	Najadaceae	goisa	H, A	fp,bf
Ottelia alismoides	Hydrocharitaceae	panikola	H, A/Pe	fs,fv,fp
Potamogeton crispus	Potamogetonaceae	keorali	H, Pe	fp,m
Potamogeton pectinatus	Potamogetonaceae	keorali	H, Pe	fp,m
Rotala sp.	Lythraceae	-	H, A	
Vallisnaria spiralis	Hydrocharitaceae	pataseola	H, A/Pe	bf,or
Free Floating				
Azolla pinnata	Salviniaceae	kutipana	H, Pe	bf
Eichhornia crassipes	Pontederiaceae	kochuripana	H, Pe	fp,bf,bg,ts,or
Lemna perpusilla	Lemnaceae	khudipana	H, Pe	bf
Pistia stratiotes	Araceae	topapana	H, Pe	bf,bg
Salvinia cucullata	Salviniaceae	indurkan	H, Pe	bf
Salvinia natans	Salviniaceae	tetulapana	H, Pe	bf
Spirodela polyrhiza	Lemnaceae	khudipana	H, Pe	fp
Utricularia sp.	Lentibulariaceae	chhotojhangi	H, A	bf
Wolffia arrhiza	Lemnaceae	guripana	H, Pe	fp,bf
Rooted Floating				
Echinochloa colonum	Gramineae	parua	H, A/Pe	fs,fp,fu
Echinochloa sp.	Gramineae	shama	H, A	
Eurayle ferox	Nymphaeaceae	makhna	H, A/Pe	fs,m
Hygroryza aristata	Gramineae	phutki	H, Pe	fs,fp
Leersia hexandra	Gramineae	-	H, A	
Limnophila sp.	Scrophulariaceae	bijatighash	H, A	fp,m,or
Limnophila heterophylla	Scrophulariaceae	karpur	H, A	fp,m
Mersilea quadrifoliata	Mersileaceae	sushnisak	H, A/Pe	fv,m
Nelumbo nucifera	Nymphaeaceae	padma	H, Pe	m,c,or
Nymphaea stellata	Nymphaeaceae	nilshapla	H, Pe	fs,fv,fp,m,bg,or
Nymphaea nouchali	Nymphaeaceae	sada, raktashapla	H, Pe	fs,fv,fp,m,bg,or
Nymphoides cristatum	Menyanthaceae	chandmala	H, Pe	fp,m,or
Nymphoides indicum	Menyanthaceae	panchuli	H, Pe	fp,m,or
Panicum paludosum	Gramineae	-	H, A	fp,fu
Pseudoraphis sp.	Gramineae	erali	H, Pe	fp
Trapa maximowiczii	Trapaceae	singra, paniphal	H, Pe	fs,fp,ff
Sedges & Meadows				
Aeschynomene aspera	Leguminosae	shola, banda	H, A	fu,bf,or
Aeschynomene indica	Leguminosae	katshola, bhatshola	H, A	fu,or
Alternanthera philoxeroides	Amaranthaceae	helencha	H, A	fv,fp

Species	Family	Local Name	Habit	Use
Arundo donax	Gramineae	baranal, gobanal	H, A	fp,fb
Asperagus racemosus	Liliaceae	satamuli, hilum	S, Pe	
Cleome hasslerana	Capparidaceae	nunirleta	H, A	m,or
Clinogyne dichotoma	Marantaceae	sital-pati	S, Pe	fb
Colocasia esculenta	Araceae	kachu	H, Pe	fv,m
Cyperus sp.	Cyperaceae	mutha	H, A	fp,fb
Eclipta alba	Compositae	kalokeshi, kalohuza	H, A/Pe	m
Eleocharis dulcis	Cyperaceae	panichaise	H, A	fp
Enhydra fluctuans	Compositae	helencha, harhach	H, Pe	fv,m
Ficus heterophylla var. *heterophylla*	Moraceae	bonolat, baladumur	S, Pe	
Fimbristylis dichotoma	Cyperaceae	joina chaise	H, A	
Fimbristylis miliacea	Cyperaceae	joina, chatkighash	H, A	
Fimbristylis squarrosa	Cyperaceae	jumka chaich	H, A	
Hemarthria protensa	Gramineae	chailla	H, Pe	fp,fb
Ipomoea aquatica	Convolvulaceae	kalmi shak	H, Pe	fv,fp
Ipomoea fistulosa	Convolvulaceae	dhol kalmi	S, Pe	fu,or
Juncus prismatocarpus	Juncaceae	-	H, A	
Lippia javanica	Verbenaceae	bhuiokra	S, Pe	
Ludwigia abscendens	Onagraceae	kesardam, mulcha	H, A	fp,or
Ludwigia repens	Onagraceae	panidoga	H, A	
Monochoria hastata	Pontaderiaceae	baranukha, kechur	H, Pe	m
Monochoria vaginalis	Pontaderiaceae	-	H, Pe	
Oryza rufipogon	Gramineae	jhara dhan	H, A	fs,fp
Phragmites karka	Gramineae	khagra, nol	S, Pe	
Phyllanthus reticulatus	Euphorbiaceae	chitki	S, Pe	
Polygonum glabrum	Polygonaceae	bishkatali, kukra	H, A	m
Polygonum stagninum	Polygonaceae	bishkatali, kukra	H, A	m
Polygonum lanatum	Polygonaceae	kukra	H, A	m
Polygonum barbatum	Polygonaceae	bishkatali	H, A	m
Rumex maritimus	Polygonaceae	bonpalong	H, A	m
Saccharum spontaneum	Gramineae	khag, aisha	S, Pe	
Sagittaria guayanensis spp. *lappula*	Alismataceae	muamia, kaowathukri	H, Pe	
Sagittaria sagittifolia	Alismataceae	chhotokul	H, Pe	
Setaria glauca	Gramineae	kulkulle, kauni	H, A	fp
Setaria fusca	Gramineae	pinginatchi	H, A	fp
Schoenoplectus articulatus	Cyperaceae	-	H, A	fp,fb
Scirpus juncoides	Cyperaceae	chisra	H, A	fp
Sclerostachya fusca	Gramineae	ekor, khuri	H, A	fp,fb
Sesbania roxburghii	Leguminosae	huli, phuli	H, A	fu,bf
Sphenoclea zeylanica	Sphenocleaceae	-	H, A	
Vetiveria zizanioides	Gramineae	binna, gandhabena	H, Pe	fb,fu
Xanthium indicum	Compositae	ghagra, khagra	H, A	fv,m
Marginal (on surrounding saturated soil)				
Alternanthera sessilis	Amaranthaceae	haicha, sachishak	H, A	fp,m
Bargia capensis	Elatinaceae	-	H, A	
Burmannia coelestis	Burmanniaceae	-	H, A	
Centipeda orbicularis	Compositae	machiti, hachuti	H, A	
Ceratopteris thalictroides	Parkeriaceae	-	H, A	fv,fp
Chenopodium ambrosoides	Chenopodiaceae	chapali ghash	H, A	
Cotula hemispherica	Compositae	kancha ghash	H, A	m

Species	Family	Local Name	Habit	Use
Croton bonplandianum	Euphorbiaceae	morchaagra, banjhal	H, A	fp,or
Cyanotis cristata	Commelinaceae	-	H, A	
Cynodon dactylon	Gramineae	durba	H, A/Pe	fp
Cyperus cephalotes	Cyperaceae	niratraba	H, A/Pe	fb
Cyperus sp.	Cyperaceae	-	H, A	
Dentella repens	Rubiaceae	sadaphuli, sadajabri	H, Pe	
Digitaria longiflora	Gramineae	chota fulka	H, A/Pe	fp
Elatine ambigua	Elatinaceae	-	H, A	
Elatine triandra	Elatinaceae	-	H, A	
Eleocharis atropurpurea	Cyperaceae	panichaise	H, A	fp
Eleusina indica	Gramineae	gaicha, chapre	H, A	fp
Eupatorium odoratum	Compositae	Shialmuti	H, A	
Euphorbia sp.	Euphorbiaceae	-	H, A	
Floscopa scandens	Commelinaceae	-	H, A	
Glinus lotoides	Molluginaceae	kakdim	H, A	
Hedyotis sp.	Rubiaceae	-	H, A	
Hygrophila polysperma	Acanthaceae	Talmakhna	H, A	
Leucas lavendulifolia	Labiatae	dron	H, A	m
Lindernia crustacea	Scrophulariaceae	bhui	H, A	
Ludwigia hyssopifolia	Onagraceae	-	H, A	
Ludwigia perennis	Onagraceae	-	H, A	
Mollugo pentaphylla	Molluginaceae	-	H, A	
Murdannia blumei	Commelinaceae	-	H, A	
Murdannia spirata	Commelinaceae	-	H, A	
Nicotiana plumbaginifolia	Solanaceae	Bontamak	H, A	
Oxalis corniculata	Oxalidaceae	Amrul	H, A	
Oxalis rubra	Oxalidaceae	-	H, A	
Paspalum conjugatum	Gramineae	dadkuri	H, Pe	fp
Polygonum plebejum	Polygonaceae	-	H, A	
Rottboellia protensa	Gramineae	barajati	H, Pe	
Rorippa indica	Cruciferae	bansarisha	H, A	
Scoparia dulcis	Scrophulariaceae	Phurphuri	H, A	
Solanum nigrum	Solanaceae	kakmachi	H, A	m
Spilanthes acmella	Compositae	marhatitiga	H, A	m
Triumfetta rhomboides	Compositae	Bonokra	H, A	m

Table E.A.4: Floodplain Fisheries Species In Dampara Project Area

Scientific Name	Local Name	Habitat	Migratory Route
Anguilla bengalensis	Bamosh	River	River - sea
Ophistemon bengalensis	Bamosh	River	River to sea - river
Tetraodon cutcutia	Potka	Beel/khal	Beel to river
Xenentodon cancila	Kaikka	Beel/river	River to beel
Channa punctatus	Taki	Beel	Beel to khal
Chamma striatus	Shole	Beel	Beel to khal
Channa marulius	Gozar	Beel	Beel to khal
Channa gachua	Chang	Beel	Beel to khal
Aplocheilus panchax	Kanpona	River	River to beel
Danio devario	Chep chela	River	River to khal
Labeo rohita	Rui	River	River to beel
Labeo calbasu	Kalibaush	River	River to beel
Catla catla	Katla	River	River to beel
Cimhinus mrigala	Mrigel	River	River to beel
Cirrhinus reba	Raik	River	River to beel
Labeo gonius	Gonia	River	River to beel
Cyprinus carpio	Carpio	River	-
Hypophthalmicthys molitrix	Silver carp	Exotic fish (pond)	River to beel
Labeo bata	Bata	River	Beel to river
Puntius sophore	Puti	Beel	Beel to river
Puntius conchonius	Kanchon puti	Beel	Beel
Puntius sarana	Sar puti	Beel	Beel to khal
Puntius gelius	Lal puti	Beel	-
Puntius ticto	Tit puti	Beel	Beel to khal
Amplypharyangodon mola	Mola	Beel	River to beel
Rohtee cotio	Dhela	Beel	River to beel
Salmostoma phulo	Chela	Beel/river	River to beel
Salmostuma bacaila	Chela	River	River to beel
Aspidoparia morar	Piali	River	River to beel
Esomus danricus	Karkina	River	River to river/beel
Lepidocephalus suntea	Gutum	Beel	River to river

Scientific Name	Local Name	Habitat	Migratory Route
Macrognathus aculeatus	Tara baim	River	River to river
Mastaceubelus armatus	Baim	River	River to beel
Mastaceubelus pancalus	Guchi/Pankal	River	River to river
Somilestes gongata	Bali chata	River	River to river
Botia dario	Rani	River	River to beel
Barilius evizardi	Bhole	River	River to beel
Wallago attu	Bhole	River	River to beel
Ompok bimaculatus	Boal	River	River to beel/khal
Ompok pabda	Pabda	River	River to beel/khal
Pangasius pangasius	Pangus	River	River to Haor
Hetoropneustes fossilis	Shing	Beel	Beel to beel/river
Clarias batrachus	magur	Beel	Beel to beel/river
Clarias gariepinus	African magur	Exotic fish (pond)	-
Rhinomugil carsula	Mullet	Estuary	River to river
Checa checa	Chaka	River	River to beel
Cenia sp.	Cinia	River	River to khal
Clupisoma garua	Garua	River	River to river
Entropiichthys vacha	Bacha	River	River to river
Ailia coila	Kazoli	River	River to river
Psendotropius atheriroides	Batashi	River	River to beel
Mystus aor	Ayre	River	River to beel/khal
Mystus seenghala	Guizza	River	River to beel/khal
Mystus tengara	Buzuri tengra	River	River to beel/khal
Mystus cavasius	Cabashi tengra	River	River to beel/khal
Mystus bleekeri	Bleekeri tengra	River	Beel to river
Puntius gonichatus	Thai sarputi	Closed and open water	River to beel
Mystus vittatus	Tengra	River	River to beel
Gagata youssoufi	Gang tengra	River	River to beel
Rita rita	Rita	River	River to river
Notopterus notopterus	Foli	River	River to river/beel
Notopterus chitala	Chitol	River	River to river/beel

Scientific Name	Local Name	Habitat	Migratory Route
Hilsa ilisha	Ilish	River	River to river
Gudunia chapra	Chapila	River	River to beel
Corica soborna	Ketchki	Beel	Beel to Beel
Colisa sota	Boicha	Beel	Beel to beel
Colisa fasciatus	Kholisha	Beel	Beel to Beel
Badis badis	Napit koi	Beel	Beel to beel
Nandus nandus	Veda	Beel	Beel to beel
Ctenops nobilis	Naptani	Beel	Beel to beel
Anabas testudineus	Koi	Beel	Beel to beel
Ambassis nama	Chanda	Beel	Beel to beel
Abbassis ranga	Lal chanda	Beel	Beel to beel
Glossogobius giuris	Baila	Beel	Beel to beel
Johnius coitor	Poa	River	River to beel
Ctenophayngudon	Grass carp	Exotic fish	-
Setipinna phasa	Fasha	River	River to river
Bagarius bagarius	Baghair	River	River to river
Chanda lalius	Lal chanda	Beel	Beel to beel
Mylopharyngodon pices	Black carp	Exotic fish (pond)	-
Labeo nandina	Nanid	River	River to beel
Tor tor	Mohashol	River	River to beel
Nemachilus botia	Balichata	River	River to River
Nemachilus zontus	Balichata	River	River to river
Labeo boga	Bhangan	River	River to river
Pama pama	Poa	River	River to river
Danio rerio	Anju	Beel	Beel to river
Aspidoparia jaya	Jaya	Beel	Beel to beel
Puntius chola	Chola puti	Beel	Beel to river
Puntius guganio	Puti	Beel	Beel to river
Macrobrachium rosenbergii	chingri	River/Beel	Beel to river
Potamon sp.	Kokra	River/Beel	River to beel
Platanista gangetica	Sine	River	River to river

Scientific Name	Local Name	Habitat	Migratory Route
Icha (Different Species)	icha	Beel	Beel to river/beel

Table E.A.5.: Project Impacts, Scoring and Mitigation Measures

Environmental Components		Impact	Score	Mitigation/enhancement	Responsibility
Physical/Chemical					
Water Resources	Groundwater quantity	Decrease in groundwater recharge by 6%	-2	Monitoring, flushing, controlled flooding, diversification of crops if need be	BWDB; Sub-PCC
	Domestic water supply	Increased access to pumps during monsoon	+6		
		Pumps may dry due to decrease in recharge	-2	Provision of Tara pumps	DPHE
	Surface water quality	Drainage congestion and general deterioration in water quality	-3	Flushing and controlled flooding. Adequate training of the CBMS for monitoring and use of drainage regulators	Consultant and Regulator Committee
	Drainage	Improvement of drainage due to channel re-excavation	+2		
		Decrease in drainage ability due to water being trapped by the embankment	-1	Monitoring, Flushing , maintenance of drainage structure	Regulator Committee
Soil	Quality	Potential decrease in soil quality due to build up of biocides and lack of organic and mineral replenishment	-1	Use of organic fertiliser and mulches	DAE
River processes	Sedimentation	Decrease sedimentation on floodplain, Increased river sediment load-possible downstream effects	-1		
	Flow rates	Flow rates to increase, possible downstream effects	-1		
	Bed modifications	Increased sediment load-downstream accretion, sand bars, etc.	-1		

Table E.A.5.: Project Impacts, Scoring and Mitigation Measures

Environmental Components		Impact	Score	Mitigation/enhancement	Responsibility
Biological Components					
Open water fishery	Habitat	Decrease in areal extent of open water habitat on the floodplain, and significant decrease in water depths of wetlands	-6	Monitoring surface water area. Channel cleaning. Controlled flooding. Declaration of channel and *beel* sanctuaries.	DOF and Regulator & Beel Committee
	Production	Decreases in production due to reduced migration, recruitment and habit loss	-6	Controlled flooding during monsoon season to allow some migration, re-excavation of *beels*, fry releases.	Regulator and Beel Committees and DOF
	Migratory routes	Significant decrease in migratory routes both from the Kangsha to the floodplain and within the floodplain	-4	Re-excavation of some internal channels Selected channels declared fish sanctuaries	BWDB and Beel Committee
	Biodiversity	Potential losses to area biodiversity	-4	New fishery's management policy	DOF
Wetlands	Habitat	Significant decreases in wetland habitat, quality and stability due to less surface water and encroachment	-4	Channel re-excavation for improved water flow, controlled flooding and flushing programmes will improve wetland viability	BWDB, Beel and Regulator Committee
	Production	Decreases due to reduction of areal extent	-4	Non-formal education programme to protect remaining wetlands through planting, limiting cutting to replacement levels and limiting access for grazing.	Consultant
	Biodiversity	Probable losses of wetland-dependant species	-4	Monitoring and enhanced conservation methods	Monitoring Consultant

Table E.A.5.: Project Impacts, Scoring and Mitigation Measures

Environmental Components		Impact	Score	Mitigation/enhancement	Responsibility
Social Components					
Agriculture	Crop-field production	Large increase in productivity, esp in *t.aman* due to earlier planting and less crop damage and increase in HYV use.	+10,	Improved farming practices through the involvement of agriculture extension.	DAE
	agroforestry and homestead gardens	Increase in productivity of homegardens and plantations due to absence of flood	+5	Net gain in production predicted. Improved gardening techniques i.e., composting will increase overall production	DAE
		Loss of 21 ha of homestead plantation and 5 ha of agroforestry land	-1		
	Livestock production	Increase in production from increased investment and secure livestock areas	+3	Grazing space on embankment land	Embankment Committee
Culture fisheries	Pond area	Predicted increase in pond area (45 ha) increased security and investment	+5	Pilot shallow floodplain aquaculture programme, etc.	DOF & Fisheries Community
	Production	Increase in pond production due to lack of flooding, predicted increase due to above	+6	Programmes under the fisheries enhancement plan eg., diversified fisheries, hatcheries, prawn and cage culture	DOF and Consultant
Public health and sanitation	Stress	Stress related to crop loss and suffering will decrease significantly.	+6		
		Potential stress and conflict from land-acquisition process	-1	Involvement of COs in acquisiton process Involvement of community in alignment	Consultant
	Social harmony	Conflict with Kangsha Project residents alleviated	+8		
		Potential conflict with those outside the embankment alignment	-4	Community organisation and education programmes. Flood-proof housing for "outsiders".	Embankment Committee
		Potential conflicts between fishers and farmers over controlled flooding and flushing programme.	-4	Committee with representatives from both communities will operate the regulators and act as forum for conflict resolution	Embankment and Regulator Committees
	Potable water supply	Access to potable water will increase during monsoon season	+6		
		Access to water will decrease further in the dry season with reduction of groundwater	-2	Provision of Tara pumps	DPHE

Table E.A.5.: Project Impacts, Scoring and Mitigation Measures

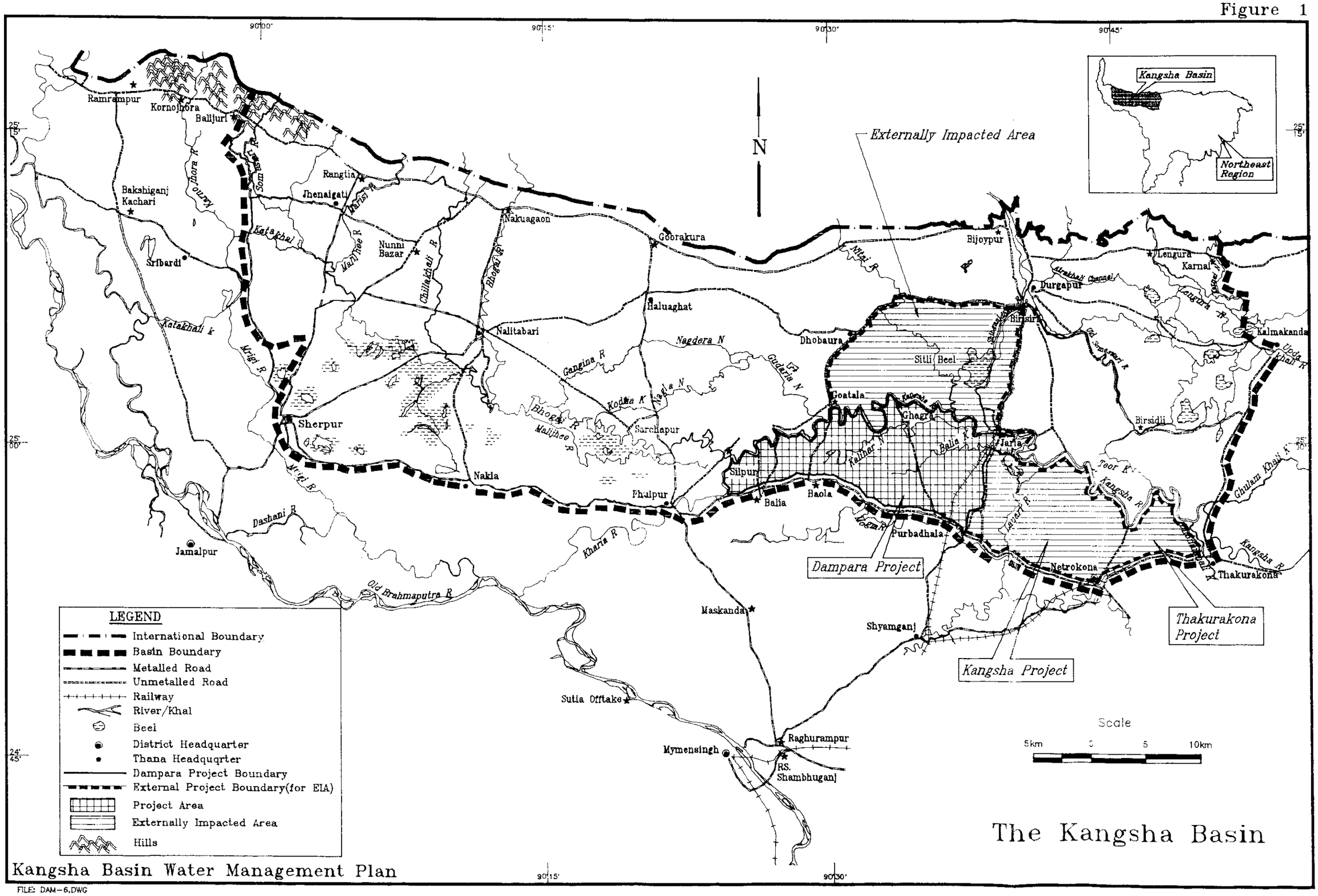
Environmental Components		Impact	Score	Mitigation/enhancement	Responsibility
	Sanitation	Access to and reliability of latrines will increase Increase in security may lead people to invest more effort in latrine building	+8	Provision of water-seal latrines	DPHE
	Nutrition	Increased nutrition levels from increased homegarden production and rice-crop production	+5		
		Decrease in the nutrition levels of subsistence fishers	-5	Training programs for fishers, enhancement of culture fisheries	Consultant
	Disease	Decrease in water borne disease	+5		
		Increase in vector disease	-2	Monitoring and spraying programs if necessary	Social Welfare Dte
Employment and education	Jobs/permanent	Increase in agricultural employment Long-term employment opportunities with industrial development	+8		
		Decrease in fisheries employment and decrease in employment for those involved in wetland product collection	-4	Training programs enhancement of culture fisheries, agricultural extension programs	Consultant
	Access to education	Access to education will increase with flood alleviation	+3		
Public Infrastructure	Protection of infrastructure	Project roads, rail links, etc will be protected and transport can remain uninterrupted year-round	+6		
Neighbouring development projects	Crop production	Positive impacts of Dampara will be extended to neighbouring projects, i.e., increases in crop production, etc.	+9		
	Social harmony	Good dykes make good neighbours	+8		
Women's opportunities	Income	Increased opportunities i.e., relief from annual flood preparedness, gardening on embankment land	+6		
	Homestead	Income opportunities increase due to improved security of homegardens etc.	+6	Enhancement activities under "Total Village Development Programme"	Consultant and relevant thana officials

Table E.A.5.: Project Impacts, Scoring and Mitigation Measures

Environmental Components		Impact	Score	Mitigation/enhancement	Responsibility
Lifestyle for fishers	Lifestyle change	Loss of lifestyle for dependant fishers and their families	-2	Intensify culture fishery through shrimp farming, nursary programmes, etc	Consultant
Economic development	Transportation	Protection and improvement of external rail and roadways (no cuts), Protection of internal roads	+8		
		Loss of navigability on Kalihar *khal*	-2	Road improvement programme	BWDB
	Investment	Increased security of land will lead to increased investment in agriculture and ponds	+4	Credit extension programme and other enhancement activities under the TVDP	BRDB
	Development	Protection of Netrokona and Jaria towns will aid in industrial and commercial development	+4		
Preconstruction and Construction Impacts					
Crop production	Agricultural land	Loss of 25 ha of land for embankment construction	-1	Use of embankment lands for gardens, etc.	Embankment Committee
Employment and education	Jobs/temporary	Many job opportunities involved in construction	+3		
Social Harmony		Conflict arising from presence of outside labourers during construction.	-1	Use of local contractors and hiring of local labour for construction activities. Code of conduct for labourers	Embankment Committee and Contractor

FIGURES

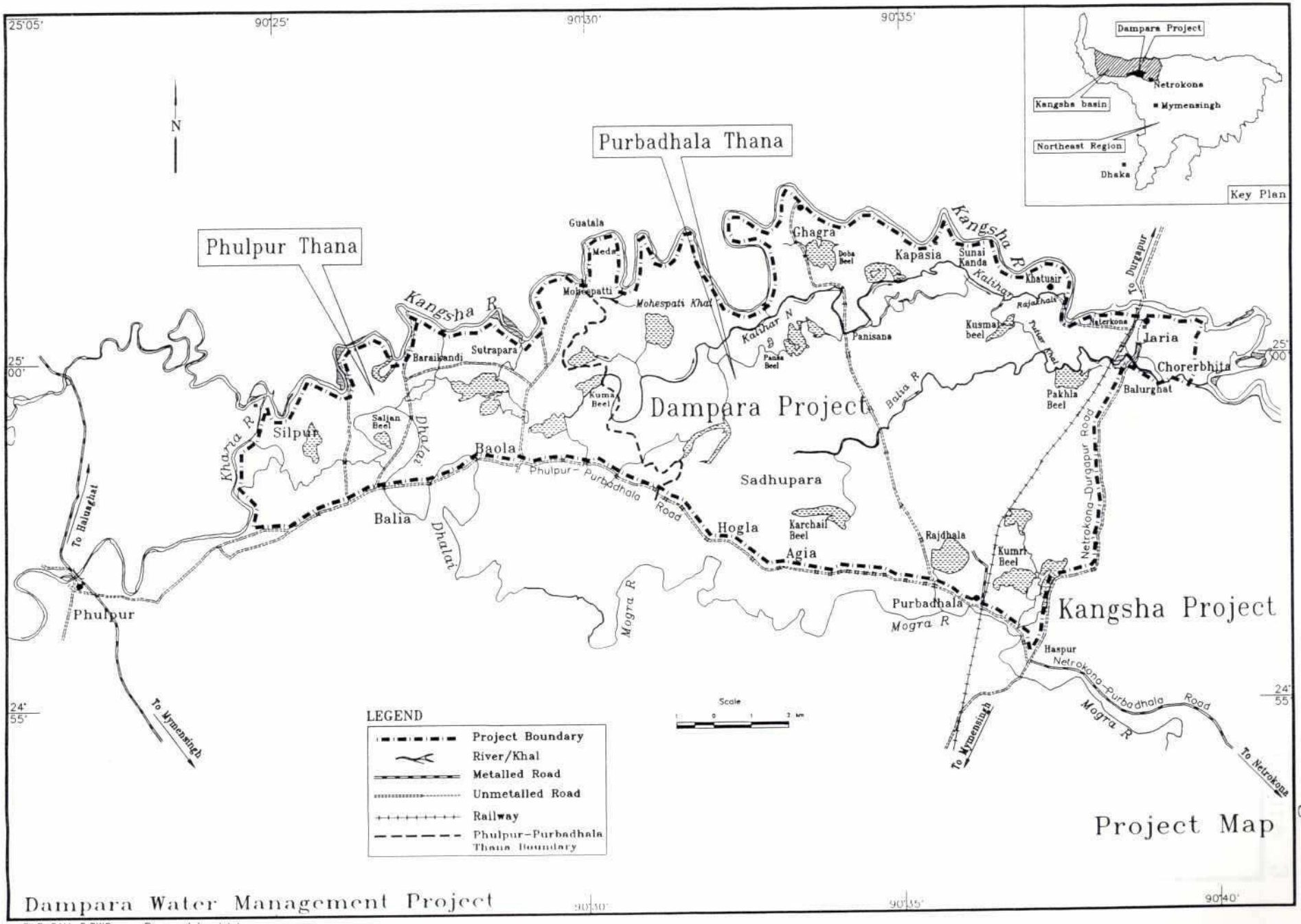
Figure 1



Kangsha Basin Water Management Plan

The Kangsha Basin

FILE: DAM-6.DWG

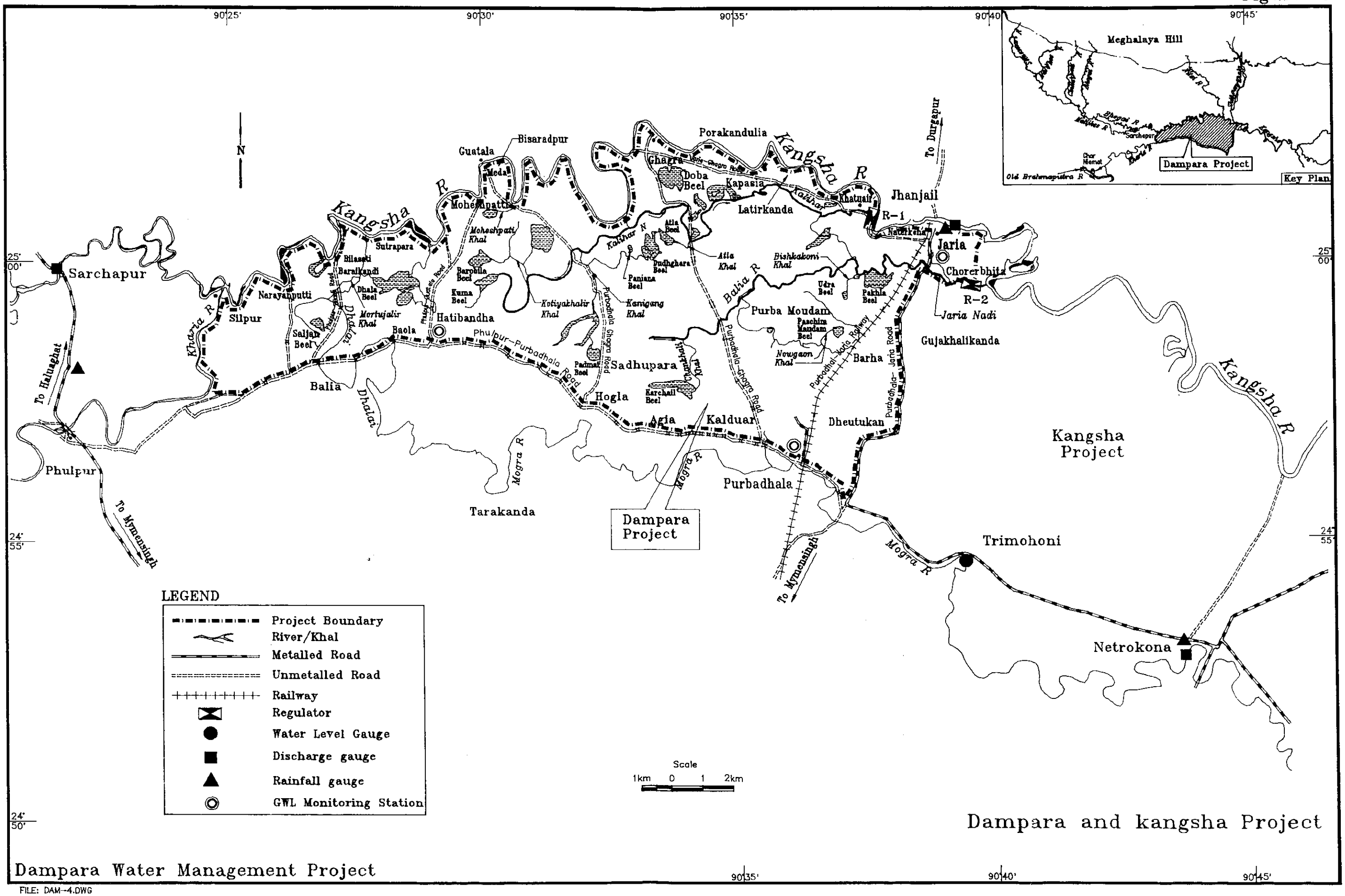


Dampara Water Management Project

FILE: DAM-5.DWG Prepared by: Jalal

Figure 2

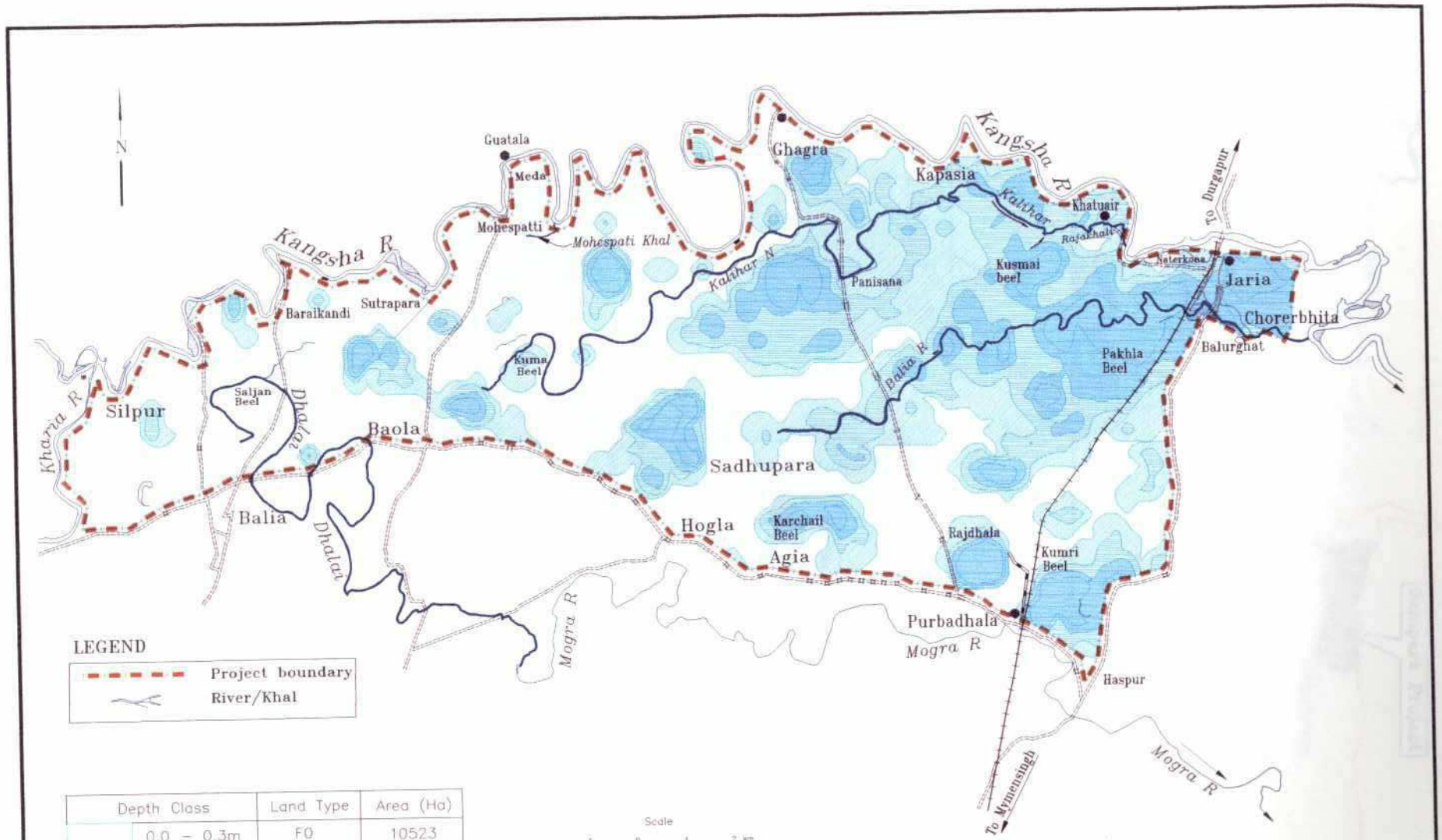
Figure 3



Dampara and kangsha Project

Dampara Water Management Project

FILE: DAM-4.DWG



Depth Class	Land Type	Area (Ha)
0.0 – 0.3m	F0	10523
0.3 – 0.9m	F1	2004
0.9 – 1.8m	F2	1486
> 1.8m	F3	987
		15000

Flood Depth Map
(Based on Post-Project 1:5 yr Design Water Level)

Dampara Water Management Project

FILE: DAM-3.DWG Prepared by: Jalal

Figure 4

Figure 5

90°25' 90°30' 90°35'

25°05'

Caritas Road
0.50m dia Pipe Sluice
Naterkona
Jaria
Pakhla
Chorerbhita
Balia R

Enlargement 1

Moheshpatti
0.90m dia Pipe Sluice
Moheshpatti Khal

Enlargement 2

N

Dampara Project
Netrokona
Kangsha basin
Mymensingh
Northeast Region
Dhaka

Key Plan

Enlargement 2
Meda
Moheshpatti
Moheshpatti Khal
Ghagra
Kapasia
Kangsha R
Kalihar
Khatuair
Enlargement 1
To Durgapur
Caritas Road
Naterkona
Jaria
Kangsha R
Baraikandi
Sutrapara
Kalihar N
Panisana
Kusmai beel
Tudiar Khal
Pakhla Beel
Chorerbhita
Kangsha Project Embankment
Kuma Beel
Dampara Project
Balia R
Netrokona–Durgapur Road
Kharia R
Silpur
Saljan Beel
Dhalai
Baola
Phulpur–Purbadhala Road
Sadhupara
Balia
To Phulpur
Dhalai Re-excavation
Hogla
Karchail Beel
Agia
Rajdhala
Kumri Beel
Purbadhala
Mogra R
To Mymensingh
Haspur

Scale
1km 0 1 2km

LEGEND
- Project Boundary
- River/Khal
- Metalled Road
- Unmetalled Road
- Railway
- Existing Embankment
- Existing Drainage Regulator
- Proposed Embankment
- Proposed Pipe Sluice
- Drain Re-excavation
- Proposed Closure
- Proposed Diversion Channel

Note: LLP Structure locations not shown

Interventions
Dampara Project

Dampara Water Management Project

FILE: DAM-2.dwg