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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

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

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.

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FLOOD ACTION PLAN

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ACRONYMS AND ABBREVIATIONS

AEZ	Agro Ecological Zone
ASA	Association for Social Advancement
ASP	ammonium sulphate
AST	Agriculture Sector Team
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BIWTMAS	Bangladesh Inland Water Transport Master Plan
BMD	Bangladesh Meteorological Department
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CAS	catch assessment survey
CBMS	community-based management system
CERDI	Central Extension Resources Development Institute
cft	cubic feet
CIDA	Canadian International Development Agency
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
cm	centimetre
CO	Community Organizer
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DOF	Department of Fisheries
DPHE	Department of Public Health Engineering
DSSTW	deep set shallow tube well
DTW	deep tube well
EIA	environmental impact assessment
EMP	environmental management plan
FAO	Food and Agriculture Organization (United Nations Agency)
FAP	Flood Action Plan
FCD	flood control and drainage
FCDI	flood control, drainage and irrigation
FES	fishing effort survey
FFW	Food for Work
FPCO	Flood Plan Coordination Organization
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
IUCN	International Union for the Conservation of Nature
kg	kilogram
km	kilometer
LGED	Local Government Engineering Department

LGRDC	Local Government, Rural Development and Cooperative
LLP	low lift pump
m	meter
MB	motorized boat
MCH	mother and child health
MITW	mechanized inland water transport
mm	millimetre
Mm^3	million cubic meters
MP	murate of potash
NERP	Northeast Regional Water Management Project (FAP 6)
NGO	non-governmental organization
NMB	non-motorized boat
PCC	project coordination committee
PRA	participatory rural appraisal
PWD	Public Works Department
RD-12	Rural Development-12
SOB	Survey of Bangladesh
SRDI	Soil Resources Development Institute
SRP	Systems Rehabilitation Project
SSFCDI	Small-Scale Flood Control, Drainage and Irrigation
SSP	single super phosphate
STW	shallow tube well
TSP	triple super phosphate
TW	tube well
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
UP	Union Parishad
WARPO	Water Resources Planning Organization

GLOSSARY OF TERMS

aarat	wholesale market
ail	small dyke demarcating boundary of agricultural plots
aman	monsoon rice crop
baowa	local monsoon rice crop
barga	sharecropping system whereby the operator provides all inputs and shares the produce equally with the landowner
bari	cluster of houses usually having kinship lineage
barshar pani	monsoon water
bazar	market
beel	floodplain lake that may hold water perennially or dry up during the winter season
bhati	low-lying downstream area
bhita	homestead
biri	indigenous cigarette
bisra	patch between homestead and crop land
bonya	flood
boro	dry season rice crop
bou	bride
bundh	earthen dam, closure
chalni	filter made of bamboo
chatai	mat made of bamboo
chira	flattened rice used as snack
choki	cot
chukti	contract
chula	woven
dai	birth-attendant
doba	ditch
duar	Deep scour hole in river
eid	muslim religious festival
fitra	contribution made to the poor on the eve of the eid after month-long fasting
gamchha	sort of towel
ghar	house
gram	village
gudara	ferry boat
gushti	kinship group
haat	big market
hara	unit of land measurement, equivalent to 16 katha or 1.28 acre
haor	Depression on floodplain located between two or more rivers, which functions as a small internal drainage basin
jakat	contribution made to the poor according to Islamic law
jal	fishing net
jala	rice seedling
jalakhet	rice seed bed
jumma	special prayer held on friday
kamla	wage labourer
kanda	raised land surrounded by crop fields used for cattle grazing or seed bed or threshing of crops

kantha	quilt made of old cloth
katha	unit of land measurement, equivalent to 0.08 acre
khal	channel
khancha	cage
kharif	Monsoon crop season, including the *aus* and *aman* crop
kutcha	thatched
logni karbar	lending money at high rate of interest
lungi	men's wear
macha	platform made of bamboo or timber
madrassa	school with emphasis on religious curriculum
majhee	boatman
mallat	samaj in Dampara
manot	pledge
maund	indigenous unit of weight, equivalent to 40 seers or 37.3 kg
mauza	lowest level of geo-administrative unit
mazar	mausoleum of a saint
mohajan	money-lender
moulana	muslim priest
mullah	islamic educated person
muri	puffed rice used as snack
nadi	river
namaj	prayer
nolua	people making bamboo products
orash	religious festival commemorating the birth or death of a saint
pankha	hand-made fan
para	cluster of several bari forming a neighbourhood
pargana	geographic unit in old days having a size of a thana
poa	unit of measuring weight, quarter of a seer
poshchim	west
pucca	paved, made of brick
purbo	east
rabi	dry season
roj kamla	labourer engaged on a daily basis
salish	arbitration
samaj	informal village institution
samity	cooperative society
sanko	bamboo bridge
saree	women's wear
seer	indigenous unit of weight, equivalent to 0.933 kg
shidol	one type of dry fish
shutki	dry fish
tahsil	lowest level revenue unit
taka (tk)	unit of currency, 1 US $ = 40 taka (approx.)
tempoo	mechanized boat carrying merchandize
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
uthan	courtyard

EXECUTIVE SUMMARY

The Dampara Water Management Project, covering a gross area of 15,000 ha, is located 14 km northwest of Netrokona Town and about 170 km north of Dhaka City. The main water resource issue in the area is the spill from the Kangsha River which lies along the northern perimeter of the project. Almost annually the area is ravaged by flash floods which occur up to four to five times in a year. Floods cause catastrophic damage to area's monsoon crops, inundate homesteads, destroy private and public infrastructures, and disrupt economic and social activities. As a result employment becomes scarce and poor people sell their assets at low price to survive. Women are particularly affected due to the disruption of homestead based economic activities upon which their autonomy largely depends.

Daily chores also become burdensome. Cooking is hampered by the lack of space and firewood. Latrines get washed away. Homesteads become isolated making access to potable water difficult, especially for the poor, who resort to flood waters for domestic purposes leading to the outbreak of diarrhoeal diseases.

The neighbouring BWDB's Kangsha River Project cannot function because its western embankment is cut by the Dampara Project people when they are flooded.

The purpose of this study is to develop a solution for the water-related physical problems faced by the area residents, propose necessary interventions and determine the economic, technical, environmental and social feasibility of these proposed interventions.

A public consultation process was initiated with the explicit objective to ensure public participation from the planning stage of the project. Seven formal and several informal meetings were held with different groups including community leaders, special interest groups, poor and landless women, *thana* officials, BWDB officials, NGOs and Grameen Bank to identify water-related problems and possible solutions. The main concern expressed by those groups is the flooding from the Kangsha River. Embankment construction along the Kangsha River right bank on the northern perimeter of the project or dredging of the Kangsha River have been suggested by the local people as the possible solution of the area's flood problems.

The local economy depends mainly on the area's agricultural production. Sixty one percent of the population who are subsistence farmers and who own sixty seven percent of the area's cultivated land cannot manage their livelihood with the reduced yield due to flood damage and as a consequence, sell their property and ultimately become landless. Reduced production also affects employment for the landless population (34% of total population) who are mostly agriculture labourers. Moreover, population is on the increase by 1.54 percent annually and in order to meet the increased demand for food, it is imperative to increase food production in the area. Thus the increased crop production is seen as the key to the improvement of the area's socioeconomic conditions.

Local people grow three main crops; *aus* (early monsoon crop), *aman* (late monsoon crop) and *boro* (winter crop) on respectively 12, 88 and 87 percent of the area's cultivated land. The figures indicate that they are mainly dependent on *aman* and *boro* crops. *Boro* is not damaged by floods

but in some areas, it is damaged by drainage congestion caused by run-off. However, *aman* is severely damaged by floods. Agricultural data collected from the field indicates a very good prospect for large scale increase in *aman* production through flood protection.

The project was conceptualized to manage floods and protect the *aman* crop during its growing period from July to October. During the April-June period, flood water will be allowed to enter into the project area to the extent that it would not inundate homesteads, roads and railway infrastructure. This period is particularly important to the fishery production as this is the time for fish to migrate and spawn.

This study examined two options - embankment construction and dredging of the Kangsha River and found that dredging is not technically feasible. As such, it recommends the embankment construction as the solution to the flood problem.

The project area drains through the Kalihar, Balia and Dhalai channels, the three main drainage channels of the area. The analyses carried out by this study demonstrate that Kalihar and Balia channels are adequate to drain out their catchments' pre-monsoon rainfall-run-off but Dhalai channel requires cleaning for about 9.6 km.

There are two existing drainage regulators - a 5-vent (vent size: 1.52 m x 1.83 m) regulator at the outfall of Kalihar Channel and a 10-vent (vent size: same) regulator at the outfall of the Balia. Flood routing analysis shows that these regulators are adequate for the area's drainage discharge. However, four small drainage outlet structures have been proposed to facilitate localised drainage.

The project's proposed components are - the construction of a 30 km embankment from Jaria to Meda, re-excavation of 9.6 km of Dhalai Channel, closing off Kalihar Channel at the outfall near the existing drainage regulator, excavation of diversion channel and, construction of four small drainage outlet structures and thirty LLP irrigation inlet structures.

The project interventions will reduce floodplain fisheries and wetland dependent species. However, project operation in accordance with the project concept will significantly reduce the negative impact on floodplain fisheries and wetland biodiversity. The project will resolve the conflict between the Dampara and the Kangsha Project people but it will likely create a new conflict between the Dampara people and people living on the other bank of the Kangsha River.

Mitigation measures and compensation measures for fisheries, conservation of selected wetland areas and resolution of social conflicts and, enhancement programmes for agriculture, fisheries and social benefits will be implemented as an integral part of the project interventions. With the implementation of these programmes, it is expected that there will be significant reduction of negative impacts and considerable enhancement of positive impacts.

The estimated cost of the project is about Tk 64.2 million (Cdn $ 2.14 million) which includes Tk 10.96 million (Cdn $ 0.37 million) for mitigation and enhancement programmes. The Economic Internal Rate of Return is 42% and the Net Present Value is Tk 134 million for a discount rate of 12%. The project will increase food production by 8,850 tons, generate employment by 216,000 person-day/yr but reduce fisheries by 86 tons (not considering mitigative

and enhancement programmes). The project's cost benefit indicators are presented in the table below.

Dampara Water Management Project- Cost Benefit Indicators

Indicator	Unit	Value
Investment	Tk million	64.2
O&M Cost	Tk million/yr	2.63
Net Project Area	ha	12,525
Benefitted Area	ha	8,000
Unit Cost	Tk/ha	8,025
Land Acquisition	ha	51
Benefit	Tk million/yr	35.58
Crops	Tk million/yr	38.70
Fisheries	Tk million/yr	(-)7.24
Homestead Plantation and Agro-forestry	Tk million/yr	2.35
Homestead and Infrastructure Damage Reduction	Tk million/yr	1.95
Wetland Product	Tk million/yr	(-)0.16
Navigation	Tk million/yr	(-) 0.02
EIRR	Percent	42
Net Present Value	Tk million	134.0

After a thorough assessment, the project was found to be technically feasible, economically viable, socially acceptable and environmentally sound. As such immediate implementation is recommended. Mitigation and enhancement programmes should be implemented simultaneously.

The study recognises that the success of a water management project depends largely on an effective O&M. BWDB frequently cites inadequate O&M resources as the major constraint. Bangladesh Government desires that the beneficiaries at least should contribute to the O&M cost of the project. There is a general belief that one of the key requirements for achieving public contribution is the increased beneficiary participation in project development and management. Acknowledging that belief, the study makes some specific proposals for development and management of the project once a decision is taken for its implementation. The proposals are:

(i) formation of a project coordination committee (PCC) with the representatives from the affected resource user groups in addition to BWDB officials and relevant *thana* officials. This committee will be responsible for implementation of quality works and solving various bottlenecks towards implementation and operation of the project.

(ii) formation of three sub-committees (Sub-PCCs) e.g. embankment committee, regulator committee and drainage channel and *beel* management committee organised around three technically rational water management structures. These committees will be mainly responsible for assisting the agencies responsible for implementation of the project, undertake O&M responsibilities after project development, resolve conflicts between different water user groups and find out ways and means to generate funds for meeting O&M expenses.

It is intended that in the long run Sub-PCCs will be entrusted with the use and maintenance of the project infrastructures and the concerned government departments' role will be limited to seeing the Sub-PCCs use the facilities in the intended manner.

In order to be effective, the members of the sub-committees should be individuals directly benefiting from the interventions, otherwise, as has been found in the Kalni-Kushiyara Pilot Dredging Project carried out by NERP, their effectiveness would diminish should they include members who do not have immediate interest at stake.

(iii) To emphasize O&M activities, it is proposed to undertake project's O&M at least for two years as a part of project development and integrating the members of Sub-PCCs in the activities. During this period, they will receive on-the-job training.

The study also proposes to monitor the project performance at least for two hydrologic cycles after its development; assess real impacts of project interventions on agriculture, fisheries, environment, human welfare, and economics; identify need for alterations and recommend project adjustments as required.

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1. INTRODUCTION

1.1 Background

The Northeast Regional Water Management Project (NERP) in its first phase, carried out pre-feasibility studies for four projects in the Upper Kangsha floodplain, one of which was the Dampara Water Management Project.

The pre-feasibility study for this Project identified flooding as the major water resource problem in the area and recommended the construction of an embankment, with drainage regulators, on the right bank of the Kangsha River. The study also found that almost all the project benefits would come from increased rice production with some losses occurring in the fishery sector.

According to the pre-feasibility study, the proposed project has a general economic rate of return of 19 percent. This compares well with the requisite rate of 12 percent, as prescribed by the government. Considering the net economic and environmental impacts of the project, the pre-feasibility study recommended that the Dampara Water Management Project (Figure 1) be studied at feasibility level.

The Canadian International Development Agency (CIDA), with the Flood Plan Coordination Organization (FPCO) and the Bangladesh Water Development Board (BWDB), decided to proceed with the feasibility study of this Project during the second phase of NERP. If the project is deemed feasible, it will be carried on to the implementation stage.

1.2 Study Objectives and Terms of Reference

The objective of this study is to determine the economic, technical, environmental and social feasibility of the Dampara Project. The study shall, in particular, include:

- the details of the organisational setup required for the adequate operation and maintenance of the completed works. These are established by formal agreement and include mechanisms for cost recovery and plans for beneficiary participation.

- an environmental management plan including the resettlement plan for people whose homesteads will be displaced by the proposed works, and

- a programme for the monitoring of socioeconomic and biophysical impacts of the construction and the operation of the proposed scheme.

Public participation shall be a fundamental component of the feasibility study and a comprehensive view of environmental concerns shall be taken following FPCO Guidelines and Procedures.

Mitigation measures of any kind shall be considered an integral part of the water management scheme under study.

1.3 Project Rationale

Agriculture is the main occupation for more than 85 percent of the people in the project area. Because the population is increasing by 1.54 percent annually, it is imperative to increase food production in the area. There is little potential for increase in dry season, or winter crop production, as most of the irrigable land is under cultivation. There is, however, considerable potential for increasing monsoon crop production through flood management.

Monsoon crops are damaged by spills that overtop the right bank of the Kangsha River and flood some 8,000 ha. of land annually. Winter crops are damaged through inadequate drainage of pre-monsoon rainfall run-off. Drainage problems have resulted from the deterioration of the existing drainage system. Flood waters also inundate homesteads causing much suffering.

Moreover, the flooding situation has worsened with the development of the Kangsha River Project that lies to the east of the Dampara project area. When the Kangsha overtops its banks, a chain-reaction occurs involving the people of the different areas and their response to the flood waters. The flood water is initially trapped by the Netrokona-Durgapur Road that serves as the Kangsha Project's western embankment. People living in the flooded area respond by cutting open the road embankment to drain the flood waters. This causes heavy damage to the Kangsha River Project's crops and infrastructure and cuts road communication between Netrokona and Durgapur. Once the Kangsha River Project's land is submerged by the draining flood waters, the people there then cut open the Netrokona-Purbadhala Road embankment thus disrupting vital road communication between Netrokona and Purbadhala. The town of Netrokona is then threatened by the draining flood waters.

Apart from the agricultural issues there are several other environmental and sociological issues of concern in the area. Fish stocks are low due to the absence of overwintering grounds, poor management and overfishing; *beels* (wetland) are threatened by continuing development and agricultural encroachment; there are problems of domestic water supply shortage, and in the next twenty-year period, more than 23,000 jobs will need to be created to maintain the current level of labour absorption.

This project proposes to manage the area's flooding and drainage problems through several structural interventions described in Chapter 6 of this report. These interventions are to be obtained with minimum interference with the natural ecosystem.

By managing floods and drainage problems, the project intends to achieve the following:

- increase in crop production through flood protection, drainage improvement and sustainable irrigation;
- protection of the project area's infrastructure from flood damage;
- increase in culture fish production;
- increase in the productivity of wetland through protection and management;
- rehabilitation of the Kangsha Project;

- flood protection of the Netrokona-Purbadhala and Netrokona-Durgapur Roads;
- flood protection of Netrokona Town;
- provision of dependable domestic water supply, and
- generation of employment opportunities.

1.4 Methodology

The study was conducted by a multi-disciplinary team consisting of a water resource planning engineer, a computer modelling specialist, a social anthropologist, a gender specialist, an agronomist, a livestock specialist, a fishery biologist, a navigation specialist, an environmental specialist, and a wetland resource specialist. Additional analytical support was provided by an environmental advisor, a water resource planner, a senior modelling engineer, and an economist.

The people's perceptions about problems and their proposed solutions were obtained through field visits, public consultation meetings and discussions with government officials, NGOs and elected representatives. These were consolidated through data analyses, team interaction meetings and the circulation of working papers (Chart 1.1).

1.5 Public Participation in the Planning Process

The public consultation process was initiated with the explicit objective of ensuring people's participation from the planning stage of the project. During public consultation a network of key informants of both genders was developed. Informants comprised community representatives, concerned individuals and local institutions. These informants were identified, contacted and interviewed for their opinions on water-related problems and perceived solutions. These interviews formed the basis of the proposals for intervention.

1.6 Data Sources

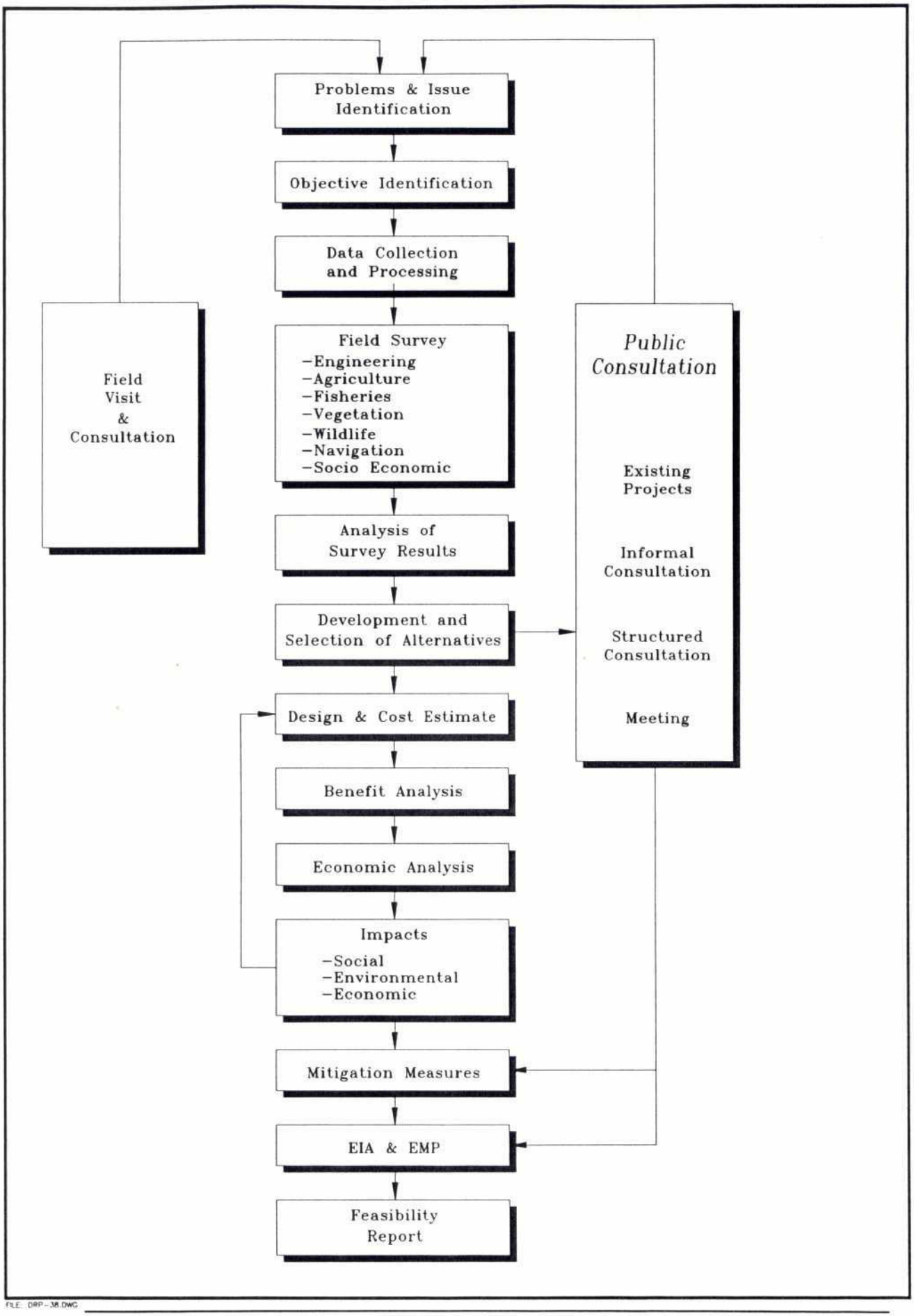
Project analyses presented in this document are based on primary data supplemented by secondary data and information obtained during field inspections and discussions with project area residents. Data sources used by the various disciplines are listed below.

Engineering

Hydrological data were obtained from BWDB and supplemented by NERP's 1994 hydrometric data collection. Climatological data were obtained from the Bangladesh Meteorological Department (BMD). Infrastructure data were collected from the Local Government Engineering Department (LGED). The existing topographic maps, surveyed by Survey of Bangladesh (SOB) in the 1960s, were obtained from BWDB. The groundwater recharge estimates were obtained from the Water Resources Planning Organization (WARPO). Groundwater data for domestic purposes were collected from the Department of Public Health Engineering (DPHE).

NERP conducted engineering surveys including pre-section surveys along the alignment of proposed embankments, cross-section surveys of the boundary rivers and internal drainage channels and a bank line survey. These were undertaken to determine model development, design and cost estimates for project works.

Flow Chart 1.1 : Feasibility Study Process



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Agriculture

The agricultural study was based largely on primary sources including land use surveys, household surveys, input use monitoring, crop cuts and field interviews. Data from secondary sources were also used. The secondary sources include the Soil Resources Development Institute (SRDI), the Food and Agriculture Organization (FAO)/United Nations Development Program (UNDP) *Land Resource Appraisal of Bangladesh*, the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Agricultural Research Institute (BARI), the Bangladesh Rice Research Institute (BRRI), the Department of Agricultural Extension (DAE), the Central Extension Resources Development Institute (CERDI), the Bangladesh Bureau of Statistics (BBS) and WARPO. Views and findings of other studies have been used where applicable.

Fisheries

Data used in the fisheries study were collected by the NERP fishery team. NERP carried out Fishing Effort Surveys (FES) and Catch Assessment Surveys (CAS) at regular intervals and at selected sites to estimate fish production. Pond fish production data were collected through a field survey. In addition, fish consumption and fish market surveys were conducted by NERP.

Vegetation

Most of the data used in the vegetation study are from primary sources. These include land use surveys and ultimate sample surveys on homestead vegetation, wetland vegetation, road side vegetation and agricultural weeds. Secondary data, obtained from the Forestry Master Plan, Bangladesh District Gazetteers and BBS, were used mainly for comparison.

Wildlife

Information regarding the occurrence and status of vertebrate faunal species was collected from field surveys carried out during Phase 1 and from subsequent visits during the feasibility study. A contemporary literature search was done and consultation took place with the Zoological Survey of India, the Forest Department and the Departments of Zoology in the universities of Dhaka and Chittagong. Further information collection and verification were done through sample unit surveys in the project area.

Navigation

Recorded data on the Mechanized Inland Water Transport (MIWT) were collected from the *Annual Traffic Report* (1993-94). The NERP Survey Report (August 1993) and the Bangladesh Inland Water Transport Master Plan (BIWTMAS, August 1989) were the source for processed and printed data. Data on country boats (both mechanised and traditional non-mechanised boats) were obtained from field surveys and through structured questionnaires at various market places and river stations on both *haat* (market) and non-*haat* days. These surveys were done in both the dry and monsoon seasons of 1995 to account for seasonal fluctuations in navigation activities.

Socioeconomic

Qualitative and quantitative information was collected mainly by a field-based team of Community Organisers (CO's). They operated through observation, formal and informal interviews with concerned individuals and groups, group discussions, key informants, check lists and the administration of a pre-designed questionnaire. Information was sought on a range of issues, processes and dynamics. The participatory rural appraisal (PRA) method was used in this respect. The CO's kept daily records in field diaries and made reports and case studies. These provided valuable information for analysis. In addition, a household sample survey was undertaken during a six-month period from June to November 1994.

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1.7 Structure of Report

The baseline situation of the project area is described in Chapter 2. Chapter 3 describes the public participation in the feasibility study process and includes a summary of the problems faced by the people and their suggested solutions. Chapter 4 outlines the water management problems and issues. Chapter 5 forecasts the future of the project area without intervention in the management of area's floods and drainage problems. Chapter 6 presents different solutions of the problems and issues mentioned in Chapter 4 and describes in detail the selected options for the proposed project. Chapter 7 assesses the impacts of the proposed project. Chapter 8 deals with the environmental impact assessment and presents the Environmental Management Plan (EMP). Chapter 9 evaluates the project's economic, social and environmental impacts and Chapter 10 provides the project's management plan.

In addition, five annexes have been prepared to provide detailed information to support the main body of this report:

Annex A - Engineering
Annex B - Agriculture
Annex C - Sociology
Annex D - Economics
Annex E - Environmental Impact Assessment

2. PROJECT AREA CHARACTERISTICS

2.1 Location

The Dampara Water Management Project lies northwest of Netrokona Town and 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 1). The project covers a gross area of 15,000 ha spread over the Purbadhala and Phulpur *thanas*. About 11,361 ha (76%) of the area lies in Purbadhala Thana and 3,639 ha (24%) in Phulpur Thana.

2.2 Land Characteristics

Topography
The general slope of the land is downwards from west to east, but the land also slopes away from the boundary rivers toward the basin centre. Land levels vary from 12.5 m (PWD) in the west in Phulpur *thana*, to 6.5 m (PWD) in the east near Jaria (Figure 2). The topography of the project area is modelled in Figure 3, and the elevation/area/storage relationship of the project area is given in Figure 4.

Physiography
The principal landform found in the project area is lowland floodplain. The highest point of land on the floodplain are often the levees - wedge-shaped ridges on the outer side of river meanders.

The highest ridge soils stand above normal flood-level. Lower ridges and depressions are seasonally flooded. Small areas in depressions are moderately (30-90 cm) to deeply (0.9-1.8 m) flooded, and stay wet for most or all of the dry season. The western part of the project area is subject to shallow flash floods and rainwater is retained on the surface within field *bundhs* (dams). Low-lying areas in this part are shallowly (< 30 cm) to deeply flooded.

Agro-ecological zone
As shown in Figure 5, two agro-ecological zones (AEZ) occur in the project area. These are AEZ 9 (sub-zone 9b - Old Brahmaputra Floodplain) and AEZ 22 (sub-zone 22b - Northern and Eastern Piedmont Plains). Sub-zone 9b covers 79.7 percent of the project area, and extends from the west to the southeast of the project area. Sub-zone 22b occupies the northeastern part and covers 20.3 percent of the land area.

Land Use
Current land use patterns in the project area are shown in Figure 6 and in Table 2.1. 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.

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Cultivated area under different flood depths is given in Table 2.2. These figures were obtained by superimposing the flood depth map (Figure 7) over the land use map. The flood depth map was prepared based on five-year one-day peak water levels.

Table 2.1: Current Land Use

Land Use	Area in ha	% of total area
Cultivated land	12 525	84
Homesteads	470	3
Ponds	120	1
Agro-forestry and plantation	810	5
Infrastructure	485	3
Channel	415	3
Beel	175	1
Total	15000	100

Soil

Six soil associations, sixteen soil series and thirteen general soil types have been identified in the project area. Major soil associations are Lokdeo-Silmandi-Ghatail, Ghatail-Lokdeo, and Lokdeo-Ghatail (medium lowland phase). Lokdeo, Ghatail, Silmandi and Susang are the major soil series. Predominant soil types are Noncalcareous Dark Grey Floodplain, Noncalcareous Grey Floodplain Soils and Acid Basin Clays.

Silt loams and silty clay loams predominate in the soil profile, especially in the highest ridge sites. Clays predominate in depressions. Organic matter content in the cultivated layer ranges from 1 to 1.5 percent in ridge soils to 2 to 5 percent in clays. General soil fertility level is low to medium. Topsoil is moderately acidic. The cultivated layer is usually medium to very strongly acidic with acidity levels higher in the rapidly permeable ridge soils and lower in depression soils. Lower ridge soils are slowly permeable. Moisture holding capacity is high in the deep silt loams on the ridge and moderate or low in more sandy or shallow ridge soils.

2.3 Climate

There is no climatological station within the project area. The nearest station is in Mymensingh, the location of which is shown in Figure 1 (inset). Data from this station was obtained from BMD and is provided in Annex A.

Temperature

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

The length of the cool winter period is 50-90 days with average minimum temperatures below 15° C. The project area experiences 0.5-5 days with maximum average summer temperatures above 40° C.

Rainfall

Mean annual rainfall figures (Figure 8) are based on data collected at 51 gauges during the period 1961-1990. Of the 51 gauges, 23 are located in Bangladesh and 28 in India (Figure 8, inset). The mean annual rainfall data from these stations have been given in Annex A. The spatial distribution of rainfall shows an increasing trend from the southwest (2800 mm) to the northeast (3400 mm).

Rainfall recorded at Mymensingh Climatological Station is not an appropriate measure for the project area. Rainfall analysis for the project area has been based on measurements at Phulpur and Jaria gauges (Figure 8). Monthly statistics, seasonal distribution, depth-duration frequency and rainfall availability from these two gauges are given in Annex A.

Table 2.2: Depth of Monsoon Flooding
(by 1:5 Year Maximum Annual Flood Level)

Flood depth in m.	Land Type	Cultivated Area	
		(ha)	%
0.00-0.30	Highland (F_0)	777	6
0.30-0.90	Medium highland (F_1)	1 319	10
0.90-1.80	Medium lowland (F_2)	4 708	38
> 1.80	Lowland (F_3)	5 721	46
Total		12 525	100

Potential Evapotranspiration

Annual potential evapotranspiration computed at Mymensingh is 1506 mm. The lowest monthly potential evapotranspiration occurs in December (87 mm) and the highest in April (162 mm).

2.4 Hydrology

2.4.1 River Systems

The project area is bounded by the Kangsha River to the north and the Kharia River to the west. The Mogra River runs outside the project boundary to the south (Figure 9).

Kangsha River

The Kangsha River originates at the confluence of the Bhogai and Malijhee, just upstream from Sarchapur (Figure 9, inset). It follows an easterly course and joins the Baulai just south of Sukdevpur (not shown in Figure). The Kangsha is an interceptor drain catching the cross-boundary inflows of the Meghalaya Hills coming through Malijhee, Chillakhali, Bhogai, Nitai, Someswari and other hill streams.

The dimensions of the channel and the tendency to meander increases noticeably after the Kharia River confluence. When the Kharia was active, the Kangsha was a direct continuation of the Kharia River and displayed similar channel patterns. Therefore, the present Kangsha River is

occupying a former distributary spill channel that probably had a different hydrologic regime. The channel is still adjusting to this change, and is very slowly reducing its size and slope by point bar accretion. The tortuous meander pattern and active formation of inner levees within a wide active floodplain are signs of this adjustment as the river forms a channel section that is approximately one-half the width of the original channel.

The bankfull capacity of the river near the project area is about 400 m^3/sec. The mean annual peak cross-boundary inflow to the reach above Jaria is more than 2550 m^3/sec indicating that the river spills overbank.

Water levels and discharges for the river near the project area are measured at Sarchapur and Jaria (Figure 9). The 25-year discharge record at Jaria indicates a range of daily discharges from 0 m^3/sec (1979) to 1430 m^3/sec (1989). The annual peak water levels of the river at Sarchapur and Jaria for various return periods are given in Annex A.

Kharia River

The Kharia River originates from Old Brahmaputra River at Char Niamat, travels past Phulpur and flows into the Kangsha River at Silpur. Since the Old Brahmaputra has changed its course the Kharia intake has silted up heavily and its mouth has been recently closed. Morphologically, the river is now inactive and its water level is controlled by the Kangsha River level. There is no hydrometric data collection programme for this river.

Mogra River

The Mogra is a local seasonal river that originates at Tarakanda and meets with the Donaikhali Khal (a distributary of Kangsha River) at Atpara. It empties into the Baulai River at Chamraghat where it bears the name of Dhanu (not shown in Figure). The Mogra River is alive only during the monsoon season.

The Mogra's water level and discharge are regularly measured at Netrokona. As well, NERP recorded water levels at Trimohoni during the 1994 monsoon period (Figure 9).

The two-year and 20-year annual peak water levels of the river at Netrokona are 8.94 m (PWD) and 9.46 m (PWD) respectively (Annex A). Discharge data at Netrokona are available for three years only (1991-1993). These show a daily discharge range from 0.0 m^3/sec to 285.0 m^3/sec.

2.4.2 Drainage Channels

Kalihar, Balia and Dhalai are the three major drainage channels, or *khals*, of the project area. Mohespatti is a minor drainage channel (Figure 9).

Kalihar Khal originates from Kuma Beel, travels 22 km over the project land and falls on the Kangsha River at Khatuair above Jaria. Balia Khal begins at Shadhupara and empties into the Kangsha River at Chorerbhita below Jaria after travelling 15.5 km over the project land. Dhalai Khal, originating from Saljan Beel, falls on Mogra at Tarakanda. Its length is about 15.5 km. Mohespatti Khal flows into the Kangsha River at Mohespatti Village and drains the Mohespatti Beel.

2.4.3 Surface Water

Surface water is in high surplus in the monsoon season and scarce in the dry season. The Mogra River dries completely after December; the Kangsha River above the Shibganjdhala confluence becomes dry, and the intake and outfall of the Kharia River become dry. There remains a small amount of water pooled at the bottom of the Kharia channel, but it is not used for irrigation since the channel width creates accessibility problems.

In the dry season, *boro* is the single largest crop produced in the project area; it requires 75.0 Mm^3 of irrigation water for the season (Annex A). About 2.0 Mm^3 of water is available from *beels* and drainage channels, but this is negligible considering the irrigation demand for the area. The people of the area construct cross-dams on the Kalihar and Balia Khals to impound water for irrigation. This water dries up with land preparation for *boro* rice.

2.4.4 Groundwater

The project area lies in the Old Brahmaputra floodplain. The alluvial sediments range from coarse, poorly sorted sands to silts and clays and are distributed in complex patterns. From the lithologies of borehole logs of BADC deep tube wells (DTW), a geological cross-section was drawn through the middle of the project from the northwest to the southeast (Figure 10). The cross-section depicts three major sequences of sedimentation pattern. The top layer consists of clay and silt with thicknesses varying from three to ten metres. This is underlain by a transitional layer composed largely of fine to very fine sand and alternating with silty sand and clay. The average thickness of the transitional layer is 30 metres. The main formation consists of fine to medium sand with coarse sands and gravel forming the aquifer materials at a depth of 50 to 100 metres.

As shown in Figure 10, excepting a few localized clay deposits, very fine to fine sand deposits exist within the upper 10 m of the reservoir. These have medium to high specific-yield values in the range of 10-13 percent, which partly explains the very good storage condition in the upper aquifer.

Groundwater Uses

Groundwater use can be divided into three categories: agriculture, domestic and industrial. Agriculture is the major user of groundwater, principally for the irrigation of the dry season *boro* crop: a major crop of the area. The project area's population (112,125 according to the 1991 census) uses groundwater for domestic purposes. The only industry in the project area comprises five small ice plants. Their use of groundwater resources is negligible; therefore, industrial use is not considered in the resource evaluation.

Groundwater level

In the project area, there are three monitoring wells: Purbadhala (MY-04), Jaria (MY-06) and Hatibanda (MY-49) (Figure 9). These wells are operated by BWDB. The water level hydrographs (Figure 11) show good recovery in the monsoon indicating good recharge conditions. In the 1994 monsoon, unusually low rainfall led to the low recovery figures.

As seen from the hydrographs, the lowest ground water levels at all locations are stable, indicating that the demand for resources reaches the maximum. Water demand for irrigation is not likely to increase substantially since the irrigated crop coverage is now at 10,783 ha, about 87 percent of the cultivated land area.

Present Use

Before the privatisation of minor irrigation, most data on groundwater irrigation were collected by BADC. After privatisation, data collection has become inherently more difficult. In 1990-91, and again in 1992-93, the CIDA-funded Agriculture Sector Team (AST) surveyed minor irrigation development in the country. Their survey results are given in Table 2.3.

Table 2.3: Irrigation Mode and Irrigation Area

Irrigation Mode	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

Quantification of groundwater use from wells is not reliable since farmers do not keep records of discharge or operating hours. Groundwater use was quantified using theoretically computed crop water requirements. The irrigation requirement for the *boro* crop is estimated at 75 Mm^3 (Annex A). The available surface water in *beels* and channels is 2 Mm^3 indicating that the demand for groundwater for irrigation is 73 Mm^3.

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 112,125. 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.

Resource Availability

The assessment of groundwater resource availability depends on an accurate determination of groundwater recharge. Recharge is the replenishment of groundwater storage depleted by groundwater discharge. Discharge is the amount of water flowing out of the aquifer through natural flows and withdrawal from wells. On an annual cycle, if the discharge and recharge are equal, extraction will be sustained in the long term.

Besides the soil properties, two other external parameters, namely rainfall and river flooding, influence the recharge rate. Potential recharge in the project area, based on a recharge simulation using average rainfall and flooding scenarios, is 818 mm (Annex A). This figure is equal to 27 percent of mean annual rainfall.

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 figures was made to compensate for uncertainties in the model calibration and in the input data.

2.5 Navigation

Navigation is very seasonal in the project area. Of the three main drainage channels, there is water transportation only in 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 2.4.

Table 2.4: 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. However, the project interventions as discussed in Chapter 6 do not affect the navigability of the Kangsha River.

2.6 Agriculture

Cropping pattern and crop area

Thirty-nine cropping patterns were identified in the project area by NERP's 1994-95 land use survey. The patterns of the major crops are presented in Annex B. Farmers practice sole-stand cropping for the major crops, and a system of mixed cropping for vegetable cultivation.

As compiled from the land use survey, total cropped area is 24,424 ha. Thus, present cropping intensity is 195 percent. Rice dominates crop farming accounting for about 96 percent of the cropped area (Table 2.5). Rape and mustard oilseeds are the major non-rice crops occupying less than three percent of the cropped area.

Rice is grown over the three seasons (*Kharif* I, *Kharif* II and *Rabi*) of the year (see Table 2.6). According to the 1994-95 land use survey, transplanted *aman* (*Kharif* II crop) is cultivated on 88 percent of the cultivated land, *boro* (*Rabi* crop) on 87 percent and *aus* (*Kharif* I crop) on 12 percent of the land.

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 absence of flood threat.

Table 2.5: Area of Major Crops

Crop	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	100.0

Table 2.6: The Seasons of Bangladesh

Gregorian Month	Cropping Season	Meteorological Season
April	**Kharif I** *aus* rice crop	**Pre-monsoon**
May		
June		**Monsoon**
July	**Kharif II** *aman* rice crop	
August		
September		
October		**Post-monsoon**
November	**Rabi** *boro* rice crop	**Dry season**
December		
January	Traditionally no rice was grown in this season. *Boro* cropping is a recent practice, thus the *boro* season does not correspond perfectly with the *Rabi* season, and *boro* is harvested in May	
February		
March		

Crop Yield and Input Use for Different Crops
Based on NERP's 1995 land use and farm household surveys, and farm monitoring study, the yield and input use for different crops are given in Table 2.7. It is to be noted that rice yield/production values given in this report are for paddy.

Labour Use. Labour requirements for the various farm activities vary by the crops and the season. There is high demand of labour during rice transplantation especially in *boro* season.

Draught Animal. Draught animals are not adequately available. Traditional land preparation in crop production involves ploughing, puddling and laddering which require substantial draught power. Timely tillage, as well as proper tillage depth are not achieved due to the shortage of draught power. Cattle are the main source of draught power.

Farm Machinery. Tiller and shallow tubewell are the farm machineries used by the farmers. In the project area few large farmers own tillers. Medium and small farmers use them renting from others. The tillers are used mainly for plouging as their efficiency is low for puddling and laddering compared with bullock drawn country-plough and ladder.

Seed Availability. Usually farmers save seeds from the harvested crop. Sometimes seeds are exchanged among farmers. 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. Nitrogen, derived largely from urea, is the most common and widely used nutrient in the project area. Phosphate is second only to nitrogen in frequency and total volume of use as a fertiliser. The most widely consumed phosphate fertiliser is TSP. Potash is the third most widely used nutrient, and MP is the only source of potash. The other fertilisers include ASP, SSP, DAP, zinc sulphate and gypsum.

Fertilizers are available in the local markets. The price of fertiliser increases in the *Rabi* season when it is used in larger quantities for *boro* rice, wheat, rape and mustard.

Fertiliser application is poorly balanced, with the actual-to-recommended ratio being low (see Annex B). Most of the farmers use no potash. Flooding, inadequate drainage facilities, poor communication, unavailability of fertilizers in time, use of local varieties and poor extension works result in the use of poorly balance use of fertilizers. The potential for balance fertilizer use could be considerably enhanced with drainage improvement, increased confidence of the farmers and shifts from local to modern varieties. The exploitation of potential however also depends upon a number of other price and non-price factors. These include i) access to infrastructure, ii) delivery systems, and iii) extension services including on-farm training to farmers.

Pesticide use. Mainly granular types are used in the project area. The other pesticides include conventional pest complex, acaricide, fungicide and rodenticide. Pesticides are mainly applied on HYV rice. They are rarely used in local rice varieties.

It was estimated from the farm monitoring that about 14% percent of the total cropped land in the project area is treated with pesticides. The application rate is significantly below than the

Table 2.7: Crop Yield and Input Use for Different Crops

Crop	Yield		Inputs Use								
	Damage Free Area (ton/ha)	Damaged Area (ton/ha)	Labour (person days/ha)	Bullock (bullock days/ha)	Seed (kg/ha)	Fertilizer			Pesticide	Irrigation	
						Urea (kg/ha)	TSP (kg/ha)	MP (kg/ha)		Traditional (ha)	Modern (ha)
Loc B Aus	1.80	0.87	96	41	67.2	39.1					
Loc T Aus	2.10	1.60	93	38	48.0	30.8	8.0	3.0	0.2		
HYV T Aus	3.90	3.10	128	60	61.8	194.6	108.1		0.6		
Loc B Aman	1.60	1.28	75	29	100.0	-					
Loc T Aman	2.20	1.60	108	64	39.2	50.7			0.1		
HYV T Aman	3.40	2.60	133	68	54.1	142.1	4.6		0.2		
Loc/Imv L Boro	2.40	1.81	110	28	58.8	72.1	17.3	8.7	0.3	1050	160
HYV Boro	4.60	4.00	153	38	61.2	173.9	41.4	10.2	0.9	980	6580
Wheat	2.03		87	34	148.3	76.2	8.6	34.6	0.4	10	60
Oilseeds	1.00		91	41	6.1	24.6	58.1	15.3			
Jute	1.50		165	40	10.7	42.2	8.4	37.8	0.6		
Vegetables	10.70		232	71	30.0	84.6	50.8	16.9		20	120
Spice	3.50		172	49	22.8	14.8	24.7	9.9			
Sugarcane	22.00		140	42	5000.0	90.0	42.0	28.0			

recommended rate. The highest application rate on average is 0.9 kg/ha compared with the recommended dose of 16.8 kg/ha in HYV boro cultivation. The application rate varied from 0.1 kg/ha to 0.6 kg/ha for other crops.

Irrigation use. Boro rice depends completely on irrigation. Irrigation is also used for the *aus* crop in upland conditions for early seedling raising and initial establishment after transplantation. In the transplanted *aman* area, limited supplemental irrigation has been reported in drought years. Among the non-rice crops, wheat, oilseeds and vegetables and spices are partially irrigated in the dry season.

2.7 Fisheries

Most of the animal protein consumed by the people comes from fish. The area is very important for both capture and culture fisheries due to the presence of several good *beels*, fish migratory routes (within the Kangsha River) and many ponds. Annual fish consumption in the project area is about 592 tons.

Fish Landing, Marketing and Ice Factories

There are nearly 28 small and large fish markets and nine fish *aarats* in the project area. Jaria is the only fish landing centre in the project area. Annual fish sales from these markets and *aarats* are about 500 tons. There are five ice factories at Purbodhala and Jaria that allow for long-range transport of the catch. Generally fish are transported to other parts of the country by train or truck.

Fishing Community

According to a NERP survey, there are 1212 fisher-supported households in the project area. It was reported that some fishers have changed profession due to fish scarcity. Three fishers' societies are present in the study area.

Fish Biodiversity

About 95 of the 155 fish species found in the northeast region were observed within the project area. Several species are uncommon and some species are now becoming rare.

The most dominant species in the project area are Rui, Lachu, Kalibaus, Gozar, Koi, Shingi, Magur, Tengra, Puti, Boal, Ayre, Foli, Kholisa, Baim, Baila, Mola, Chella, Chanda, Gutum, Balichata, and Icha. Major carp usually breed around mid-May with the spawn and fry appearing at the end of May. Among threatened species, Nanid, Mohasol and Pipla are very rare in the project area.

2.7.1 Capture Fishery

Fisheries Habitat

The Kangsha is the most important river for fisheries in the project area. Kalihar and Balia, the two drainage channels of the project area, link the Kangsha River with the project area's *beels* and floodplain. There are 30 seasonal and 10 perennial *beels* in the area. There are also 12,110 ha of seasonal water bodies which includes 6000 ha of very shallowly (0.0 - 0.3 m) flooded land, 3179 ha shallowly (0.3 - 0.9 m) flooded, 2250 ha moderately (0.90 - 1.8 m) flooded and 681 ha deeply (> 1.8 m) flooded land.

Migratory Behaviour

During the pre-monsoon season, smaller fishes begin migrating to the shallow floodplain from adjacent perennial wetlands such as the Doba, Pakhla, and Paniana *beels* (Figure 9). Riverine fish species migrate to *beels* and floodplains just after the wetlands become connected to the rivers. Fish enter the project area from the Kangsha River along the main migratory routes: the Kalihar and Balia Khal.

Fish Production

Annual open water fish production in the project area is estimated to be in the order of 450 metric tons. This estimate is based on NERP's monthly sampling survey from a range of fish habitats. Production varies between habitats from 10 kg/ha (very shallowly flooded floodplain) to 107 kg/ha (moderately flooded floodplain). Channel production is 104 kg/ha.

Fisheries Management

The Kangsha River, from Jaria to Sonaikanda, is under an annual leasing system. Ten of the project's forty *beels* are also under an annual lease. No long-term leasing system is observed. Fishery management is almost nonexistent in the project area.

2.7.2 Culture Fishery

Status and Practice of Culture Fishery

NERP's land use survey identified 1085 ponds covering a total area of 120 ha. The NERP fishery team estimated that about 29 percent of the area's ponds are flood-prone. There is no government fish hatchery in the project area but one private hatchery is under operation. Nearly 35 private nurseries raise fish fry from spawn in the project area.

Existing pond culture is of a traditional type. Most of the fingerlings are collected from nurseries and fry traders. Fingerlings are occasionally caught from the open water where there is no enforcement of fishing regulations and no management of stocks. Fertilizer and fish feeds are used in very small quantities.

Fish Production

Average flood-free pond production in the project area is 929.1 kg/ha. Flood-prone pond production is about 706 kg/ha. Total pond production is estimated to be around 100 tons.

Fish Culture Extension Programme

The Danish International Development Agency (DANIDA) and two NGOs (CARITAS and WORLD VISION) have taken up major pond fish culture extension programmes in the project area.

2.8 Vegetation

Terrestrial flora

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 is the single most important plant community, occupying about 700 ha of the project area. This vegetation generally includes two types of plant: those cultivated for their economic value and those that are self propagating. 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. Besides supplying food, fodder, medicine and other household requirements, trees are the major source of timber and renewable biomass energy. Annual return from an average homestead platform is about Tk. 7,000.

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 project. Annual returns from these plantations total Tk. 152,000 per hectare or Tk. 15.8 million for the total area.

Crop field vegetation extends over 12,525 hectares or 83.5 percent of the project area. This area is largely used for rice monoculture. Grasslands are concentrated in the eastern part of the area, and cover about eight hectares of land. They are used as common grazing land.

Excepting the Syamganj-Jaria Road, roadsides are generally without trees. Recent planting has been undertaken on some portions of the Purbadhala-Phulpur Road. All other roadside trees are privately owned and not planted as roadside plantation.

Aquatic flora

Wetlands are generally shallow and have very little water remaining in the dry season. Perennial wetland plants grow with difficulty under such conditions.

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 higher 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 *Nelumbo nucifera* and *Eurayle ferox*.

In the western section, where the land is much higher and perennial water bodies are few, aquatic plants have very little opportunity 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 the regeneration process.

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. In seasonally flooded areas, the growth period for the wetland plants extends from May to October only.

Human use of aquatic plant products remains very low. Wetland plant products are minimally used for food, medicine, fuel, fodder and thatching materials.

2.9 Wildlife

Of the faunal species surveyed, 39 percent are dependent on aquatic and 61 percent on terrestrial habitats.

Aquatic Fauna

Data on the occurrence of wildlife species and habitat preference were collected by a specially developed survey method in which sample units were selected for both flora and fauna. In all, 29 aquatic sample units were surveyed within the project area. A total of 104 species of aquatic fauna were observed. Of these, 68 species are totally dependent on wetlands (*beels*, river, ponds), and 36 species are partially dependent on wetlands. The survey also showed a habitat preference for stretches abutting homestead backyards. The reasons for this preference are security and availability of cover.

Terrestrial Fauna

A total of 161 terrestrial species were observed within the project area. Of these, 133 species preferred homestead and open woodland areas while 28 species preferred grass or fallow land habitats.

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 *Vulpes bengalensis* (khek shiyal), *Prionailurus viverrinus* (mecho biral), *Lutra perspicillata* (ud biral), *Leptoptilos javanicus* (modontak), *Haliaeetus leucoryphus* (kural), and *Varanus flavescens* (halud gui). In addition, some species found within the project area are listed in the Schedules of the *Convention on International Trade in Endangered Species of Flora and Fauna* (CITES). Those listed are *Lutra lutra* (ud biral), *Falco peregrinus* (baz pakhi), *Kachuga tecta* (kori kaitta), *Lissemys punctata* (sundi kasim), *Melanochelys tricarinata* (shila kochop), *Aspideretes hurum* (jat kasim), *Varanus bengalensis* (kalo gui), *V. flavescens* (halud gui), *Ptyas mucosus* (dharaj sap), *Naja naja* (gokhra), and *Rana tigerina* (sona bang).

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*).

Commercial exploitation of economically important species like *Lutra lutra, Varanus bengalensis, Ptyas mucosus* and *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.

2.10 Socio-economic Situation

Population

The population of the Dampara Project area, according to the 1991 population census, is estimated to be 112,125. The population density is 747/km² which is very close to the national figure of 755/km².

Population Growth

In the period 1981-1991 the population increased at a rate of 1.54 percent annually. This is much lower than the rate for Bangladesh as a whole (2.01%), and may be attributable to net out-migration. Long-term annual population growth has been 1.28 percent since the first census in 1872 (Graph 2.1).

Religion and Ethnicity

The predominant population, comprising 92.9 percent of the total, is Muslim of a single ethnicity. Minorities are Hindu (6.6 percent) and Christian (0.5 percent). In Kalduar, Sadhupara and Hogla (Figure 9) there are 88 households (0.4% of the population) belonging to the Garo ethnic community. They are all Christian by faith.

Demographic features

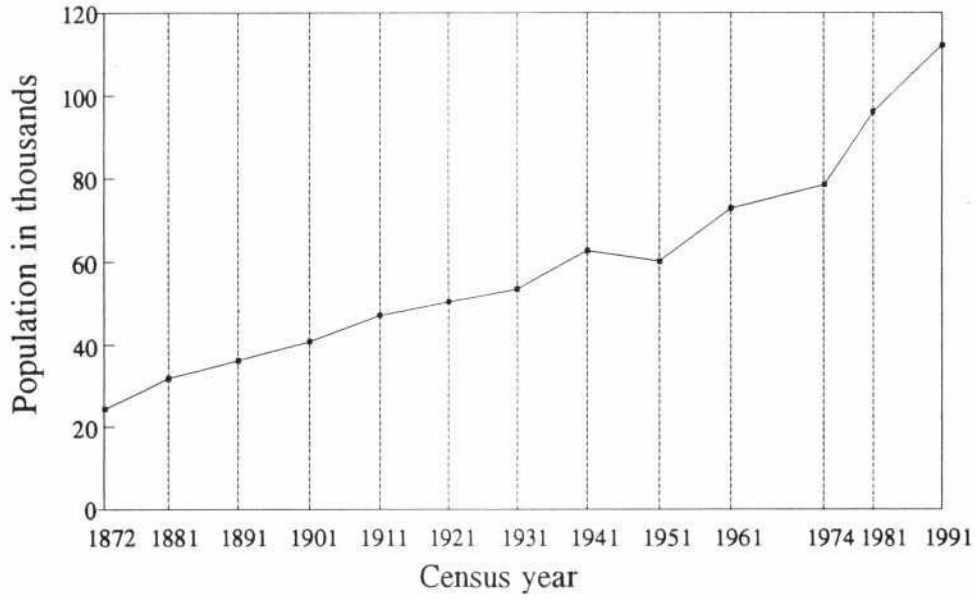
According to the NERP household survey, the average household size is 5.13 which is lower than the figure for Bangladesh (5.48). The sex ratio (number of males per 100 females) is 103. This is also lower than the national ratio of 106. Households with large farm holdings are generally larger than poorer households. In poorer families, there are more female members than male.

Nuclear families are predominant in the area. The larger, extended families are more common only in large farm holding households.

Human settlements

Human settlements are distributed in villages belonging to 114 *mauza*. Houses are built on earthen mounds. One village may have one or several clusters based on hydrological and social factors. A cluster comprises one *para* (neighbourhood) or a *bari* that is the conglomeration of several *ghar* (house). A *bari* represents an extended family or several nuclear families having a common lineage. Often, members of a *bari* jointly own or share some resources, such as a pond, a courtyard, a family graveyard, homestead vegetation or land for seedbed.

Graph 2.1: Population growth



Settlements are dense in the villages along the Kangsha River and are relatively sparse in the middle part of the study area, particularly in villages of Meghshimul, Kalihar and Bahuli.

Land ownership

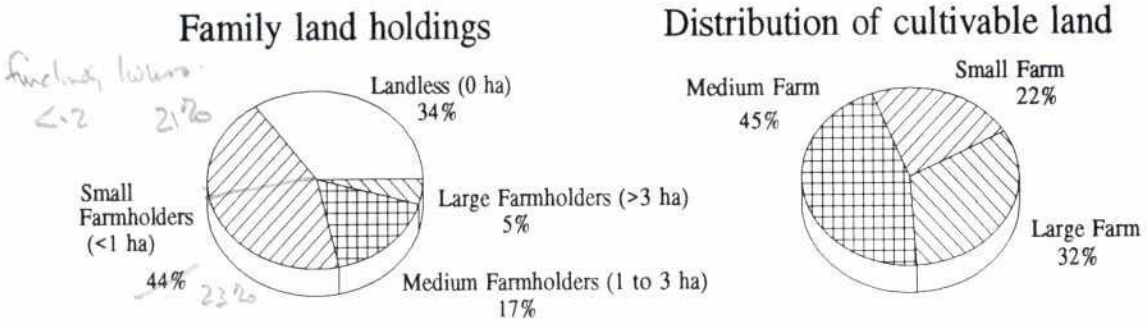
Land distribution is unevenly distributed with few large landowners. It has been observed that about 5-10 families own most of the land in an average village. Results of a household survey show that 34 percent of the households do not own any cultivable land (Graph 2.2) and another 21 percent own an amount of cultivable land not exceeding 0.2 ha. This group is considered functionally landless. Survey data also show that the bottom 55 percent of households own only 4 percent of the total cultivable land while the top 5 percent own 32 percent.

Tenancy Conditions

Farms are mostly owner-operated. The system of *barga* (sharecropping) is also practiced. Usually the landless and small landowners sharecrop, mainly for subsistence. Five percent of the farmland in Dampara is worked by farmers who do not own any cultivable land. Also, many small farmers try to increase their farm area under sharecropping arrangements. In Dampara, 17 percent of farm area is cultivated under the crop-sharing system. Cash rental of land is virtually absent. Sometimes landowners mortgage their land in times of economic distress. They borrow money

and the land is given as collateral. The operational right of the land rests with the moneylender and the income generated from it is reaped by him until the loan is repaid. Mortgaged land accounts for 5 percent of the total farm area.

Graph 2.2: Land-ownership patterns



Source of livelihood

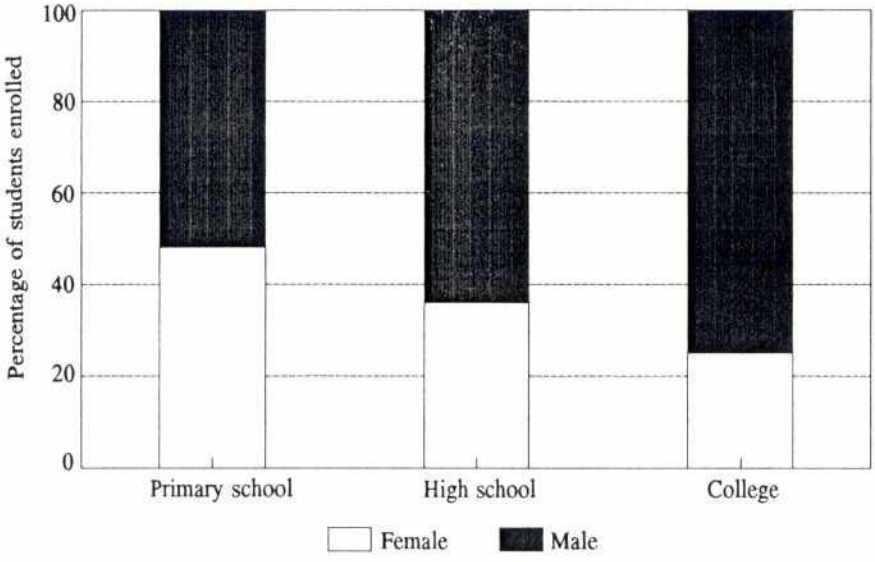
The economy is mainly land-based and agriculture is the predominant source of livelihood for most households. Agricultural labour is an important occupation for poorer households, and is the main source of income for one-fifth of the small farmers. Fishing and trading are also important sources of living for some poor households. Among the large farmers, very few are involved in non-farm occupations.

Women are mainly involved in activities determined by traditional gender roles. They fetch water, grow vegetables, do post-harvest processing of rice, raise poultry, make *kantha* (quilts), make household utilities with bamboo and cane, collect fuel, etc. Women do such work irrespective of their household economic status. They are mostly "self-employed" or unpaid family workers. Wage employment is not readily available for women. Some poor women parboil and husk rice or work as housemaids in better-off families.

Education

According to the 1991 population census, the literacy rate of the population of seven years and older is 23 percent in Purbadhala *thana* and 21 percent in Phulpur *thana*. These rates are much lower than the national rate (32%). In the study area within Purbadhala *thana*, there are 27 government primary schools and 10 government-approved private primary schools. The population-primary school ratio is similar in Purbadhala and in Bangladesh (roughly 4.4 schools per 10,000 population). There are also seven secondary schools and two colleges. The female literacy rate is lower than the male literacy rate in all groups. The ratio of female students to male students drops with the higher levels of education (Graph 2.3).

Graph 2.3: Gender Distribution of Students



Health and Sanitation

There is one government health centre/hospital in Purbadhala *thana* headquarters. There are seven graduate doctors and three nurses in the hospital. There is one Family Welfare Centre (FWC), run by an extension worker known as Family Welfare Visitor (FWV), in each union. FWCs provide mother and child healthcare (MCH) services to villagers, supply contraceptives to eligible couples and provide immunization to children and pregnant mothers.

Analysis of information on patients treated in the *thana* hospital in 1994 shows that people mainly suffer from worm infestation, diarrhoea and skin diseases. More patients come to the hospital in the post-monsoon period (October to January). Most patients belong to the older age groups and only 3 percent of the patients are below one year of age. The neonatal mortality rate is quite high, about 29 per thousand live births, and another 2.1 percent die between one month and one year of age.

There is one public hand tube well per 91 persons. The tube well/population ratio is higher than that of Bangladesh (1/123). Five percent of the tube wells were out of order during the study time. In the dry season when STWs and DTWs are in operation for irrigation many hand tube wells run dry due to the lowering of the water table. The problem is resolved by sinking *Tara* pumps. In the study area, 31 percent of the hand tube wells are *Tara* pumps. All households use tube well water for drinking purposes. For most households (71%), tube wells are located within 100 meters.

The state of sanitation is appalling. Most households do not have latrines. Few medium and large farm households possess water-seal latrines.

Urbanization
Purbadhala *thana* headquarters is the lone *de jure* urban centre in the study area. Its population is 15,996 (1991 census). Urban population, therefore, accounts for 14 percent of the total population. This is lower than the figure for Bangladesh (20%). Jaria is another potential urban enclave.

Markets and Growth Centres
Jaria is the main growth centre and a landing station for traded commodities. Other important market places are Purbadhala, Hogla, Dheutukun, Ghagra and Baola (Figure 9). There are permanent shops and *aarats* in all these markets. Traders and customers gather in large numbers on *haat* days. Hogla is the biggest *haat* in this area. Rice is the most important export commodity and is transported to Phulpur, Netrokona, Mymensingh, Noakhali and Dhaka. Among other traded commodities are jute, vegetables and poultry.

2.11 Infrastructure

Roads
There are about 10 km of metalled and 76 km of unmetalled roads in the project area in addition to many kilometres of village roads. As shown in Figure 9, almost all the motorable roads run north-south and are intercepted by the Phulpur-Purbadhala Road. All these roads were constructed under Food for Works (FFW) Programme. The LGED has earmarked the roads for further development in their programme to connect all growth centres of the area by metalled roads.

Railways
In the project area, there are more than 9 km of metre gauge railway line and six railway bridges between Purbadhala and Jaria. It is a part of the Mymensingh-Shymganj-Purbadhala-Jaria railway line, with the north terminus at Jaria (Figure 9). Before road development, it was the only transport route for the northern area. It is still the most dependable route during floods when road communication is frequently disrupted. Country boats connecting the different growth centres of the area coordinate their schedules with the trains' arrivals and departures.

Drainage Structures
There are two drainage regulators in the area. One regulator (R-1) with five vents on the Kalihar Nadi outfall at Khatuair, and another (R-2) with ten vents on the Balia Nadi outfall at Chorerbhita (Figure 9). Vent size is 1.52 m x 1.83 m for both regulators.

Road Bridge across the Kangsha River
Two road bridges - one at Jaria and the other at Goatola (Figure 9) across the Kangsha River are under construction.

3. PUBLIC CONSULTATION

3.1 Mode of Data Collection

In accordance with FPCO guidelines, a public consultation process was initiated with the explicit objective to ensure public participation from the planning stage of the project. The field team included two female and two male Community Organizers (CO). The CO's were based in the project area and operated as a link between the study team and the community. The process of data collection was highly participatory and included informal methods that required socialization within the community. Besides the work of the CO's, senior NERP professionals also made regular field visits for data collection purposes.

3.2 Public Meetings

Knowledgeable persons and community leaders were identified and invited to informal meetings to discuss water-related problems and possible solutions. Two such meetings were held: one at Ghagra on 4 August 1994 and the other at Shadhupara on 27 November 1994. The Ghagra meeting was attended by 99 persons from 12 villages belonging to two unions. The Shadhupara meeting was attended by 62 persons from nine villages belonging to five unions. Later, proceedings of these meetings were prepared in *Bangla* and distributed to attendees. Opinions and suggestions of the people were used for the feasibility study and in the formation of hypotheses concerning the project.

3.3 Meetings with Community Leaders

Separate meetings were arranged for community representatives to solicit opinions and to disseminate the project idea. *Union Parishads* (UP) Chairmen and Members attended two such meetings. One meeting took place at Jaria on 5 August 1994 and was attended by 14 community leaders from Jaria and Ghagra unions. The other meeting was held at Shadhupara on 25 November 1994 and was attended by 26 community leaders from Hogla, Agia, Purbadhala, Balia and Baola unions. Minutes were later prepared in *Bangla* and distributed among the participants.

3.4 Meetings with Special Interest Groups

Formal and informal meetings with different groups were held to solicit the perceptions of the people. Discussion centred around problems of the area and suggested solutions.

One meeting was held at Naterkona in February 1995 that was attended by 60 people representing different socioeconomic groups. 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 planning the dyke alignment, attempts were made to consult people with homesteads outside the protected area. Group discussions were held in 17 villages along the proposed dyke alignment from Naterkona to Bisharadpur. The main purpose of these meetings was to learn the nature and extent of the impact of the dyke construction, and to simplify understanding of issues related to the safety and the maintenance of the dyke.

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.

A meeting with the *Jaria Nadi Nitimala Samity* was held at Gujakhalikanda on 17 October 1994. The meeting was attended by 25 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*.

A meeting with members of fishing community was arranged at Barha village on 16 February 1995. Discussions were held on the possible impacts of the flood control infrastructure on fish resources.

Meetings were also held with local staff members of NGOs that are active in the project area. Among these NGOs are Association for Social Advancement (ASA), SECCA, CARITAS and Grameen Bank. A meeting with senior management of CARITAS and ASA was held in Dhaka. Information regarding ongoing activities and processes of community organization was sought. CARITAS is the only area NGO involved in dyke construction. They built on an *ad hoc* basis in response to community requests.

3.5 Summary of Concerns

During the public consultation process, many problems and issues were identified and discussed. Solutions were also suggested. The following is a summary of these discussions.

3.5.1 Problems and Issues:

- Flood water comes suddenly from the hills. Rivers have silted up and cannot drain much water. As a result, flood water spills over the banks during the monsoon;
- Flood water damages *aman* crops, houses and homestead plantations;
- Cooking food and keeping poultry and livestock become extremely difficult during floods;
- When tube wells are submerged or become inoperative, the suffering of women is multiplied;
- The embankment benefits one side of the river while the other side suffers;
- Flood water stays longer than before because drainage is obstructed by roads and embankments, particularly by the Purbadhala-Jaria road embankment;
- Drainage regulators are not effective;
- Dampara area residents cut the Kangsha Project embankment to save houses and crops;
- Fish resources have declined since the construction of a drainage regulator at Chorerbhita and the closure on the *Jaria Nadi*;

- The incidence of fish disease has increased. This is due to the deterioration of water quality from increasing use of agro-chemicals, and

- In the dry season there is scarcity of surface water for irrigation. The *khals* and rivers dry up. *Boro* fields are negatively affected and boat transportation is disrupted.

3.5.2 Suggested Measures:

- A flood protection embankment should be constructed along the right bank of the Kangsha;

- The embankment should be built close to the river bank so that more households can be protected;

- When planning the alignment of the embankment, care should be taken that cultivable land remains inside the embankment;

- The rivers that are silted up should be dredged to help irrigation; Kangsha River should be dredged to improve drainage.

- Enlargement of the Kalihar drainage regulator is needed;

- A drainage regulator should be constructed at Dheutukun Bazaar, 8 km south of Jaria;

- Measures should be taken against river erosion;

- LLP inlet structures should be constructed so that high embankments do not hamper the use of low-lift pumps (LLPs), and

- Those who will lose their land should be compensated.

3.6 Operation and Maintenance

In the public consultation meetings, the need for locally-based O&M was emphasised in order to give the people (beneficiaries) a sense of ownership of the project. The COs have been involved in a public education process where the need for and the benefits of locally-based O&M was discussed and explained. The audience also suggested to increase the role of the elected local government councils. Chairmen and members of the concerned union parishads also showed a keen interest in the O&M of the infrastructures.

Interest and enthusiasm of the beneficiaries in the project activities has been evident in the case study of Naterkona dyke (see Annex C). This involvement may be formalised through an appropriate institutional mechanism.

4. WATER MANAGEMENT PROBLEMS AND ISSUES

4.1 Introduction

Water management problems and issues in the project area were initially identified by NERP in consultation with the people of the area. Field data collection and analysis were carried out to confirm concerns expressed during consultation (see Chapter 3).

Flooding is perceived to be the main water resource problem in the area, though there are also problems of adequate surface drainage during the pre-monsoon season. There seems sufficient groundwater for irrigation purposes, but domestic water wells often run dry when groundwater resources are used for irrigation.

This chapter identifies in detail these water resource issues and explains how the problems influence the area's economic activities, social life and infrastructure.

4.2 Flooding

The following highlights are the observation made by NERP during the 1995 flood.

The 1995 Flood

Flooding occurred twice in 1995 in both June and July. Of the two floods, the latter was more severe and longer in duration. Flooding began 13 June in the lower areas of Ghagra and Purbadhala unions. There was no standing crop at the time and only a few houses in Meghshimul village went under half a meter of water. The water receded on 23 June. Water began to rise again on 4 July and flood conditions continued until the first week of August. The period from 6 to 17 July was particularly critical. Homesteads in several villages were flooded for about two weeks.

Among the worst affected unions were Jaria, Purbadhala and Ghagra. Water submerged village platforms in almost all villages and entered some houses. The flood situation was particularly severe in Barha and Meghshimul. All homesteads in these two villages went under water. Earthen houses fell.

Access to potable water became a serious problem during the flood. Tube wells were frequently submerged; in Meghshimul and Barha no tube well remained above the flood level. Finding safe water became a burden, particularly for women. Rafts, made of banana plants, were used for transport, particularly to bring water from a distance. Some had to wade through waist-deep water to reach drinking water from other houses.

Economically the area was devastated. Water remained stagnant on agricultural land in the villages of Ghagra, Purbadhala, and Jaria unions until the first week of August. In Jaria union, matured *aus* and *jala* (seedlings) of *aman* were destroyed. Transplanted *aman* was also damaged on 20-25 ha of land in Barha. As the water subsided, farmers tried to transplant *aman* again. The price of *jala* and rice seed rose dramatically after the flood, sometimes the price tripled, putting replanting beyond the economic reach of many farmers.

Other forms of agriculture and pisciculture were also affected. Summer vegetables like pumpkin, brinjal, cucumber, ladies finger, water gourd and bitter gourd were ruined. The price of vegetables and other commodities rose, but prices for livestock were low. Because of the unavailability of fodder and space to keep animals, area residents were often compelled to sell livestock at depressed prices. Some pond-owners were forced to sell their fish before maturity at low prices.

The negative effects of the flood fell disproportionately on the poor. The economic condition of day labourers and small traders worsened. Because of poor road conditions, *rickshaw wallahs* and bullock-cart drivers could not work. Since the poorer families live at lower elevations, their houses suffered greater damage. Many poor families took shelter in the homesteads of wealthier people. Because there was no work in the fields male family members often left the area in search of work. The women worked in the houses in which they were seeking shelter. They would often fetch drinking water and perform other chores in exchange for shelter and meals. Many had to borrow rice, and sometimes cash, from neighbours or relatives.

4.2.1 Sources of Flooding

Flooding results from the inability of the Kangsha River channel to carry peak flows. More than 74 percent of the project area is inundated by the annual floods (Figure 12). Flood waters from the Kangsha start entering the area through the Kalihar and Balia channels. A bank line survey along the Kangsha right bank from Jaria to Meda (Figure 13), conducted by NERP, shows that there is a spillover into the project area even under a two-year flooding situation.

4.2.2 Flooding Characteristics.

The area is located in a flash flood zone of the Kangsha River. Kangsha floods occur more than once a year and may occur at any time. In 1991, there were six floods between June and October (Figure 14). The extent of damage caused by a flood depends largely upon its duration and timing. Generally, flood waters stay in the area for seven to ten days, and floods occurring late in the year are more damaging than early ones.

4.2.3 Impact of Flooding

Agriculture
Despite the presence of a small fishery sector, the economy of the area is almost completely dependent on agriculture: the major crop being rice. There is a "service sector," which is projected to be a source of increasing employment, but it is dependant upon agricultural output.

The major economic impact of flooding, therefore, is on rice cultivation. The *aus* crop, which is grown on highlands covering 12 percent of the cultivated land area, is moderately affected by floods. The *boro* crop is grown on 87 percent of the cultivated land area in the dry season. It relies heavily on irrigation and is rarely affected by floods. Flooding has its greatest impact on the transplanted *aman* crop. Of the three rice crops, t.*aman* covers the largest area (88%). It is a rainfed crop with low fertilizer and pesticide inputs. Depending upon time of occurrence, flooding affects t. *aman* at its three stages of development:

Seedling stage: The *aman* crop is seeded on highlands and transplanted to lower lands once the threat of the early flood is perceived to have passed. Early floods (June-July) can damage seedlings depending on the depth of the flood and the elevation of the seedbed. Farmers may buy new seedlings from others with higher land, but often at double or triple pre-flood prices.

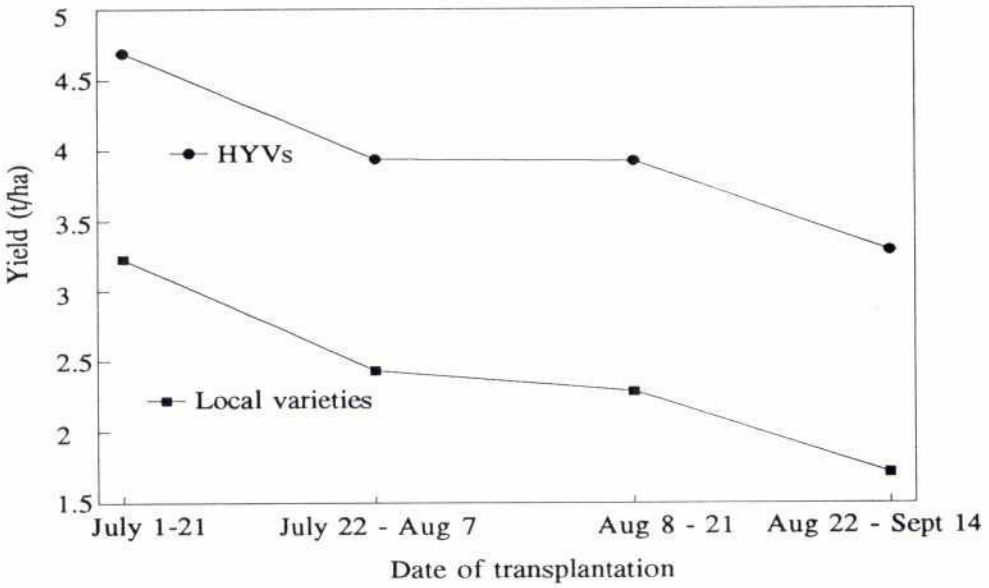
Economically marginal farmers are the most affected group since they are unable to keep sufficient seedling stocks. The raising of fresh seedlings is not feasible since the transplantation period will be over by the time the new seedlings are ready. Many areas remain fallow after early floods due to lack of seedlings.

Vegetative Growth Stage: The July-August floods damage standing t. *aman* crop at the vegetative growth stage. The crop may be re-transplanted if seedlings are available but ultimate yield decreases significantly. The yield-decreasing effects may be attributed to the use of old seedlings and too late-planting.

Low yield for late transplantation: Since the final flood recession time is unpredictable, seedlings are kept from the beginning of the transplanting period. Moreover, taller seedlings are preferred for transplantation in lowlands. Thus, the use of aged, old and unhealthy seedlings is common.

Transplanted *aman* initiates panicle or flower primordia in response to a short photoperiod or day-length. Thus, t. *aman* varieties mature at the usual time despite shortened vegetative growth

Graph 4.1: Effect of Transplantation Timing on Yield of T. *Aman*



period due to late planting. The short growth period results in poor tiller production, which in turn negatively effects grain yield. A NERP survey indicates that the yield from local variety rice crops (paddy) transplanted in late June is about 3.25 tons/ha compared to 2.4 tons/ha from the crop transplanted in mid August (Graph 4.1).

Reproductive Stage: Late floods (September-October) damage the crop completely. Seedlings are not generally available then. Despite seedling availability, the yield from such a late transplantation would be so low that it would not pay the input costs to farmers. The loss from late floods, therefore, is usually total.

The 1991 floods (Figure 14) damaged t.*aman* crops at the seedling stage, again in the vegetative stage and finally in the reproductive stage. The loss was colossal. Area people reported that in the last fifty years, the *aman* crop has only been satisfactorily harvested in 1994, the year in which there was no flooding.

Fisheries

Eighty percent of area's fish are produced in open water. Flooding is a significant factor for open water fish production since a large area remains under water. The Kangsha River is the main fish source in the project area. Migration routes through the Balia channels are impeded by the 10-vent regulator at the outfall of the Balia channel. This inhibits fish production and species regeneration

Another factor inhibiting floodplain fish production is the inadequacy of overwintering grounds. Perennial *beels* often become seasonal due to deposition of silt by flood waters. Brood fishes are trapped in drying *beels* and channels. Several *beels* like Rajdhala have almost lost their migratory link with the river because of the siltation of link canals. This results in low fish production despite the large water area.

Floods also affect the practice of pisciculture. About 30 percent of the project's ponds are prone to overtopping during floods. This discourages the pond owners from engaging in intensive fish culture.

There are about 1200 professional fisher families in the study area (total population 112,125). Because of inadequate fisheries resources some are forced to find alternate employment, but the paucity of other employment opportunities leaves them with few options.

Vegetation

Though homestead platforms and orchards are higher in elevation than nearby crop fields, they often suffer from flooding. Flood damage occurs especially in the eastern and central portion of the area where the land levels are lower. Most of the commercially important tree species are highly or moderately sensitive to flooding and if flood waters persist longer than a week many trees die. Other plants, like herbs, shrubs and climbers are more vulnerable to flooding and die with shorter periods of inundation.

Social Perspective

Employment opportunities are available mainly in the *boro* season. In the monsoon season jobs are scarce. This problem is exacerbated by flooding. During the flood season, many labourers go to other districts in search of work. Chittagong, Comilla, Noakhali, Feni and Sylhet are preferred areas of employment. Labourers can earn Tk.50-60 and three meals a day. This compares favourably to the wage rate in the Dampara area (Tk.20-30 plus food).

The impacts of flooding are different for women. Women play a key role in customary homestead-based activities. Besides many other chores, they grow fruits and vegetables, raise poultry and livestock, make household utilities with bamboo, cane and other available material. Much of their relative autonomy depends on the return they receive from these activities. These activities are seriously disrupted by floods, particularly when the homestead platform is submerged. In extreme cases the whole infrastructure supporting such activities is destroyed.

Daily chores also become burdensome. The cooking of food is hampered by the unavailability of fuelwood and dried cow dung. Hand tube wells become inundated, making access to potable water difficult. Homesteads become isolated from one another and latrines get washed away. Some, especially the poor, resort to using flood waters for domestic purposes; this leads to the outbreak of diarrhoeal diseases. Often essential medical services can not be reached due to the disruption of road communication.

The Kangsha Project

The BWDB's Kangsha Project lies to the east of the Dampara Project area. Before construction of the Kangsha Project, floodwater flowed from the Dampara Project area through the Kangsha Project area. Part of the Kangsha Project included making the Purbadhala-Jaria Road the project's western embankment (Figure 15) by closing the bridge culverts. As a result, flood waters are effectively dammed in the Dampara Project area and homesteads not previously subject to flooding are now being flooded. This leads the people living in the Dampara Project area to cut open the road embankment, resulting in the flooding of the Kangsha Project and the destruction of standing crops. The following highlights are the observation made by NERP during the 1995 flood.

The 1995 Flood and the Kangsha Project

On 20 June 1995 water levels in the Kangsha Project area were about 2.75 meters below those in the Dampara Project area. The level of the Kangsha at Jaria was 10.68 m (PWD).

On 7 July at midnight, Dampara Project area residents cut the Kangsha Project west embankment at the Bamonkhali Bridge (Figure 15). As a result the bridge was washed away completely. On the same day the Purbadhala-Jaria Road was overtopped at Guzalikanda and breached in three places. The entire Kangsha Project was then flooded. The level of the Kangsha at Jaria was 11.35 m (PWD).

On 9 July a pipe outlet under construction at Garkanda on the north embankment of the Kangsha Project was breached due to the failure of the west embankment. Kangsha Project area residents then cut the eastern embankment (Baroari Road) for rapid drainage of flood waters. This, in turn, flooded the Thakurakona Project (Figure 15). The Kangsha Project's southern embankment (Netrokona-Purbadhala Road) was submerged in four places closing the road for a week.

On 10 July Thakurakona Project area residents cut the eastern embankment near the Thakurakona Regulator to drain out the flood water to the Kangsha River.

Road and Rail Transportation

The Netrokona-Purbadhala and Purbadhala-Jaria road network plays a vital role in transportation and communication. The disruption of road communication has a significant impact on the area's economy. When flooding occurs and this link is submerged or breached through human action, communication within the entire region is disrupted. There are more than 76 km of seasonally motorable roads and many kilometres of village roads in the area. Floods submerge and damage these roads at many locations and wash away major road structures.

Sections of the Purbadhala-Jaria railway become submerged by Kangsha floods, forcing railway authorities to suspend rail communication.

Netrokona Town

Floods entering the Kangsha Project area also submerge the low-lying areas of Netrokona Town. The 1993 flood damaged a bridge structure on the outskirts of Netrokona Town disrupting road communication with Thakurakona, an important landing centre for the northern areas of Netrokona District. In 1995 floods in the Kangsha Project area submerged large sections of Netrokona Town.

4.3 Drainage

Though flooding is the single largest problem of the area, pre-monsoon rainfall run-off is also problematic due the lack of adequate surface drainage. It is mainly young *aus* and *boro* crops that are damaged by drainage congestion.

Three main channels drain the area: Kalihar, Balia and Dhalai. Dhalai channel passes through Phulpur and Purbadhala *thanas* and drains the Deola, Baghaura and Attua *beels* through the Attuar *khal* (Figure 9). The beds of both the Attuar *khal* and the Dhalai channel have suffered serious deterioration due to siltation and encroachment by farmers and pond-owners.

The bed of the Dhalai channel has been transformed into agricultural land or ponds in many parts. Land-owners on both sides of the channel have developed the bed for crop cultivation leaving only one to two meters of channel width. The channel is also being used as a water reservoir and for fish ponds by wealthier residents.

In an attempt to alleviate inadequate drainage, the Mortujalir *khal* was excavated to drain out the upper catchment of Dhalai channel. This, however, negatively affected farmers in the Dhala *beel*. After excavation, their *boro* crops were submerged by the upland drainage. The Chairman of Balia union proposed re-excavation of the Mortujalir *khal*, but attempts were resisted by farmers of Dhala *beel*. From Mortujalir *khal* to Kaichapur village, the Dhalai channel is no longer visible.

Among villages more severely affected by inadequate drainage are Charalpara, Araton Kanpara, Shalikakanda, Shaljan, and Uttarkanda. Shaljan *beel* was once connected to Dhalai channel by a *khal* that has since silted up completely. Since the water of Shaljan *beel* cannot be drained, crops in about 200 ha of land in the *beel* are damaged. As a result, many have sold their land and migrated out of the area.

4.4 Irrigation

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

Surface water is very scarce in the area. At present, the Kalihar and Balia channels are dammed and used to store water for irrigation. Since irrigation from surface water sources is cheap, there is a demand for augmentation of water storage in these two channels. About 97% of the area's irrigation water comes from groundwater sources.

Domestic water supply suffers due to the heavy withdrawal of groundwater for irrigation. Suction mode hand tube wells (HTW) are widely used for withdrawing groundwater for domestic use.

But large scale groundwater withdrawal for irrigation lowers the water table. As a consequence, many HTWs run dry. There is apprehension that the groundwater reserves will become depleted and the area will suffer from water shortages in future.

These concerns are addressed in Chapter 6.

4.5 Other Issues

The following are some other issues related to flooding, drainage and irrigation development:

- Conflicts arise between the people of the different project areas over the cutting of embankments.

- There is conflict between farmers (85% of the population) and fishers (5% of the population). Farmers want to reduce flooding during the monsoon to protect their crops; but fishers feel that more water increases fish resources.

- There is also conflict between upland farmers and lowland farmers over water flow. To protect their crops, upland farmers divert drainage flow towards lowland. This damages the lowland crops. In the dry season upstream farmers retain water for irrigation. This deprives downstream farmers of using surface water for irrigation.

5. WITHOUT-PROJECT TREND

5.1 Introduction

As discussed in Chapter 6, this 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. However, changes in the biophysical and socioeconomic environment of the project area will occur even without those interventions.

The purpose of this chapter is to characterize the future of the project area without the proposed interventions. Trends in the resource base have been analyzed to project future scenarios. These are described briefly in the following paragraphs.

5.2 Social Trends

Population growth

According to projections made by the World Bank, the Net Reproductive Rate (NRR) for Bangladesh will be 1 by 2010 and the annual growth rate will be 1.23 percent for the period 2010 to 2015. Assuming a growth rate of 1.54 percent in 1991 (rate for Bangladesh) that decreases linearly to 1.23 percent in 2015, the population in the area is projected to be 155,710 in year 2015 (see Table 5.1). This corresponds to an average annual growth rate of 1.38 percent.

Table 5.1: Future Population

Year	Growth Rate	Population				
		Total	Urban	Rural	Rural	Civilian
1991	1.54	112,125	15,996	96,129	52,871	52,665
1995	1.49	119,034	18,004	101,030	57,229	57,273
2000	1.42	127,908	20,871	107,036	63,186	63,034
2005	1.36	137,008	24,195	112,813	69,762	68,794
2010	1.29	146,292	28,049	118,243	77,023	74,555
2015	1.23	155,710	32,517	123,194	85,039	80,315

Urbanisation

The development of new urban centres other than Purbadhala *thana* headquarters is unlikely. Purbadhala town, which possesses infrastructure for education, health and employment, will continue to draw people from rural areas. Population growth rates are unavailable for Purbadhala. Using the growth rate of Netrokona town (3%) as a base figure, urban population in Dampara is projected to increase from 15 percent to 21 percent in the year 2015 (Table 5.1).

Jaria, an important landing station for freight traffic, will lose its commercial significance after the construction of the proposed bridge across the Kangsha.

Land endowment
One impact of population growth may be changes in land endowment. The average size of land holding will diminish as the land is shared among a greater number of people. There will also be growth in the landless population. This will occur both through the natural growth rate within that group and through increases in the number of people becoming landless through socioeconomic forces. Assuming a 2 percent growth of the rural landless population (natural growth rate 1.38%), the proportion of the functionally landless (<0.2 ha/family) will be 69% in 2015 compared to 55% in 1991.

Labour force
The civilian labour force (CLF), defined as the population aged 10 years and older, was 46.97 percent of the total population of Bangladesh in 1991. According to national projections, the CLF will be 51.58 percent in the year 2015. Assuming a similar trend and linear growth, more than 23,000 jobs will need to be created in the next twenty years to maintain the current level of labour absorption in the project area.

Environmental hygiene
Increased population will have adverse effect on environmental hygiene. Rural population will increase by twenty two percent in the next twenty years (1995-2015). More people will crowd on homesteads. There will be little space for latrine, cow-shed, dwelling house and kitchen garden. Population-tube well ratio will increase.

Status of Women
Women work with low wages. The situation will further deteriorate as more women will compete for work. In many cases, they will have to enter into uneven competition with male labourers in the job market. With shrinking size of homesteads, women's opportunities for home-based economic activities will decline.

Social Conflict
With the need for more production in the Kangsha and Thakurakona project areas to satisfy the demand of the growing population, conflict will increase between the Dampara area people and the people of those two project areas.

Local authorities will continue to construct flood control schemes. Some of these will be unplanned and uncoordinated and will be 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 project conditions.

5.3 Agriculture and Fisheries

Land use
According to NERP's 1995 land use survey, the area of land under homestead is 470 ha. The per capita availability of homestead land, therefore, is roughly 0.004 ha. If the same land-person ratio is maintained in the future, the potential demand for homestead land will increase by 152 ha to 622 ha in 2015.

Part of the potential demand for homestead will be met through increasing population densities of homestead areas. The projection for increase in homestead land has therefore been based on 50 percent of the potential demand of 152 ha. The area under homestead is thus projected to be 546 ha in 2015.

Demand for land for other purposes, including social and economic infrastructure, will also increase. Land availability for crops will decline to meet the requirements for homestead and other purposes.

The net cultivated area is 12,525 ha (83.5 percent of the project area) compared to 11,160 ha (74.4%) in the early 1980s, representing a 9.1 percent increase over the past decade. Almost 100 percent of the cultivable area is now under cultivation and there is little potential to expand the cultivable area. Expected future land use patterns of the area without project intervention are given in Table 5.2.

Table 5.2: Land Use Pattern - Present and Future Without Project

Land Use	Present (ha)	FWO (ha)	Change (ha)
Net Cultivated Land	12525	12377	-148
Homesteads	470	546	76
Ponds	120	135	15
Agro-forestry and Homestead Plantation	810	857	47
Infrastructure	485	500	15
Channel	415	415	
Beel	175	170	-5
Total	15000	15000	

Crop Damage

Recent flooding patterns in the project area have resulted in increasing pressure on the crop production system. Effective transplanted *aman* season is getting shorter; consequently, the amount of land under monsoon crop is decreasing. The occurrence of late floods, which are more damaging to t.*aman* crops, is increasing.

Water levels of the Kangsha River at Jaria from 1964 to 1995 show no change in the trend. Since flooding in the area and Kangsha River levels at Jaria are directly related, it is projected that flooding and consequential crop damage will continue.

It is further projected that there will be an increase in loss of *boro* and *aus* crops due to continued deterioration of the drainage channels. Every flood causes sediment deposition in the channels, and human encroachment will continue due to the population increase. Further channel encroachment will occur when monsoon crop failure forces people to resort to increasing crop production by cultivating dry season crop on the drainage channels.

Crop Production Growth
It has been hypothesized that crop production in the area could increase by expanding the area under irrigation in the dry season. In the past, the area under irrigation has increased due to the rapid development of STWs. By 1995, 94 percent of the project area's cultivated land was under irrigation. It is projected, therefore, that there is little potential for a further increase in this respect. However, a slight increase in general production is expected due to increased cropping intensity and improved crop management.

Floodplain Fishery
Observations of past fish production suggest an annual decline of three to five percent. This decline is due to overfishing, fish diseases, increasing sedimentation, the absence of overwintering grounds and the deterioration of water quality due to the increased use of pesticides on agricultural lands.

Pond Fishery
Pond fishery is likely to expand in flood-free areas but people in flood-prone areas will be discouraged to invest in this sector.

5.4 Flora and Fauna

Terrestrial flora
Past trends did not favour plantation of trees, which is now experiencing increasing popularity. Both area under plantation and number of tree species are increasing in homestead plots. Scarcity of forest products and the rising cost of fuel make plantations extremely profitable, while improved management has decreased mortality rates. Orchards and bamboo groves, also very lucrative, are on the increase. Roadside plantations have not gained momentum yet, but some government organisations and NGOs have started work in the sector. It is predicted that existing grasslands are likely to disappear in the future as demand for more "economic" uses of the land increases.

Aquatic flora
Due to the deteriorating state of the wetlands, the future of aquatic flora is grim. Wetlands in the project area are highly modified by human activities. Every year more wetland area comes under agriculture. Moreover, remaining wetlands are used as a source of irrigation water, which destroys the regeneration process.

Wildlife
Local wildlife populations are declining drastically due to habitat alteration and human interference. Projected increases in human population will only exacerbate this situation. Declines in wildlife population will continue unless effective conservation measures are taken.

5.5 Transportation

Although historical data on water transport in the area are unavailable, it was surmised from field studies that a large volume of rice paddy was transported by country boats during the monsoon. This sector has experienced substantial declines in recent years, due largely to improvements in the roadway network. Currently only two mechanised boats ply the Kalihar Channel (the lone navigable channel of the project area) on market days and only one boat on non-market days. As

well, a few non-mechanised boats ply the channel. In future, water transportation will continue to decrease due to expansion and improvement of road communication and continuing siltation and human encroachment of waterways.

Road transportation will increase with LGED's programme to connect all the growth centres with the national highways. This will include the construction of two road bridges at Jaria and Goatola. The roadways will become the most important mode for the transport of high value agricultural products like poultry, dairy products and fish.

The rail system will lose its importance with the improvement of road networks.

5.6 River Morphology

Of the three boundary rivers, the Mogra and the Kharia are morphologically inactive. The Kangsha River which controls the project area's flooding and drainage is active and relatively stable. No significant changes in the River's morphology are expected along the project area from Sarchapur to Jaria. However, bank erosion will continue at the outside of meander bends as part of the normal meandering process.

6. PROPOSED PROJECT

6.1 Project Concept

As discussed in Chapter 4, the main water management problem in the area is flooding from the Kangsha River. Floodwaters spill into the project area over the river bank from Jaria to Meda (Figure 1) damaging monsoon crops, homesteads and infrastructure. The purpose of the project is to protect major monsoon crops and secure the safety of homesteads and infrastructure through flood management.

The two major monsoon crops are the rice varieties *aus* and *aman*. *Aus* is grown in the early monsoon and *aman* is the late monsoon crop. They cover 12 and 88 percent of the cultivated land respectively. The coverage of *aman* is not only higher in comparison to *aus* but its production is substantially greater. Moreover, much of the *aus* area is located on flood-free highlands. For these reasons, the main thrust of this project is to protect the *aman* crop. *Aman* crop protection may be achieved by providing flood protection from July to October which is the flood-vulnerable period for this crop.

The concept of the project is to protect the major monsoon crops through flood management but with minimum impacts on other sectors e.g. fisheries and wetlands. This will be accomplished by allowing the early monsoon floods to enter into the project area to the extent that homesteads and infrastructure are not threatened. Though this will negatively affect the *aus* crop, it will allow the area to derive beneficial aspects of flooding, i.e., improvement of floodplain fisheries, regeneration of wetlands and improvement in soil fertility. Early monsoon flooding is particularly important to the fisheries, because of the timing of fish migration and spawning.

6.2 Project Alternatives

This study examines two alternatives for reducing flood depths in the project area and for achieving the project objectives:

- Alternative 1: Dredging of the Kangsha River
- Alternative 2: Construction of an Embankment

As discussed in Chapter 3, these are the two alternatives suggested by the local people as a way to solve flooding problems.

6.3 Assessment of Alternatives

Alternative 1: Dredging of the Kangsha River. This alternative was assessed by simulating the effects of channel re-excavation with the MIKE-11 hydrodynamic model. Data from 1991 were used to simulate flood conditions.

In order to assess this alternative, the channel's cross sectional area was increased by an average of 300 m^2 over a distance of 40 km between Jaria and Paikpara (Figure 15). This excavation increased the channel area by about 25 percent at bankfull stage. The total volume of excavated material was estimated to be approximately 12,000,000 m^3. Water levels were lower by about 0.4 m at peak flood conditions (Figure 16). The decrease in water level would not prevent bank overtopping.

The cost of channel excavation would be high, in the order of Tk 1,440,000,000 (US $ 25,000,000), assuming a unit dredging cost of 120 Tk/m^3. Problems of dredge spoil disposal would probably increase these costs, since land acquisition would be required for disposal sites. Approximately 300 dredger-months would be required to complete the work (assuming 18" dredgers were used, operating 10 hours/day and 20 days/month). For example, with five dredgers operating 12 months of the year, the work could be completed in a minimum of five years.

The Someswari River supplies sand-sized sediment to the Kangsha River. Consequently, channel sedimentation would take place in the dredge cut, starting at the upstream end near Jaria and eventually progressing downstream. Therefore, annual maintenance dredging would be required to prevent the channel from silting up again. Ongoing annual maintenance dredging would probably be in the order of 1,500,000 m^3/year which corresponds to a cost of Tk 180,000,000/year (US$ 3,200,000). On the basis of preliminary analysis it is clear that dredging will not provide a long-term, sustainable solution to monsoon flooding in the Dampara Project area.

Alternative 2: The Construction of an Embankment. An embankment is the alternative plan to reduce flooding in the area. About 29.7 km of embankment from Jaria to Meda would be required to prevent Kangsha flood spills. The flood routing analysis for the 1991 hydrological conditions indicates that an embankment would lower water levels in the project area by up to 0.86 m at peak flood conditions and prevent bank overtopping, even during severe floods like that of 1988 .

The cost of the embankment would be low, in the order of Tk 18,853,000 including cost of appurtenant structure, compared to Tk 1440,000,000 for dredging cost. The construction could be completed in two working season. Ongoing annual maintenance costs would not be more than Tk 1,054,000/year compared to a cost of Tk 180,000,000/year in case of channel maintenance.

The overwhelming majority of people in the area advocate for an embankment. This demand is not new. The NERP social team discovered that people have been demanding such an embankment, or *bundh*, since the 1930s (see box).

After analysis of all the data on the two options, the embankment emerged as the best alternative. Therefore, the feasibility study was conducted for this option only.

History of the Dampara *bundh*

The need for an embankment on the Kangsha has been expressed by local people for many years. The issue of the Dampara bundh (Figure 1) was first raised during the peasant movements against the feudal land-renting system in the 1930s and 40s. Eventually local farmers were mobilised to provide voluntary labour for the construction of a 300-meter *bundh* in Dampara village in the mid-forties.

In 1946, at a peasants' conference in Netrokona, the Dampara Bundh was identified as a major problem. The *bundh* was causing the discharge of the Kangsha to enter through Naya Khal, flood surrounding villages and damage *aman* crops on vast areas of land. In response, the peasant leaders attempted to close the mouth of Naya Khal, but, due to high velocity of water in the river, the attempt failed.

Finally, in 1949 large tree trunks were placed across Naya Khal and both banks of the *khal* were embanked to protect the *bundh*. The people on other side of the river however, were not satisfied. Thinking that their crops would be at risk, they cautioned the people of Dampara that they would cut the *bundh*. The situation became tense and the *bundh* was guarded around the clock, but nothing came of the confrontation.

The *bundh* and both embankments of the Naya Khal were eroded during floods. They were repaired both by the *Union Parishad* and by flood-affected villagers living on both sides of *khal* at different times. More recently CARITAS (a national NGO) has become involved in the maintenance of the *bundh*. Since 1989 it has also been extended by 2 km through the collective work of local people, the *Union Parishad* and CARITAS.

The *bundh* provided some benefit to the people of the area, but after the formation of the Shibganjdhala Channel, water levels changed and the *bundh* was no longer effective as a flood-protection device.

6.4 Project Description

Though flooding is the main problem in the area, this project also addresses drainage and irrigation problems. Proposed project interventions are given in Figure 17.

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 (Figure 17). Field surveys indicate that there are no spills above Meda. The proposed embankment will connect to the existing Kangsha Project embankment which ends near Jaria.

The FPCO's guidelines recommend the utilisation of existing roads for embankments. Around Naterkona Village, there are two potential roads for embankment use - one to the north of the village and the other to the south (Figure 17). The north road (Caritas Road) is close to the river, and is not very 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. To ensure adequate safety to the project area against flooding, this study therefore recommends the development of the southern road as the project's embankment. To prevent flooding of the village, it is proposed to improve the Caritas

Road. In case the Caritas Road is breached , only Naterkona Village will be affected but the project area will still be protected by the project embankment. This proposal was agreed upon by the people of the village.

The topography of Naterkona Village slopes towards south to the project area. To drain rainfall-run-off from the village area, it is proposed to install three small drainage outlets on the proposed project embankment.

It is further proposed to test and construct drainage regulators to aid in the drainage of the project area's rain waters. There are two existing drainage regulators - one at Khatuair on the outfall of Kalihar Channel and the other at Chorerbhita on the outfall of Balia Channel. 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*.

Interventions in Drainage Problems

Young *aus* and *boro* crops are damaged by drainage congestion caused by pre-monsoon rainfall-run-off. 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-run-off 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. The detailed computations are in Annex A.

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. As discussed in Chapter 2, the total irrigation need is 75 Mm^3. Of it, only two Mm^3 is 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. They proposed that surface water be augmented by enlarging the Kalihar and Balia channels.

Channel enlargement is not a viable option. Kalihar and Balia channels are adequate for draining their respective catchments (Annex A) so 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 which is negligible. Enlargement will induce siltation in the channel requiring re-excavation periodically. Also, since there are many homesteads located on the banks of Kalihar Channel, enlargement will displace many people.

There is apprehension that groundwater reserve will be depleted and the area will suffer water shortages in future. But as stated earlier, available groundwater is 92.0 Mm3 which is greater than the present use (75.0 Mm^3). Since 94 percent of the project's cultivated land is already under winter crop, there is little room for increasing the area under irrigation. It is predicted, therefore, that demand for ground water will remain relatively stable (Figure 11) and supply appears adequate.

In view of these considerations, this study does not propose interventions for irrigation development. However, it is recommending a continuation of groundwater monitoring at three locations: Purbadhala, Jaria and Hatibanda (Figure 9).

Proposed Project Interventions
The main components of the proposed project include the following:

- construction of 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;
- utilization of existing two regulators at the outfall of Kalihar and Balia Channels;
- closing off the Kalihar Channel at the regulator site and excavation of the diversion channel;
- 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 30 LLP inlet structures.

The proposed interventions will:

- protect the project area's crops from damage caused by floods and drainage congestion;
- rehabilitate the Kangsha Project;
- protect the Netrokona-Purbadhala and Netrokona-Durgapur roads and the project's internal infrastructure;
- protect Netrokona Town;
- protect ponds from flooding; and,
- protect the project area's infrastructures and homesteads from flood damage.

6.5 Planning and Design of Structures

Detailed computations for design and analyses of various components of the scheme are provided in Annex A. The findings are summarised below.

Embankment (Jaria-Meda)
Alignment: Selection of a proper alignment is a key to the success of any embankment project. The alignment must be technically safe as well as socially acceptable. These aspects have been seriously considered while planning the alignment of the proposed embankment.

The local preference is for an embankment on the bank of the river so that the maximum amount of land and homesteads come under its protection. Unfortunately, morphological processes dictate that the best alignment is that which is furthest away from the river bank. When too many people are left unprotected the safety of the embankment can not be assured. Therefore a compromise must be made whereas homesteads and farm lands are protected without sacrificing the safety of the embankment.

A social survey, conducted by NERP in villages along the river's right bank, found that many farmers are willing to "sacrifice" homesteads rather than crop land. This is particularly true for those who own both homestead and cropland. The implicit assumption is that if one loses a crop, one loses their means of living. But when the homestead is inundated, the people suffer for a few weeks and then "everything becomes normal" again. These views have been considered in aligning the proposed embankment.

The Kangsha River reach through the project area is a depositional zone. This implies that there is little bank erosion taking place. Because of this, the proposed embankment can safely be aligned with the minimum setback distance of six metres from the river bank. In the few places where erosion has regularly occurred, the setback has been fixed based on the erosion rate. An extra margin, equivalent to five years of the present erosion rate, will be added to the minimum setback figures.

Past channel shifting was estimated by comparing the 1990 channel alignment (from 1:50,000 scale SPOT imagery) and the alignment in 1961 (shown on 1:15,480 scale water development maps). It was found that the overall channel pattern has remained unchanged, but erosion has occurred along the concave banks of river meanders. Erosion rates are difficult to assess accurately, given the lack of precision of small scale mapping. However, it appears that many bends have shifted 90 to 120 m and some have shifted up to 250 m over the last 30 years. An average erosion rate on the meanders has been estimated to be about four metres per year. Thus the minimum setback required at the concave bend is 20.0 m.

A setback of 15.0 to 30.0 m from the top of the river bank has been designed and is shown on a *mauza* map in Annex A. While planning the alignment, the following additional considerations have been made:

- wherever possible, all available roads have been used as a part of the embankment;
- homesteads and farmlands have been kept in the protected area as much as possible;
- to avoid displacement of homesteads, the alignment has been detoured, and
- the acquisition of poor family's land has been avoided as far as possible.

The preliminary layout plan indicates no displacement of homesteads.

Design: The main purpose of the embankment is to protect the agriculture of the area. BWDB's criteria in such cases is to provide protection for a 20-year flood with a free board of 0.91 m. An additional 0.25 m was added to the design elevations to compensate for consolidation and confinement effects. Accordingly, the embankment crest level is set at 12.83 m, PWD at Meda and 12.46 m, PWD at Jaria based on 20-year peak flood levels of the Kangsha River at Sarchapur and Jaria respectively. The elevations are shown in Table 6.1.

Following BWDB's guidelines, the top width is 4.27 m with a river-side slope of 3:1 and a country-side slope of 2:1. A typical cross-section and longitudinal profile are shown in Figure 18.

Table 6.1: Embankment Crest Elevations

Location	Section (km)	20-yr Flood Level (m,PWD)	Design Crest Level (m,PWD)	Constructed Crest Level (m,PWD)
Jaria	0.0	11.30	12.21	12.46
Meda	29.7	11.67	12.58	12.83

Re-sectioning of Caritas Road by Naterkona Village

The Caritas Road by Naterkona Village takes off the proposed embankment at km 1.118 to run for 2.01 km and ends at km 2.65 of the embankment. Design consideration for the road embankment is the same as that for the Jaria - Meda embankment. Design elevations are given in Table 6.2, and the longitudinal profile is shown in Figure 19.

Table 6.2: Design Crest Elevations for Caritas Road

Location (Jaria-Meda Embankment)	Section (km)	20-yr Flood Level (m,PWD)	Design Crest Level (m,PWD)	Crest Level to be Constructed (m,PWD)
Km 1.118	0.00	11.30	12.21	12.46
Km 2.650	2.01	11.33	12.24	12.49

Earthwork. The amount of earthwork required for construction was estimated based on design sections and ground levels obtained from NERP surveys. Cross-sections (totalling 1,647) were taken along the Jaria - Meda embankment at intervals of 20 m and at critical locations. An estimated 743,000 m^3 of infilling will be required for construction of the embankment (Annex A).

On the Caritas Road section, 138 cross-sections were taken at intervals of 15 m and at critical locations. About 24,400 m^3 of infilling will be required for this section of the embankment.

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 minimise land acquisition, earth will be procured from landowners through the payment of royalties.

Drainage Regulators

The catchment areas of the drainage channels have been delineated and are shown in Figure 20. The area drained by the different channels are: Kalihar, 7270 ha; Balia, 4090 ha; Dhalai, 1640 ha, and Mohespatti, 200 ha. About 1800 ha drains directly into the Mogra River.

The construction of an embankment along the Kangsha will close the openings of Balia, Kalihar and Mohespatti channels in order to stop the entry of flood water into the area. These closures will impound rainfall-run-off in the project area. As a mitigation measure, regulating structures are required to make passage for draining rainfall-run-off to the Kangsha River when river levels permit.

Two drainage regulators exist in the project area: one of 5 vents (vent size: 1.52 m x 1.83 m) located at Khatuair at the outfall of Kalihar Channel and the other of 10 vents (same vent size) situated at Chorerbhita at the outfall of Balia Channel. The adequacy of these two structures was checked by flood routing analyses, following BWDB's criteria, during pre-monsoon (April-May) and monsoon (July-October) seasons. Detailed computations of the flood routing analyses are given in Annex A. The analyses indicate that the existing structures are adequate for draining their respective catchments. The maximum polder water level for the design rainfall has been computed to be 9.94 m (PWD).

A comparison of 1994 water levels measured at Chorerbhita on the Kangsha and Trimohoni on the Mogra shows that the Mogra River level is about 1.5 m lower than that of the Kangsha River (Figure 21). Though the present drainage pattern of the area is towards the Kangsha, this situation suggests investigation of the possibility of diverting a portion of the drainage flow from the Kalihar and Balia catchments to the Mogra River. Since there is no direct channel towards the Mogra from the catchment areas, the drainage flow would be diverted to the Mogra over the Kangsha Project.

Flood routing analysis reveals that the Dampara Project would benefit by a lowering of water levels by 0.74 m but the Kangsha Project's water level would be raised by 0.25 m. The benefit to one project is offset by the cost to the other project, therefore the diversion is not recommended.

Small Drainage Outlet Structures

Four new small drainage outlet structures are required to drain Moheshpatti Beel and Naterkona Village. As shown in Figure 17, a small drainage outlet structure (0.90 m) is proposed at the outfall of the Mohespatti Khal to drain the Mohespatti Beel. There are also three other small structures (0.50 m) for draining Naterkona Village. These structures were checked and found adequate to drain their respective catchments (see Annex A for details).

Drainage Channel Re-excavation

This study analyzed the adequacy of the area's three main drainage channels (Kalihar, Balia and Dhalai) to discharge the pre-monsoon rainfall-run-off without damaging crops. Details of the analyses are given in Annex A.

The design discharge was computed from drainage area and drainage modulus. Each channel was subdivided into a number of reaches. Drainage area under each reach was computed based on drainage patterns. The drainage moduli for the Kalihar and Balia catchments have been calculated based on 10-day 10-year pre-monsoon rainfall (up to 31 May) recorded at Jaria and computed to be 30.6 mm/day and those for Dhalai catchment to be 26.1 mm/day based on Phulpur rainfall records. The design discharge has been calculated by multiplying the drainage area by the drainage modulus.

A computer programme for back water using the Step Method was run to compute the channel's design water levels. The existing cross-sections of the channels were used. The sections were enlarged where inadequate. Flow velocities at design discharge were checked and kept between 0.30 to 0.70 m/sec.

It was found that Kalihar and Balia channels are adequate to drain the design discharge but the Dhalai Channel needs re-excavation for 9.6 km involving the removal of 92,000 m^3 of earthwork.

7. IMPACTS OF PROJECT INTERVENTIONS

7.1 Introduction

The purpose of this Chapter is to identify significant project impacts. The environmental impact assessment (EIA) identified important environmental components (IECs) that will be affected by the project development. This chapter deals with the most significant of these impacts. The detailed EIA, including methodology is contained in Annex E (Environmental Impact Assessment).

The IECs identified through a scoping process and discussed in this chapter are:

- surface water quantity
- groundwater quantity
- surface water quality
- open water fishery
- wetlands
- agricultural production
- culture fisheries
- employment
- navigation
- homestead and public infrastructure
- public health
- social harmony
- women's opportunities

7.2 Physical/Chemical Impacts

7.2.1 Impact on Surface Water

As a result of flood protection measures, monsoon season peak water level in the project area will be reduced by more than 86 cm for a 5-year rainfall conditions. This, in turn, will mean reduced depths of inundation. The maximum project area water level will be 9.94 m, PWD.

The 5-yr rainfall conditions have been adopted for the selection of cropping patterns with project conditions. The underlaying rationale is that farmers will opt for a higher degree of protection if they are to more in HYV crops in future with project conditions.

The cultivable area under different flood depths for FWO and FW project conditions are given in Table 7.1. Flood depth maps were prepared for FWO project conditions based on 1:5 year maximum Kangsha River levels and for FW project conditions based on a design polder water level of 9.94 m, PWD. The flood depth maps for pre- and post-project conditions are shown in Figures 7 and 22 respectively. Net cultivated areas under different flood depths were computed by superimposing the land use maps (adjusted for FWO and FW conditions) over the flood depth maps (see Annex B for details).

Water Levels on the Left Bank

Embanking the right bank of the Kangsha River from Jaria to Meda will raise water levels on the left bank floodplain. A hydrodynamic model analysis reveals that the interventions will raise water levels by five centimetres and ten centimetres respectively under 2-yr and 20-yr flooding conditions. This rise of water level is not expected to affect the cropping pattern in that area.

Table 7.1: Depth of Monsoon Flooding

Flood Depth (m)	Net Cultivated Area (ha)	
	FWO	FW
0.00-0.30	650	8517
0.30-0.90	1300	1582
0.90-1.80	4705	1339
>1.80	5722	854
Total	12377	12292

7.2.2 Impact on Groundwater Recharge

The proposed embankment would reduce flood depths in the project area and affect groundwater recharge. To determine the impact of the embankment on groundwater recharge, the WARPO Recharge Model was run at the request of NERP using 1988 hydrological data, with and without flooding conditions. Reduced flood depths predict a decrease of groundwater recharge by about 6 percent. The output is presented in Table 7.2.

With reduced recharge, available groundwater is 86.2 Mm^3. The groundwater requirement for irrigation is 73.0 Mm^3. Thus even with reduced recharge, groundwater is sufficient to meet the demand for irrigation in the area.

Table 7.2: 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

Impact on Hand Tube Wells

At present, groundwater withdrawal for irrigation lowers the water level to the extent that in many areas the No. 6 suction mode HTWs, upon which area people are dependent for domestic water supply, are running dry. These hand pumps cannot operate beyond 7.0 m of suction head. The reduced recharge will slightly aggravate the situation.

7.2.3 Surface Water Quality

Floodwater from rain and river 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.

7.3 Biological Impacts

7.3.1 Open Water Fishery

At present more than eighty percent of the area's fish production comes from the open water fishery, which is dependant on seasonal flooding. The floodplain fishery is important because professional fishers and landless people earn their livelihood by fishing the open resource of the floodplain. Also whereas species are very limited in culture fishery, the floodplain fishery is highly diversified.

Fisheries production, before and immediately after project development has been given in Table 7.3. Floodplain fishery resources will be reduced by about 221 tons or 50 percent of present production. The production is reduced due to the reduction of water surface area and the alteration of habitat type by the project interventions. The project will reduce about 978 ha of water surface area and convert 3000 ha of deeply flooded land (>0.30 m of flood depth) to shallowly flooded area (<0.3 m of flood depth) which is poor in fish production. The main reduction is due to the reduction of moderate deeply flooded land (0.90 m to 1.80 m flood depth) from 2250 ha to 603 ha. Fish production in this type of habitat is the highest (Table 7.3).

Irrespective of project development, losses in the floodplain fishery are predicted to occur at the rate of three percent per year due to overfishing, improper management of beels, fish disease, absence of overwintering grounds and the deterioration of water quality due to increased use of pesticides on agricultural lands. Considering this, the average fish availability under the FW and the FWO scenarios over a thirty-year period (the projected lifetime of the project) is given in Table 7.4 (see Annex D for details).

Table 7.3: Open Water Fish 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	0-0.3	10	6000	60	10	9000	90
	0.3-0.9	29	3179	92	29	1042	30
	0.9-1.8	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**

Table 7.4: 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	108	0	0
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	- 127	- 4.9	115	156	41	1.2

7.3.2 Wetlands

There are no wetlands of either national or international importance within the Dampara Project area. The area has no *haor*, and is characterised by a large floodplain that is seasonally inundated. It contains a large number of *beels* that are locally important for their economic and biodiversity values.

The project will affect the seasonal wetlands (floodplain) by reducing the water surface area. It will reduce winter wetland area by 8 percent from 860 ha to 787 ha. and summer wetland area by 30 percent from 2048 ha to 1438 ha.

The wetlands of the Dampara area provide habitat for at least 104 wildlife species, a number of which are currently on the IUCN *Red Data Book* and others which are listed with CITES. The impact on permanent water bodies would be insignificant in respect to surface area but significant change could develop in water depths. Habitat reduction could have a profound effect on certain wetland species that may be more sensitive to hydrological changes than others. Some rare species that would likely not survive would be *Nelumbo nucifera* and *Eurayle ferox*. In some instances species may be able to adapt to drier conditions and conditions where human activity is likely to increase as a result of the wetland reduction but the area's biodiversity will be weakened.

The projected economic impact of the project on wetlands is negative. Using an annual production figure of Tk. 300 per hectare for both summer and winter wetland areas gives a total annual loss of Tk 0.20 million per year (Table 7.5).

Table 7.5: 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

7.4 Economic Impacts

7.4.1 Agriculture

Crop production

The major benefits expected from the project relate to increased crop production. The crop production is increased as a result of the increased HYV crop coverage due to reduced flood depth in the project area by the project interventions, timely plantation of t. *aman* crop and reduced damage from floods and drainage congestion. The increased crop production also

includes crop production loss from 25 ha of cultivated land to be taken for embankment construction, 45 ha for pond and 15 ha for public infrastructure development (see Annex B-Agriculture).

The present and future (FWO and FW) crop patterns and crop production have been given in Annex B (Agricultural Study). The crop production is summarised in Table 7.6. There are two required downward adjustments to the basic estimate of FW incremental crop production and economic benefit. These are:

- The project is designed to give protection against (externally-generated) monsoon floods for a 1:20 year return period. Thus, it is probable that during the 30-year project period the entire crop might still be completely destroyed about 1.5 times. This is mathematically equivalent to a loss of about 5 percent of the incremental net benefit/annum.

- The drainage system has only been designed for a 1:5 year rainfall. This "internal event", therefore, will still generate additional flooding 20 percent of the time irrespective of the flood control measures here being considered. It is expected that this will effectively destroy about 30 percent of the crop affected in this manner. This is mathematically equivalent to about 6 percent of the incremental net benefit/annum.

As given in Table 7.6, the project will increase rice production by 8,850 tons, and non-rice production by 1,315 tons annually. This increased crop production will earn an incremental net economic output of Tk 38.7 million per year (see Annex D - Economics for details).

The project interventions will increase crop production in the Dampara Project as well as in the Kangsha and Thakurakona Projects. As the proposed project interventions will protect the Dampara Project area from flooding, there will be no cutting of the Kangsha and Thakurakona Projects' embankments. Thus these two projects will be rehabilitated and serve the intended purpose. Though not quantified, similar crop production and employment benefits proportionate to those of the Dampara Project will be derived from these two projects.

Table 7.6: Annual Crop Production and Economic Benefit

Item	Unit	Present	FWO	FW	Net Increment	
					(FW-FWO)	After Adjustment
Rice Production	tonne	68,300	67,260	77,200	9,940	8,850
Non-Rice Production	tonne	3,010	3,540	5,020	1,480	1,315
Net Economic Benefit	mtk	245.80	243.70	287.19	43.49	38.70

Homestead Plantation and Agro-Forestry Production

The project will make 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 will lead to increased tree plantation.

In the flooded zone, the present annual production per hectare of homestead lands and agro-forestry is valued at about Tk 100,000 and Tk 152,000 respectively. A survey in the project's non-flooded area reveals that annual production from these category of lands has a value of Tk 130,000 and 170,000 respectively.

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. It is likely that in future without project there will be no increase in coverage of these two categories of land. But after project development, homestead plantation and agro-forestry lands will be reduced to 176 ha and 28 ha respectively due to acquisition of 26 ha of land for embankment construction.

Despite loss of production from 26 ha of homestead lands, the net benefit from this sector will be Tk 3.1 million (Table 7.7) after project development. The increase in net economic output will be Tk 2.35 million per year (see Annex D).

Table 7.7: Homestead Plantation and Agro-Forestry

Category	Scenario	Impacted Area (ha)	Production (Tk. 000/ha)	Total Production (MTK)	FW-FWO (MTK)
Homestead Plantation	FWO	200	100	20.0	2.9
	FW	176	130	22.9	
Agro-Forestry	FWO	30	152	4.6	0.2
	FW	28	170	4.8	
Total					3.1

7.4.2 Culture Fishery

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 by Year 4 of project implementation.

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. 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. and achieve full production by Year 14 of the FW project cycle (see Annex D for details). The net production gain will be 41.0 tons/year (Table 7.4).

7.4.3 Employment

Agricultural Employment

The project is projected to generate 340,000 person-days of new employment in the agricultural sector (Table 7.8). According to various studies, woman workers in Bangladesh comprise 9 to

16 percent of agricultural workers. Woman who work in harvesting and post-processing activities will also benefit from increased employment. Assuming that woman will share 10 percent of the increased employment, the project will generate 34,000 person-days of new jobs for woman in the agriculture sector.

The increased agricultural production will increase the work load of farmers' wives. It will provide opportunity for increased income for landless women, particularly during the post-harvest period (parboiling, husking etc.).

Fishery Employment

The floodplain fishery production loss will reduce fishery employment by 127,000 person-days per year (Table 7.8). However, increased pond fish production will create 4,000 person-days per year leaving a net loss of 123,000 person days employment. This will affect mainly the professional fishers who lack skill for other jobs.

Table 7.8: Employment

Sector	Present ('000 pd/yr)	FWO ('000 pd/yr)	FW ('000 pd/yr)	Net Increment ('000 pd/yr)	
				Before Adjustment	After Adjustment
Agriculture Labour	3074	3028	3407	379	340
Fisheries - Floodplain - Pond	446 12	288 13	161 17	-127 4	-123
Wetland	5.8	5.8	4.5	-1.3	-1.3

Note: Labour requirement: 1.0 pd/kg of floodplain fishes; 1.0 pd/9 kg of pond fishes.
(Source: NERP's field survey).

Wetland Employment

People gather starch food, vegetables, fodder and forage, medicine, thatching and mat making materials, fuel and bait. These common property resources are of some importance to the poor who gather wetland products for personal consumption or sale. Generally, fodder and building materials are collected by men and food and medicinal materials are collected by women. Based on the assumption that the harvesting of wetland products requires two person days/ha/year, the employment impact of the project will be a loss of 1,300 person days per year (Table 7.8) of which 30% will be borne by women.

7.4.4 Navigation

In the Dampara Project area navigation is seasonal and limited. Only Kalihar Channel is used seasonally for that purpose. The destination of the traffic from the project area is Jaria and Jhanjail. The Dampara Project entails the closure of this channel at its outfall at Khatuair by the existing drainage regulator. Khatuair is four kilometres from Jaria and Jhanjail.

The closure will require the transhipment of cargo across the drainage structure. The 1995 NERP boat traffic survey found 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. 26,500.00 annually. In the economic analysis, this cost has been treated as a disbenefit to the project.

7.4.5 Homesteads and Commercial Infrastructure

The project will make flood free 12,400 households and benefit about 65,000 people. The direct benefit (net economic value) derived from the reduction of flood damage to homesteads, commercial assets and public infrastructure is Tk. 1.95 million per year. The estimate is made from a damage frequency curve and the mathematical expectation of annual flood damage prepared based on the data collected from the project area (see Annex D: Economics). Flood damage to homesteads and public infrastructure are likely to steadily increase under the FWO situation and progressively reduced in the FW situation.

The protection of homestead platforms will permit continued homestead-based activities like gardening, poultry and livestock keeping, post-harvest processing, bamboo and cane product-making, net-making and quilt-making. 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. Homestead protection will also ease the burden of women from flood-preparedness and flood repair activities. As well, such daily activities as fetching water, will be eased.

7.5 Social Impacts

7.5.1 Public Health

Environmental sanitation will be effected in a number of ways. Presently, most people do not build pit latrines because it is overflown and filled up with sediment during the flood. Under improved conditions, water-sealed pit latrines would be easy to maintain. Once homesteads are protected, 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 mitigation will provide easy access to both latrines and potable water and will decrease the incidence of waterborne diseases. However, stagnation of surface water due to drainage problems from the embankment could lead to an increase in vector-borne diseases such as malaria and encephalitis.

The nutrition levels of some will increase with flood protection. The protection of homesteads will mean that home gardens, which provide the family with a variety of vegetables, will no longer be inundated. There is also the potential of expansion of home gardens to provide families with a greater variety and quantity of food. However, 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.

7.5.2 Social Harmony

There are numerous sources of potential social discord regarding the embankment. As detailed in Annex C, there are 516 households located between the proposed embankment alignment and the Kangsha River right bank. Conflict may arise resulting in construction disruption, embankment breaching, political interference, and physical skirmishes.

Water level changes on the left bank area will be minor when compared to the current situation. However, during the monsoons those on the left bank will observe a difference - on their side

there will be flooding and on the opposite bank there will be 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.

The project will alleviate the current conflict between the Dampara and Kangsha areas. 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.

7.5.3 Women's Opportunities

The project will simplify the role of women in several ways. Firstly, the project will generate a net new employment of 21,000 person-days for women after considering the loss of women labour of 12,700 person-days for fish processing (10% of the total labour) and 390 person-days for gathering wetland products. However, the loss of employment in fisheries and wetland sectors will be largely reduced by fisheries and wetland mitigation measures and enhancement programmes (see Chapter 8). 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.

7.5.4 Summary of Salient Data

A summary of the salient data is presented in Table 7.9 in the following page.

Table 7.9: Summary of Salient Data

AGRICULTURAL IMPACTS	Incremental	Present	FWO	FW
Net Economic Output (Tk million/yr)	38.70 [1]	245.80	243.70	287.19
Cropping Intensity		1.95	1.94	2.02
Average Rice Yield (tonnes/ha)		2.92	2.93	3.29
Average Net Margins (Tk/ha)		19,600	19,700	23,400
Agriculture Labour ('000 pd/ha)	340 [1]	3070	3030	3410
Rice Prod'n (tonnes/yr)	8,850 [1]	68,300	67,260	77,200
Non-Rice Prod'n (tonnes/yr)	1,315 [1]	3,010	3,540	5,020

FISHERIES IMPACTS		Floodplain	Pond
Incremental Net Econ. Output (Tk million/yr)		-4.9	1.2
Water Area (FWO)-ha		12,330	120
Water Area (FW)-ha		11,350	180
Average Fisheries Production (tonnes/yr) -FWO		288	115
Average Fisheries Production (tonnes/yr) - FW		161	156
Incremental Labour ('000 pd/yr)		-127	4

OTHER BENEFITS		Present	FWO	FW
Agro-Forestry-Incr Econ Output (mtk/yr)	2.35			
Household Affected (no.)		12,400		
Population Affected (no.)		65,000		
-Homestead & Pub. Infrastructure (Tk million/yr)	1.95			

OTHER DISBENEFITS				
Wetland Incr. Net Econ Output (Tk million/yr)	-0.16			
Wetland Incremental Labour ('000 pd/yr)	-1.3			
Navigation (Tk million/yr)	-0.02			
Land Acq, loss of EconOutput (Tk million/year)	0.21			

[1] After adjustment

8. ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

The purpose of this environmental management plan (EMP) is to provide specific mitigation and compensation plans that will be carried out during development and operational phases of the project to manage the impacts on project area's water and related natural resources (see Chapter 7) so as to reduce their affects to an acceptable level and make the project environmentally friendly. An environmental enhancement plan has also been included in this management plan to increase the benefits of the positive impacts resulting from project development.

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.

Implementation of the environmental management plan is outlined in Section 8.5. 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.

Details of EMP's Work Breakdown Structure which includes environmental protection plan, contingency (disaster management) plan, environmental enhancement plan and monitoring plan have been given in Annex E - Environmental Impact Assessment and Environmental Management Plan. Also included in that report are the detailed mechanism including EMP implementation schedule through which this environmental management plan will be implemented. The report (Annex E) also includes residual impacts and detailed cost estimate.

8.2 Mitigation and Compensation Plans

8.2.1 Water Resources

Impact: Reduced groundwater recharge
The proposed embankment would reduce flood depths in the project area and affect groundwater recharge.

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.

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. Because it is lacking the necessary information, 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).

Impact: Stagnation of water trapped by embankment
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.

8.2.2 Fisheries Resources

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 Chapter 10). 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 catches 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.

8.2.3 Land and Agricultural Resources

The most significant impact on land and agricultural resources is the acquisition of land for embankment construction.

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.

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 Chapter 10) who will work with the community to select the final embankment alignment with BWDB and the Consultant.

The PCC (see Chapter 10) 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.

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 will 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.

8.2.4 Wetland Resources

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.

8.2.5 Human Resources

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.

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 516 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 covering an area of 16.16 ha. To bring them under the project umbrella, their homestead areas will be raised above the 20-yr flood level with project funds.

Responsibility: The Consultant 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 the 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.

3. 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 Chapter 10) 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.

8.3 Environmental Enhancement Plan

8.3.1 Agriculture Enhancement Programme

The IFAD funded Netrokona Integrated Agricultural Production and Water Management Project has a component (Agriculture Development Support) which support 80,000 small and marginal farmers in Netrokona District. The Dampara Project area is part of the District.

DAE is the implementing agency of the 'Agriculture Development Support' component. The major activities of this component include: i) demonstration of new technologies on seed multiplication and preservation, food processing and preservation, homebased vegetable production; ii) training of farmers, DAE field level extension workers, and personnel from other organizations; iii) motivation of farmers to adopt new technologies; and iv) contact research for crop improvement and intensification. This programme is being carried out to increase crop production under existing agro-hydrological conditions.

After Dampara Project development, the agro-hydrological conditions within the project area will be changed. It is essential for the project farmers to be familiar with this change. As such, DAE is required to carry out some additional tasks in this project area to familiarize the farmers with the changed hydrological conditions to further increase agricultural production. The enhancement programme identifies those tasks which are listed below:

- 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 along with IFAD project's activities which suit to the changed agro-hydrological conditions. 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.

8.3.2 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.

8.3.3 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 to keep 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 through which the embankment will pass. The poorest households will be provided with the tubewells giving preference to women-headed households and households affected by land acquisition.

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 requiring 2,700 latrines. DPHE will supply these latrines and the project will bear the cost.

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.

8.4 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 adjusted 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 of project construction.

Social monitoring will include the life-style of fishers and the effects of the embankment on the condition of landless and women.

Responsibilities
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 (see Chapter 10).

8.5 Implementation of Environmental Management Plan

8.5.1 Institutional Arrangement

The activities contained in the environmental management plan are treated as the integral part of project development activities and will be implemented simultaneously with them. The institutional arrangement for implementation and management of the total project is given in Chapter 10.

8.5.2 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.

8.6 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.

8.7 Cost Estimate

Detailed cost estimates for implementation of the different components of the environmental management plan have been given in Annex - E. Those are summarized below:

8.7.1 Mitigative Works

Table 8.1: Cost for Mitigative Works

Sector	Item of Work	Amount ('000 Tk)
Fisheries	Re-excavation of *Beels*	1,410
	Cleaning of Internal Channel	200
	River Sanctuary	390
	Sub-Total	**2,000**
Wetland	Plantation of Commercial wetland Trees	**400**
Social	Raising of Homesteads	2,456
	Flood Shelters	484
	Sub-Total	**2,940**
Total		**5,340**

8.7.2 Environmental Enhancement Plan

a. Agricultural Enhancement Programme

Table 8.2: Agricultural Enhancement Programme Cost

Item of Work	Cost ('000 Tk)
1.Multi-location testing of new/improved production and management practices and technology under new agro-hydraulic condition	120
2. Demonstration of practices and technology	120
3. Pilot production	80
4. Management	80
Total	**400**

b. Social Enhancement Programme

Table 8.3: Social Enhancement Programme Cost

Particulars	Cost ('000 Tk)
1. Water supply: Installation of HTWs	96
2. Sanitation: Supply of 2,700 water seal latrines	1,350
3. Livestock and poultry: Vaccination training	30
4. Women's LCS: Operational cost	100
5. Education: Supply of furniture, scientific equipment etc. to schools	224
6. Social forestry: Plantation of saplings	200
Total	**2,000**

c. Fisheries Enhancement Programme

Table 8.4: Fisheries Enhancement Programme Cost

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

8.7.3 Monitoring Plan

Cost for collection of data and their analyses have been included with the monitoring consultancy cost (see Chapter 10).

8.7.4 Cost Summary

Table 8.5: Mitigation and Enhancement Cost Summary

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

9. PROJECT ASSESSMENT

9.1 Introduction

This Chapter deals with the project appraisal and recommendations made thereon. The assessment is not based solely on the financial and economic analysis but also considers those impacts that are described in physical or qualitative terms. Before examining these related factors, the economic and financial viability of the proposed project is addressed.

9.2 Economic Analysis

The economic analysis is essentially a cash flow analysis of the incremental economic costs and benefits of the proposed scheme, including the cost of mitigation measures for the negatively impacted areas. This involves:

- the use of economic prices (also known as 'shadow' or 'accounting' prices) which, unlike market prices, reflect the real resource costs of inputs and outputs to the national economy; and

- calculation of single-value measures of project economic viability - including the Economic Internal Rate of Return (EIRR) and the Net Present Value (NPV) - as a basis for ensuring the most economically efficient use of scarce resources.

9.2.1 Methodology

This study used the FPCO Guidelines for Project Assessment (May 1992) which outlines the valuation procedures to be used for both the incremental costs and benefits attributable to the proposed project. This includes, in particular, how to convert market prices into economic prices, the time frame to be employed, the appropriate discount rate, and the desired phasing of benefits. Details of the critical assumptions employed in the economic analysis have been presented in Annex D - Economics.

The methodology employed relies on discounted cash flow analysis of the projected incremental benefit & cost streams emanating from the FW and FWO situations over a 30-year period. The Net Present Value (NPV) and Economic Internal Rate of Return (EIRR) are calculated on the basis of the incremental net benefits resulting from the *future with* and *future without* situations. Additionally, sensitivity analyses were used to measure the reliability and robustness of estimates, and to identify the benefit and cost items which have the greatest influence on the overall economic viability of the project, as well as the extent of their influence.

Constant 1991 prices have been used in the analysis as per the *FPCO Guidelines*. Current market and administered prices were deflated to 1991 constant prices using the Bangladesh Bureau of Statistics' gross domestic product (GDP) deflators for agriculture, fisheries and other resource-based commodity prices.

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9.2.2 Cost Estimation

Capital Cost
Cost estimating procedures are generally consistent with those recommended in the *FPCO Guidelines*. Detailed quantity and cost estimates have been provided in Annex A (Engineering) and Annex E (Environmental Impact Assessment).

Total project costs are estimated to be Tk 64.2 million, inclusive of costs for mitigative measures and enhancement programmes and are summarized in Table 9.1. This includes Tk 8.74 million for mitigative and enhancement programmes.

Since the cost of the proposed enhancement programmes are not offset by a projected benefit stream, however, neither the costs nor benefits of enhancement are included in the economic analysis. Economic costs are thus reduced by about Taka 3.4 million. In addition, land acquisition costs are excluded from the economic analysis (Taka 20.5 million), because it is more appropriate to shadow price land in terms of the annual production foregone.

Physical contingencies equal to 15 percent of base construction costs as per *FPCO Guidelines* were used to cover unforeseen costs. Engineering costs (survey, design, preparation of tender documents, supervision of construction and administration) were taken as 9 percent of base construction costs plus physical contingencies.

Capital costs were then deflated to June 1991 constant prices so they were comparable to the benefit stream calculations which were similarly calculated in terms of constant 1991 prices.

O & M Cost
Also following the *FPCO Guidelines for Project Assessment* (May 1992), O & M costs have been calculated as a percentage of capital costs. That is:

- Earthwork in embankment and drainage channels 6%
- Structure 3%
- Other costs (except homestead raising) 5%

These costs will cover all costs of technical staff, departmental overheads, maintenance of embankment and drainage channels, operation and maintenance of regulator gates, and replacement of items subject to wear and tear. Data collected from different BWDB existing projects indicate that percent costs given in the *FPCO Guidelines* is adequate to cover the O&M cost of the project.

Physical contingencies equal to 15 percent of O&M costs are then added to this sub-total to obtain the total estimated O&M cost per year. O&M costs are expected to amount to about Tk 2.63 million/year after project development (during Years 4 through 30).

Table 9.1: Capital and O&M Cost Summary

Capital Cost ('000 Tk)				O&M Cost ('000 Tk)		
Type	**Item**	**Price**		**Percent**	**Price**	
		1995	**1991**		**1995**	**1991**
FCD Interventions	Embankments	16,294	14,268	6	978	856
	Structures	3,524	3,086	3	886[1]	783
	Channel	1,302	1,141	6	78	68
	Closure & Diversion Channel	866	758	6	52	45
	Sub-Total	**21,986**	**19,253**	-	**1,994**	**1,752**
Mitigation Measures	Fisheries	2,000	1,752	5	100	88
	Wetland & Wildlife	400	352	5	20	18
	Homestead Raising	2,940	2,572	-	-	-
	Sub-Total	**5,340**	**4,676**	-	**120**	**106**
Enhancement Programme	Agriculture	400	350	5	20	18
	Fisheries	1,000	876	5	50	44
	Social	2,000	1,750	5	100	88
	Sub-Total	**3,400**	**2,976**	-	**170**	**150**
Land		20,500	17,952	-	-	-
	Total	**51,226**	**44,857**	-	**2,284**	**2,008**
	Physical Contingencies (15% of total)	7,684	6,729	-	343	301
	Sub-Total	**58,910**	**51,586**	-	**2,627**	**2,309**
	Study Cost (9% of Sub-Total)	5,302	4,643	-	-	-
	Grand Total	**64,212**	**56,229**	-	**2,627**	**2,309**

[1] An amount of Tk 26.0 million has been added to the capital cost for two existing structures to compute O&M costs.

Phasing & Disbursement

Three years are required to implement the project initiatives. Cadastral surveys, topographic surveys, detailed engineering design as well as preparation of tender documents and awarding of contract will be carried out in Year 1. Land acquisition will be started in Year 1 and will be completed in phases prior to the start of construction. Construction will start in Year 2 and will be completed in Year 3. An itemized implementation schedule is shown in Table 9.2. Capital cost investment and O&M cost schedules are given in Tables 9.3 and 9.4 respectively.

Table 9.2: 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, Construction of Closure & Diversion Channel		30	70
Construction of Structures		50	50
Mitigative Measures		40	60

Table 9.3: Capital Cost Investment Schedule
(1991 Price)

Item	Financial Price (Tk '000)	Economic Cost (Tk '000)	Capital Cost Investment (Tk' 000)					
			Year					
			1		2		3	
			Finan.	Econo.	Finan.	Econo.	Finan.	Econo.
Embankment	14,268	12,414	-	-	7,134	6,207	7,134	6,207
Channel, Closure & Div. Channel	1,899	1,652	-	-	570	496	1,329	1,156
Structure	3,086	2,440	-	-	1,543	1,220	1,543	1,220
Mitigation Measures	4,676	4,068	-	-	1,870	1,627	2,806	2,441
Base Cost	23,929	20,574	-	-	11,117	9.550	12,812	11,024
Phy. Contin. 15%	3,589	3,086	-	-	1,667	1,432	1,922	1,654
Engg. (9% of Base+Contin.)	2,477	2,129	991	851	743	639	743	639
Total	29,995	25,789	991	851	13,527	11,621	15,477	13,317

Table 9.4: O & M Cost Schedule
(1991 Price)

Item	O & M Cost Schedule					
	Financial Cost (Tk '000)	Economic Cost (Tk '000)	Year			
			1	2	3	4 to 30
Embankment	856	745	-	-	372	745
Channel, Closure & Div. Channel	113	99	-	-	30	99
Structures	783	619	-	-	582	619
Mitigation Measures	106	91	-	-	37	91
Base Cost	1,858	1,554	-	-	1,021	1,554
Phy. Contin.- 15%	278	233	-	-	153	233
Total	2,136	1,787	-	-	1,174	1,787

9.2.3 Benefits and Disbenefits

Project benefits and cost streams including phasing of benefits/disbenefits and costs are presented in Table 9.5. Details are provided in Annex D.

The project's benefits and disbenefits have been discussed in Chapter 7 with details in Annex D. The principal direct benefit is the projected increase in agricultural production in the project area while supplementary benefits are due to a reduction in damages to public infrastructure, commercial and agricultural assets, pond fish, homestead gardens and agro-forestry. Substantial indirect benefits (although not included in the analyses) should also be realized by the World Bank/IDA Kangsha River project through the flood protection afforded by the development of this project. The main disbenefits come expected losses to the floodplain fishery resources along with small navigation and wetland resource losses.

Table 9.5: Economic Cost-Benefit Stream: Base Case (million Taka)

Year	Cost		Total Cost		Benefit/Disbenefit					Total Benefit		Net Benefit	
	Capital	O&M	Nominal	Discount	Crop	Fisheries	Infrastruc	Navigati	Agro-	Nominal	Discount	Nominal	Discount
1	.85	0.00	0.85	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.85	-0.76
2	11.62	0.00	11.62	9.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-11.62	-9.26
3	13.32	1.17	14.49	10.31	0.00	-7.24	0.00	-0.02	-0.16	-7.42	-5.28	-21.91	-15.59
4	0.00	1.79	1.79	1.14	7.74	-6.48	1.94	-0.02	0.08	3.26	2.07	1.48	0.94
5	0.00	1.79	1.79	1.01	15.48	-6.17	2.00	-0.02	0.32	11.61	6.59	9.82	5.57
6	0.00	1.79	1.79	0.91	23.22	-5.86	2.06	-0.02	0.55	19.95	10.11	18.17	9.20
7	0.00	1.79	1.79	0.81	30.96	-5.55	2.12	-0.02	0.79	28.30	12.80	26.51	11.99
8	0.00	1.79	1.79	0.72	38.70	-5.24	2.19	-0.02	1.02	36.65	14.80	34.86	14.08
9	0.00	1.79	1.79	0.64	38.70	-4.93	2.25	-0.02	1.26	37.25	13.43	35.46	12.79
10	0.00	1.79	1.79	0.58	38.70	-4.63	2.32	-0.02	1.49	37.86	12.19	36.07	11.61
11	0.00	1.79	1.79	0.51	38.70	-4.29	2.39	-0.02	1.73	38.50	11.07	36.72	10.56
12	0.00	1.79	1.79	0.46	38.70	-3.95	2.46	-0.02	1.96	39.15	10.05	37.37	9.59
13	0.00	1.79	1.79	0.41	38.70	-3.61	2.54	-0.02	2.20	39.80	9.12	38.02	8.71
14	0.00	1.79	1.79	0.37	38.70	-3.43	2.61	-0.02	2.20	40.05	8.20	38.27	7.83
15	0.00	1.79	1.79	0.33	38.70	-3.26	2.69	-0.02	2.20	40.30	7.36	38.51	7.04
16	0.00	1.79	1.79	0.29	38.70	-3.10	2.77	-0.02	2.20	40.54	6.61	38.76	6.32
17	0.00	1.79	1.79	0.26	38.70	-2.94	2.86	-0.02	2.20	40.79	5.94	39.00	5.68
18	0.00	1.79	1.79	0.23	38.70	-2.79	2.94	-0.02	2.20	41.02	5.33	39.24	5.10
19	0.00	1.79	1.79	0.21	38.70	-2.64	3.03	-0.02	2.20	41.26	4.79	39.47	4.58
20	0.00	1.79	1.79	0.19	38.70	-2.49	3.12	-0.02	2.20	41.50	4.30	39.71	4.12
21	0.00	1.79	1.79	0.17	38.70	-2.35	3.21	-0.02	2.20	41.73	3.86	39.94	3.70
22	0.00	1.79	1.79	0.15	38.70	-2.22	3.31	-0.02	2.20	41.96	3.47	40.18	3.32
23	0.00	1.79	1.79	0.13	38.70	-2.09	3.41	-0.02	2.20	42.19	3.11	40.41	2.98
24	0.00	1.79	1.79	0.12	38.70	-1.96	3.51	-0.02	2.20	42.43	2.80	40.64	2.68
25	0.00	1.79	1.79	0.11	38.70	-1.83	3.62	-0.02	2.20	42.65	2.51	40.87	2.40
26	0.00	1.79	1.79	0.09	38.70	-1.71	3.73	-0.02	2.20	42.88	2.25	41.10	2.16
27	0.00	1.79	1.79	0.08	38.70	-1.60	3.84	-0.02	2.20	43.11	2.02	41.32	1.94
28	0.00	1.79	1.79	0.07	38.70	-1.48	3.95	-0.02	2.20	43.34	1.81	41.55	1.74
29	0.00	1.79	1.79	0.07	38.70	-1.37	4.07	-0.02	2.20	43.57	1.63	41.78	1.56
30	0.00	1.79	1.79	0.06	38.70	-1.27	4.19	-0.02	2.20	43.80	1.46	42.01	1.40
PV				**30.44**							**164.42**	**NPV**	**133.98**

Source: Annex D

9.2.4 Economic Assessment

Economic prices of agricultural inputs and outputs, gross economic income from crops, production costs per hectare, and net economic benefits from crops have been given in Annex D. Costs of production include labour, fertilizer inputs, traditional and modern irrigation methods, draught animals, and seed and pesticide costs. The labour charge is applied against both owner-operated farmer labour and hired labour. The primary data also indicate that only draught power (i.e., no power tiller utilization) is used for crop production in the area.

It is anticipated that the established crop marketing system will handle increased crop production without any impact on price levels. Assuming the current annual growth in the demand for grain remains about 3 percent, the increased cereal production is unlikely to present any marketing difficulties.

The resulting estimate of the economic Net Present Value (NPV) of the incremental net benefit stream (see Table 9.5) employing a 12% annual discount rate over thirty years is 134 million Taka. This discount total is about 5 times the size of the initial economic investment. This positive and relatively large NPV estimate indicates that at least from an economic perspective the proposed Dampara Water Management Project (DWMP) appears to be a very feasible investment opportunity.

Similarly, the imputed Economic Internal Rate of Return (EIRR) is determined to be about 42% per annum, much higher than the designated "cut-off" rate of 12% per annum. This EIRR estimate once again emphasize that the DWMP appears to be a very attractive economic investment opportunity.

An independent analysis has also been carried out with the cost of the re-excavation of the Dhalai Channel and the resulting benefit accrued from the pre-monsoon drainage conditions. The analysis indicates a positive NPV in the order of Tk 3.93 million and EIRR of 40.6 percent per annum. The result demonstrates that the desiltation of the Dhalai Channel is feasible on its own.

Accompanying sensitivity analyses were then conducted to assess the reliability and robustness of these estimates, as well as help identify the benefit and cost items which have the greatest influence on the overall viability of the project (Table 9.6).

Table 9.6
Summary of Sensitivity Tests

Item	NPV (Taka m. 1991)	EIRR (percent)
BASE CASE	134.0	41.9
1. Sunk Costs Included (Tk 21 m; 1991)	112.7	30.1
2. Capital + O&M Costs Increase 20%	124.2	37.2
3. Exclusion of All Non-Crop Impacts	144.1	52.5
4. Damaged Flood Lands Yield Losses 50%	64.3	28.2
5. Full Ag. Benefits Delayed to 10 Yrs	93.9	29.5
6. Ag. Costs of Production Increase 20%	113.5	38.2
7. Project Implementation Delay by 2 Years	104.0	40.9
WORST CASE SCENARIO (Items 2-6)	30.5	20.3

These simulations highlight the following:

- The very economical project design does enhance the EIRR very considerably. Assuming that the two existing drainage structures were current (rather than sunk) costs, for example, would drop the EIRR from 42% to 30% per annum.

- A similar negative impact would be expected if the projected agricultural benefits were not fully realized for 10 years after construction or if the flood damaged crop yield losses are being greatly over-estimated.

- At the same time, if it wasn't for the project's expected negative impact on fisheries, the proposed project would have an even higher expected EIRR.

- The Worst Case Scenario suggests that the lower EIRR that we might expect is 20% per annum, almost double the 12% per annum requirement for project acceptance. A 20% EIRR would correspond to a positive NPV @ 12% per annum of about 30 million Taka, which implies a real rate of return which is still two times the cumulative project investment level over a 30 year time frame.

9.3 Financial Analysis

There are two particularly important financial considerations: 1) financial impact on project beneficiaries; and 2) financial impact on the project implementing agency.

The principal project beneficiaries will be some 14,000 households who own cultivated land; small farms with about 1/3 ha; medium-sized farms which are about 1.5 ha. in size; and larger farms which average about 4 ha. in size. The anticipated financial impact of the project on each of these three farm sizes is summarized in accompanying Table 9.7 and highlights the following:

- the proposed project should make a substantial difference to gross farm income (at project maturity), increasing small and medium-sized gross farm income by more than 20 percent;

- the project's overall impact on total farm family income, however, is a function of how dependent they are on the farm as a source of total family income. The largest relative impact would be on medium-sized farms (16% increase) while the smallest relative impact would be on small farms (7%). Both small and large farms tend to rely more on other sources of income for their livelihood;

- incremental gross farm income/person would, at the same time, be highly skewed in favour of larger farmers. This is equally true of the incremental gross farm income/person day estimates. This is because of the relative size of the farms since, on a per-hectare basis, the change would actually be greater for small farmers; and,

- the overall change in the family labour required would be about 5 days/year for small farmers and 14 days/year for middle-sized farmers. It is estimated (see Chapter 7) that perhaps 10% of this change would be a female labour requirement.

This same farm financial analyses suggests that the project implementing agency could probably introduce a viable cost recovery policy for operation and maintenance of the proposed works. That is to say, if the additional financial income generated by the project is (say) 5,000 Taka per hectare per annum during Years 8-30 (as suggested in Table 9.7) while the project O&M cost is

Table 9.7: Farm Budget Analysis, by Farm Size (Taka per Year)

Item	Small Farm (0.3 ha)			Medium Farm (1.5 ha)			Large Farm (4.0 ha)		
	Present	FWO	FW	Present	FWO	FW	Present	FWO	FW
Gross Value of Production	14309	14201	16759	62598	62662	74006	161695	161779	178813
Total Cash Costs	4215	4189	4596	23557	23569	26186	71231	71367	73774
Gross Farm Income	10094	10012	12162	39041	39093	47819	90464	90412	105039
Incre. Gross Farm Income			2150			8726			14627
Total Family Income	32943	32861	35011	55491	55543	64270	174977	174926	189552
Percent Change in Family Income		-0.2%	6.5%		0.1%	15.7%		0.0	8.4%
Return per Family Member									
Average No. in Family	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Gross Farm Income/person	1941	1925	2339	7508	7518	9196	17397	17387	20200
Incre. Gross Farm Income/Person			414			1678			2813
Return to Family Labour									
Family Labour (person days)	66	66	71	254	253	268	277	277	276
Gross Farm Income/Person Day	152	152	172	154	154	179	327	326	381
Incre. Gross Farm Income/Person Day			30			33			53

Percent of Households	44	17	5
Percent of Cultivable Land	22	45	33

Source: Annex D

1.79 million Taka (1991 economic price) per year or 146 Taka per hectare of cultivated land, these O&M costs would only amount to about 3 percent of the incremental crop income. Crop farmers with land ownership should have the financial capacity to pay this amount.

9.4 Environmental Assessment

The key areas of environmental impact of this project are described below. Additional information is given in Annex E, Environmental Impact Assessment.

Agriculture

The major proportion of the benefits accruing to the project are a result of increased *t.aman* productions well as reduction in the damaged area under *aman*. These benefits are a result of increased yields due to a shift to HYV *aman* rice varieties from local *aman*. Average crop yields would increase as a result of reduced flood damage. Cropping intensity would increase to 202 percent (FW) from 194 percent (FWO).

Projected increases in cereal production have been documented in Table 7.6. Briefly, the project is expected to increase the production of Rice crops by 8,850 tonnes per year and to increase the production of non-rice crops by 1,315 tonnes per year. Assuming net rice grain (milled rice) available for consumption is 65 percent of the rice (paddy) production, then the food availability would increase by 15 percent from 769 gm per person per day (FWO) to 883 gm per person per day (FW) (Table 9.8). Availability of non-rice would increase by 42 percent from 62 gm per person per day to 88 gm per person per day (Table 9.8).

Table 9.8: Indicators of Food Availability (grams/person/day)

Food Group	Present (1995)	FW (2005)	FW (2015)	FWO (2015)
Rice	1022	1003	883	769
Non-Rice	69	100	88	62
Open Water Fish	10.0	3.4	2.2	4.3
Aquaculture	2.4	3.0	3.0	2.1
Population	119,034	137,008	155,710	155,710

Twenty five hectares of land will be taken from the cultivated land for embankment construction. Assuming that this area is under rice production and has average yields, this loss corresponds to foregone cereal production of about 143 tonnes per year or about 1.4 percent of total incremental cereal production. The loss of foregone production is insignificant compared to the gains.

Fisheries Production

Open Water Fisheries Production. There will be a *net disbenefit* accruing to the *open-access* common resource fishery base due to the implementation of the project. By 2015, floodplain fish production would decline by about 119 tonnes (ie., a 49 percent decrease).

The production loss will cause a decrease in fish availability from open water sources. By 2015, the availability will decrease from 4.3 gms per person per day (FWO) to 2.2 gms per person per

day (FW) and is given in Table 9.8 above. This is a very major project disbenefit since the local population (and subsistence fishermen in particular) depends almost exclusively on fish for their intake of animal protein. This underlines the importance of the proposed mitigation measures and enhancement programmes (see Chapter 8) for fisheries.

Aquaculture Production. By 2015, aquaculture production will be increased to 171 tonnes (FW) from 118 tonnes (FWO), an increase of 45 percent. This implies an increase in pond fish availability, due to the project from 2.1 gm per person per day (FWO) to 3.0 gm per person per day (FW) (again see Table 9.8). However, the aquaculture production gains (53 tonnes) do not offset the open water fishery losses (119 tonnes).

Homestead/Other Flooding
Homestead and related structural flooding damage would be significantly reduced. The estimated annual economic value of reduced flood damage is Tk 1.95 million.

Homestead Gardens, Agro-Forestry and Wetlands
Despite loss of production from 26 ha of homestead lands to be taken for embankment construction, the net annual economic benefit will be Tk 2.36 million. The benefit will accrue from increased production in the remaining areas due to flood protection. Moreover, the embankment area will also be available for tree plantation and vegetable gardens.

At the same time, a small amount of disbenefit would result from the loss of food, shelter and tree products that are currently harvested from the seasonal wetlands. The estimated annual economic value of lost wetland products would be Tk 160,000.

The net annual impact (at project maturity) is expected to be about Tk 2.2 million per annum. (For details, see Annex D)

Navigation
The project will obstruct water transportation which is seasonal and increase freight by Tk 23,000 annually.

9.5 Social

The key areas of social impact by this project are described below. Additional information is given in Annex E, Environmental Impact Assessment.

Employment
There will be an overall increase in employment of 216 thousand person-days per year. This is comprised of:

- an increase in agriculture labour employment of 340 thousand pd/yr, of which roughly 10 percent will be shared by women of the household.

- a decrease in employment opportunities for fishery professionals and landless people of 124 thousand pd/yr, comprised of changes in the following areas:

  - Fishing Labour: a net decrease of 123 thousand pd/yr in addition to a corresponding loss in support activities such as net making and post-catch processing (mainly drying), much of which is done by women. This will result from labour decrease (127 thousand pd/yr) due to reduced production of floodplain fisheries but will be partly offset by an increase in employment (4 thousand pd/yr) for pond culture fisheries.

- Wetland labour (gathering wetland products): decrease of 0.0013 million pd/yr. Fodder and building materials are gathered mainly by men. Food, fuel, medicine are gathered by women.

The additional employment changes generated from projected changes to agro-forestry production, navigation, and homestead/other flood protection impacts are relatively small and, therefore, have not been tabulated.

Conflicts
The project will resolve one conflict but will likely generate a new one:

- The proposed project will remove the prevailing conflicts between the people of Dampara and Kangsha Project areas over the cutting of Jaria Road.

- There would be resentment from the Kangsha River left bank people against the right bank people as the project will create two distinctly separate zones - one flooded area in the left bank and the other non-flooded area in the right bank.

Economic Equity
The net economic equity impact is, on balance, difficult to ascertain.

- Large landowners who represent 5 percent of the total population and own approximately 33 percent of the cultivated land (Graph 2.2) will receive substantial benefits from the proposed project interventions. These large farmers, however, can generally manage their livelihood even in the face of reduced yields stemming from flood damage and, thus, really do not need the project to sustain their livelihood. This impact is, therefore, very *regressive*.

- On the other hand, the small and medium farmers who makeup sixty-seven percent of the total population and own 67 percent of the remaining cultivated area often cannot sustain their livelihoods with flood-reduced yields. Often, they are forced to sell their land after floods and, ultimately, become landless. The project will arrest landlessness caused by flood damage to these cropped areas. So, in this context, the impact on landowners is somewhat *progressive*.

- Pondowners will be helped somewhat, which is also *regressive* because they too tend to be relatively wealthy.

- Landless people who represent 34 percent of the total population work as agricultural labourers will be benefitted from the increase in agricultural employment opportunities with the increased cropped area and yield. This is *progressive*.

- Sharecroppers may also be net gainers in relation to the area cultivated by them. This appears to be somewhat *progressive* as the sharecroppers are typically poor farmers as well.

- Families dependent upon fishing labour are expected to negatively impacted with the project and these families tend to be landless and poorer than average. This impact is, therefore, also *regressive*.

- Families involved in gathering wetland products are another group which is expected to be negatively impacted. And since these families are also mainly landless and very poor, this impacts is similarly *regressive*.

Gender Equity

The net equity impact would appear to be *progressive*. Employment opportunities for women will increase significantly. Reduced homestead flooding will greatly favour women, given that most of the household activities including household economic activities are performed by them.

9.6 Summary Assessment

A Multi-Criteria Analysis (MCA) facilitates a review of the impacts of the project in economic, quantitative and qualitative terms. This assessment is summarised in Table 9.9. Impacts that can be valued in monetary terms have been incorporated into single value measures and listed in Section 1 (Economic). Those impacts which can only be quantified in physical terms are set out in Section 2 of the Table. Impacts for which neither value estimates nor quantitative estimates can be made are displayed in qualitative terms in Section 3 of the Table. The results of the financial analyses are presented in section 4 of the Table.

Principal negative Impacts (without consideration of mitigation and enhancement programmes) include:

- reduced *open-access* fisheries and wetland resources;
- reduced employment opportunities for fishermen and people involved in gathering wetland products;
- obstruction to seasonal water transportation;
- conflict between Kangsha River right and left bank people;
- reduction in wetland dependent flora and fauna;

Principal positive impacts include:

- substantial increase in *t.aman* rice production;
- increased crop diversification and as a result increased non-cereal production;
- increased economic returns to land owners;
- increased agricultural employment;
- increased safety of the population in flood-prone area;
- progressive impact on gender equity;
- reduced disruption of economic and social activities;
- substantial indirect benefits from Kangsha Project;
- improved domestic water supply and sanitation; and,
- reduced psychological stress from flood hazards.

9.7 Recommendation

The above discussion has shown that there are substantial benefits accruing to the proposed *Dampara Water Management Project*. In the (most likely) *Base Case*, it has been shown that there will be positive net present value of approximately Tk 134 million (US$ 3.35 million) and an economic internal rate of return of 42 percent/annum. These are substantial returns for a project which requires such a relatively low capital investment (Tk 64.2 million).

Identified negative impacts will be substantially reduced with the implementation of the proposed mitigation and enhancement programmes.

Thus, the *Dampara Water Management Project* is, on balance, considered to be a very good public investment opportunity. Taking into account the relatively low investment cost, positive and relatively large NPV and EIRR, low net negative impacts, and high public demands, this study recommends that:

- the project be implemented immediately;
- improved agricultural and fisheries extension services be provided to the area people;
- fisheries mitigation measures and fisheries and social enhancement programmes be implemented simultaneously since these are an integral part of the project;
- local people participate in the entire project implementation process; and,
- the subsequent management of the project be transferred to the local community (see Chapter 10).

Table 9.9: Multi-Criteria Analysis

1. Economic		
Variable	**EIRR (percent)**	**NPV (million taka)**
Base Case (Capital and O&M Cost)	42	134
Increase Capital and O&M Costs by 20%	37	124
Full Ag. Benefits Delayed to 10 Yrs	30	94

2. Quantitative Impacts			
Indicator	Unit	**Value**	**Percent**
Incremental Cereal Production	tonne	8,848	13
Incremental Non-Cereal Production	tonne	1,478	42
Incremental Fish Production by 2015	tonne	- 66	18
Change in Floodplain Wetted Area	ha	978	8
Homesteads Protected from Floods	No.	12,400	54
Increased Employment (Agri+Fishing+Wetland)	million pd/yr	0.216	7

3. Qualitative Impacts (ranked from -5 to +5)	
Impact	**Rank**
Wetland Biodiversity	- 2
Economic and Social Activities	+ 4
Domestic Water Supply and Sanitation	+ 3
Benefits from Kangsha Project	+ 5
Surface Water Quality	- 2
Access to Common Resources	- 2
Conflicts	- 1
Socio-economic Equity	- 2
Gender Equity	+ 3
Responds to Public Concern	+ 3
Decentralized Organization and Management	+ 4
Conformity to Regional Strategy	+ 4

4. Financial	
Investment Costs (Tk Million)	64.2
O&M Costs (Tk million/yr)	2.63
Agricultural Value Added (Tk million/yr)	39
Agricultural Value Added (FW/FWO)	1.16

10. PROJECT MANAGEMENT PLAN

10.1 Description of the Project

10.1.1 Background

Dampara Water Management Project covering a gross area of 15,000 ha is located near Netrokona Town and about 140 km north of Dhaka City. The main water resources issues in the area are the flooding from Kangsha River and drainage congestion in the Dhalai Channel catchment.

With the financial assistance of the Canadian International Development Agency (CIDA), the pre-feasibility study for this Project was completed in 1994. After review, CIDA together with the Flood Plan Coordination Organization (FPCO) and the Bangladesh Water Development Board (BWDB) decided to proceed with the feasibility study in the same year.

To solve flooding problem and to relieve drainage congestion, the feasibility study proposes the following structural interventions:

- construction of 30.0 km of flood embankment along Kangsha River;
- re-sectioning of 2.0 km of Caritas Road along Naterkona as flood embankment;
- closing off Kalihar Channel at its outfall near the existing drainage regulator;
- excavation of diversion channel to connect the existing drainage regulator with Kalihar Channel;
- construction of 4 small drainage structures and 30 LLP inlet structures; and,
- re-excavation of about 10.0 km of Dhalai Channel.

These interventions will increase significantly agricultural production, create employment opportunity for farm labourers and enhance economic activities through flood protection to homesteads and infrastructures, but will impact negatively on fisheries and wetland resources. To reduce those negative impacts and to benefit all social groups of the project population, the study proposes the following mitigation and enhancement programmes:

- re-excavation of five selected *beels* and a few kilometre of minor drainage channels connecting *beels* with main drainage channels to improve fish resources;
- diversification of fisheries activities;
- raising of about 160 ha of homestead areas and premises of 10 schools above the 20-yr flood level;
- wetland conservation programme; and,
- agriculture, fisheries and social enhancement programme including training to local people.

The feasibility study found a substantial benefit accruing to the Project. It has been shown that there will be positive net present value of approximately Tk 134 million (Cdn $ 4.47 million) and an economic internal rate of return of 42 percent. These are substantial returns for a project which requires a low capital investment of Tk 64.21 million (Cdn $ 2.14 million).

Negative impacts caused by the project interventions will be substantially reduced with the implementation of the proposed mitigation and enhancement programmes which are considered as an integral part of the project interventions.

Taking into account the relatively low investment cost, positive NPV and high EIRR, reduced negative impacts and high public demands, the feasibility study recommends the project to be implemented immediately.

The next phase of the project will be to assist the Government of Bangladesh to implement the above initiatives and programmes and undertake O&M including monitoring and evaluation of the project's performance.

The duration will be 3 years for implementation with an assumed start from November 1997 and continue for another 2 years for O&M and, post-project monitoring and evaluation.

10.1.2 Project Goal and Purpose

The Project goal is to stimulate broadly-based locally managed socio-economic conditions in the Dampara project area.

The purpose of the Project is to increase crop production, improve quality of life and enhance economic activities through flood protection to crop land, infrastructures and homesteads.

10.1.3 Logical Framework Analysis

The Logical Framework Analysis (Exhibit 10-1) shows the path from the Project inputs through the Project's goal and objectives to its outputs, and specifies objectively verifiable indicators of achievement.

Inputs from Canada and Bangladesh
Canada will provide

(i) assistance to implement structural and non-structural measures (estimated cost: Cdn $ 1.28) and cost of operation and maintenance of the Project for two years (estimated cost: Cdn $ 0.18 million) including contingency funds ;

(ii) technical assistance for design, construction supervision, preparation of final project document, social mobilization, human resource development and integration of people in the local people in infrastructure management (estimated cost Cdn $ 1.35 million);

(iii) technical assistance for monitoring and evaluation (estimated cost Cdn $ 0.655 million).

Exhibit 10-1
LOGICAL FRAMEWORK ANALYSIS

CIDA's CDPF objective(s) relating to the project: To assist in improving rural infrastructure service in order to encourage the growth of the rural economy

NARRATIVE SUMMARY	EXPECTED RESULTS	PERFORMANCE INDICATORS	SOURCES OF VERIFICATION	KEY CRITICAL ASSUMPTIONS
GOAL To improve socio-economic conditions in the Dampara Project area	**IMPACTS** Increased job opportunities especially for poor and women	Reduced outmigration	Local residents'report	***Assumptions to be monitored*** Increased concentrations of land in large land-owners' hands
		Increased labour wage	Comparison with nearby flood prone area	In-migration
	Increased incomes for a broad cross-section of area residents	Improved house type (size and construction materials)	Reconnaissance survey	***Risks to be addressed*** EMP not implemented properly
PURPOSE To increase crop production, improve quality of life and enhance economic activities through flood protection to crop land, infrastructure and homesteads	**OUTCOMES** Increased *t.aman* production	Increased use of fertilizer during *t.aman* period	Sale proceeds of area's fertiliser dealers	***Assumptions to be monitored*** Availability of agricultural inputs at reasonable price
		Increased *aman* rice supply in the market	Market survey	Continued government commitment to rice procurement programme
	Increased homestead-based economic activities	Increased dairy and poultry production	Thana Livestock office reports	***Risks to be addressed*** Infrastructures not working as intended
		Locally manufactured cane and bamboo products in local markets	Market Survey	
	Increased production of a wide range of food crops	Locally-grown food varieties in local markets	Market Survey	
	Improved water supply and sanitation facilities	Reduced Morbidity	Local informants and Health Centres' records	

NARRATIVE SUMMARY	EXPECTED RESULTS	PERFORMANCE INDICATORS	SOURCES OF VERIFICATION	KEY CRITICAL ASSUMPTIONS
INPUTS **Bangladesh:** Land Acquisition: Tk 25.7 m BWDB staff Other **Canada:** Capital cost: Cdn $1.28 million O&M Cost: Cdn $ 0.18 million Consultancy: Cdn $ 2.02 million Performance Monitor Other	**OUTPUTS** Infrastructure (embankments, drainage structures, improved drainage channels) Improved flood protection within the embanked area Raised platforms for households between the embankment and the Kangsha River Hand tubewells and sanitary latrines for poor and destitute women	Physical construction Within the embanked area, reduced water level to that of Kangsha River Reduced flood damage to crops during monsoon Uninterrupted flow of road and railway traffic Social harmony between project's residents and the people living between the embankment and the Kangsha River Reduced morbidity	Monitor's report Gate operator's gauge records for regulator's u/s and d/s gauges Reconnaissance survey during flood time Local informants Local informants Local informants and Health Centres' records	***Assumptions to be monitored*** Reaction of the "outsiders" to the embankment ***Risks to be addressed*** Sustainability of project's O&M

Exhibit 10-1: Logical Framework Analysis

Bangladesh will provide

(i) BWDB and other departmental counterpart personnel;

(ii) local currency of Tk 25.7 million including contingencies for land acquisition required for project implementation; and,

(iii) payment of taxes and duties on any imported goods provided to GOB by the Project.

Outputs
The major Project outputs are:

- FCD infrastructures;
- Raised platforms for households between the embankment and the Kangsha River; and,
- Hand tube wells and sanitary latrines for poor and destitute women.

10.1.4 Project Management Strategy

The strategy for attaining the goal and purpose of the Project, is to manage area's floods and drainage problems through structural interventions and to reduce the adverse impacts on environment caused by those interventions through mitigation and compensation measures. The environmental management programme will be treated as an integral part of project development.

Another strategy of this project development is to deliver benefits to the poor and disadvantaged people through:

- preferentially hiring poor and disadvantaged people, especially destitute women, in employment for project construction and operation;
- preserving and enhancing wetland and other natural areas wherever possible;
- developing programmes and projects which target the poor and disadvantaged (for example, enhancement of open water fisheries and social benefit programmes).

Interests of many social groups and concerned government departments lie with the management of water resources in the project area. As such, a multi-disciplinary team including all interested parties will be formed to implement the project so that the development does not sacrifice the interest of any groups. Accordingly, a Project Coordination Committee will be formed with the representatives of concerned social groups and government officials.

All social groups participating in the project development will be institutionalized through establishment of local committees. In the long run this institution will take over the responsibility of the project's O&M and attain sustainability to the development even after withdrawal of external assistance.

Training programmes will be conducted for the different social groups for capacity development in their respective profession so that they can exploit the area's natural resources, without external support, to improve their socio-economic conditions.

10.2 Scope of Work

10.2.1 Work Breakdown Structure

The Work Breakdown Structure (WBS) breaks the project into five major work packages called project Components, which are:

- Management (100)
- Implementation (200)
- People's Participation (300)
- O&M (400)
- Monitoring (500)

Each Component is further broken down into manageable second-order work package called Project Elements. The Components and Elements are illustrated on the Work Breakdown Structure diagram (Exhibit 10-2). The contents of each component is summarized in the following paragraphs.

Management (100). The goal of the Management Component is to ensure best value for resources applied; by monitoring, coordinating, and controlling inputs to and outputs from the project, in accordance with the Terms of Reference. It is also intended to issue an inception report, quarterly progress reports, annual reports and a final report.

Implementation (200). This component includes engineering surveys, land acquisition, design of project components, cost estimates, preparation of contract documents, construction supervision of project interventions and environmental management programmes including mitigation and enhancement programmes, preparation of as built drawings, final bill of quantities, final payment and preparation of O&M Manual.

People's Participation (300). The goal of this Component is to develop a locally-based management system that will integrate BWDB, the local authority and local people in the implementation and operation and maintenance of the project including human resource development. This component will strengthen the local community to take over the responsibility for operation and maintenance of the project after withdrawal of external assistance. The activity includes formation of project coordination committee (PCC), local committees (Sub-PCCs) and involve them in the implementation and operation and maintenance of the project (see section 10.3).

Social mobilisation programmes will be undertaken to resolve different issues and conflicts e.g. land acquisition, relation between the people of the two banks of the Kangsha River and management of regulator operations.

DAMPARA WATER MANAGEMENT PROJECT
WORK BREAKDOWN STRUCTURE

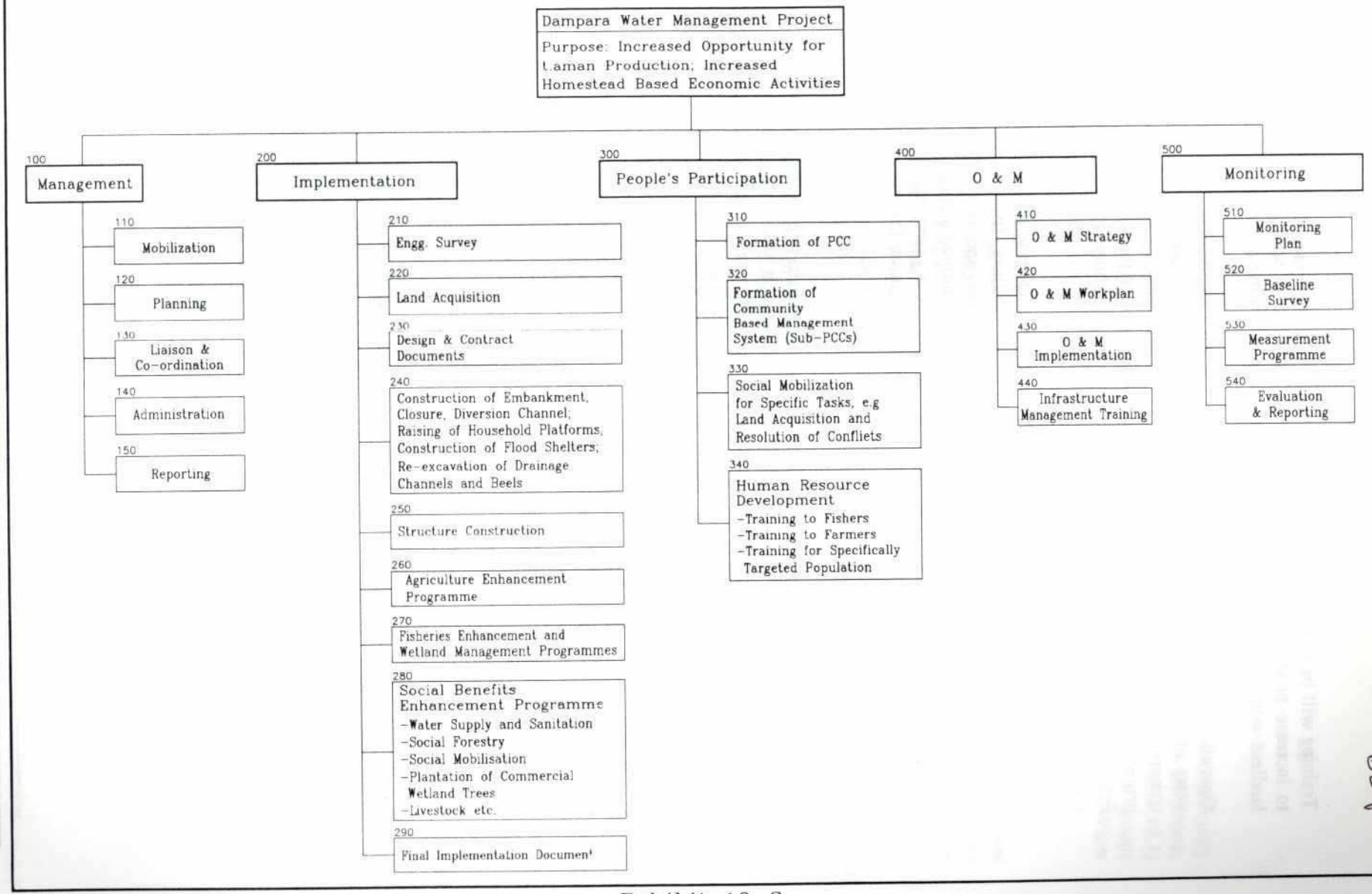


Exhibit 10-2

Training will be provided to farmers and fishers to transfer to them the appropriate technology to increase production. Training will also be provided to specially targeted population e.g. landless women to educate them about the income generating activities.

Operation & Maintenance (400). The project will be responsible for O&M for the first two years after implementation. During this two year period, O&M will be done through local committees as recommended in section 10.3 with the financial and technical assistance of the project. In this way local committee members will receive on the job-training in O&M activities. Efforts will be made to develop a mechanism for generating funds locally to support future O&M costs.

Monitoring (500). The purpose of the monitoring programme is to achieve a better understanding of the actual impacts of the project interventions on agriculture, fisheries, environment, human welfare, and economic development in the project area and provide information on any unanticipated changes resulting from the project. The component includes selection of variables that are to be monitored, identification of baseline surveys, carrying out baseline surveys as necessary, field data collection, evaluation and recommendation for project adjustment.

10.2.2 Expected Results

It is expected that the project will increase agricultural production by 8,850 tons per year, the net economic output of which will be Tk 38.7 million per year. It will increase job opportunities for farm labourers by 0.34 million person-day per year and enhance economic activities through protection of about 90 km of motorable roads, many kilometres of village roads and, several educational institutions and growth centres. It will provide protection to 12,000 homesteads from flood damage and reduce sufferings of more than 60,000 people.

10.2.3 Key Results and Indicators

The key results are the increased income for farmers and farm labourers. An average farmer will have an incremental financial income in cash and/or food for family consumption of more than Taka 4780 per year. The indicators are better living standard of farmers' family and reduced outmigration of farm labourers.

10.2.4 Gender Strategy

The Project will simplify the role of women in several ways. Firstly, the Project will generate about 34,000 person-day job opportunity for them in the agricultural sector. The income will allow them 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 for them such as growing fruits and vegetables, raising poultry and livestock, making household utilities with bamboo, cane and other available materials, and in turn permitting them 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 monsoon.

10.3 Project Organization, Management, Roles and Responsibilities

10.3.1 Institutional Analysis

Several government departments as well as institutions and groups dedicated to community development are involved in any water management projects as they affect local infrastructure, agriculture, livestock, fisheries, navigation and wetlands, etc. The following table (Table 10.1) identifies the roles and weaknesses of different institutions, agencies, organizations and groups that are relevant to the bio-physical and the socio-economic development in the Dampara Water Management Project (DWMP) area.

Institutional Problems and Issues

Land Acquisition. Based on the experience of other water management projects, land acquisition for construction of civil works is identified as one of the major constraints facing the Dampara Project. The Executive Engineer, BWDB Netrokona is required to process the land acquisition case through the Deputy Commissioner's office for the approval of the Land Ministry. The GOB land acquisition process as given in Table 10.2 shows that after submission of the land acquisition plan to the Deputy Commissioner Office by the BWDB Executive Engineer, it takes more than one year to acquire the land.

Existing Institutional Setting. One of the characteristics of the existing institutional setting related to the project is that the administration is highly centralized with most major decisions made in the capital city of Dhaka, resulting in limited coordination between line ministries at the local level. Moreover, there is no existing institution that can effectively coordinate the work of various ministries and local organizations involved in water management at project level.

O &M. Another aspect which is to be considered in order to ensure the success of the water management project is an effective O&M. In Bangladesh, water management projects do not achieve their intended purpose because of lack of effective O&M. BWDB frequently cites inadequate O&M resources as the major constraint which prevents proper follow-ups once the project is completed. The funds allocated for O&M are mainly used to cover BWDB's establishment costs and only a small proportion is available to provide for operation and repair of completed projects.

Bangladesh Government desires that the beneficiaries at least should contribute to the O&M cost of the project. There is a general belief that one of the key requirements for achieving this objective is the increased beneficiary participation in project development and O&M activities.

People's Participation. Interests of many social groups lie with the management of water resources in the project area. As such, it is required to integrate them, especially the affected water resource user groups, in the project management so that the development does not sacrifice the interests of any of the groups.

These problems and issues are addressed in the following sub-sections.

Table 10.1

Roles and Weaknesses of Institutions Relevant to Sustaining DWMP Benefits

Agency, Institution, Organization	Mission, Mandate, Roles and Responsibilities	Weaknesses in Relation to DWMP
1.0 Biophysical: Water Resources Development and Management		
1.1 MOWR - Ministry of Water Resources	Overall responsibility for water resource development and management in Bangladesh	Poor co-ordination with other ministries
1.1.1 BWDB - Bangladesh Water Development Board	Key national agency in water sector. Semi-autonomous under the jurisdiction of the Ministry of Water Resources; planning, implementation, design, construction, maintenance of flood control, drainage and major irrigation works.	Programming exceeds budget Cumbersome procedures Fragmentation with other agencies Poor user participation Poor responsiveness to users Start-up & implementation delays Poor performance against plans. Poor coordination with other departments
1.2 MOEF-Ministry of Environment and Forest 1.2.1 DOE-Department of Environment	Formulation and enforcement of environmental laws and regulations, training and environmental education, environmental planning management, and monitoring; (EIA) Environmental Impact Assessment; providing advice to line agencies on their activities affecting soil and water conservation, forests, wildlife and other natural resources	Unable to carry out many of its responsibilities, due to insufficient institutional resources such as staff, equipment and so on.
1.3 The Ministry of LGRD & C 1.3.1 LGED - Local Government Engineering Department	Responsible for rural physical infrastructure including construction and maintenance of growth centre connecting roads, development and maintenance of small-scale water management structures, provides technical support to district and thana level in design, construction, operation and maintenance of local civil infrastructure, including water control structures and embankments	Weak mechanism for coordination with other Ministries and sector departments
1.4 MOL-Ministry of Land Administration and Land Revenue	Owner of all *khas* land, responsible to manage and dispose of *khas* land as per the law. Acquires land needed in the construction of civil works.	Few staff and delays in land acquisition applications

Agency, Institution, Organization	Mission, Mandate, Roles and Responsibilities	Weaknesses in Relation to DWMP
2.0 Socio-economic: Food and Agriculture		
2.1 DAE-Department of Agricultural Extension	Disseminates crop production information to farmers	Technical vocational system not effective; extension service lacks links to other agencies involved in the sector
2.1.1 BARC-Bangladesh Agricultural Research Council	Coordinates the national agricultural research system; provides sufficient technologies to sustain increased farm productivity for all agricultural and environmental situations	
2.1.2 BRRI-Bangladesh Rice Research Institute	Conducts basic and applied research on rice production and provides training on rice cultivation of officials	
2.1.3 BARI-Bangladesh Agriculture Research Institute	Conducts research on non-rice food crops except sugar and tea	
2.1.4BADC-Bangladesh Agricultural Development Corporation	Promotes the use of modern agricultural inputs among farmers and supplies seed	
2.1.5 BJRI-Bangladesh Jute Research Institute	Conducts research on jute	
2.2 Ministry of Fisheries and Livestock 2.2.1 DOF-Department of Fisheries	Responsible for fisheries resources management, conservation, development, enforcement, statistics, quality control, extension and training for both inland and marine.	DOF suffers from shortcomings in planning, project implementation, design of extension activities and inter-agency coordination. Absence of a clear mandate for the DOF results in "confusing and/or overlapping divisions of responsibility" between DOF and MOWR, MOL, FRI, BFDC and thana administration. Weak main structure. Committed donor assistance cannot be fully utilized.
2.2.2 FRI-Fisheries Research Institute	Does research on aquaculture, riverine fisheries, marine fisheries and brackish-water fisheries	There is a need for involvement of DOF in programme prioritization of FRI research activities

Agency, Institution, Organization	Mission, Mandate, Roles and Responsibilities	Weaknesses in Relation to DWMP
2.2.3 BFDC-Bangladesh Fisheries Development Corporation	Develops, processes and markets marine fisheries Intended to operate as commercial enterprises	Financial performance is poor
3.0 Socio-economic: Community Development		
3.1 Deputy Commissioner (under Ministry of Establishment)	Exercise Land acquisition authorities at district level for development activities	Delay as above
3.1.1 TNO- Thana Nirbahi Officer	Public administration at the thana level	
3.1.2 UP-Union Parishad (lowest-level local self-government council under the Ministry of LGRD & C.	Play important role in the management and maintenance of roads, rural markets and small water bodies.	
3.1.3 Upazila Parishad	Not yet functional only recommended by a commission, set up by the government, to activate at the *thana* level.	
3.2 BRDB-Bangladesh Rural Development Board	Organises farmers into cooperative societies (KSS) and provides them with credit	
3.2.1 TCCA-Thana Central Cooperative Association	Apex organization of BRDB, provides short-term credit for crop production and medium-term credit for the procurement of draft power, implements and irrigation equipment	
3.3 DPHE-Department of Public Health Engineering (A national agency within the Ministry of LGRD&C)	The key government agency in the field of drinking water and sanitation and is mainly responsible for installation and maintenance of rural potable water supply system based on a network of hand tube wells. It also provides extension service for installation of water seal latrines.	Staff in-experienced in handling BWDB schemes

Agency, Institution, Organization	Mission, Mandate, Roles and Responsibilities	Weaknesses in Relation to DWMP
3.4 NGOs:- BRAC, ASA, Caritas	They follow a "target group approach", where the landless and women are the target audience. They are broadly grouped into 2 categories in terms of their activities: service delivery and catalytic. Social mobilization , rural development, capacity building and institutional development of the vulnerable groups, through the formation of village-based groups or cooperatives by the "conscientization process"; health and family planning services, particularly community health education; non-formal education, particularly for adults; rural credit; promotion of employment, in the field of livestock, poultry, fisheries, and sericulture; training for income generating activities.	No activity related to water management.
3.4.1 Grameen Bank (NGO)	Extends credit to rural poor, especially women	
3.5 Ministry of Food FFW-Food-For-Work	Food For Work (UNWFP) disburses grain in exchange for labour.	
3.6 Grass-roots Institution:		
3.6.1 KSS-Krishi Samabaya Samity	A village level farmers' cooperative society sponsored by the BRDB. At the thana level, all KSSs are federated to a central society named TCCA.	
3.6.2 NGO group	These village based groups are often federated to higher tier at the union and thana levels. BRAC and Grameen Bank are some of the NGOs working in the area.	
3.6.3 LCS- Landless Contracting Society	A group centred around a *Sardar*, involved in earthwork.	
3.6.4 Others	Traditional social institutions at the village level named as *samaj* who exerts influence over its members and regulates their social and economic life.	

Table 10.2: GOB Land Acquisition Process

Stage	Schedule Time Frame in days (as per 1994 Land Acquisition Law)		Time Taken in Practice (days)	
	Without Objection	With Objection	Without Objection	With Objection
1. Meeting, Scrutiny and Approval by District Land Acquisition Committee	30	30	60	60
2. Service of Notice under Clause 3 and Settlement of objection and submission to Land Ministry	15	30	30	60
3. Return to Deputy Commissioner after Approval by Land Ministry	30	90	90	120
4. Service of Notice by Deputy Commissioner Under Clause 6	15	30	30	60
5. Preparation of Estimate by Deputy Commissioner and forwarded to BWDB	7	7	30	60
6. Approval by BWDB Superintending Engineer and Placement of Fund under Clause 7(3)	60	60	60	60
7. Settlement of Land Compensation by Deputy Commissioner under Clause 10(2)	60	60	60	90
8. Transfer of Possession	30	30	45	45
Total Time (days)	247	337	405	555

Source: Executive Engineer, BWDB Netrokona

10.3.2 Management Approach

According to the existing institutional arrangement, Bangladesh Water Development Board will be the implementing agency for the Dampara Project. However, the BWDB is a civil-engineering dominated organization and as identified in Table 10.1, its coordination with other departments and its response to users are deficient. Moreover, user participation in its projects is also poor. But the successful management of the Dampara Project will require coordination among several departments and agencies working in the area. They include the Department of Fisheries, the Department of Agricultural Extension, the Bangladesh Rural Development Board, Local Authorities and NGOs, each of which may be involved in its own areas of expertise.

The proposed management approach of this project is to integrate local authority and local people in the project development along with BWDB so that ultimately the local people take over responsibility of the future project O&M.

PCC

According to the existing BWDB framestructure, implementation, operation and maintenance programmes in the Dampara Project area will be the responsibility of the Executive Engineer, BWDB Netrokona Division. This Division is within the administrative jurisdiction of the BWDB Mymensingh Circle.

To have better liaison between the Executive Engineer, Netrokona Division and other relevant government agencies working in the project area, it is proposed to form a project coordination committee (PCC) in accordance with the guidelines prepared by FAP 16 (see Manual for Environmental Impact Assessment - section 7.4). In accordance with the *Guidelines*, BWDB will convene the PCC and Member of Parliament (MP) from Pubadhala thana will chair it. The Sub-Divisional Engineer, BWDB, Jaria is proposed to be the member secretary of the committee. In addition to relevant thana officials related to project activities, the elected representatives from the affected resource user groups and NGOs working in the area will be included in the PCC.

Sub-PCCs

The *Guidelines* also recommend to form a set of sub-committees (Sub-PCCs) organised around "technically rational water management structures". Accordingly, the following three Sub-PCCs will be formed:

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

In order to be effective, the members of the sub-committees should be individuals directly benefiting from the interventions, otherwise, as has been found in the Kalni-Kushiyaya Pilot Dredging Project carried out by NERP, their effectiveness would diminish should they include members who do not have immediate interest at stake.

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

Regulator Committee. Although the drainage regulator is a part and parcel of embankment; its operation directly affects fishery and wetland resource user groups. Therefore, this committee will be formed from 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. Therefore, this committee will be formed from representatives of these three groups.

Consultants
There will be two team of consultants - the main consultant and the monitoring consultant. They will be directly responsible to the Bangladesh Water Development Board. They will also maintain liaison with PCC and Sub-PCC members.

The main consultant headed by an expatriate team leader will assist BWDB, PCC and Sub-PCCs for development, operation and maintenance of the Project (Component 100 to 400 as described in section 10.2.1). The other team from a local consulting firm will assist them for monitoring and evaluation (Component 500). A local Water Resource Engineer will head the team. The team will be supported by a part time expatriate consultant.

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.

10.3.3 Organization Chart

The Project Organization Chart is given in Exhibit 10-3. The consultants will be responsible to CIDA (HULL) and to BWDB through the Superintending Engineer (SE), Project Implementation Unit (PIU), under the supervision of Chief Engineer, Central Zone, above that, the Member (Implementation). Consultants will coordinate the work with the Superintending Engineer, Design and Superintending Engineer, Mymensingh through PIU.

BWDB will be linked to PCC and Sub-PCC at field level. Consultants will be maintaining liaison with PCC and Sub-PCCs. PCC will be placed under Ministry of Water Resources in consideration of allocation of project fund from that Ministry.

10.3.4 Roles and Responsibilities

Role of CIDA Headquarters
Canada's inputs to the Project will be managed by a Project Officer at CIDA Headquarters in Hull. CIDA/Hull is responsible for;

- preparing a Memorandum of Understanding which outlines the Project objectives and the two governments' responsibilities; while preparing MOU, CIDA/HULL will consult BWDB and MOWR;
- approving invoices and controlling the disbursement of Project funds to BWDB and consultants;

PROJECT ORGANIZATION CHART

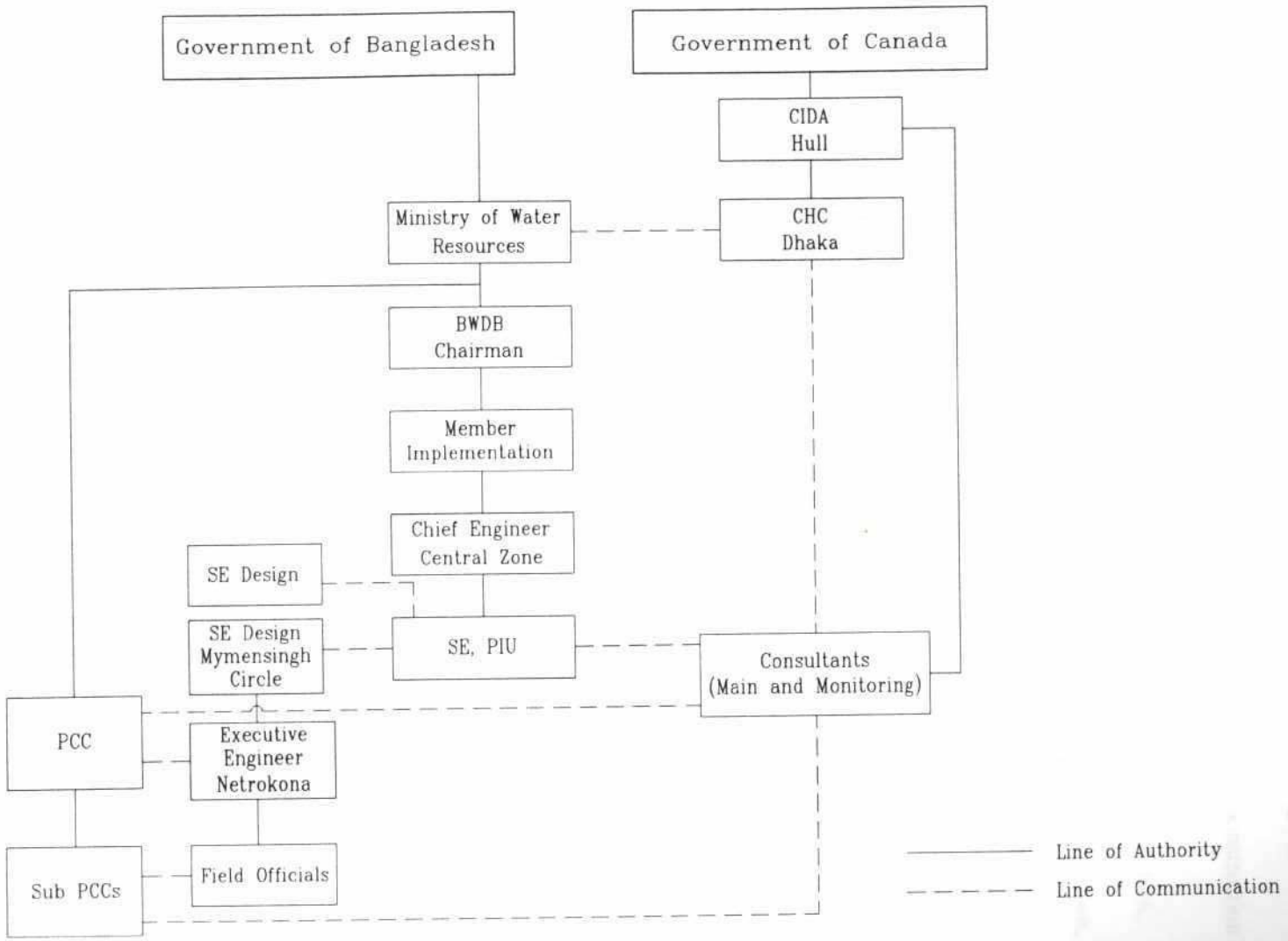


Exhibit 10-3

- liaison with the consultants, BWDB and CHC/Dhaka on project related matters;
- monitoring the technical acceptability of activities and outputs, and efficiency of project administration by reviewing project reports and fielding review and supervisory missions; and,
- conducting interim and final project evaluations.

Role of Canadian High Commission

The Canadian High Commission (CHC), Dhaka, is responsible for:

- negotiating and signing the Memorandum of Understanding and this Management Plan;
- providing information and liaison between CIDA , BWDB and consultants as needed, including attending project related meetings as requested;
- assisting the consultants generally, and in particular with mobilization/demobilization of personnel, and the storage or transfer to another project, of equipment and material at the conclusion of this Project;
- disbursements for local implementation contracts directly funded by CIDA;
- monitoring the progress of the Project and ensuring that activities and outputs contribute to the Project's stated goals and objectives;
- reviewing terms of reference, arranging meetings and field trips, and reviewing reports of CIDA evaluation missions.

Role of Bangladesh Water Development Board

BWDB 's specific responsibilities include:

- providing a Project Director (Superintending Engineer), salary to be paid by GOB;
- clearing materials imported for BWDB through customs (including tax and duty payment);
- assisting in field data collection associated with the monitoring activities;
- facilitating liaison with other government agencies responsible for aspects of water resources affected sectors (e.g. agriculture, fisheries etc);
- overseeing the consultants' activities and reviewing consultants reports (see Section 4, below);
- preparing land plan jointly with the consultant;
- acquiring land (through Deputy Commissioner) in accordance with agreed-upon time frame;

- approving design, tender documents and awarding tenders;
- procuring and delivering construction materials and equipment to construction sites;
- supervising construction and making payments from funds supplied by CIDA.
- participating in programs to involve local residents in project construction, operation, and maintenance; and,
- Oversee the Sub-PCCs activities in project operation and maintenance.

Role of Consultants

Main Consultant. The main consultant's Head Offices are responsible for:

- maintaining a full complement of CIDA - and BWDB - approved Canadian and local staff as required;
- establishing quality control procedures (such as personnel evaluation and reviews);
- providing a quarterly cash flow forecast and progress report to CIDA and also to BWDB as per existing procedure of BWDB.

The consultant in-country team is responsible for:

- ***Project Management*** - monitoring, coordinating, and controlling the Project inputs and outputs defined in the Consultant's Terms of Reference.
- ***Implementation*** - preparation of land plan, implementation documents including design, working drawings and contract documents, construction supervision and, preparation of final implementation documents.
- ***People's Participation*** - taking initiative for formation of PCC and Sub-PCCs and integrating them in the project's implementation, operation and maintenance; provide training and transfer technology to fishers and farmers for increased production; also arrange training for specially targeted population to enhance income generating activities.
- ***O&M*** - carrying out O&M work through PCC and Sub-PCCs and provide on-job training to them in consultation with the relevant departments.

Monitoring Consultant. The monitoring consultants will be responsible for monitoring of project performance and evaluation. The task includes identifying and carrying out pre-project baseline survey if required; preparing post-project monitoring plan, conduct measurement programme, and evaluate and report for project adjustment. The consultants will prepare an inception report including a work plan within two months of the commencement of the project and obtain concurrence from CIDA and BWDB and proceed with the activities accordingly.

Role of Project Coordination Committee

The Project Coordination Committee is responsible for:

- disseminating information on planning, implementation, operation and maintenance of the Project and to seek area people's active participation;
- assisting land acquisition process;
- solving constraints and impediments to the implementation of the project;
- ensuring that the local landless people including women are benefitted from the project through employment opportunities as this stage represents a period of capital inflow into the project area;
- monitoring progress and quality of work;
- overseeing operation and maintenance of the project and mediate in any matter concerning O&M between beneficiaries and affected groups;
- ensuring Sub-PCCs' active participation in project's O&M;
- overseeing the establishment and functioning of agricultural support services, including agricultural extension, supply of seeds, fertilizers and pesticides, etc;
- arranging training for farmers and fishers to adapt post-project conditions and new technologies to enhance production; and,
- arranging credit facilities.

Role of Sub-Project Coordination Committee

Embankment Committee. The main responsibilities of this committee are to:

- select final embankment alignment with BWDB and the Consultants. This is a decision that the community can most meaningfully participate in. If the community does participate genuinely in this decision, land acquisition will be much easier to achieve than if they do not;
- assist in land acquisition process (motivate and obtain agreement from the owners of land over which the embankment will pass);
- accommodate those remaining outside the embankment;
- employ local landless people including poor women in embankment earthwork and turfing and maintenance of the embankment;
- find out ways and means to generate fund for maintenance of the embankment. It is considered premature to prescribe how the community will arrange the maintenance. However, one method adopted in other projects has been to exchange access to embankment land for maintenance service rendered; and,
- obtain training for maintenance of the embankment and take over O&M from BWDB.

Regulator Committee. The main responsibilities of this committee are to:

- select small drainage outlet structure sites;
- request the contractor to employ local labours as much as possible;
- operate the structure as per the O&M Manual. One of the aspects of operation of the structures is to keep them open from January to June to allow fish migration and spawning and regeneration of wetland products in the wetlands. During July- October, flush in river water at times of no rain and flood to the extent that standing crops in the project area are not damaged;
- solve problems between farmers and fishery and wetland resource user groups arising out of the operation of the structure;
- appoint gate operator and find out ways and means to generate fund for operator's remuneration and maintenance and repair of the structure;
- arrange training for the operator for operation and repair of gates etc; and,
- take over O&M from BWDB.

Drainage Channel and Beel Management Committee. The main responsibilities of this committee are to:

- recover drainage channel land (govt. land) from illegal possession;
- employ local landless people including poor women in channel re-excavation work;
- manage disposal of spoils;
- develop, manage and protect beels to enhance production of fisheries and wetland resources;
- find out ways and means to generate fund for maintenance of drains and beels;
- obtain training for enhancement of fisheries production and wetland resources; and,
- take over O&M from BWDB.

10.3.5 Project Implementation Schedule

The Project Master Schedule is shown in Exhibit 10-4. The Project is assumed to run for a period of three years for implementation from November 1997 and continue for another two years for operation and maintenance, and monitoring. The schedule shows the time frame for each project component and element.

PROJECT MASTER SCHEDULE

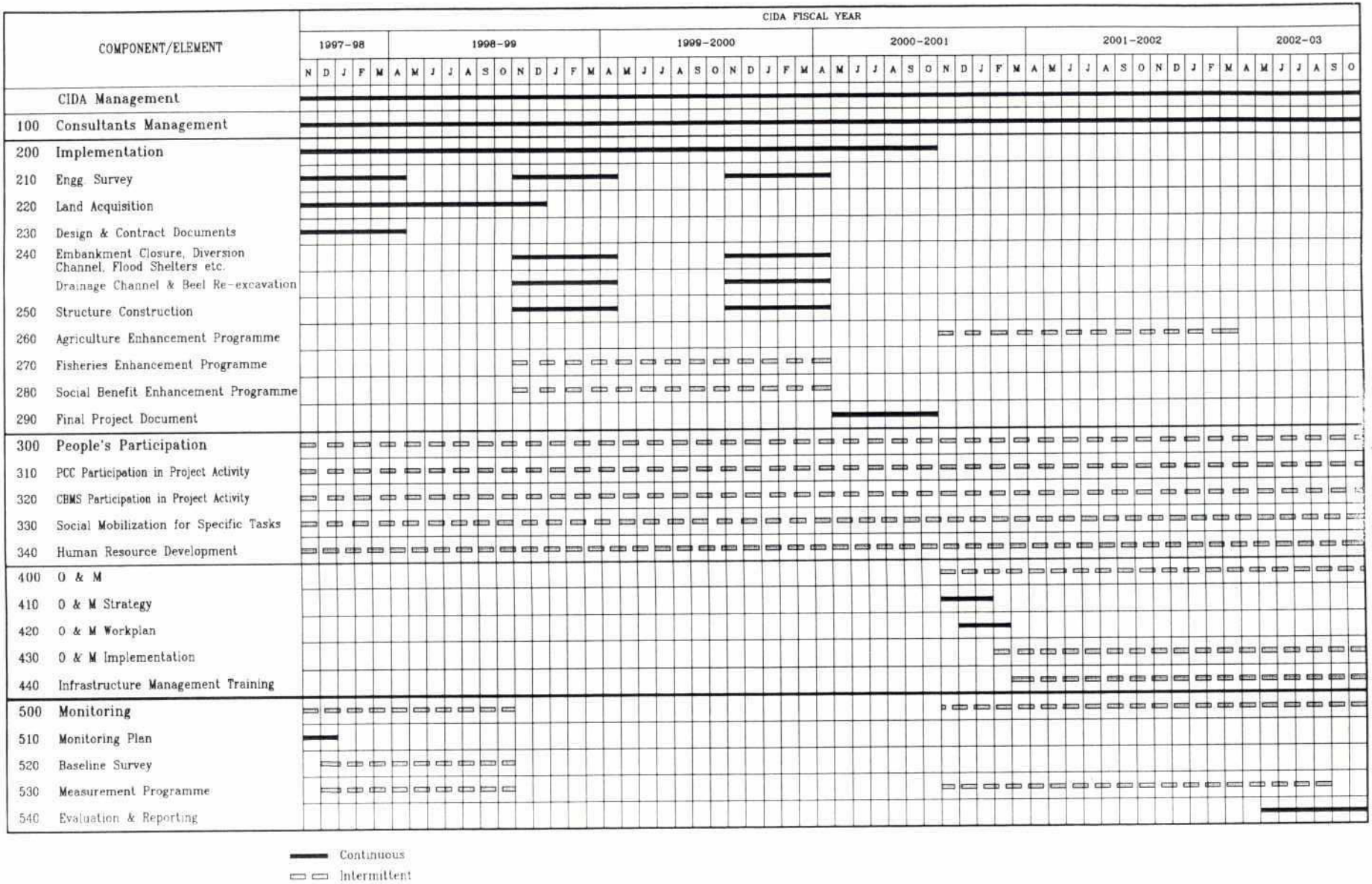


Exhibit 10-4

As stated in section 10.3.1 the main implementation problem in this project is the land acquisition and takes more than one year to get the land possession. The process may be shortened by empowering the Deputy Commissioner to settle all issues without submission to the Land Ministry and also reduce the period required by each step of the process, especially the approval time by the BWDB Superintending Engineer. Inclusion of Sub-PCCs in the preparation of land acquisition plan and involvement of local MP in the acquisition process may expedite the matter.

The project should start at a time when the land acquisition process can immediately be initiated. The first step for land acquisition is the cadastral survey which includes selection of the final embankment alignment and identification of land plots in the field. This will be followed by an engineering survey for design and contract documents. For these activities, November - December is considered the best time and as such it is also considered the best time to start the project.

There should also be a firm commitment from GOB about timely availability of fund for land acquisition.

10.3.6 Project Contracts and Implementation Responsibilities

Broadly, the project activities as given in the Work Breakdown Structure (Exhibit 10-2) are divided into the following two contracts:

- Implementation and O&M; and,
- Monitoring.

Implementation and O&M
Implementation. The implementation activities (Component 200 as shown in Exhibit 10-2) are sub-divided into eight sub-contracts (Table 10.3 below):

Table 10.3: Project Development Contracts

Contract	Amount (Tk 1,000)	Implementing Agency
1.Embankment, Homesteads and School Premises	24,100	BWDB
2.Closure and Diversion Channel	1,090	BWDB
3.Drainage Channel, Beel and Internal Channel	3,650	BWDB
4. Structure Construction	4,420	BWDB
5. Agriculture Enhancement	500	DAE
6. Fisheries Enhancement, River Sanctuary & Wetland	2,240	DOF
7. Water Supply and Sanitation	1,800	DPHE
8. Social Forestry & Social Mobilisation	700	Social Welfare Dte
Total	**38,500**	

The overall responsibility of the project development will lie with the BWDB. Specifically it will work with the respective Sub-PCCs to implement contracts 1 to 4. The remaining four contracts will be implemented by the concerned departments and Sub-PCCs. BWDB will control funds and will release them to other ministry officials as per budget allotment. All implementing agencies will remain responsible for their performances to the PCC as well as to their line ministries.

O&M. The project will bear expenses for O&M for the first two years after project development. Mainly the Sub-PCCs will be responsible for the O&M activities. The concerned departments' responsibilities will be limited to ensuring that the Sub-PCCs use the facilities in the intended manner. During these two years, PCC, Sub-PCCs and the Consultant will develop a mechanism to meet the future project O&M expenses. In this connection, it is to be mentioned here that in the neighbouring BWDB's Kangsha Project, BWDB will leave the responsibility of the O&M activities with the project beneficiaries; but no mechanism has been developed so far for its accomplishment.

Monitoring

The Monitoring Consultant will be responsible for monitoring the project performance for the first two years after project development, evaluate the project performance based on the data of these two years and develop a system for a long term monitoring.

After two years, the relevant GOB agencies and local committees will then take over and continue with the long- term monitoring. Table 10.4 shows the breakdown of the monitoring phase and the agencies responsible for short and long term monitoring:

Table 10.4: 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

Employment provision

In the project contract documents, provision will be kept for preferentially hiring poor people affected by project development and disadvantaged people, especially destitute women, in employment for project construction and, operation and maintenance.

10.4 Monitoring, Control and Evaluation

10.4.1 Monitoring

The consultants will install appropriate monitoring and review functions within its organization. Periodically CIDA and SE (PIU) will field review and supervisory missions to examine the work performance and to recommend improvements to the Project. The consultants will assign staff to travel with these missions, provide information requested by them, and in all other respects cooperate fully.

10.4.2 Reporting

Both consultants will produce the following reports and submit to CIDA and BWDB:

Work Plan
The work plan, which will be submitted by each of the consultants within two months of contract award will provide a detailed work plan for the first project year, and overall plan for the remaining period.

Quarterly Progress Report
This report will contain details on procurement, construction and finance.

Annual Report
Same as Quarterly Report, plus next Annual Work Plan.

Final Report
This report provides a detailed account of services performed on the project together with accounting of financial data. Two reports will be prepared by the main consultants - one after completion of implementation (after three years) and the other after completion of O&M programme (two year after implementation).

The Monitoring Consultant will submit the final report after completion of monitoring programme (two year after implementation).

10.4.3 Evaluation

Evaluation will be conducted by CIDA, jointly with GOB where possible. The first evaluation at or shortly after the conclusion of the first project year will be undertaken to measure project progress and management against planned schedule and targets.

A midterm evaluation will be undertaken after the completion of the project construction to measure quality and completeness of project's physical works.

A final evaluation will be undertaken after completion of the Project's O&M and monitoring works to assess its overall success, the degree to which its stated goals, purposes and outputs were achieved and its environmental and gender impacts.

10.5 Project Budget

10.5.1 Project Development and O&M

Personnel Requirement (Main Consultancy)
The deployment of implementation team professional resources over the life of the project for the main consultants is shown in Exhibit 10-5. A person-manmonth total is given for each position. Overall totals are 388 Bangladeshi and 12 Canadian person-months. The consultants budget by expenditure type is as follows:

Table 10.5: Cost for Main Consultancy

Expenditure Type	Amount Cdn $1,000
Canadian Professional Services and Allowances	220
Bangladesh Professional Services and Allowances	580
Consultant Operation: office, support staff, local travel, data collection	520
Project Travel Outside Bangladesh	30
Technical Assistance Total, Including Inflation Allowance	1,350

Capital and O&M Works
The capital and O&M cost budget (excluding land acquisition cost) is as follows (Capital cost by contract is given in Table 10.6):

Table 10.6: Capital and O&M Costs

Item	Amount (Tk 1,000)
Capital Cost	38,500
O&M for two years	5,300
Total	**43,800**

PERSONNEL REQUIREMENT
(Main Consultancy)

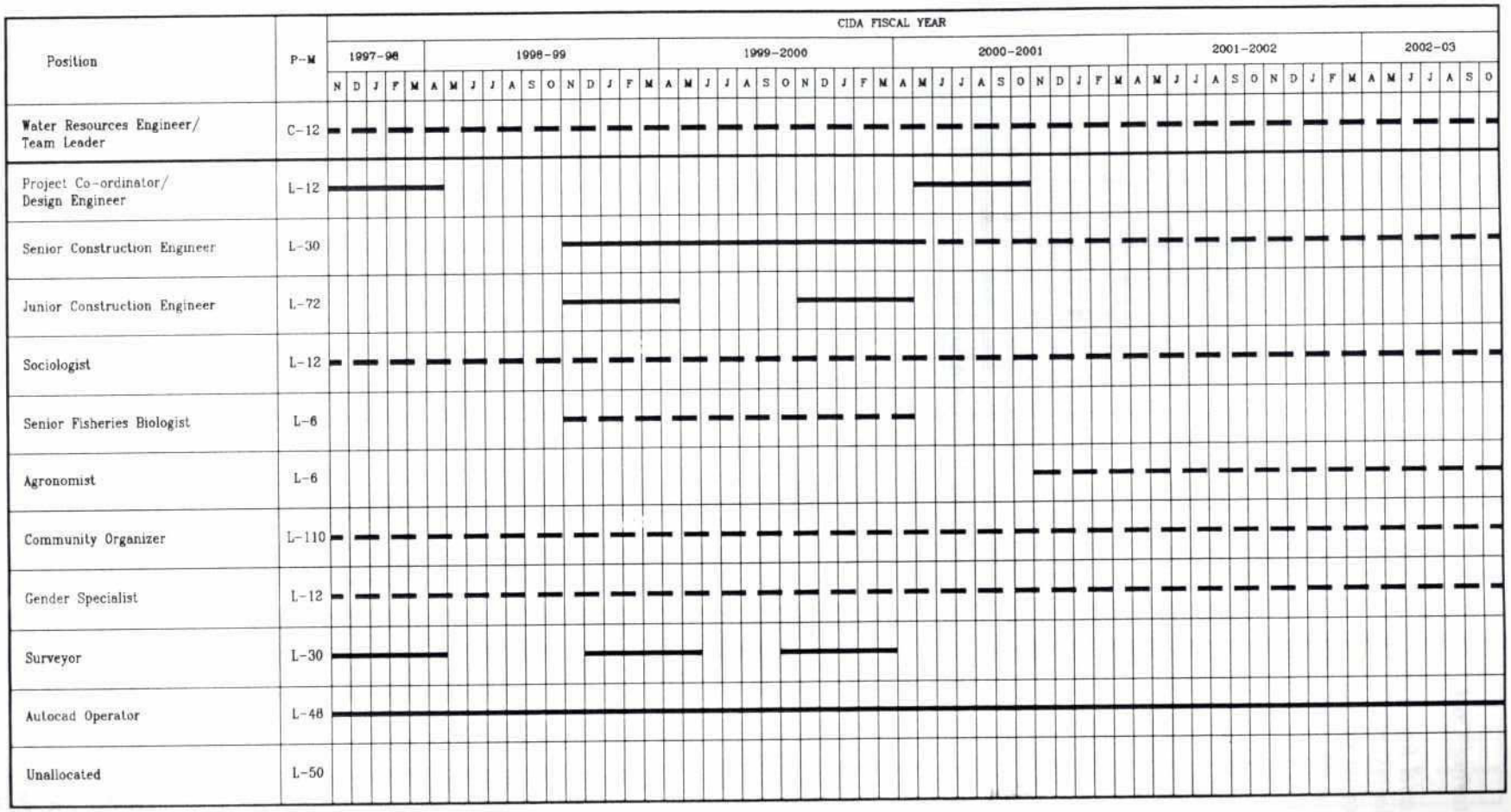


Exhibit 10-5

10.5.2 Monitoring Cost

Personnel Requirement (Monitoring Consultancy)
The deployment of implementation team professional resources over the life of the project for monitoring consultancy is shown in Exhibit 10-6. A person-manmonth total is given for each position. Overall totals are 252 Bangladeshi and 9 Canadian person-months. The consultants budget by expenditure type is as follows:

Table 10.7: Cost for Monitoring Consultancy

Expenditure Type	Amount Cdn $ 1,000
Canadian Professional Services and Allowances	165
Bangladesh Professional Services and Allowances	325
Consultant Operation: office, support staff, local travel, data collection	145
Project Travel Outside Bangladesh	20
Technical Assistance Total, Including Inflation Allowance	655

10.5.3 Total Project Budget

The total project budget as summarized in Table 10.8 below is Tk 129.65 million.

Table 10.8: Budget Summary

Expenditure Type	Amount	
	(Tk 1,000)	Cdn $ 1,000
Capital Cost (excluding land cost)	38,500	1,280
O&M Cost for two years	5,300	180
Main Consultancy Cost	40,500	1,350
Monitoring Consultancy Cost	19,650	655
Sub-Total	**103,950**	**3,465**
Land Acquisition	25,700	857
Total	**129,650**	**4,322**

Note: Cdn $ 1.0 = Tk 30.0

10.5.4 Budget Assumptions

The Project Development and O&M budget assumes that fees and allowances for both expatriate and local personnel are compatible with those experienced in Phase II of NERP. Local professional and support staff is to be provided by local consulting firms at their current markup.

A separate office is to be set up for this component. Three vehicles are to be transferred from NERP or another CIDA funded project.

The same assumption are also made for the monitoring consultancy with respect to fees. In this case however, the contract is to be awarded to a local consultant firm who will operate from their premises.

PERSONNEL REQUIREMENT
(Monitoring Consultancy)

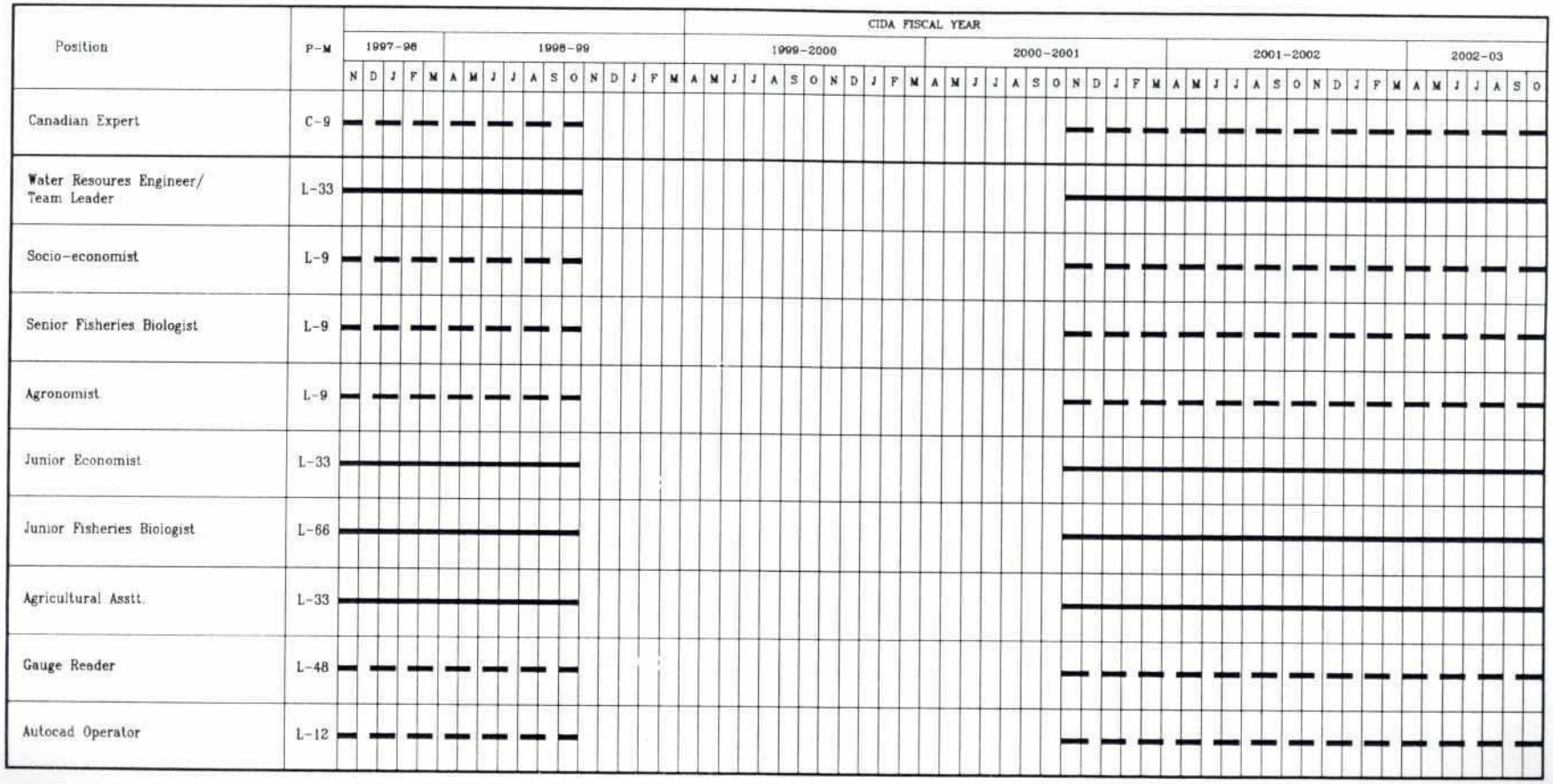
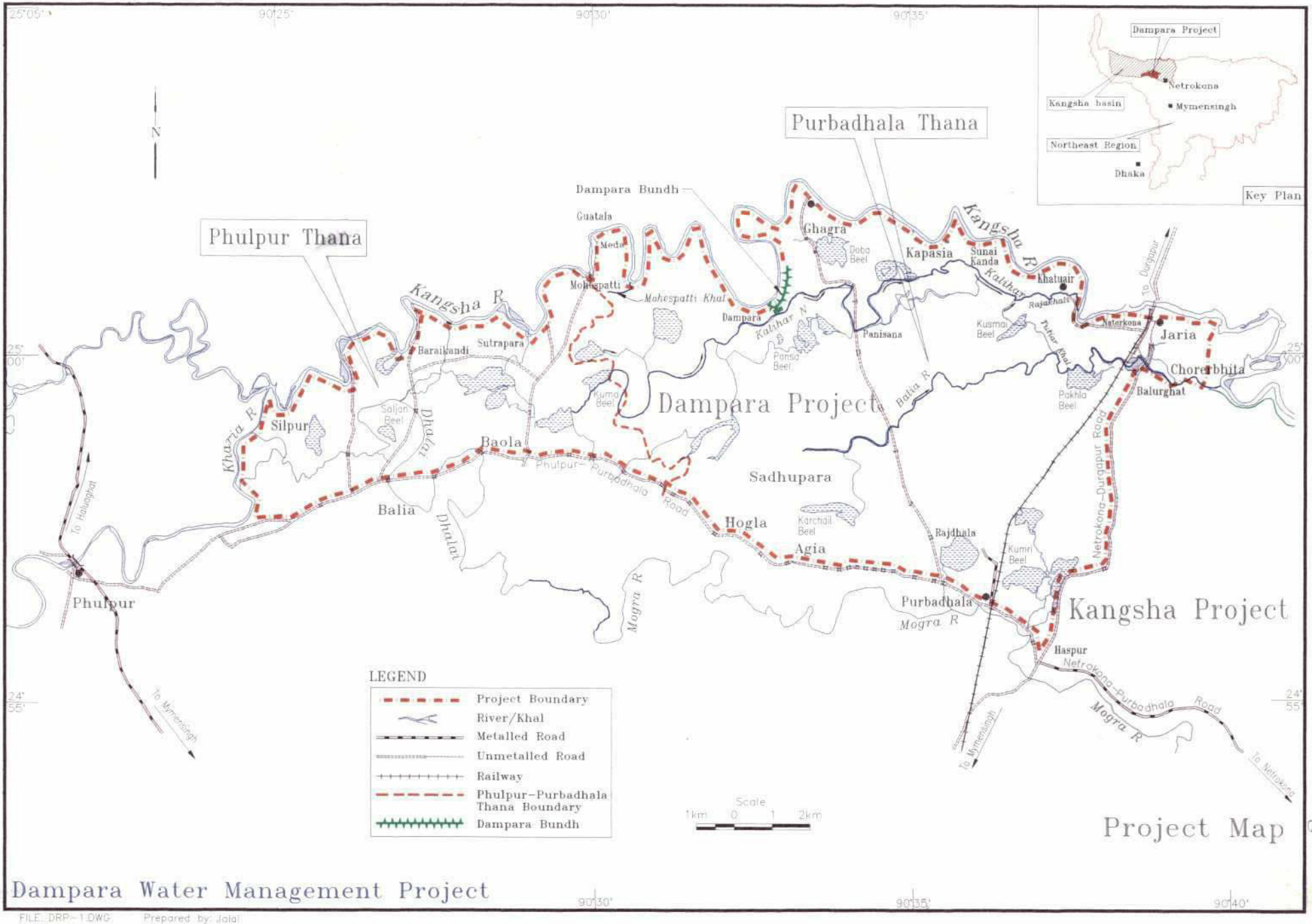


Exhibit 10-6

FIGURES

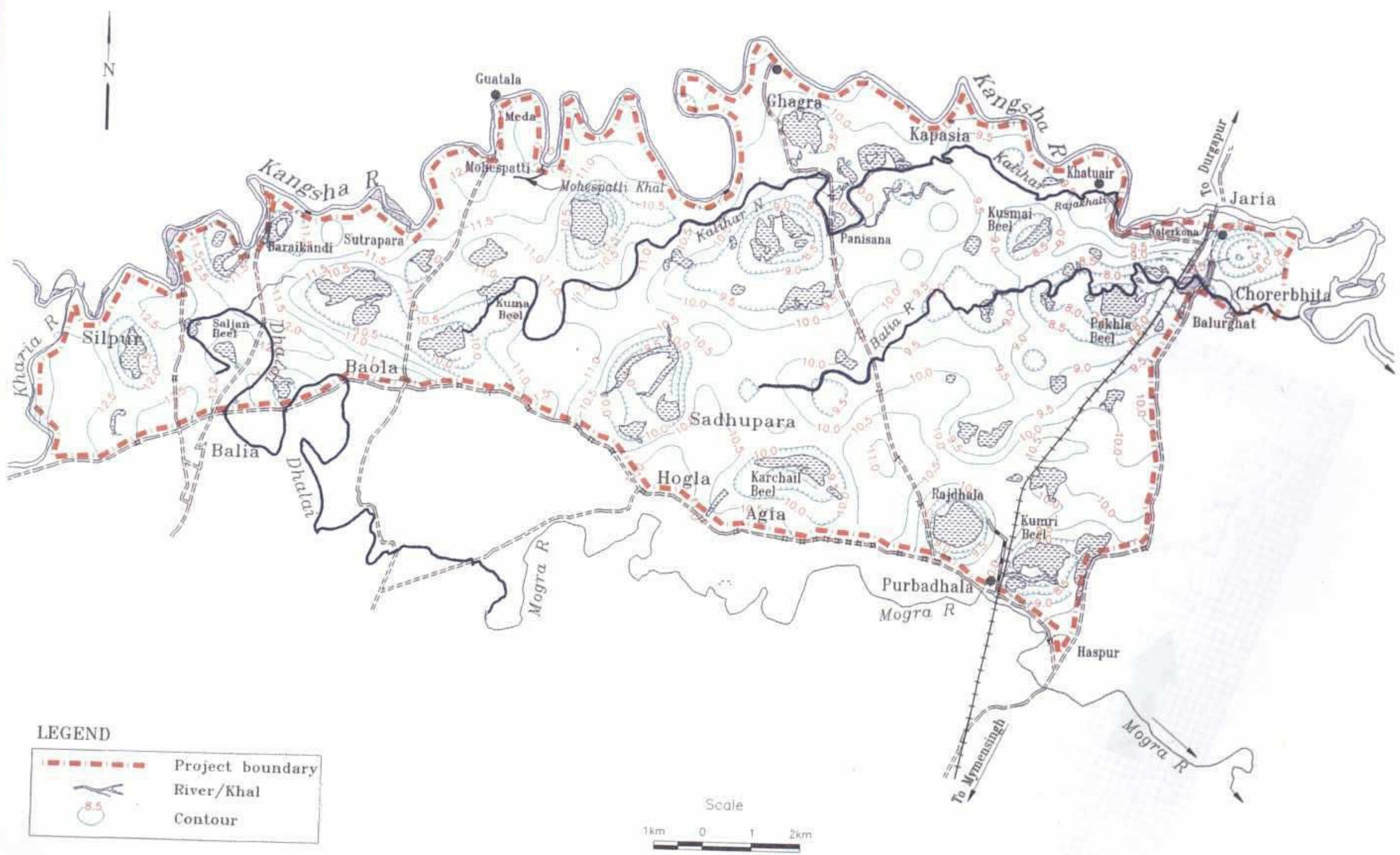


Dampara Water Management Project

FILE: DRP-1.DWG Prepared by: Jalal

Figure 1

Figure 2

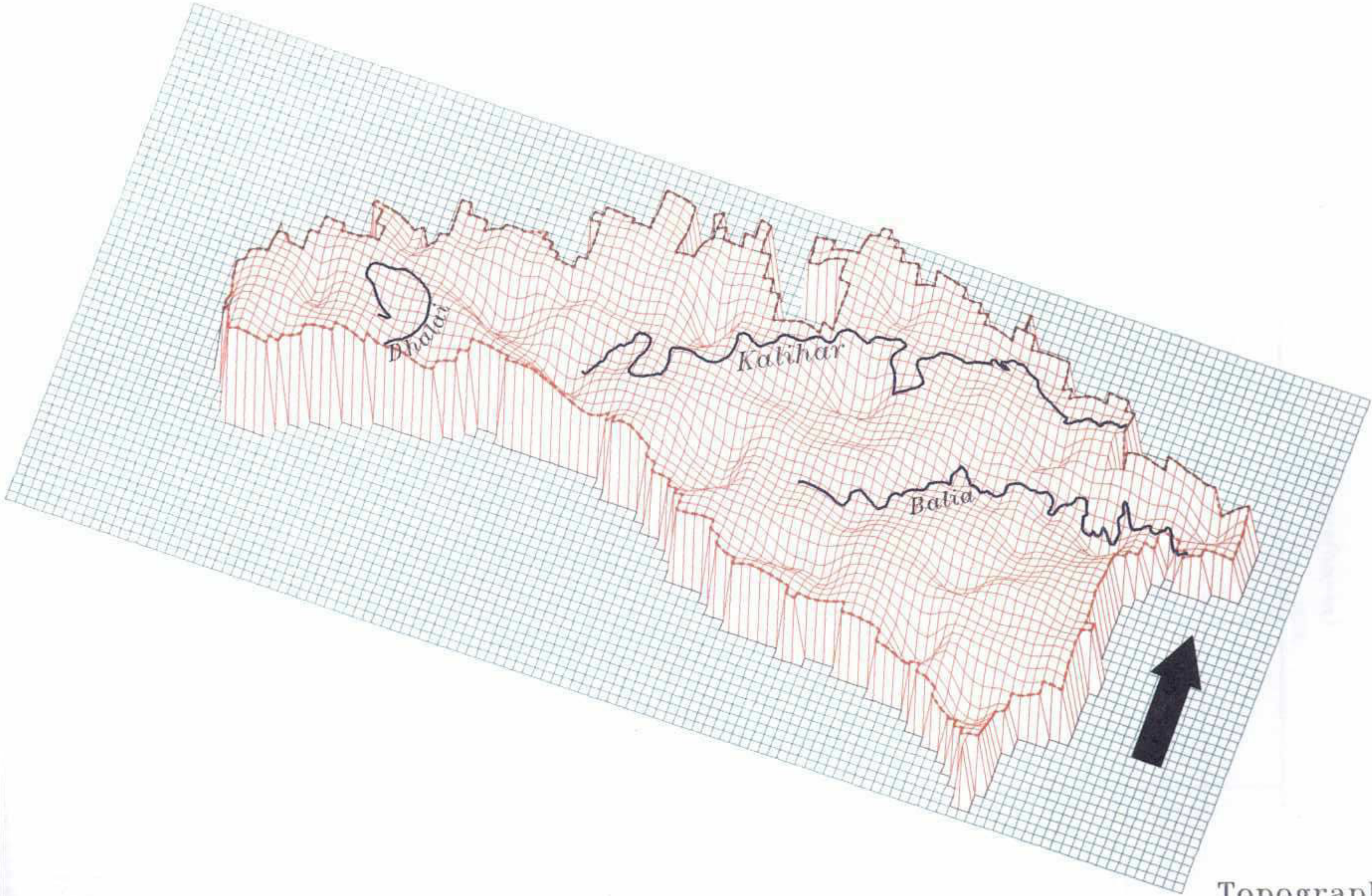

N
Guatala
Meda
Mohespatti
Mohespatti Khal
Kangsha R
Kangsha R
Ghagra
Kapasia
Khatuair
Kalihar
Rajakhali
Kalihar N
To Durgapur
Jaria
Nalerkona
Chorerbhita
Balurghat
Kusmai Beel
Panisana
Pakhla Beel
Balia R
Sutrapara
Baraikandi
Kuma Beel
Silpur
Saljan Beel
Dhalai
Baola
Balia
Dhalai
Kharia R
Sadhupara
Hogla
Karchail Beel
Agla
Rajdhala
Kumri Beel
Purbadhala
Mogra R
Mogra R
Mogra R
Haspur
To Mymensingh
LEGEND
Project boundary
River/Khal
Contour
Scale
1km 0 1 2km

Land Levels

Dampara Water Management Project

FILE: DRP-2.DWG Prepared by: FR

Figure 3

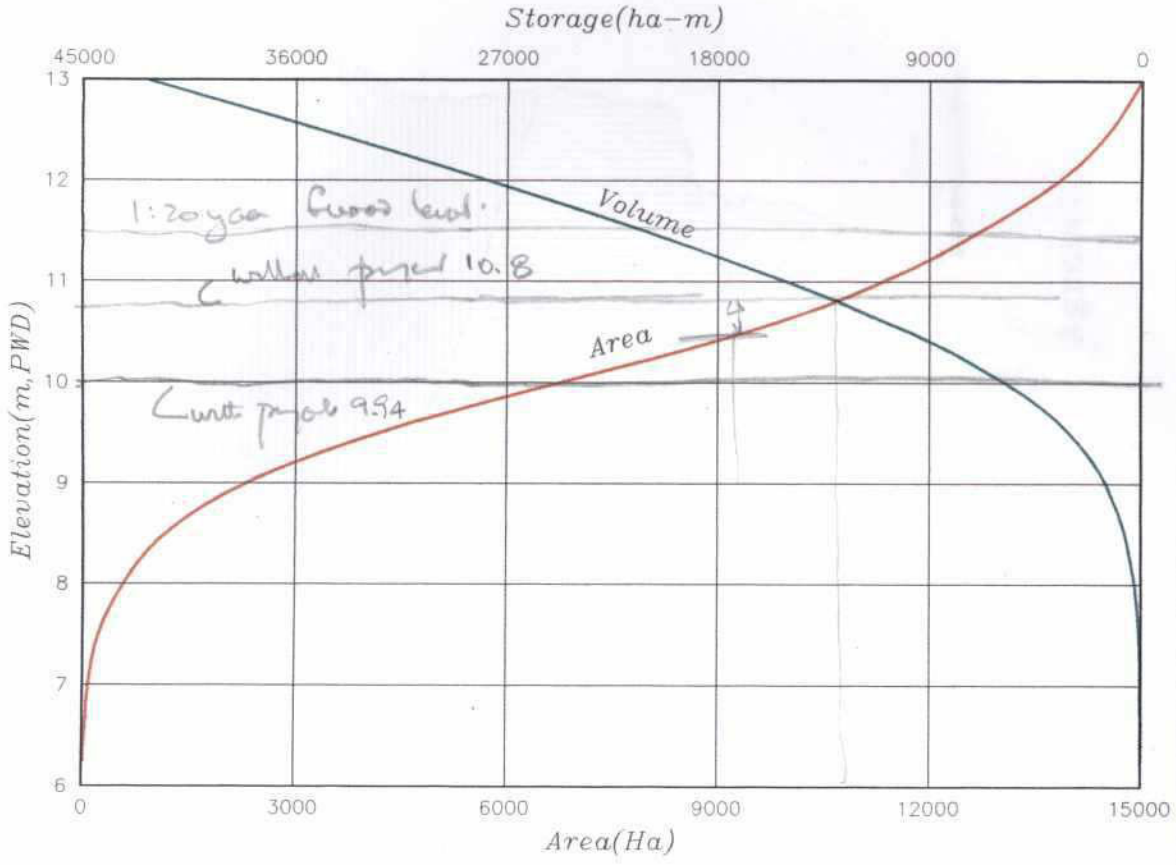


Topography

Dampara Water Management Project

FILE: DRP-3.DWG Prepared by: Awlad, Oct/1995

Figure 4



EL(m,PWD)	Area(ha)	Storage(ha-m)
6.24	6	0
6.50	13	2
7.00	63	21
7.50	171	80
8.00	550	260
8.50	1057	662
9.00	2164	1467
9.50	4043	3019
10.00	6725	5711
10.50	9559	9782
11.00	11419	15026
11.50	12741	21066
12.00	13893	27725
12.50	14627	34855
13.00	15000	42262

Elevation – Area – Storage
Dampara Project Area

Dampara Water Management Project

FILE: DRP-4 Prepared by: Awlad

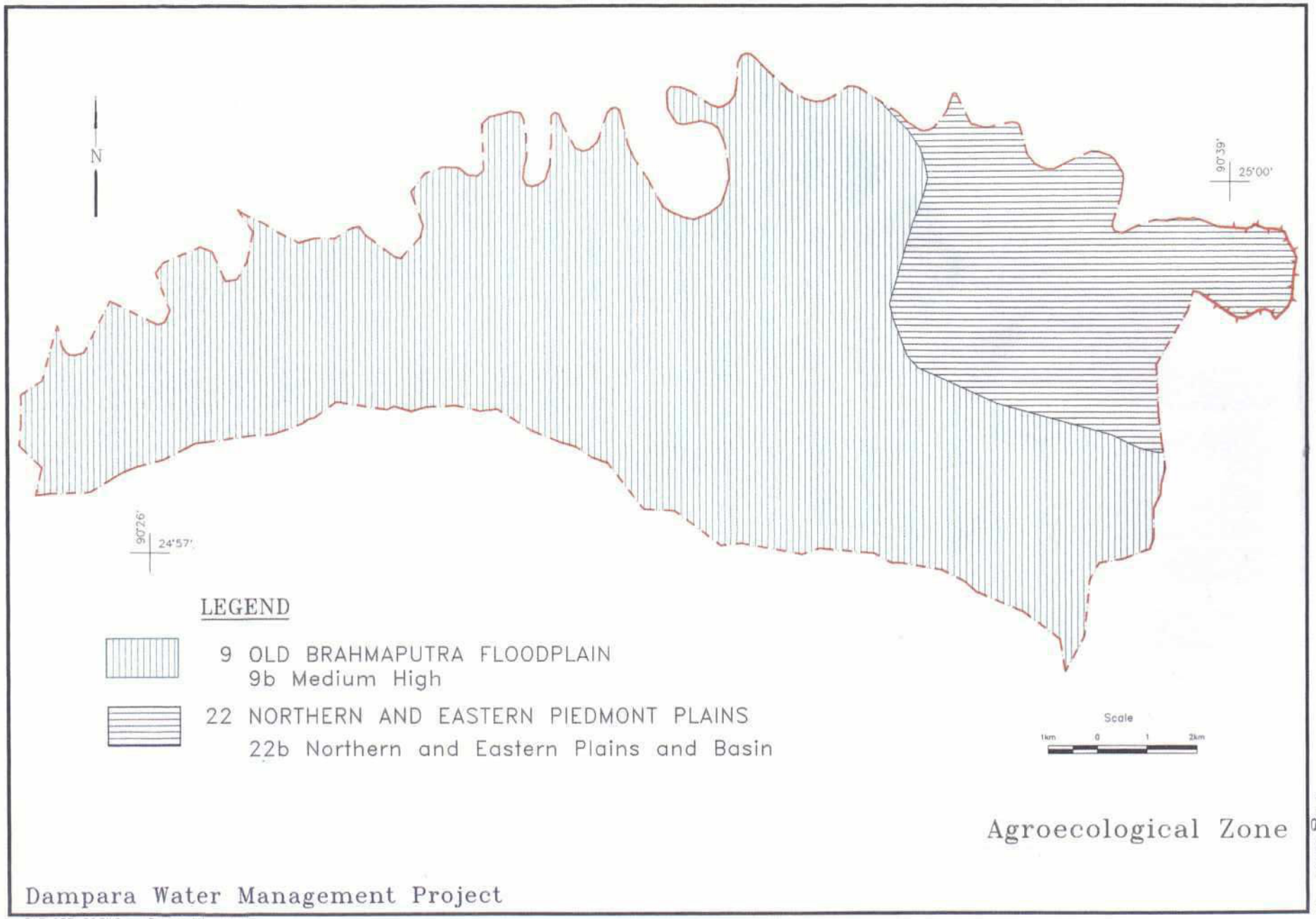
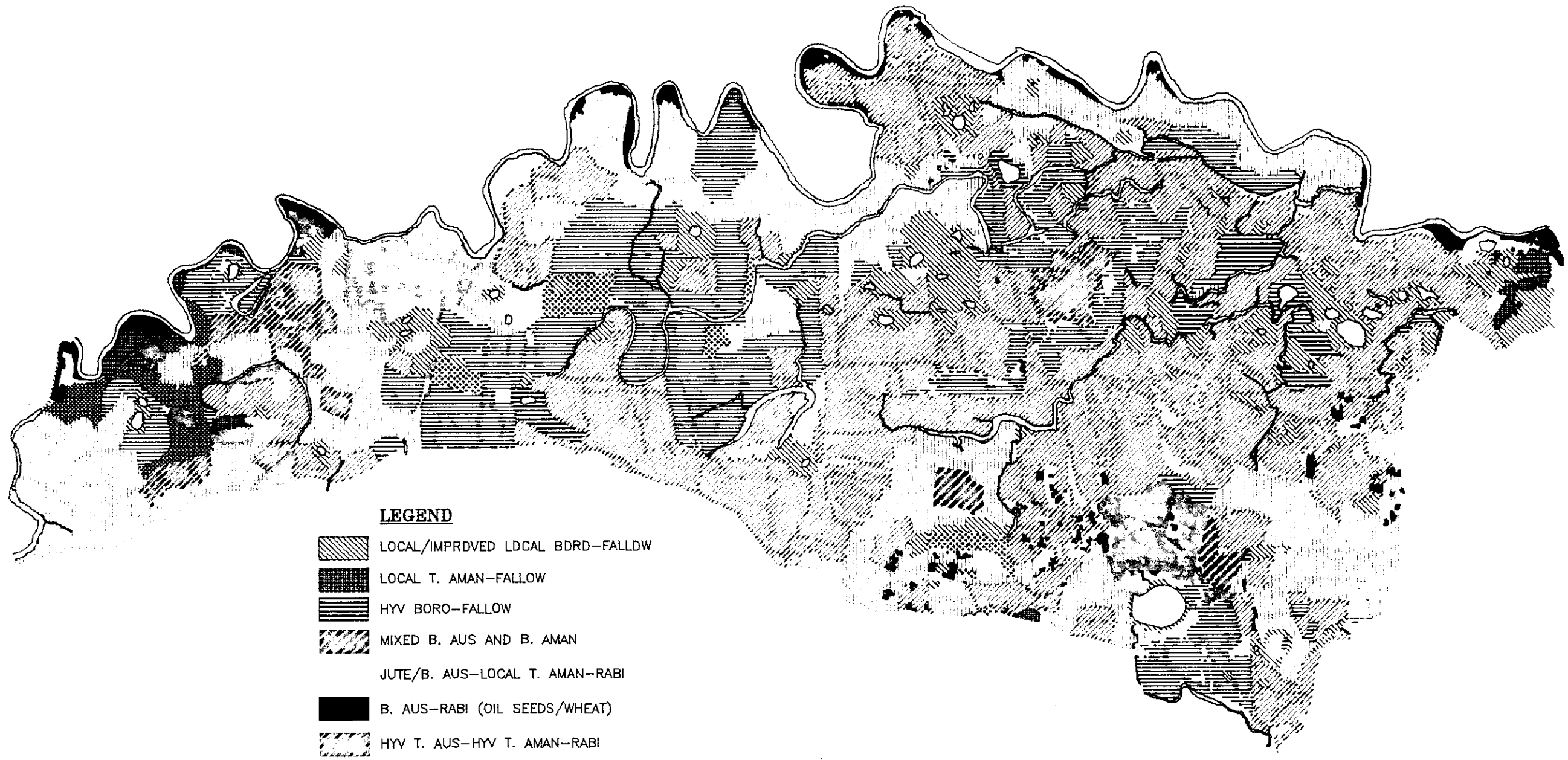

N
90°26'
24°57'
90°39'
25°00'
LEGEND
9 OLD BRAHMAPUTRA FLOODPLAIN
9b Medium High
22 NORTHERN AND EASTERN PIEDMONT PLAINS
22b Northern and Eastern Plains and Basin
Scale
1km 0 1 2km
Agroecological Zone
Dampara Water Management Project
FILE: DRP-36.DWG Prepared by: Jalal

Figure 5

287

Figure 6

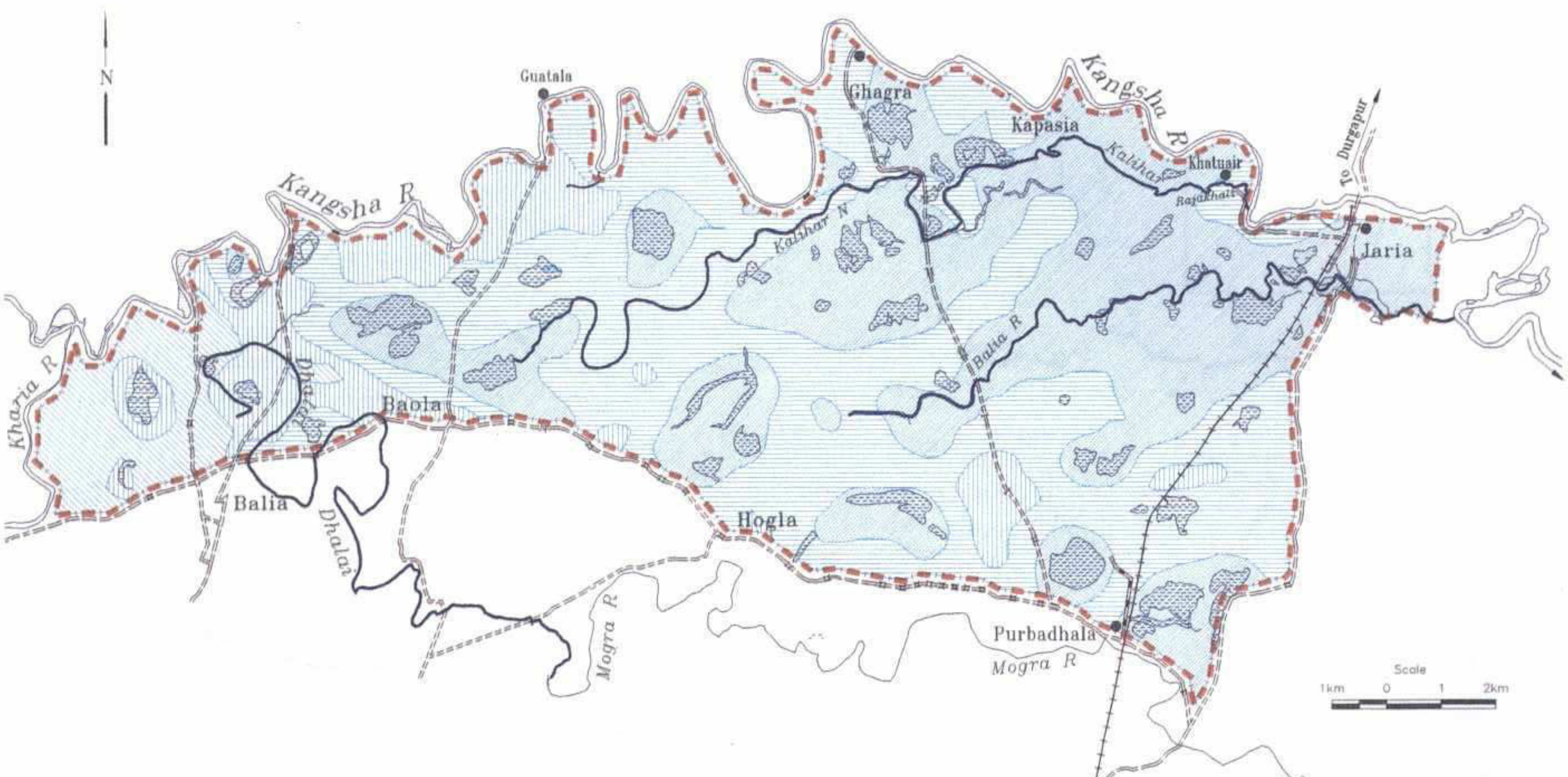


Present Land Use (1995)

Dampara Water Management Project

FILE: PRESENT.DWG

Figure 7



LEGEND

- Project boundary
- River/Khal

Depth Class		Land Type	Area (Ha)
	0.0 – 0.3m	F0	922
	0.3 – 0.9m	F1	1865
	0.9 – 1.8m	F2	5938
	> 1.8m	F3	6275
			15000

Depth of Monsoon Flooding
1:5 Year Maximum Annual Flood

Dampara Water Management Project

FILE: DRP-5 Prepared by: FR

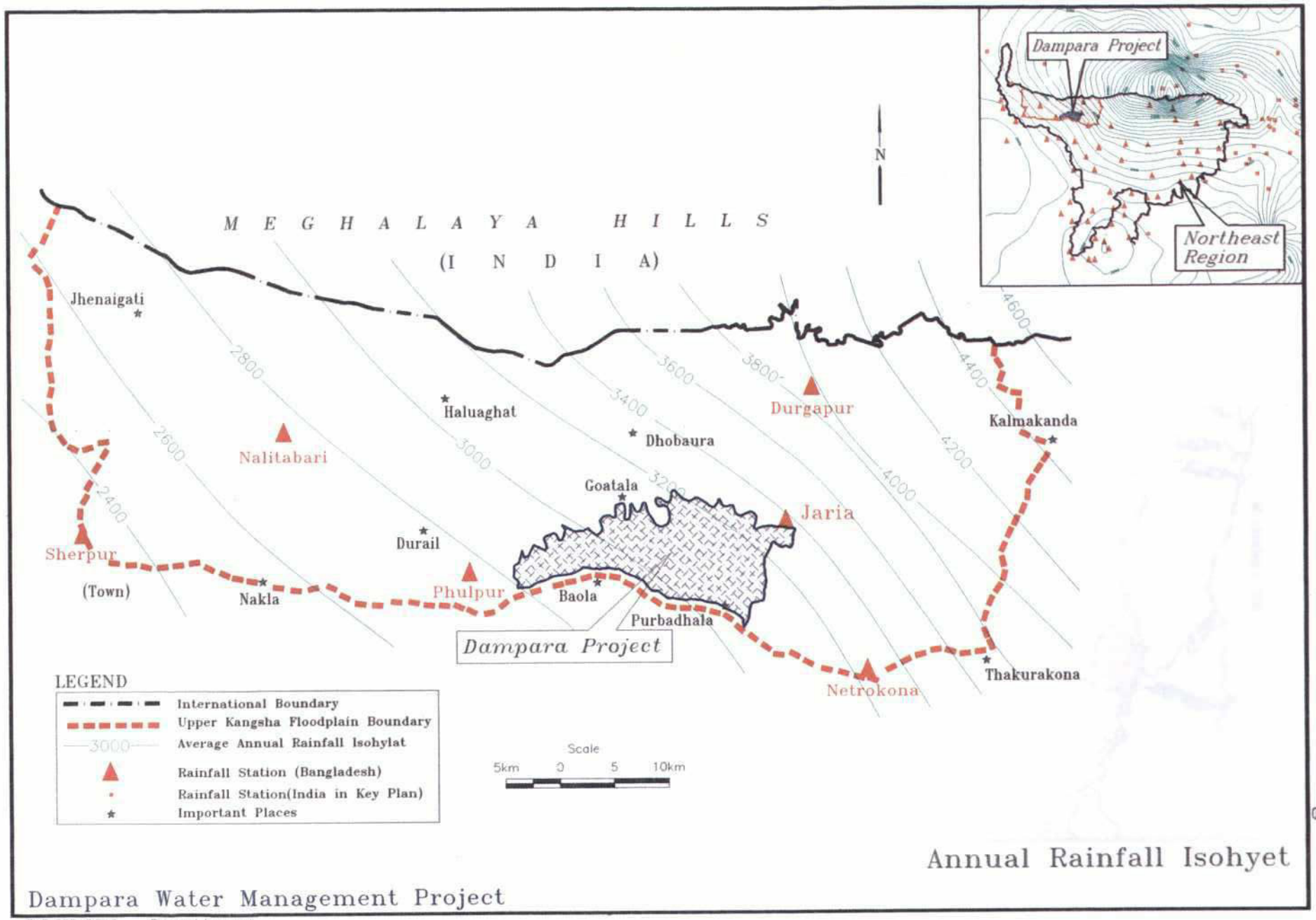
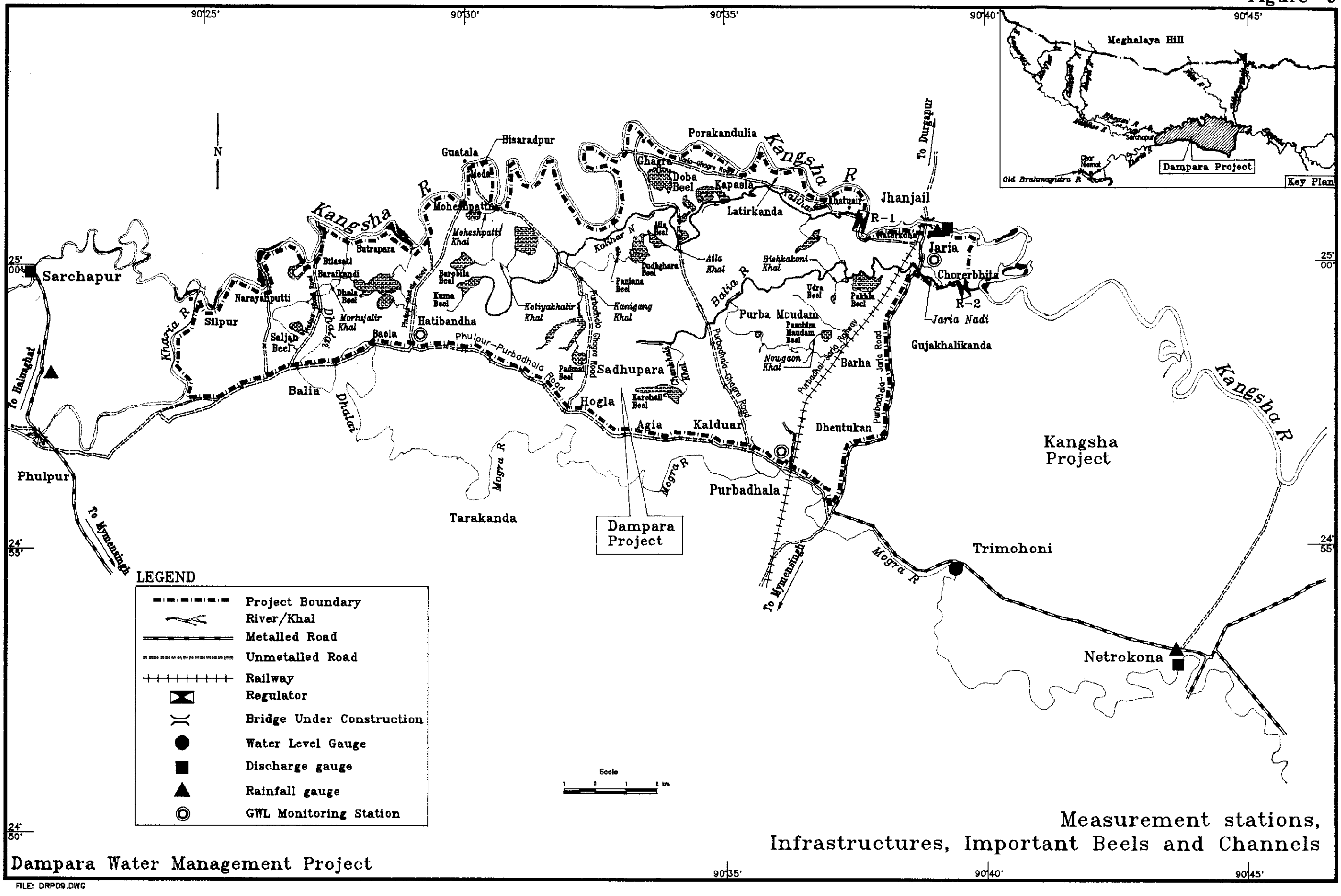

Dampara Project
Northeast Region
N
MEGHALAYA HILLS
(INDIA)
Jhenaigati
Haluaghat
Dhobaura
Durgapur
Kalmakanda
Nalitabari
Goatala
Jaria
Durail
Sherpur
(Town)
Nakla
Phulpur
Baola
Purbadhala
Dampara Project
Netrokona
Thakurakona
2800
2600
2400
3000
3200
3400
3600
3800
4000
4200
4400
4600
LEGEND
International Boundary
Upper Kangsha Floodplain Boundary
3000
Average Annual Rainfall Isohylat
Rainfall Station (Bangladesh)
Rainfall Station(India in Key Plan)
Important Places
Scale
5km 0 5 10km
Annual Rainfall Isohyet
Dampara Water Management Project
FILE: DRP-7.DWG
Prepared by: Awlad

Figure 8

Figure 9

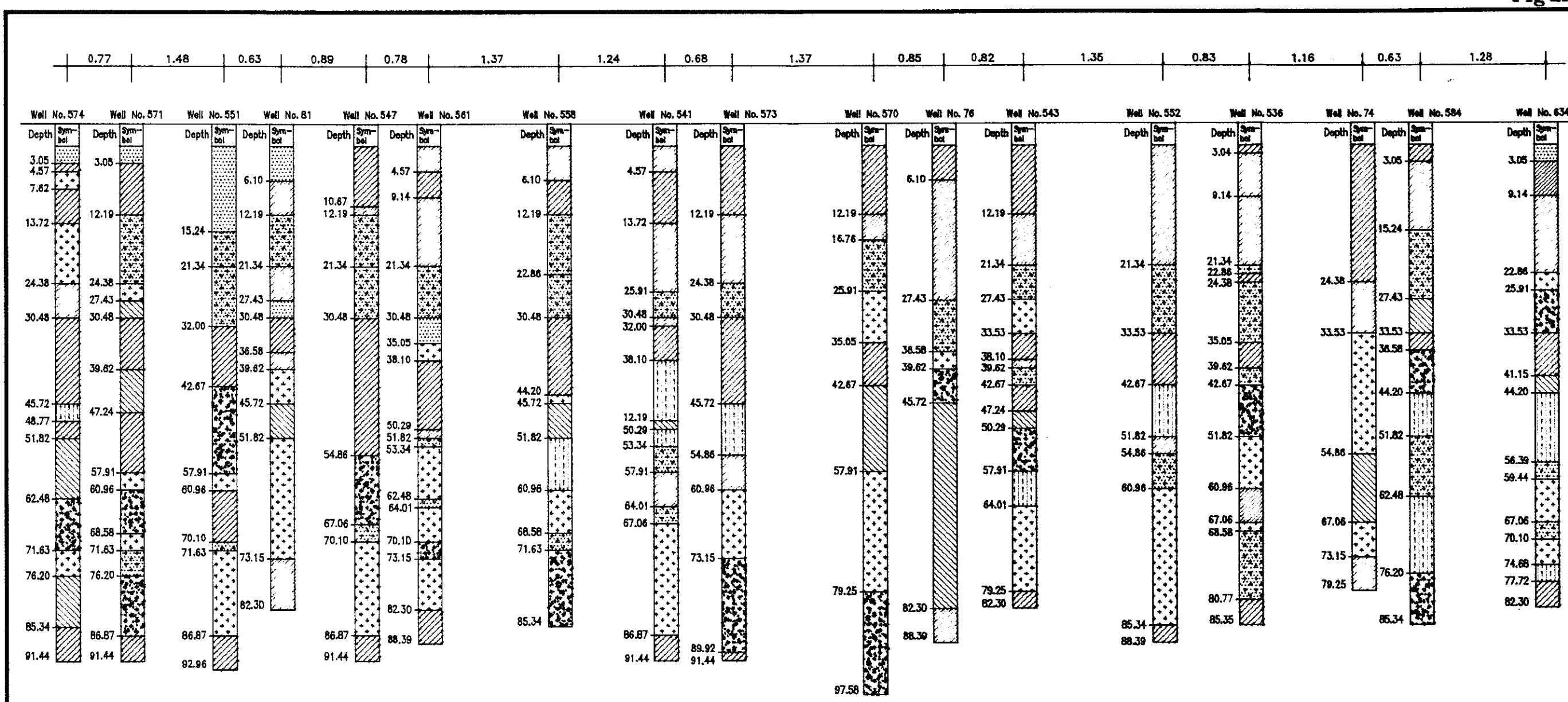


Dampara Water Management Project

Measurement stations, Infrastructures, Important Beels and Channels

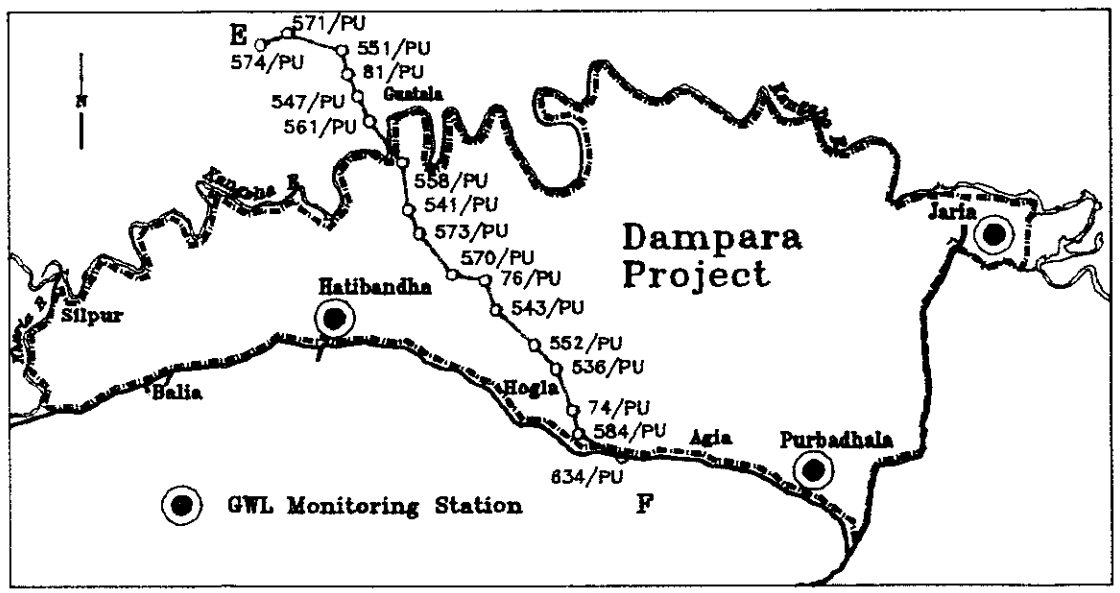
FILE: DRPD9.DWG

Figure 10



Note:– Depths are in metre

LEGEND			
Clay/Silt	Clay/Fine Sand	Medium Sand	Coarse Sand
Silt	Fine Sand/ Very Fine Sand	Coarse Sand/ Medium Sand	Medium Sand Gravel
Clay	Fine Sand/ Medium Sand	Coarse Sand	

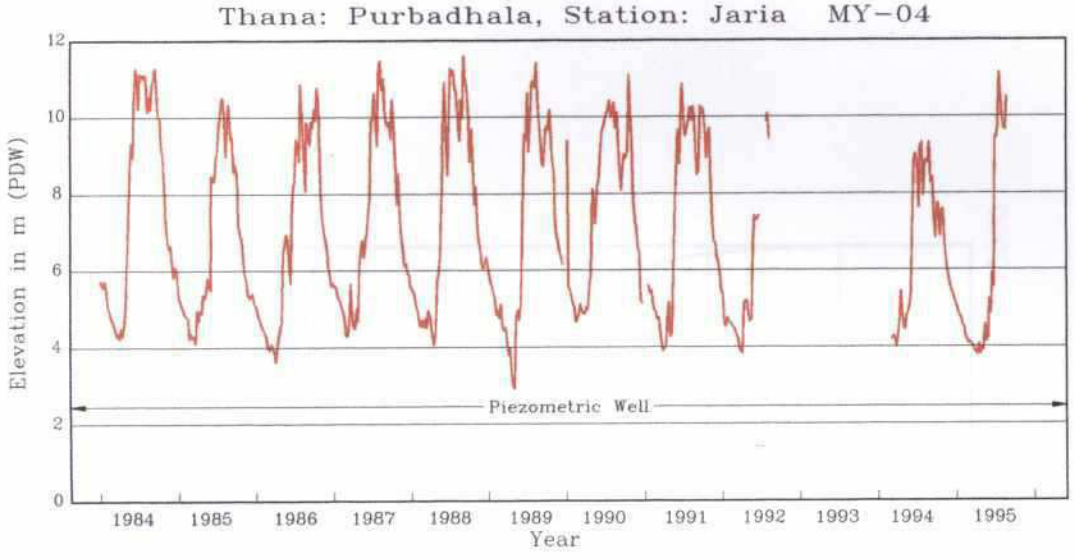


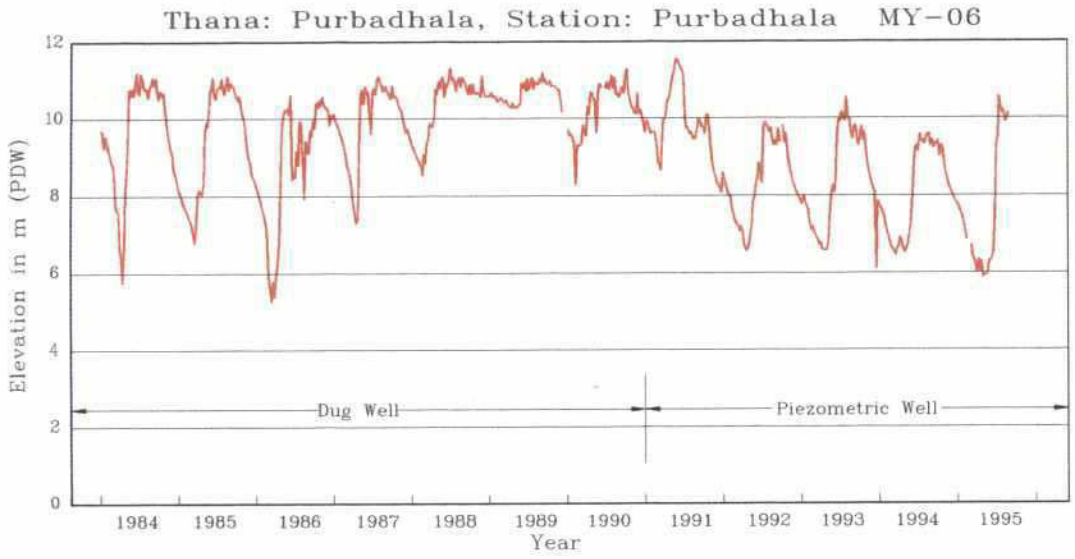
Lithology

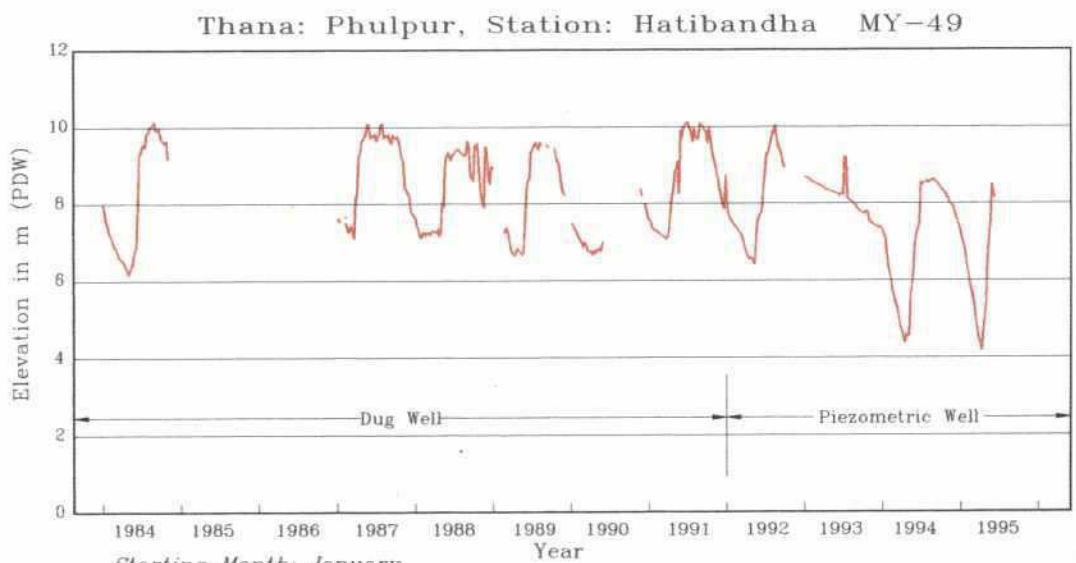
Dampara Water Management Project

FILE: DRP–9.DWG Prepared by: Jalal

Figure 11



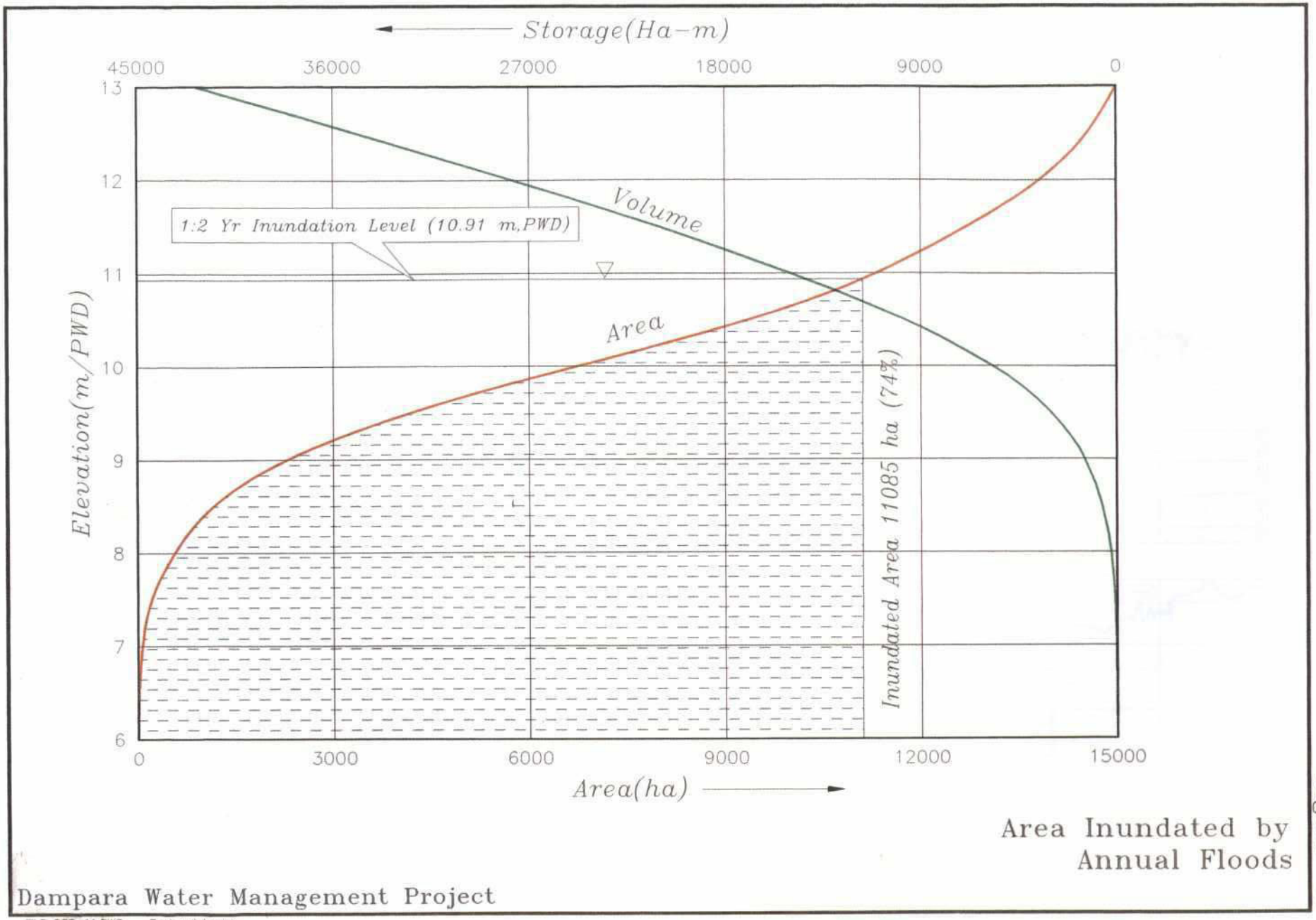




Groundwater Level Hydrograph

Dampara Water Management Project

FILE: DRP-10.DWG Prepared by: MCR

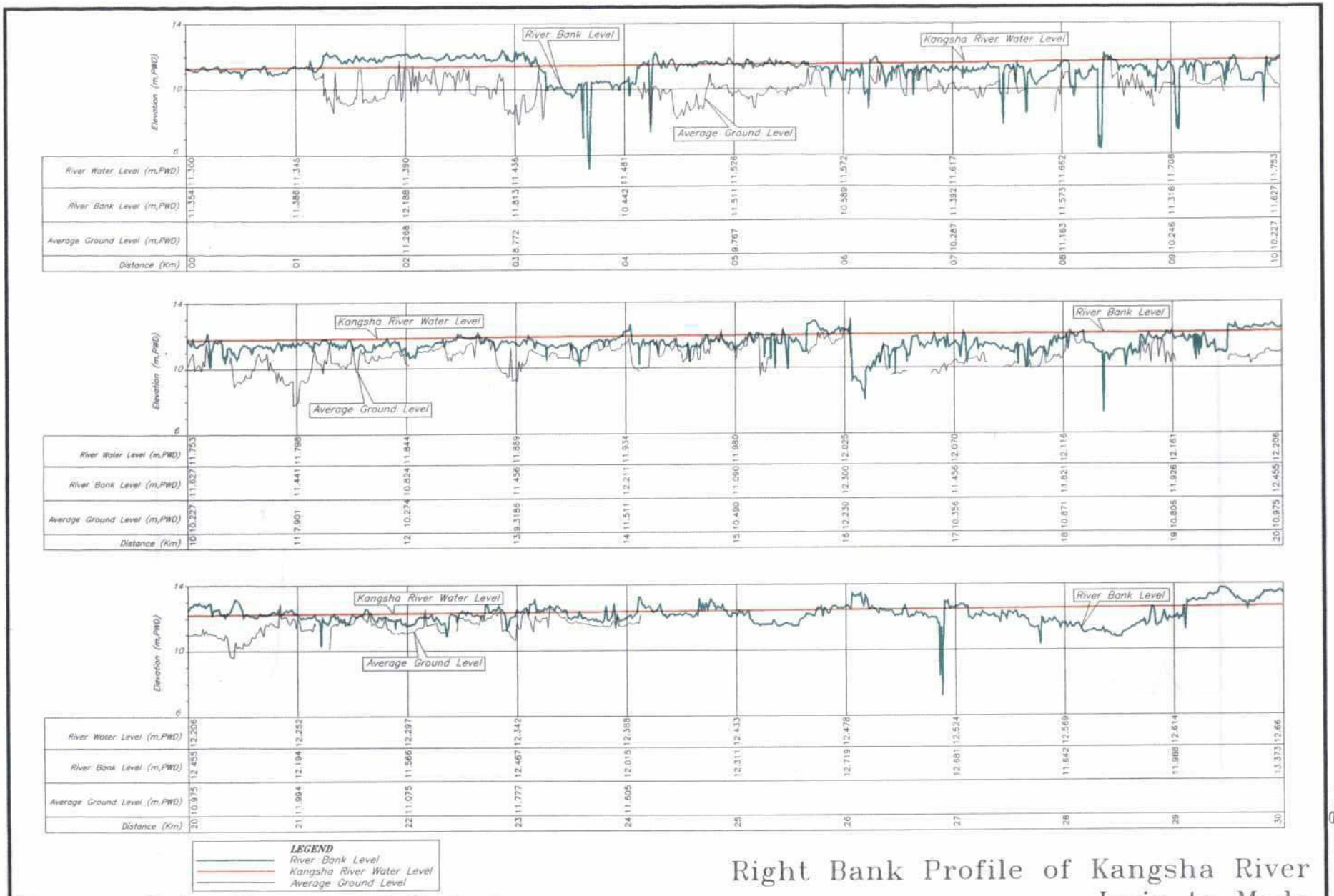


Area Inundated by Annual Floods

Figure 12

Dampara Water Management Project

FILE: DRP-11.DWG Prepared by: FR

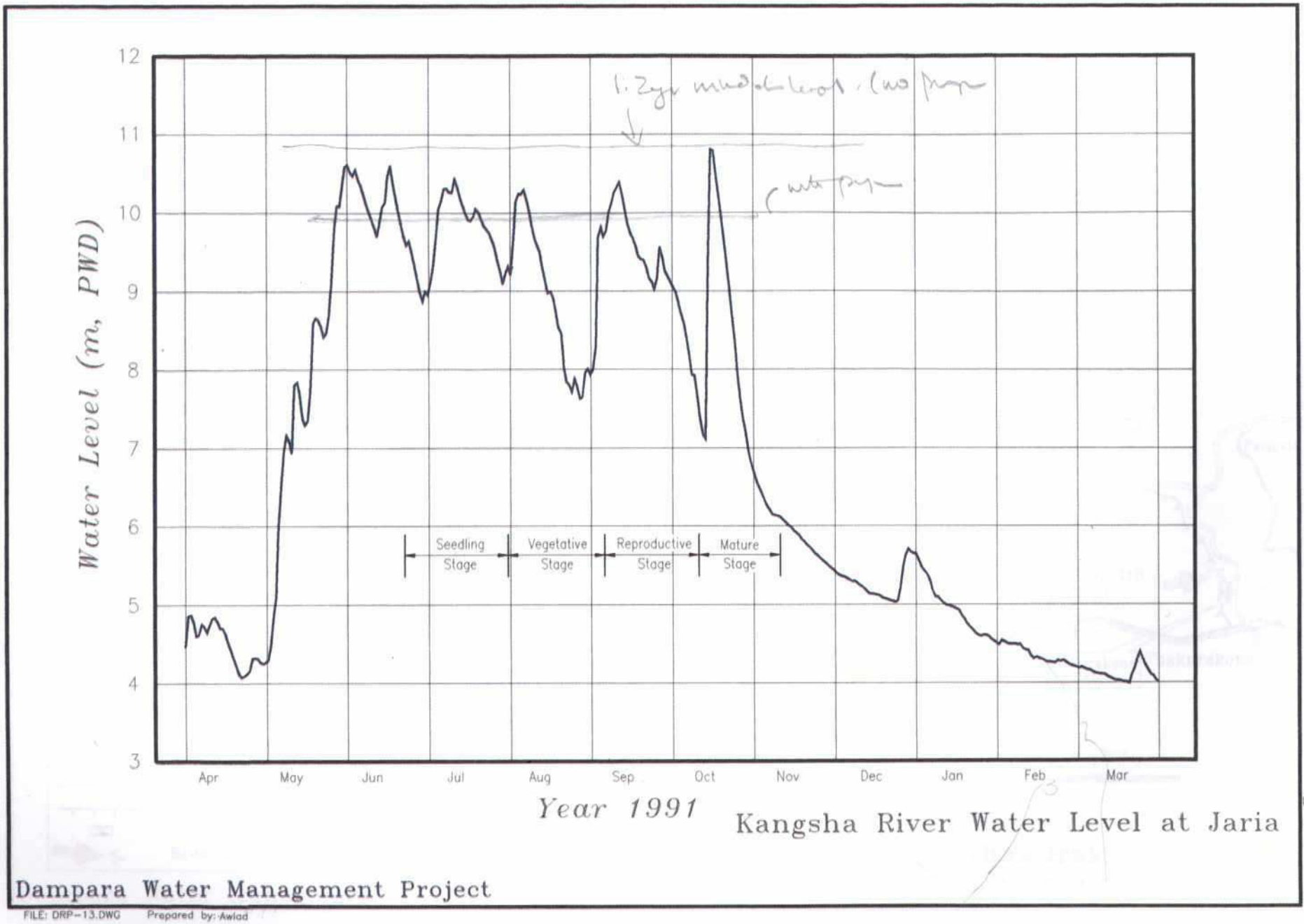


Dampara Water Management Project

Right Bank Profile of Kangsha River
Jaria to Meda

FILE: DRP-12.DWG Prepared by: Awlad

Figure 13

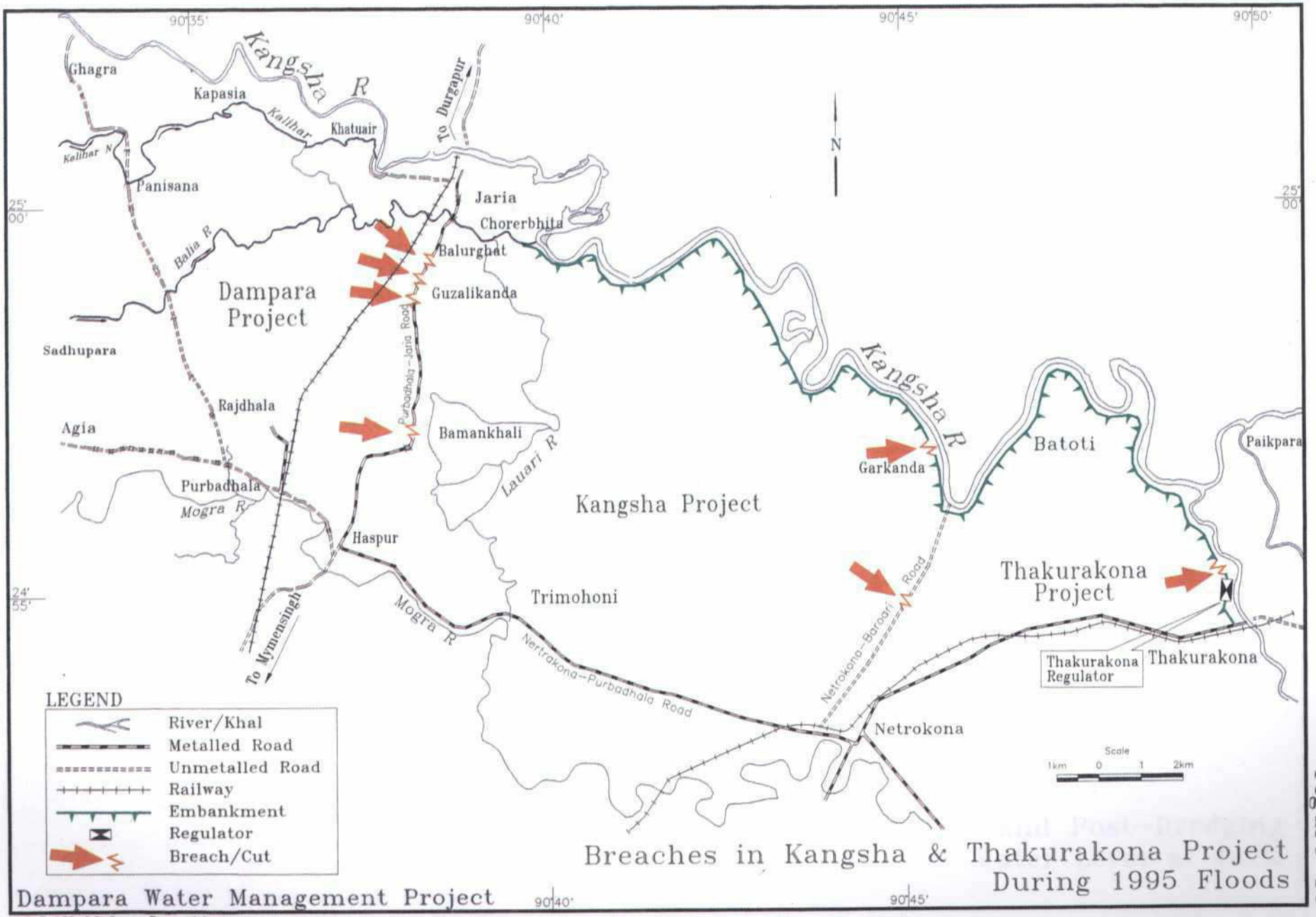


Kangsha River Water Level at Jaria

Figure 14

Dampara Water Management Project

FILE: DRP-13.DWG Prepared by: Awlad

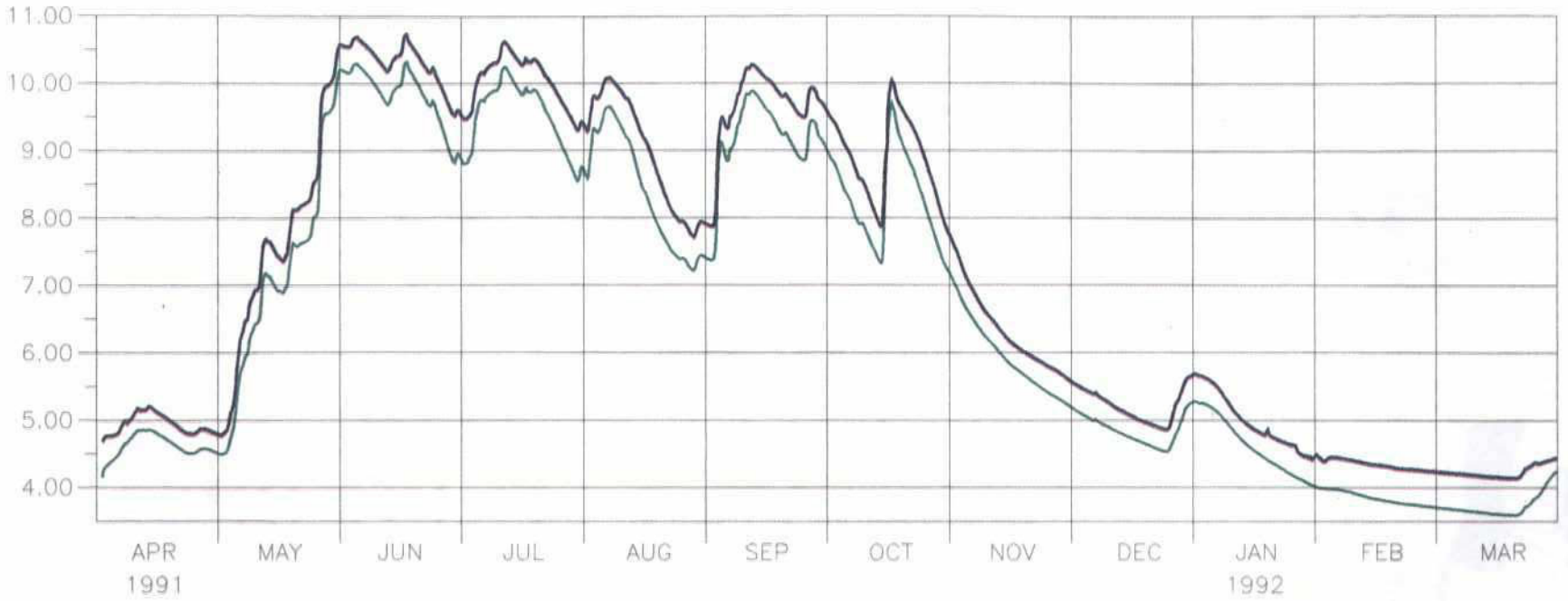


Breaches in Kangsha & Thakurakona Project During 1995 Floods

Figure 15

Dampara Water Management Project

FILE: DRP-6.DWG Prepared by: FR



LEGEND

Pre-Dredging WL

Post Dredging

Pre- and Post-Dredging
Water Level at Jaria

Figure 16

Dampara Water Management Project

FILE: DRP-15.dwg Prepared by: Awlad

Figure 17

90°25'
90°30'
90°35'
22°55'
25°05'

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

Enlargement 1

Moheshpatti
0.90m dia Pipe Sluice
Moheshpatti Khal

Enlargement 2

N

Dampara Project
Netrokona
Mymensingh
Kangsha basin
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
Kalihar N
Panisana
Kusmail beel
Tuskar Khal
Pakhla Beel
Chorerbhita
Kangsha Project Embankment
Kangsha R
Baraikandi
Sutrapara
Kuma Beel
Dampara Project
Baha 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
Mogra R
Purbadhala
Mogra R
To Mymensingh
Haspur

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

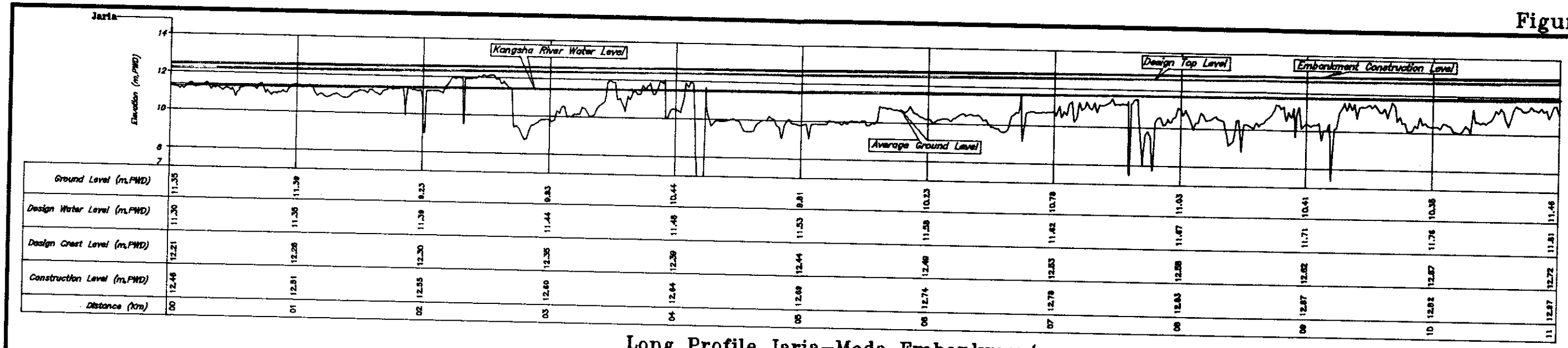
Scale
1km 0 1 2km

Interventions
Dampara Project

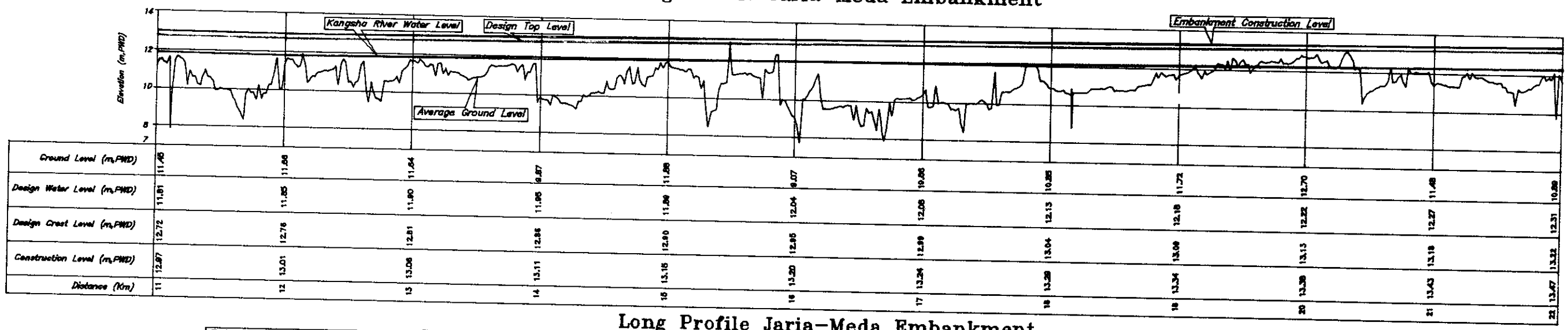
Dampara Water Management Project

FILE: DRP-16 Prepared by: Jalal

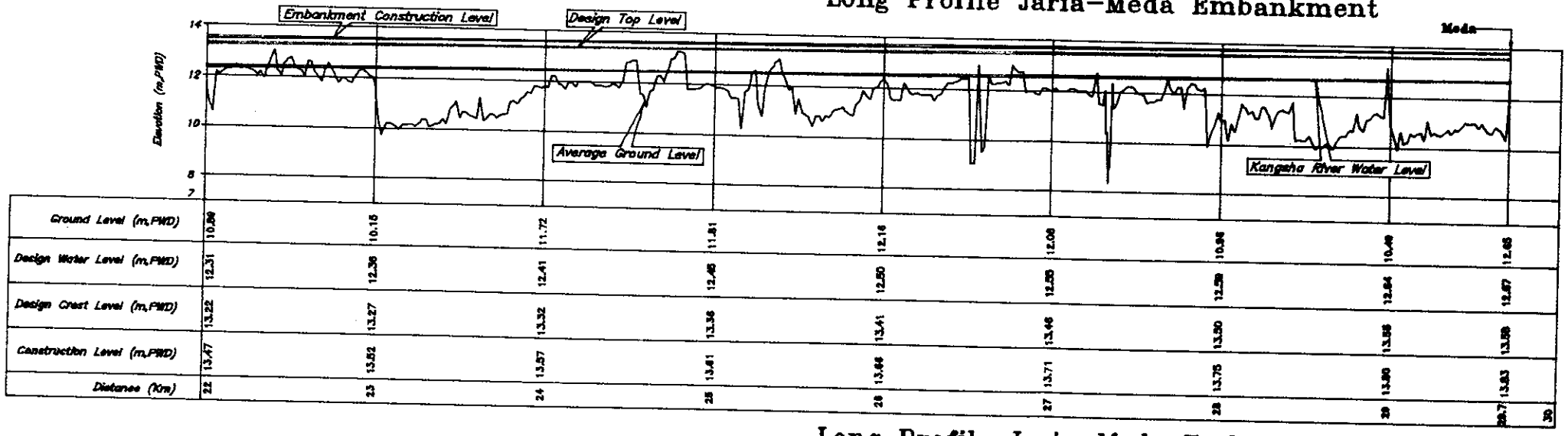
Figure 18



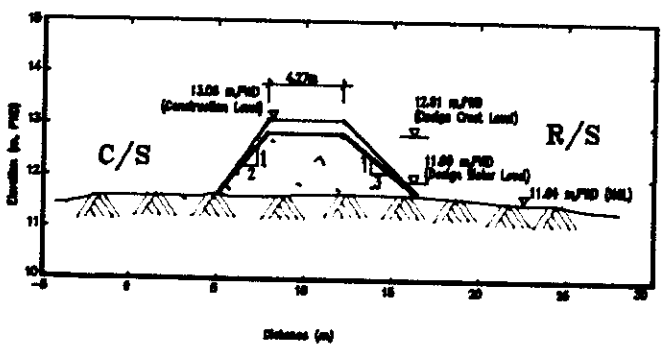
Long Profile Jaria–Meda Embankment



Long Profile Jaria–Meda Embankment



Long Profile Jaria–Meda Embankment

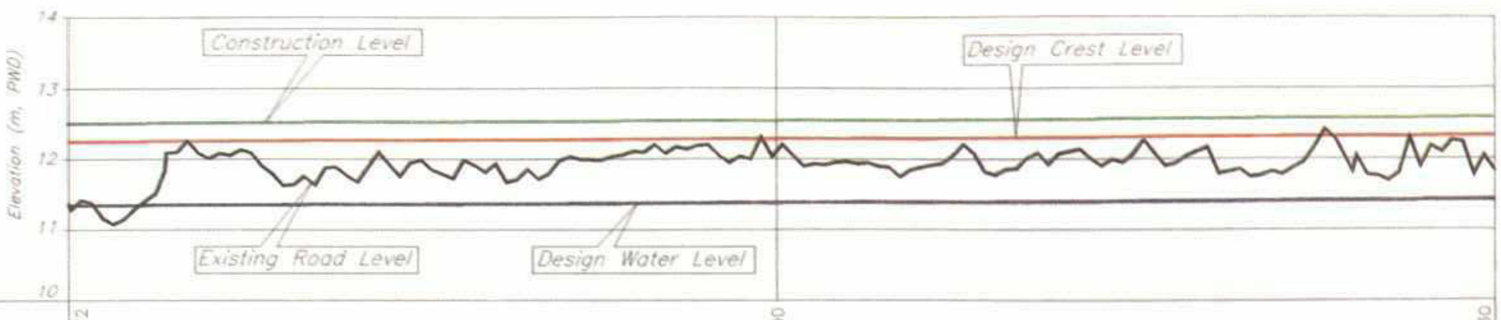


Typical Emabankment Cross section
(Ch–13000 m)

Dampara Water Management Project

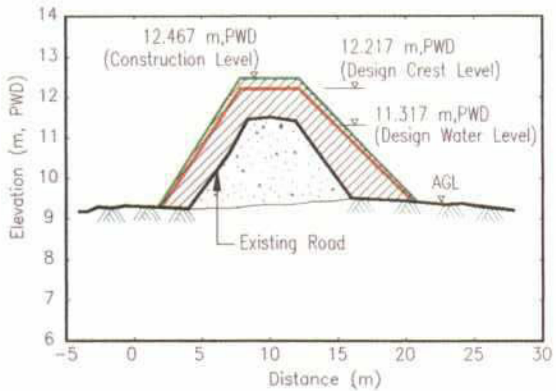
FILE: DRP–17N.DWG

Jaria–Meda Embankment
Longitudinal Profile



Road Level (m,PWD)	11.372	12.200	11.830
Design Water Level (m,PWD)	11.351	11.386	11.420
Design Crest Level (m,PWD)	12.257	12.286	11.830
Construction Level (m,PWD)	12.501	12.536	13.091
Distance (Km)	0	1.0	2.01

Caritas Road



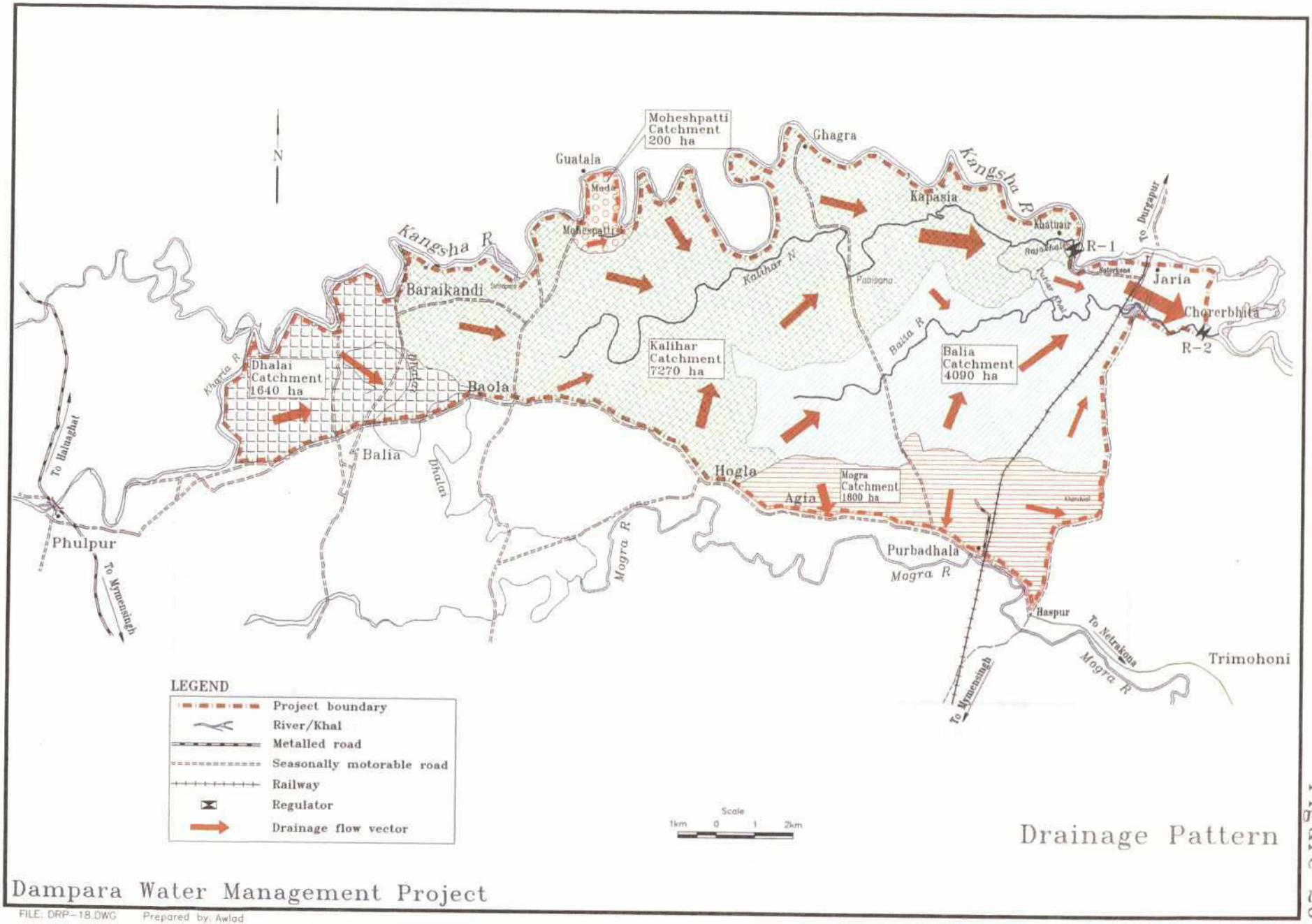
Typical Emabankment Cross section

(Ch-1.358 m)

Re-sectioning of Caritas Road Long and Cross Section

Dampara Water Management Project

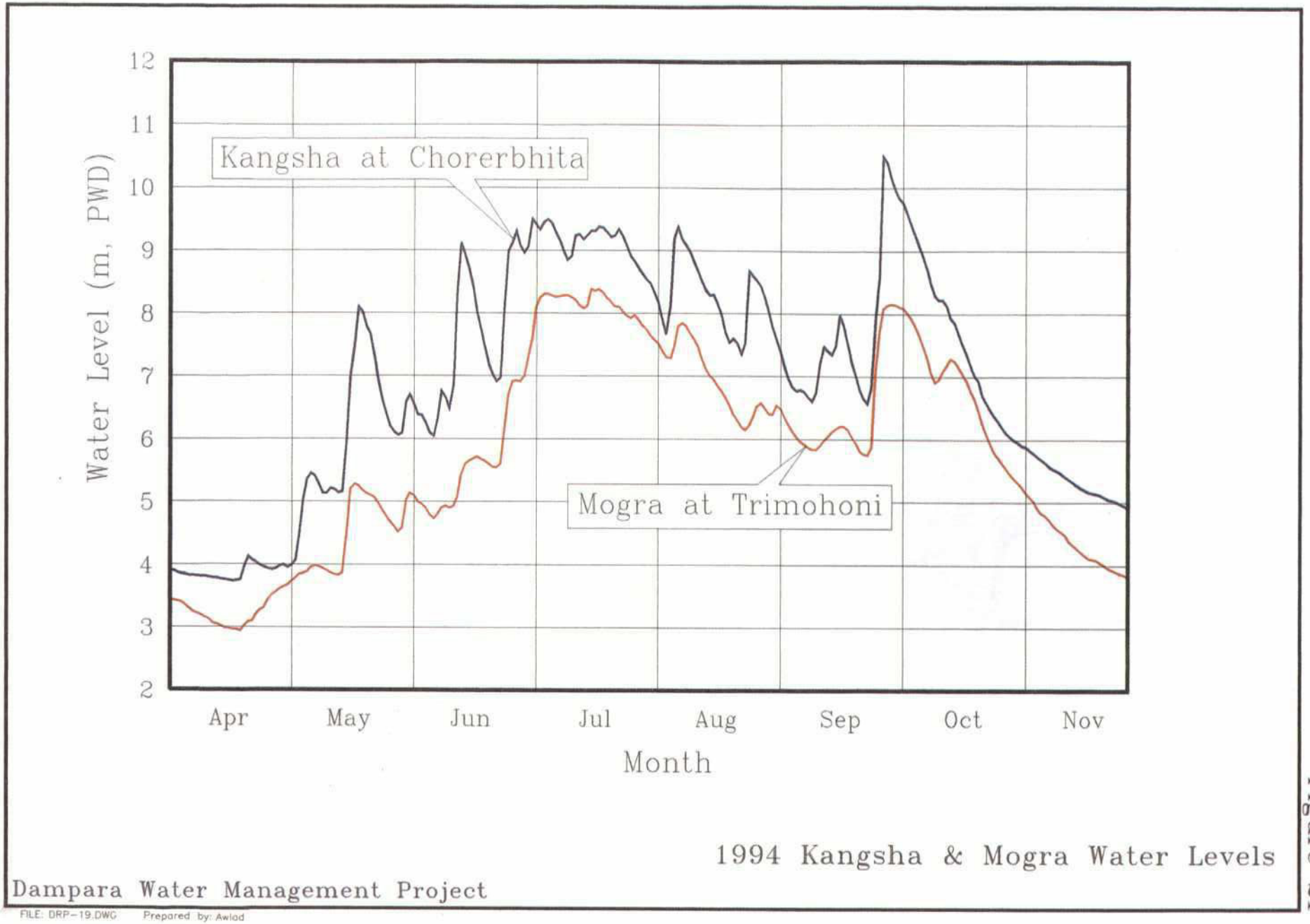
FILE: DRP-29.DWG Prepared by: Awlad



Dampara Water Management Project

FILE: DRP-18.DWG Prepared by: Awlad

Figure 20

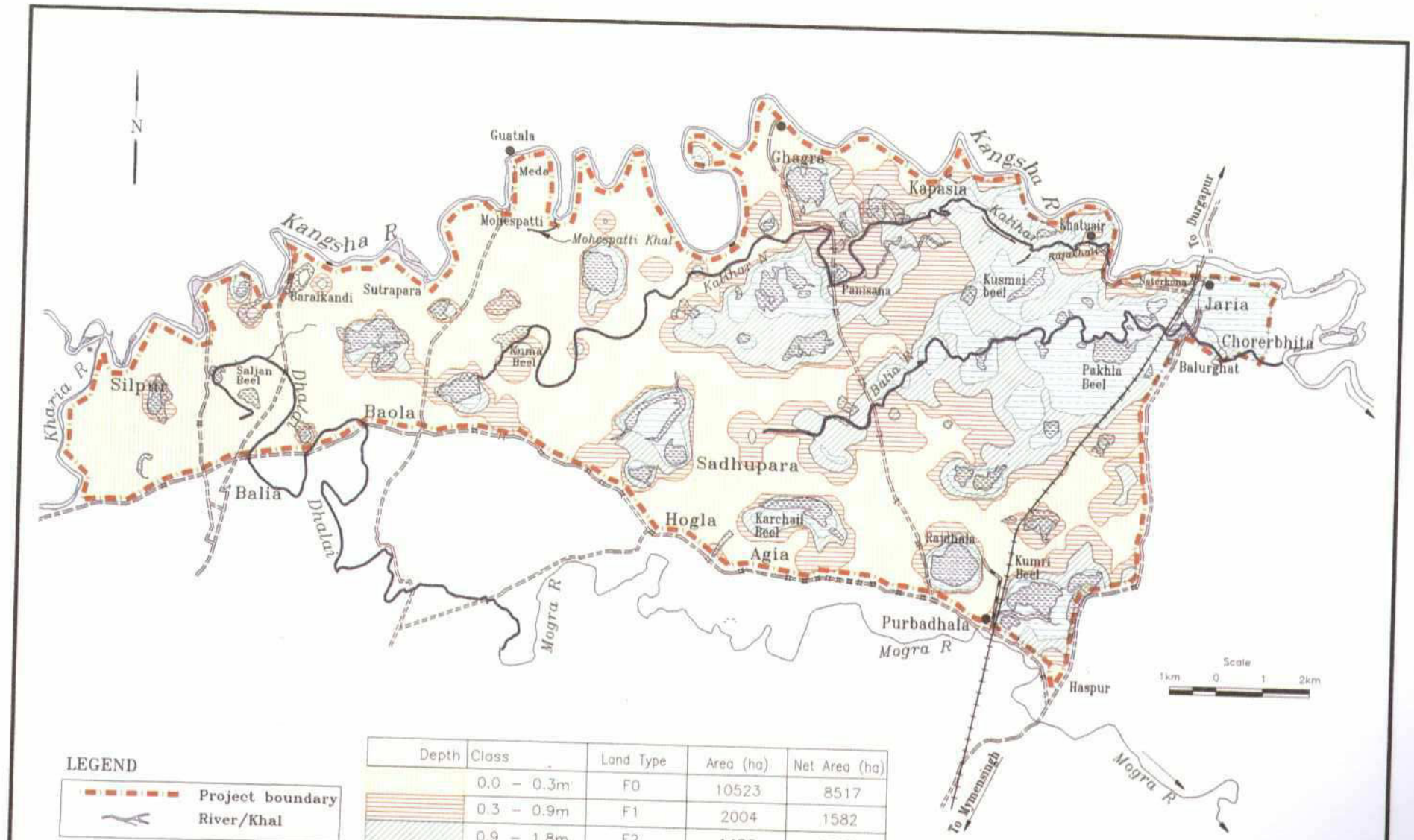


1994 Kangsha & Mogra Water Levels

Dampara Water Management Project

FILE: DRP-19.DWG Prepared by: Awlad

Figure 21



LEGEND

- Project boundary
- River/Khal

Depth Class	Land Type	Area (ha)	Net Area (ha)
0.0 – 0.3m	F0	10523	8517
0.3 – 0.9m	F1	2004	1582
0.9 – 1.8m	F2	1486	1339
> 1.8m	F3	987	854
		15000	12292

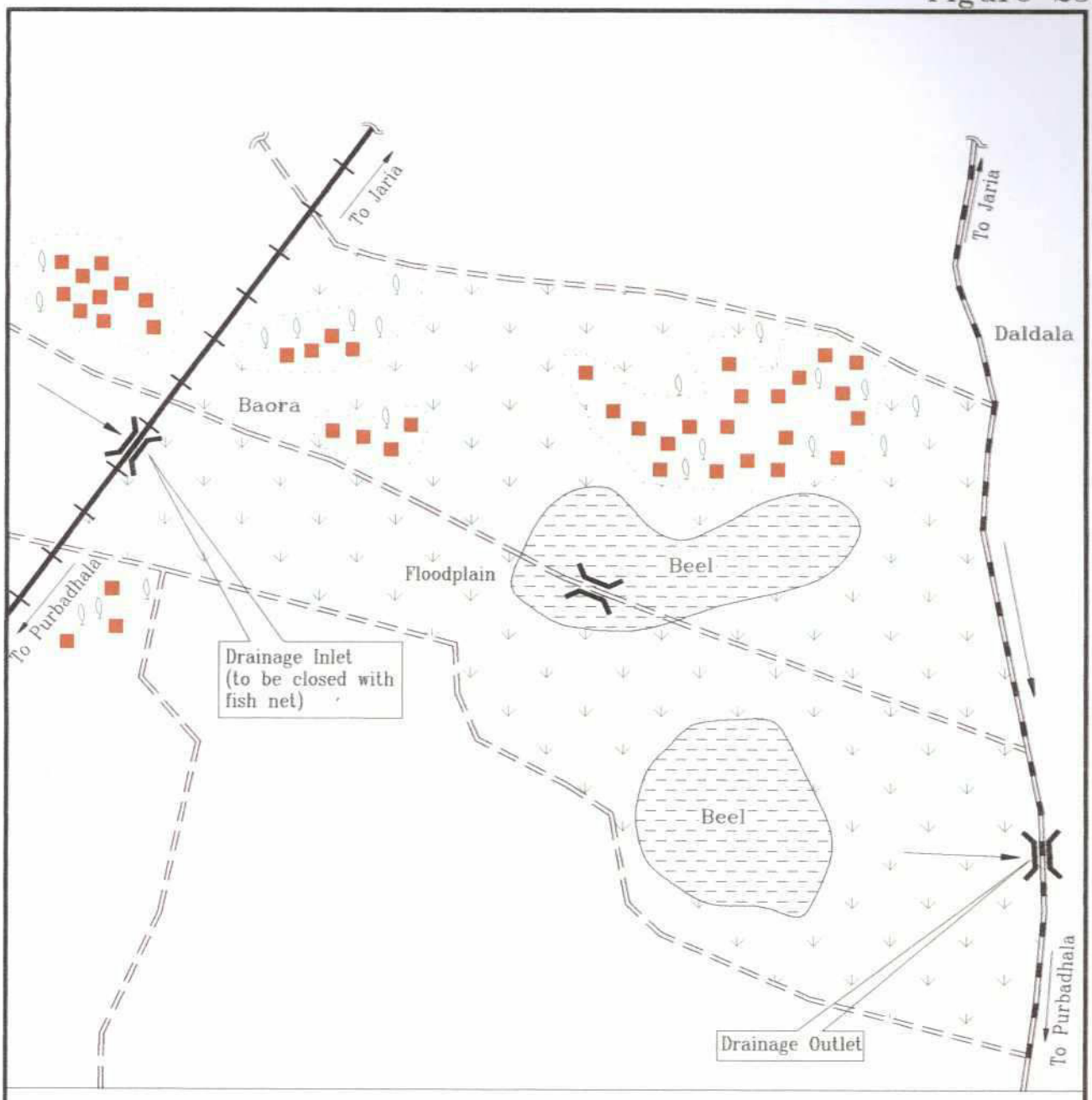
Flood Depth Map
(Based on Post-Project 1:5 yr Design Water Level)

Dampara Water Management Project

FILE: DRP-20N Prepared by: FR

Figure 22

Figure 23



LEGEND

- Metalled Road
- Unmetalled Road
- Railway
- Beel
- Homestead
- Culvert (Existing)

N

Note:
The existing bridge will be modified to maintain minimum level of water in the floodplain and will be closed with fish net .

Scale
10m 0 10 20m

Aquaculture in Shallow Floodplain

Dampara Water Management Project

FILE: NERP-430.DWG Prepared by: FR