Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Water Resources Planning Organization

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

KALNI-KUSHIYARA RIVER MANAGEMENT PROJECT FEASIBILITY STUDY

ANNEX J
PILOT DREDGING PROJECT

Final Report
March 1998

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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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
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
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BCIC	Bangladesh Chemical Industries Corporation
BFDC	Bangladesh Fisheries Department Cooperation
BHP	British Horsepower
BIWTA	Bangladesh Inland Water Transport Authority
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
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
C : N	Carbon to Nitrogen ratio
CAS	Catch Assessment Survey
CBMS	Community-based Management System
CCF	Commodity Conversion Factor
CDN	Canadian
CEA	Canadian Executing Agency
CEC	Cation Exchange Capacity
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
COP	Cost of Production
c/s	country side
CPUE	Catch per Unit of Effort
d	draught
D	Depth
DAE	Directorate of Agricultural Extension
DANIDA	Danish International Development Agency
DC	Deputy Commissioner
DFO	District Fisheries Officer
DOE	Department of Environment
DOF	Department of Fisheries
DOLS	Directorate of Livestock Services

DPHE	Department of Public Health Engineering
DSSTW	Deep Set Shallow Tube Well
DTM	Digital Terrain Model
DTW	Deep Tube Well
EC	Electrical Conductivity
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPZ	Export Processing Zone
FA	Fisheries Association
FAO	Food and Agriculture Organization (United Nations Agency)
FAP	Flood Action Plan
FCDI	Flood Control Drainage and Irrigation
FES	Fishing Effort Survey
FFWP	Food for Works Program
FPCO	Flood Plan Coordination Organization
FRI	Fisheries Research Institute
FW	Future With Project
FWC	Family Welfare Centre
FWO	Future Without Project
FWV	Family Welfare Visitor
GEV	General Extreme Value
GOB	Government of Bangladesh
GPS	Global Positioning System
ha	hectare
HH	Household
hr	hour
HTW	Hand Tube Well
HYV	High Yielding Variety
IEC	Important Environmental Components
IGA	Income Generating Activity
ILO	International Labor Organization
IRR	Internal Rate of Return
IUCN	International Union for the Conservation of Nature
kg	kilogram
km	kilometre
KK	Kalni-Kushiyara
KKRB	Kalni-Kushiyara River Basin
KKRBA	Kalni-Kushiyara River Basin Authority
KKRIP	Kalni-Kushiyara River Improvement Project
KKRMP	Kalni-Kushiyara River Management Plan
LAD	Least Available Draught
LB	Left Bank
LBS	Left Bank Side
LCS	Landless Contracting Society
LGED	Local Government Engineering Department
LGRDC	Local Government, Rural Development and Cooperative
LLP	Low Lift Pump

LLW	Low Level Water
LOA	Length Over All
m	metre
MB	Mechanized Boat
MCH	Mother And Child Health
MITW	Mechanized Inland Water Transport
mm	millimetre
Mm^3	Million cubic metres
MOEF	Ministry of Environment and Forestry
MOL	Ministry of Land
MOS	Ministry of Shipping
MOWR	Ministry of Water Resources
MP	Murate Of Potash
MPO	Master Plan Organization
mt	metric tonne
NCA	Net Cultivable Area
NERP	Northeast Regional Water Project
NGO	Non-Governmental Organization
NMB	Non-Mechanized Boat
NMFP	New Fisheries Management Policy
NPV	Net Present Value
NRR	Natural Rate of Reproduction
NSA	Navigation Survey Area
O&M	Operation and Maintenance
PAP	Project Affected Person
PCC	project Coordination Committee
PD	Person-Day
PIO	Project Implementation Officer
PMP	Projection Management Plan
POL	Petroleum, Oil, Lubricants
PRA	Participatory Rural Appraisal
PWD	Public Works Department
RB	Right Bank
RBS	Right Bank Side
RD-12	Rural Development-12
RRA	Rapid Rural Appraisal
R/S	Riverside
SDE	Sub-Divisional Engineer
SOB	Survey of Bangladesh
SPARRSO	Space Research and Remote Sensing Organization
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
SWMC	Surface Water Modelling Centre
TCCA	Thana Central Cooperative Association
TFO	Thana Fisheries Officer

Tk	Taka (Bangladesh currency. $1 CDN=approx. Tk 30)
TNO	Thana Nirbahi Officer
TSP	triple super phosphate
TW	tube well
UK	United Kingdom
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
UNWFP	United Nation World Food Programme
UP	Union Parishad
USA	United States of America
VP	Village Platform
WARPO	Water Resources Planning Organization

GLOSSARY

aar bandh	a traditional method of platform protection using vegetation and a bamboo
aarat	wholesale market
adhibhagi	sharecropper
ail	small dyke demarcating boundary of agricultural plots
aman	monsoon rice crop
aus	pre-monsoon rice or rice grown in *kharif* I season.
b. *aman*	broadcast or deepwater *aman* rice grown in *Kharif* I and II seasons
bandhak	mortgage
bangla	bengali language
baowa	local monsoon rice crop
barga	sharecropping system whereby the landowner and the share the operator inputs and the produce
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
beeper	harvesting laborer coming from other districts
bhati	low-lying downstream area
bhita	homestead
biri	indigenous cigarette
bisra	patch between homestead and crop land
bondh	crop land
bonya	flood
boro	rice grown during the winter season
bou	house wife
bundh	earthen dam, closure
chailla	a grass (Hemarthria protensa) grown in low-lying floodplains
chalni	filter made of bamboo
chanda	contribution
char	silted-up river bed
chatai	mat made of bamboo
chira	flattened rice used as snack
choki	cot
chhon	native grass used as roof material
chara bisra	slightly elevated land adjoining the homestead platform
chukti	type of leasing system for singled-cropped land where the operation pays a fixed amount of rent after harvest
chula	woven
class I channel	3.6 metre depth; 50 metre width perennial
class II channel	2.4 metre depth; 50 metre width perennial
class III channel	1.8 metre depth; 37 metre width perennial
class IV channel	1.5 metre depth; 37 metre width seasonal
country boat	wood hull boat of traditional design; capacity usually not more than 500 *maunds* (19 tonnes)

dai	tradition birth-attendant
dawa	harvesting
dawal	local harvesting laborer
decimal	unit of land measure; 0.01 acre; 0.004 ha
dhala	breaches across river banks
dhol kolmi	a woolly shrub (Ipomoea fistulosa)
doba	ditch
dry season	5 months: December-April inclusive
duar	scour hole in river bed which provides habitat for fish and river dolphins
durba	a type of grass (Cynodon dacyon)
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
ghat	riverine landing or assembly place
girost	farmer
gopat	pathway
gram	village
gudara	ferry
gushti	kinship group
haal	unit of land measurement, 1 haal is equal to 1.5 ha (approx.)
haat	big market
haor	depression on floodplain located between two or more rivers
hara	unit of land measurement, equivalent to 16 katha or 1.28 acre
hati	neighborhood cluster
hizol	type of water tolerant tree
ikor	native grass
IWT craft	steel-hull boat 350-500-tonne capacity; single screw
jailla	fisherman
jakat	contribution made to the poor according to Islamic law
jal	fishing net
jala	rice seedling
jalakhet	rice seed bed
jalmohal	waterbody used as fishery
jumma	special prayer held on Friday
kamla	wage laborer
kanda	raised land surrounded by crop fields used for cattle grazing or rice threshing
kantha	quilt made of old cloth
kare	unit of land measurement, 1 kare is equal to 0.12 ha (approx.)
katha	unit of land measurement, equivalent to 0.08 acre
katha	brush park type fish production system
khal	channel
khancha	cage
kharif	monsoon crop season, including the *aus* and *aman* crop
khas	government owned land or water bodies
kochuri panna	an aquatic plant, water hyacinth (Eichhornia crassipes)
kore	unit of area equivalent to 0.11 ha
koroch	type of water tolerant tree
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
manot	pledge
maund	indigenous unit of weight, equivalent to 40 seers or 37.3 kg
mauza	lowest level of geo-administrative unit
mazar	mausoleum
mohajan	money-lender
moulana	muslim priest
mullah	islamic educated person
muni	wage laborer
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
pajubon	grasslands
pankha	hand-made fan
para	a neighborhood cluster (same as *hati*)
pargana	geographic unit in old days having a size of a thana
parishad	council
poa	unit of measuring weight, quarter of a seer
poshchim	west
pucca	paved, made of brick
purbo	east
purdah	a state of physical or social seclusion for women
rabi	dry season
rangjoma	type of leasing system where the operator pays a fixed rent in cash at the time of contract
roa	transplantation
roj kamla	laborer engaged on a daily basis
ruaichha	transplanted *aman*
sal bollah	wooden pillar
salish	arbitration
samaj	traditional village institution
samity	cooperative society
sanko	bamboo bridge
sadar	Headquarters (district)
saree	women's wear
seer	indigenous unit of weight, equivalent to 0.933 kg
shidol	one type of dry fish
shutki	dry fish
t. *aman*	transplanted *aman* rice grown in *Kharif* II season or monsoon season
tahsil	lowest level revenue unit
taka (tk)	unit of currency, 1 US $ = 40 taka (approx.)
tarja wall	protection wall made from bamboo

tempoo	mechanized boat carrying merchandise
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
wet season	7 months: May-November inclusive

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1. INTRODUCTION

1.1 Background

The Kalni-Kushiyara River Management Project (KKRMP) covers a gross area of 335,600 ha and extends over the districts of Sylhet, Sunamganj, Moulvibazar, Habiganj and Kishoreganj in the Northeast region of Bangladesh. The study area is shown in Figure J.1

Due to a major avulsion of the Bibiyana River, partly caused by man-made interventions, some 30 years ago, the river has experienced ongoing sedimentation and instability. This has led to bank and homestead erosion, pre-monsoon floods causing damage to rice crops and deteriorating navigation during the dry season.

With the financial assistance of the Canadian International Development Agency (CIDA), the pre-feasibility study of the project was completed in 1994. After review, CIDA together with the Flood Plan Co-ordination organization (FPCO) and the Bangladesh Water Development Board (BWDB) decided to proceed with the feasibility study.

Given the nature of the problems facing the study area, the project was formulated to meet multiple objectives. These included the following:

- improving the river's stability and providing a more stable environment for development;
- reducing damages to agriculture by reducing pre-monsoon flood damage and improving post-monsoon drainage;
- improving living conditions along the river by reducing erosion damage to villages and by creating flood-free village platforms, and
- improving navigation during the dry season.

In order to meet the above objectives, the feasibility study analyzed two alternatives, including the following interventions:

- loop cuts, one at Issapur (Alternative-1), the second at Katkhal;
- dredging of the Dhaleswari River at two locations (Alternative-1) or dredging the whole reach (Alternative-2);
- dredging the Kalni River reach between Issapur and Ajmiriganj;
- constructing flood-resistant village platforms from the dredged spoil;
- constructing bank protection works at various sites;
- constructing levees along low banks to reduce spills, and
- maintenance dredging for improved navigation up to Fenchuganj.

The location of these works is summarized in Figures J.2 and J.3.

These interventions will increase significantly agricultural production, provide living space for the local population, protect the infrastructure against erosion and enhance economic activities through improved river transportation. However, before embarking on such a massive program, the pre-feasibility study recommended a pilot dredging project to gain experience with dredging and the disposal of dredge spoil with minimum negative environmental impact.

In the light of above-mentioned recommendation, CIDA, along with the Flood Plan Co-ordination Organization (FPCO) and the Bangladesh Water Development Board (BWDB) have decided to proceed with the implementation of a pilot dredging project, further lending credibility to the feasibility study of the KKRMP. According to CIDA's terms of reference, the pilot dredging project was to be carried out at selected sites in the 50 km reach of the Kalni-Kushiyara River from Markuli to Madna to test and demonstrate various concepts relating to technical operations, environmental monitoring, mitigation measures, and public participation and community organization.

1.2 Location

The pilot dredging project constructed two disposal sites on the Kalni River downstream of Ajmiriganj. The first site, Kakailseo is located on the left bank of the Kalni River in Kakailseo *thana* of Habiganj district, about six kilometres downstream of Ajmiriganj. The second site, Gazaria is located on the right bank of the Kalni River in Itna *thana* of Kishoreganj district, about four kilometres downstream of Ajmiriganj (Figure J.4).

1.3 Scope and Objectives

The scale of the pilot dredging operations, including Environmental Management Plan (EMP), was determined by the available capital works budget of CDN $2.1 million. The pilot dredging operations were scheduled to be completed in one dry season (November 1995 - June 1996) while the EMP works are to be carried out until December 1996.

Specific objectives of the pilot project were:

- to evaluate the effectiveness of dredging methods in terms of productivity, maintenance requirements, need for environmental management, and cost;
- to develop, test, and demonstrate beneficial uses for dredged spoil, including potential to create new village platforms;
- to clarify social aspects of disposing spoil and identify constraints that may affect the site selection and design of future dredging programs;
- to develop a methodology for public participation activities in future dredging programs, and
- to develop a framework for institutional co-operation in Kalni-Kushiyara River dredging activities.

1.4 Project Summary

The process of selecting pilot project dredging sites was initiated in June 1994. By March, 1995 NERP had finalized their recommendation for construction of homestead platforms at two villages, Kakailseo and Gazaria. While the project was being publicized for tendering, NERP received approval for the Implementation Plan (NERP, 19956 a)) and EMP (NERP, 1996 b)).

By November, after the monsoon waters had sufficiently drained, equipment was mobilized and construction began. Dredging and filling of platform confinement chamber was completed in May 1996 at Kakailseo and early August 1996 at Gazaria. The platform at Kakailseo has an area of 3.1 ha and required 133,125 m^3 of dredged spoil. In addition to indirectly benefiting over 800 households (HHs), the new platform expands the homestead of 51 families. At Gazaria, the platform has an area of 4.6 ha and required dredge spoil of about 250,000 m^3. The platform expands the land of 158 Homesteads, more than half the entire village.

Monitoring of the project components, engineering, environmental, and social works was scheduled to be complete by December 1996. However, in November and December 1996, conditions were such, in particular the conditions of the ground, still wet from the monsoon, that post-monsoon work and monitoring had to be delayed. The related activities were carried out from January to march 1997. In addition, in May and June 1997, NERP is assisting the village beneficiaries to protect their platforms for the 1997 monsoon, an activity not scheduled in the project's Implementation Plan.

Results of the engineering and environmental monitoring indicate that the physical impact of the project on the surrounding areas is minimal.

1.5 Report Layout

The first section of the report summarizes the engineering, environmental, and socioeconomic activities undertaken for the pilot dredging project. Detailed descriptions of these activities are provided in Appendices J.1 (Engineering), J.2 (Environmental Component) and J.3 (Socioeconomic and Gender).

2. ENGINEERING CONSIDERATIONS

2.1 River Survey

NERP developed a fast, accurate method for preparing hydrographic charts of the river bed. The surveys were made by installing a Global Positioning System (GPS), a digital depth sounder together with a laptop computer in a river survey boat. The equipment enabled collection of water depth values corresponding to the horizontal position. A second GPS was installed at Ajmiriganj as a base station to differentially correct the mobile unit's positions. This allowed the positions to be determined to an absolute accuracy of 5 to 10 m during most operations. Custom software was written to convert the data into AUTOCAD format for plotting and verification. The river bed topography was represented on 1:10,000 scale maps with 1m contours and spot elevations.

2.2 Pilot Dredging Platform Concepts

2.2.1 Disposal of Dredge Spoils

Disposal of dredge spoils is one of the main issues in river dredging. If the spoils are released back to the river, shoals may develop downstream, thus defeating the intended purpose of dredging. If they are spread overland, conflicts with landowners are likely to arise. The spoils, composed mainly of sand may significantly reduce the fertility of agricultural land. However, the dredge spoil can be put to use for raising existing homesteads and developing new ones, in order to benefit local communities. This has been one of the objectives of the Pilot Dredging Project.

During the monsoon, the *haor* is flooded. Most villages consist of small man-made platforms above the flood line, where the inhabitants live in isolation 5 months of the year. As a result, flood-proof high land is extremely valuable. The Pilot Dredging Project proposed to use spoil material from river dredging operations to fill confinement chambers, thus creating or extending flood-proof land.

2.2.2 Confinement Chambers

Confinement chambers are disposal facilities for the dredged river spoil material. The internal volume of the chamber is designed to accommodate the anticipated dredge spoil from the river shoal. The chambers are located adjacent to the village to increase living space and provide access to portions of the village normally separated during the monsoon flood time. Photograph J.1 is a view of the proposed confinement chamber location at Kakailseo.

Dykes, which form the boundary of the confinement chambers, are constructed with soil excavated from the bottom of the chamber. The dykes were designed to withstand internal and external soil and water pressures. Exterior slopes are 1v : 2h and interior slopes are 1v : 1.5 h; crest elevations were designed for the 1 in 10 year flood plus allowance for consolidation and freeboard.

2[0]

Photograph J.1: Kakailseo Prior to Chamber Construction

Locations of the inlet and outlet structures were selected to maximize the in-chamber settlement time of effluent from the dredge. Inlet pipes from the dredge were placed on top of the dyke, and were regularly moved to prevent uneven filling of the chamber. The outlet is a drainage structure composed of a weir or steel pipes which discharges the effluent into the outlet channel.

The outlet channel is needed to return effluent water back to the river channel. The channels were constructed in cut or fill depending on local topography. Their main purpose was to prevent water damage to adjacent crop land and the environment.

Photograph J.2 was taken from the same vantage point as Photograph J.1 (the minaret of the mosque adjacent to the platform), but shows the platform filling near completion. Also note the outlet structure pipes which discharge water toward the Kalni River.

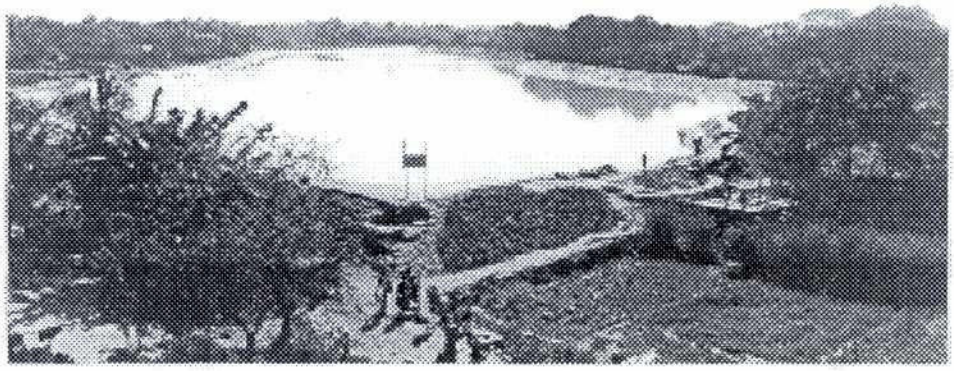
Figure J.5 is a sketch of the main features of a typical confinement chamber.

2.3 Preliminary Evaluation

Platform sites were considered wherever there was a need for river dredging and a community's request for a platform. Reconnaissance surveys and social surveys were done to identify several sites. The engineering evaluation considered channel shifting, bed aggradation or degradation, and the occurrence of bank breaches. The details of the preliminary engineering evaluation are discussed in Appendix J.1.

The engineering and socioeconomic analyses indicated that the most appropriate location for the pilot dredging program would be several villages in the 24 km reach of the Kalni River downstream of Ajmiriganj. These sites are shown on the Location Map (Figure J.4).

Photograph J.2: Kakailseo Chamber & Platform Filling



2.3.1 Evaluation of Preliminary Sites

Gazaria
A project at Gazaria would benefit all homesteads and join the North and South communities separated during the monsoon season by a breach in the village platform. From a technical perspective, the site presents more difficulties than other sites. The river bed material in the reach directly opposite Gazaria contains a high proportion of fines which would not settle in the confinement chamber but would return to the river.

Shahanagar
Construction of a platform at Shahanagar would improve the living conditions of some Homesteads and of the community in general. A shoal is located on the bank opposite the disposal site. Unfortunately, placing a floating pipeline across the river would seriously obstruct navigation.

Kakailseo
A project in Kakailseo would generate important community benefits by linking the market to the school and by raising the land of 51 existing homesteads.

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Anandapur
Removal of the existing shoal at Anandapur would benefit navigation, the existence of *khas* land would simplify the implementation of a platform, and the sandy river bed material in this area would be suitable for platform construction.

Katkhal
Katkhal is the smallest of the five sites and, although direct benefit from raising the land would accrue to only a few Homesteads, the community would expand their school yard and market place. There does not appear to be any major technical problem associated with dredging or platform construction.

2.3.2 Selection of Recommended Sites

On the basis of the above evaluation, Kakailseo, Gazaria, and Khatkal were the sites recommended for the final dredging project. Following is a brief description of each of these sites. A more detailed descriptions is provided in Appendix. J.1

Kakailseo
The site is located on the left bank of the Kalni River in Habiganj District, about six kilometres downstream of Ajmiriganj. The existence of a depression in the centre of the village causes deep flooding during the monsoon season, isolating outlying *paras* and impeding access to the school and Kakailseo market (Photograph J.1).

Dredging would be done on the left side of the Kalni River channel, starting about 500 m downstream of the site and progressing upstream (north). The effluent would be discharged back to the Kalni River through a natural drainage channel.

Gazaria
The site is located in Kishoreganj District about four kilometres downstream of Ajmiriganj. The village is exposed to prolonged flooding and is completely surrounded by water for up to five months of the year.

During the 1988 flood Gazaria experienced considerable erosion, which divided the village platform into two *paras*, Gazaria North and Gazaria South. The village is also affected each year by wave erosion on its western (*haor*) side, and is consequently very narrow, typically only 10 m wide. During the monsoon, people living in the lowlands move to the raised village platform, in an already inadequate space with its livestock and straw stacks.

To repair the 1988 flood damage, NERP planned to connect Gazaria South and Gazaria North with a platform contiguous to both villages.

Katkhal
Katkhal village is located on the right bank of the Kalni River about 14 km downstream of Ajmiriganj. The village is a major commercial centre in the KKRMP area, with a daily circulation of approximately three thousand persons. The proposed site is contiguous to the Katkhal market and the plan would extend the existing platform by about 120 m on the western side.

The plan was to dredge the right side of the Kalni River channel, leaving the left side open for navigation. Dredging and filling of the chamber would progress from south to north with the effluent water draining through an existing channel.

2.4 Tendering and Construction

2.4.1 Contractor Pre-qualification

Three companies responded to the invitation for pre-qualification, one registered in Bangladesh, the other two registered in India. These two foreign companies could not be considered due to time constraints. A second Bangladeshi contractor was invited to obtain competitive bids.

2.4.2 Evaluation and Contract Award

The two companies retained for pre-qualification presented tenders which met all bid criteria. The tender quotes were quite close to one another and much higher than NERP estimate. The reasons for these higher costs are related to economy of scale and the remoteness of the project area.. To remain within budget, the pilot dredging work program was scaled down by removing Kathkal from further consideration.

Basic Engineering Ltd., the lowest bidder, were informed on the conditional acceptance of their tender and invited to contract negotiations. The negotiated contract between NERP and Basic Engineering Ltd. was for a total of Tk 53,242,303, including a provision of Tk 414,960 for dredge stand-by time due to potential environmental restrictions.

2.4.3 Construction

During the final alignment of confinement dykes, on-site adjustments were made to accommodate land boundaries and avoid social conflicts. Final disposal site plans were prepared on the basis of actual alignment.

Dredging operations were carried out by two 18" suction dredges (S.D. Titas and S.D. Kasalong) rented by the dredging contractor from the Directorate of Dredge, BWDB. S.D. Kasalong arrived from Chittagong on 7 November 1995, and S.D. Titas arrived from Dhaka on 15 November 1995.

Kakailseo Site

Due to relatively high ground at Kakailseo, water had drained from the site by mid-November 1995. Construction of the confinement dykes started on 22 November 1995 and was completed by 30 December 1995. Since the Gazaria confinement chamber was not yet ready, dredging and filling operation started with both dredges on 12 January 1996 until 27 February 1996 when S.D. Titas was sent to Gazaria. Filling at Kakailseo was completed on 12 April 1996. The Kakailseo disposal chamber has an area of 3.1 ha and required 133,125 m^3 to fill it to the design height. Figure J.6 presents the location of the Kakailseo new platform in relation to the Kalni-River and the dredged area in the river. Figure J.7 is a sketch of the existing and new platforms.

Gazaria Site

The land surrounding Gazaria village is much lower than at Kakailseo and the water only drained completely by the first week of January 1996.

Because the dredges were old and could breakdown at any time, the Gazaria confinement chamber was designed and built with two compartments, chamber A and chamber B, in order to ensure that the work would be completed in the stipulated time.

Chamber A was designed with an area of 3.3 ha and required 182,000 m^3 of dredged spoil to fill it to the design height. Construction of this chamber started on 4 January 1996 and was completed on 28 February 1996. Dredging started on 2 March 1996 and was completed on 25 July 1996. Gazaria platform A extended the Homesteads of 110 families, including 12 families whose Homesteads were eroded during the 1988 flood when a breach formed on the village platform. The Homesteads of those families were subsequently rehabilitated.

Gazaria chamber B has an area of 1.3 ha and required 67,000 m^3 of dredged spoil to design height. Construction of the confinement chamber started on 3 March 1996 and was completed on 13 April 1996. Dredging started on 24 April 1996 and was completed on 8 August of the same year. The platform extended the Homesteads of 51 families.

Figure J.8 presents the location of the Gazaria new platform in relation to the Kalni-River and the dredged area in the river. Figure J.9 is a sketch of the existing and new platforms.

Both platforms were handed over to village beneficiaries on 30 August 1996.

2.5 Lessons Learned

Even though an implementation project should be finalized well ahead of construction, the alignment of the platform can only be finalized on-site. This is due to people's changing perspectives and possible lack of appreciation of the exact alignment when reviewing the preliminary plans. This issue is discussed in greater detail in Appendix J.3.

2.5.1 Dredges

Considering actual pumping hours of the two dredges operating at the sites, the dredges' output had an efficiency of 44%, which is much lower than the 75% generally achieved in this kind of operation. Major delays were experienced, related to mechanical breakdown, extension of discharge pipes, maintenance and repair of dykes and effluent outlet channels. Improved dredge maintenance and better operational planning on the contractor's part would have improved efficiency. Photograph J.3 shows the discharge pipe needed to reach the chamber at Gazaria. It took close to a week to assemble the 800 meters of discharge pipe required at this site.

After the dredging was completed in April at Kakailseo, the dredged channel remained stable throughout the pre-monsoon season. During the course of dredging, several deep local holes were excavated; these filled in completely within a few weeks. Excavating holes, while advantageous for the contractor, is clearly undesirable when the purpose of the work is to produce a specified channel grade. Future work should include surveying and depth sounding to prevent unnecessary excavation.

Maintenance dredging during the monsoon season, will not be very useful, since the river bed will rapidly fill with fine sediment. The best time for maintenance dredging is during the dry season (December to April).

Photograph J.3: Dredge Discharge Pipe at Gazaria

The overall trap efficiency of the disposal chambers was typically 96% (range 87% to 99%). There was good agreement between the observed trap efficiency and predictions made using design techniques developed by the US Army Corps of Engineers. The lower trap efficiencies occurred when the dredge encountered fine sediment (clay/silt); this problem was more common at Gazaria than Kakailseo. The trap efficiency was also reduced during the last stages of filling when the retention time in the basin was shorter. However, this was successfully mitigated by installing *tarja* walls perpendicular to the direction of flow in the confinement chambers.

2.5.2 Confinement Chamber Dykes

It is difficult to build high quality dykes with the material found on the platform sites, since this material is predominantly silt. Seepage through the body of dykes built with this material, poses a high risk of failure. As experimented at both sites, this seepage failure can be effectively reduced through the use of polyethylene lining on the inner face of the dyke.

Over a period of three months, the dykes settled over 50 cm. Once the filling operation started, it was difficult to rebuild the dyke to its original height because soil was not available. In low spots, the design level of the crest was restored with sand bags. This indicates that the composition of the parent material should be known at the design stage to properly account for settlement.

Dyke stabilization is a key project issue. Dyke erosion and spilling of the dredged material would not only have an adverse impact on the adjacent land but also on peoples' perception of platform construction projects. Slope stability is critical before the onset of flooding. During the project, when the paddies and pastures were inundated by monsoon flood waters, cows and goats moved onto the dykes and ate the grass. This damaged both the trial grass slope protection method and the dykes. Field rats also took shelter by burrowing into the dyke and posed a major threat to stability. Rats caused the dyke crest at Gazaria to fail in several locations.

Several attempts were made to stabilize the slopes before the onset of the monsoon, with limited success. Locally developed approaches had better results. The traditional protection method using bamboo fence protection with *chailla* grass was more effective than other methods and is recommended for temporary slope protection.

2y

As the dyke settles, accumulated rain water runs over the unevenly graded platform surface and overflows the perimeter. Rain cuts develop, erode the slopes and increase the risks of dyke failure. Rain water should be collected in the middle of the platform and diverted to the outlets by a single drainage channel.

At Gazaria, earthen dykes were also constructed in the back of the new platform, adjacent to existing homesteads, leaving a small space between the houses and the new platform. Drainage water from local runoff collected in those area. Special drainage facilities had to be constructed to drain the water past the villagers' homes. Graded swales or filling the local depressions at the interface should be considered for these areas in future designs. Interruption of existing drainage patterns and drainage onto land contiguous to the platform should also be considered. Disregarding these issues may affect relations with the villagers.

3. ENVIRONMENTAL MANAGEMENT PLAN

The EMP of the pilot project was developed in order to mitigate the adverse impacts of pilot dredging activities. Some construction activities were carried out by the contractor and the remainder was executed directly by NERP. Environmental activities undertaken by the Contractor included construction of cross drainage and effluent outlets, platform drainage and dyke protection works, homestead damage repair, navigation lighting, and disaster management. Storage of sandbags and *tarja* walls, as part of a contingency plan in the event of dyke failure, was also under the contractor's responsibility.

Environmental activities undertaken by NERP included drainage and land improvement outside the platforms, installation of alternate irrigation facilities and road overpasses, platform maintenance, and crop compensation. These activities entailed the provision of permanent and temporary facilities to compensate for inconvenience caused to the local population while aligning dykes and dredging.

NERP other responsibilities included activities related to the aquatic habitat; testing fish tolerance to turbidity, observing the natural habitat of fish and dolphins during dredging, testing an experimental bamboo barrier around a dredge to trap re-suspended sediments, water quality monitoring and protection of the dyke slopes against rain and wave action .

Activities related to infrastructure replacement and initial dyke protection have both bio-physical and social implications. In order to maintain clarity the social aspects are discussed in the social and gender section (section 4) and the Socioeconomic and Gender Appendix (Appendix J.3).

3.1 Fish Tolerance Tests

Turbidity, an indirect measurement of total suspended solids, is an important physical factor for all aquatic fauna. Suspended solids concentration of 20,000 parts per million (ppm) or more is considered lethal to fish.

To test the impact of turbidity in effluent channels, fish were placed into cages in the river within of the turbidity plume originating from the effluent outlet and their behaviour was periodically observed. Three fish species, abundant in the river reaches considered were selected for the experiment: one pelagic fish species, *Puti* (Puntius sophore), and two bottom feeder fish species, *Gulsha* (Mystus cavasius), and *Tergra*. Fish were kept in four bamboo cages (1 m x 0.7 m x 0.7 m) which were placed at four different locations in the river.

A cage was set 500 m upstream of the outlet to provide baseline information on the experiment. The other cages were placed downstream of the effluent outlet at regular intervals to measure the effect of the turbidity plume. Five to ten individuals from each specie were put together in each cage. The cages were then placed within the turbidity plume for five to six consecutive hours and were lifted every 2 hours to observe the fish.

2K

Surviving fish were numbered and dead fish examined. Two series of experiments were carried out at both Kakailseo and Gazaria. Three replications of each series were conducted, each one considering a different conditioning period (the period fish were kept in cages in an undisturbed river location before the experiment). Fish had either one hour, one day, or 2 days conditioning periods (see Appendix J.2 for details).

The turbidity tolerance tests indicated that, for short conditioning periods and short exposure periods, there is a very high survival rate: 98% of all fish exposed to various levels of turbidity for 1 or 2 hours survived. Even exposed to high turbidity (10 m from the effluent outlet), 95% survived. Very turbid water (10 m from the outlet) will only be lethal if the fish are exposed for long periods, after a long conditioning period, an indication that the length of the conditioning period may be as detrimental to fish as exposure to extreme turbidity levels.

3.2 Dolphin Observation Program

NERP field biologists attempted to located dolphins close to the project sites to observe their behaviour during dredging. In addition, they interviewed local fishermen and boat owners on the general behaviour of dolphins.

The biologists did not sight any dolphin in the dredging reach, either before or during project implementation. The dredging activities were carried out in shallow water, while river dolphins generally live in the deeper sections (*duars*) of the river. There is no evidence that dolphin habitat was modified due to the dredging works.

3.3 Bamboo Barrier

For environmental considerations, a geo-textile curtain is often placed around a dredge to protect fish and prevent re-suspended sediment from spreading downstream. An inexpensive alternative was tested at Kakailseo, consisting of a bamboo barrier with a water hyacinth mat. The apparatus, when first installed was carried away by the current. The concept was abandoned. Water quality testing downstream of the dredge indicated that the turbidity level increased only marginally. Moreover, there were no observations of fish trapped by the dredge suction head.

3.4 Water Quality Monitoring

Water quality monitoring was conducted to determine the effect of dredging on total alkalinity, dissolved oxygen, hardness, pH, temperature, turbidity, and Secchi disk reading (an indirect measurement of turbidity). The monitoring of these parameters was essential to ensure it did not pose any risk to humans and aquatic flora and fauna. Detailed numerical data are provided in Tables 6 and 7 of the Environmental Appendix (Appendix J.2).

Total alkalinity ranged from 25 mg/l to 125 mg/l at Kakailseo and from 16 mg/l up to 71 mg/l at Gazaria, (acceptable values should read 25 mg/l to 75 mg/l). The higher values measured in the inlet and outlet at both sites were most likely due to high concentration of suspended matter. pH values ranged from 7.3 to 7.8 and from 7.5 to 8.4 at Kakailseo and Gazaria respectively, (acceptable values should be in the range 6.0 to 8.0). Hardness measurements did not vary considerably at either site. The values ranged from 26 mg/l to 57 mg/l, which is natural for river water. Very low dissolved oxygen values were observed in inlet waters, disposal chamber (pool) water, and outlet water. Measurements in the out-fall, immediately downstream of the outlet, showed a significant increase of dissolved oxygen.

Turbidity readings confirmed the estimated retention capacity of the chambers.

Field observations indicated that the turbidity plume from the outlet discharge covered a narrow strip along the shore and extended about one km downstream of the outlet.

3.5 Work Completed or In Progress in the 1996-97 Dry Season

3.5.1 Rescheduling of Post-Monsoon Repair and Maintenance Program

According to the Implementation Plan schedule, platform post-dredging repair and maintenance, mitigation and enhancement, activities all under the EMP budget, were to be completed in the October-December 1996 period. As has often been the case on this pilot project, knowledge gained from field experience provides an understanding for future planning.

The original time frame for platform completion did not take into account the seasonal nature of all activities on the *haor*. The earth work on the platform could only be commenced when the monsoon water had receded from the surrounding area and the soil had sufficiently dried-up. Secondly, the local farmers who were contracted for the finishing work were engaged in agriculture, thus would not have been able to complete the construction work required in the limited time frame. Also, NERP social team came to the conclusion that the beneficiaries, particularly at Gazaria, are not yet capable of protecting the platforms during the next monsoon season from their own resources. Therefore it was recommended that NERP should assist them with traditional protection before the 1997-98 monsoon season. . Furthermore, the material and community labor for the 1997-1998 soft dyke protection is only available in the April-May period when the *haor* vegetative matter is mature and the harvest complete

With the above factors in mind, the post-construction finishing of the platforms commenced at the end of November 1996 and will be ongoing until mid-June 1997. The following works are either completed or in progress (May 1997) in the communities of Gazaria and Kakailseo.

3.5.2 Leveling

Top-grading consisted of spreading the dredged materials evenly over the platforms. Leveling was required to provide the base for placement of the organic matter (straw) and to lay out the surface drainage. On the two platforms, the work was carried out by 25 local women contractors utilizing a labor force of 400 women.

3.5.3 Top-soil Placement

The EMP proposed to save the original topsoil from the disposal sites and to redistribute it over the newly dredged platforms. However, it was found that the topsoil needed to be used for supplementing a shortage of earth in construction of the disposal chambers.

The dredge spoil material on the surface of the platforms is sandy and subject to wind erosion, in the dry season, and water run-off through rain cut, in the monsoon season. Lacking in clay content, the dredge spoil does not have the capacity to retain moisture. As a result, the low humus (organic matter) content will decrease rapidly due to leaching.

Top soil placement was required to stabilize the platform surface and to provide soil nutrients. The top soil was placed to a depth of 15 cm and leveled over the sandy platform surface. The placement was carried out by male contractors. The contract was based on labor rates only. Landowners in Kakailseo and Gazaria provided the required top soil, free of cost, from fields and ditches near the platforms.

3.5.4 Improvement of Soil Structure and Productivity

Methods of improving the soil structure and productivity are being developed to protect the disposal site from erosion. These include production of biomass on the platform by the deposition of a straw layer and the cultivation of African *dhaincha* (sesbania sp.).

A layer of 5 cm straw was applied between the leveled sand and the top soil. In a test plot, straw was found to be preferable over *dhol kolmi* because it produced a better quality of humus on decomposition.

3.5.5 Ditch Fill at Kakailseo

The platform at Kakailseo was constructed between several *paras* of the village and the river. As a result, the platform obstructed the flow of water from a large ditch to the river. This created water-logging in the pre and post monsoon periods, thereby, hindering the passage of people from their houses and presenting a danger for children playing near the ditch.

The ditch was filled with sand, surplus to requirement after leveling the Kakailseo platform. The work was carried out by 12 women contractors utilizing a labor force of 150 women. The additional placement of top-soil on the sand enabled the area to be converted into a productive space.

3.5.6 Outlet Channel Fill at Gazaria

The dredge effluent channel used to pass through the agricultural fields at Gazaria. As part of the mitigation required, the effluent channel was filled. This work was carried out by 13 women contractors. Earth for the channel fill was provided, free of cost, by six Gazaria landowners.

3.5.7 Clearance of Dredge Spill at Gazaria

Leaks in the dredge pipes had caused sand spills on agricultural land at Gazaria. As part of the mitigation required, the sand was lifted and removed from the land. This small volume of work was carried out by male labor, hired on a daily basis.

3.5.8 Road Shifting at Gazaria

At Gazaria the southern road coming from the *haor* had to be rebuilt due to the platform displacing the location of the road. The road shifting contract was based on labor rates only. Earth for road construction was contributed by Gazaria South landowners.

3.5.9 Temporary Drainage of the Platforms

To prevent erosion and rain cuts, earthen channels will drain monsoon rain off the platform surface. Maintenance of the surface drains will be the responsibility of beneficiary households. For the 1997 monsoon, the large drains have been temporarily constructed during April and May using sandbags and pipes. If the Kalni-Kushiyara Community Development and Monitoring Project (KKCDMP) is implemented, concrete drains will be constructed in the following year when the platforms' dykes have settled further. It should be noted that construction of permanent structures is shifted from the current Phase II program to the proposed KKCDMP. However the funds have been allocated in the current EMP budget to cover a part of this construction.

3.5.10 Dyke Repair

Despite protection, the un-compacted dykes of both platforms suffered from wave erosion and rain cuts during the monsoon season. Dyke repair was required to correct sections of localized dyke failures and re-establish the proper slopes. Dyke repairs were carried out by local male contractors. The dyke repair contract was based on labor rates only. The communities of Kakailseo and Gazaria provided the required earth, free of cost, from fields and ditches near the platforms.

3.5.11 Turfing

Once the dykes were built, turf was planted on the dyke slopes at Gazaria and Kakailseo to impede erosion by rain cuts. Over the past year the turfing has been damaged by pedestrians and livestock climbing the dyke slope to access the platform. Loss of turf has reduced the slope's capacity to withstand rain erosion. Vulnerable areas of dyke slope at Gazaria and Kakailseo were re-planted with turf in the April-May period. This in preparation for the 1997 monsoon.

3.5.12 Soft Protection for Dyke Slopes

The monsoon presents a major risk for the integrity of the platforms. Kakailseo benefits from the natural protection provided by surrounding *paras,* but at Gazaria the dykes are fully exposed to monsoon waves from the *haor*.

Soft protection refers to a bio-physical method of slope protection, adapted from traditional methods used for homestead platforms in the *haor* areas. It consists of the comprehensive use of an *aar bandh* frame with *chailla* grass (Hemarthria protensa, family: Gramineae) and *tarja* walling applied to the outside slope of the dyke. Individual homesteaders apply the *aar bandh* frame and vegetative packing on an annual basis. Flood- tolerant trees, shrubs and grasses on the lower slope and the toe of the platform provide the long term aspect of the soft protection method.

Currently, in late May and early June 1997, soft protection consisting of the *aar bandh* frame, *chailla* grass packing and *Tarja* walling, is being applied to the vulnerable slopes of the Gazaria and Kakailseo dykes. Platform committees, local contractors and homestead beneficiaries are engaged for this work.

3.5.13 Koroch Sapling Plantation and Care on Gazaria

Long term sustainability of the new platform is greatly dependent on the growth of a tree belt near the toe of the dyke. As part of the soft platform protection, water-tolerant trees will provide soil security and erosion protection of the western dyke which is exposed to a long fetch of *haor* waves.

Five meters of land was donated by Gazaria landowners all along the dyke. Over 2,000 adult-sized (4 - 5 ft.) *koroch* saplings were planted along the toe of the west, south and northern slopes of the dyke. Five women, selected by the Gazaria community are engaged in watering the saplings during the dry season.

3.5.14 Shrub and Grass Plantation

A component for the long-term effectiveness of the soft platform protection, is a dense growth of water-tolerant shrubs and grasses on the lower slopes and the toe of the dyke. This secures the soil of the new platforms thus reducing the intensity of wave erosion.

As part of the soft platform protection, put in place in May and June 1997 period, beneficiary households in Gazaria have been supported to cultivate rhizomes and root stocks at the toe of the dyke. Beneficiaries have provided land and contributed labor for transplanting *ikor* (sclerostachya fusca), *dhol kolmi*, *murta* (clinogyne dichotoma), and *nal kagra* (phrangmites kanka). Beneficiaries were provided with the costs for transporting cuttings and roots from nearby villages.

3.6 Environmental Lessons Learned

3.6.1 Fish Tolerance

Very turbid water (10 m from outlet) will only be lethal to fish when they are exposed for long periods after a long conditioning. This situation is unlikely since fish would naturally swim away from these areas. In addition, field observations indicated that only a short and narrow plume along the shore were exceedingly turbid.

The results for short exposure periods associated with short conditioning are probably the most indicative of actual effects. Fish are mobile and can quickly move to safer places. Short exposure experiments indicate that the effect of the dredging effluent, if any is marginal.

3.6.2 Water Quality

Except for the turbidity readings along the shore in the first 400 to 500 meters downstream of the effluent outlet, data were typical of any river in the Northeast region. Water quality results confirm the conclusion of the fish tolerance test experiment, i.e. the effluent from the disposal chambers will not have significant impact on the aquatic ecosystem.

3.6.3 Sediment Quality

Based on a chemical analysis of sediments samples collected near Kakailseo and Gazaria, the alluvium in the Kushiyara River can be classified as uncontaminated. Under North-American or European guidelines, this material can be used for homestead or agricultural purposes without restriction.

3.6.4 Using Alum to Decrease Settling Time

Alun is a compound often used to accelerate the precipitation of suspended sediments. Both laboratory and field testing were done to assess the effect of alun on the settlement of suspended sediments in the confinement chambers during dredging. It is believed that very large quantities of alum would be necessary to significantly improve the settlement process, (Appendix J.2).

The installation of bamboo barriers inside the chamber in order to maximize the particle retention time proved to be an easier and a more efficient method than the use of chemicals. Alum may only be considered towards the end of the filling operation when sediment retention time in the disposal chamber is reduced.

In typical dredging operation, a different method is used to fill the pond near the outlet, where the retention time is much reduced and filling waste much dredging time. Part of the confinement chamber is over-filled and, when the settling rate decreases substantially, the excess spoil is pushed in the pond.

4. SOCIAL AND GENDER COMPONENT

4.1 The Nature of the Social and Gender Component

During the pilot project's preparatory phase, the social and gender component consisted mainly in public consultations and social analysis. During the construction and monitoring phases, the Enhanced Social and Gender Program was implemented by institutional strengthening, protection and maintenance, and gender development (Appendix J.3, Section 6.1).

To carry out this work, three female and two male COs have been assigned to the Kakailseo and Gazaria sites and are supported by two Dhaka-based staff. The social team provide the interpretative linkage between the technical aspects of engineering and the social issues, interfacing at village level.

The social and gender activities have consisted of social analysis for site communities; *khas* land studies; surveys of local female labor; formation and strengthening of village and *thana* committees; land dedication; advocacy and monitoring of women's' labor groups; compensation; and training for community-based platform protection, maintenance, and improved use.

4.2 The Socioeconomic Characteristics of Kakailseo and Gazaria

A raised platform of 3.1 hectares was constructed on low land in the center of Kakailseo village. This provided flood-free homestead land to 51 landowners along its perimeter and improved access to the market and school for outlying portions of the village. In Gazaria, a raised platform of 4.6 hectares was constructed along the western (*haor*) side of two existing village platforms. It joined the two platforms which had been separated by erosion. In Gazaria North the new platform provided flood-free and expanded homestead land for all HHs on the existing platform and for a third of HHs on the Gazaria South platform. The provision of expanded homestead space for 158 HHs on the Gazaria platform is of significant socioeconomic value.

The socioeconomic characteristics of the platforms are provided in Table J-1. The configurations of the new platforms are shown in Figures J.7 and J.9.

Table J.1: Social Characteristics of the Village Platforms

Village	Platform size (ha)	Total no. HHs	Number of beneficiary HHs	Direct benefits (only beneficiary HHs)	Community benefits (all village HHs)
Kakailseo	3.1	814	51	Expand homestead land for increased production and water & sanitation Expand school ground for sports and culture	Flood- secure passage to market and school Space for paddy threshing Flood-secure space for cattle
Gazaria N	3.3	110	110	Homestead land, as above Space for playing field	Join 2 clusters to provide flood-secure passage Flood secure, space for near-by villages and cattle
Gazaria S	1.3	250	48	As for Gazaria N	As for Gazaria N

There are 814 HHs in the 4 *para*s surrounding Kakailseo platform. In all of Kakailseo village there are 21 *para*s and an estimated 3,000 HHs.

4.3 Community Development

4.3.1 Land Dedication

Photograph J.4: BWDB, NERP and Thana Officials Handing Over Gazaria Platform

Individual landowners provided land for the project to construct the dyke and fill the disposal chamber. Upon completion, the developed platform was returned to the landowners. The term "land dedication" is used to describe this type of temporary arrangement, where no financial transaction was made for land by either party.

The multiple number of owners for a single registered plot and the contested ownership of some land plots made it inadvisable for NERP to enter into separate agreements with individual landowners. Therefore land dedication was agreed between NERP and the village committee (Section 4.3.3), who negotiated with landowners and signed on their behalf. Photograph J.4 above is the official hand-over ceremony at Gazaria. In the same way, the developed plots were returned to the committee for distribution to their respective landowners. This proved to be a satisfactory method, as there were no disputes about land dedication between NERP and landowners on either site.

4.3.2 Compensation

The EMP called for mitigation measures to offset losses caused by the construction and filling of the chamber and by the dredge effluent channels. NERP made compensation payments to individual householders and landowners through the village committees. In most cases the social team was required to negotiate the compensation terms. The village committee members were not effective in dealing with ensuing compensation problems because their interests in being compensated often conflicted with their role as committee members.

At Kakailseo and Gazaria householders and landowners were compensated for:

- the value of standing crop for paddy plantation to obtain earth outside the chamber for dyke and effluent channel construction;

- replacement or moving costs for tubewells, latrines, trees, houses, or roads destroyed or displaced by the dyke or the chamber.

A summary of compensation costs is provided in Table J.2.

Table J.2: Combined Compensation Payments for all Three Sites

AREA	AMOUNT (Tk)
Kakailseo	28,196
Gazaria North	49,017
Gazaria South	60,447
Grand Total Compensation	137,660

Construction of the perimeter dyke and the long effluent channels at Gazaria required considerable earth. The greater compensation cost for Gazaria was related to the need to obtain earth outside the disposal chamber. The earth was needed to supplement the deficiency due to the narrowness of the chamber and because it contained 14 ditches.

4.3.3 Village Committees

Village committees were formed in Kakailseo, Gazaria North, and Gazaria South to represent the beneficiary HHs for such issues as land dedication, compensation, labor recruitment, and platform protection and maintenance.

Although the social team facilitated the formation and functioning of the committees, in this pilot project there was no attempt to influence its composition. The committees were selected by the village elite and reflected the power relationships specific to each community. In the case of Kakailseo, those committee members who were not benefited by having land on the platform were particularly uncooperative.

The performance of all three committees in resolving problems related to compensation, local labor, and community contributions for protection and maintenance has been weak. The committees' capacity to make decisions in the civic interests of the community has been limited. Committee members have tended to be ineffective in consistently distributing technical information to all members of the community. The performance of the Kakailseo and Gazaria committees is representative of traditional village committees, where the economic and political elite monopolize any type of development resource coming to the community.

4.4 Gender

Women in the remote areas of the *haor* have been isolated from government and non-government programs targeted for women in other parts of Bangladesh. NERP has utilized the opportunities provided through the pilot project to introduce a number of pro-gender activities through the Enhanced Social and Gender Program (Appendix J.3, Section 6.1).

Over 300 local women who traditionally work as agricultural labourers in the dry season were engaged in earth construction of the dykes. Women's' labor participation was at 23%. This exceeded the 20% quota contractual requirement. Twenty-one women's' construction groups from eight villages travelled up to three kilometres to work on sites on both sides of the river. On the average, women earned Tk 35 per day working in dyke construction.

Women who were members of HHs owning land on the Kakailseo platform were not involved in construction labor. Three women's' groups, not owning land, worked on platform construction. In Gazaria, where all HHs owned land on the platform, five women's' beneficiary groups worked in construction.

Photograph J.5: Female Construction Labor on the Gazaria Site

Women who work in public construction sites have been compelled to abandon the conventional norms of *purdah* in order to provide an income for their families. The large number of women from landless HHs who were willing to work on platform construction is a reflection of the poverty level of the project area.

Aruti's story is typical of the women who worked in earth construction at the platform sites

ARUTI - THE FORTUNE OF A CONSTRUCTION WORKER

Aruti is a widow, about 35 years old, who supports her two minor sons through working as a labourer. She was married at the age of 14 to a man who owned a tea shop in Kakailseo market. Two years ago Aruti's husband died from tuberculosis. During the course of his illness, he had lost their house and homestead land through debts for the purchase of medicine. In the past two years Aruti has worked as an agricultural labourer in transplanting and weeding, as a domestic labourer in rice processing, as a construction labourer in a "food for work" scheme, and independently in rice gleaning (collecting kernels remaining in the field after harvest). During the monsoon season, she catches and sells small fish from the *haor*. Throughout the year, Aruti works for about 150 days and earns about Tk 25 per day. Preceding the monsoon season, when work is scarce, she is forced to borrow money at a high interest rate from moneylenders.

Aruti worked as a member of a female labor group on the Kakailseo site. Due to a disagreement over payment, she formed her own earth-cutting group for work on the Gazaria sites. Aruti had 80 days of steady work in platform construction, earning Tk.3,000 (about Tk 38 per day). With this money she repaid last year's loan, built a small thatched house on her landlord's property, and purchased clothes for her children. This year she did not take a consumption loan.

Aruti has learned dyke construction skills, earth measurement, and rate calculations. She has gained the confidence to negotiate with a contractor and to work outside her local area. Aruti feels respected by her community because she works to support her family. This year, in addition to her regular labor activities, Aruti and her group of 15 members have invested their savings of Tk 1,600 to cultivate paddy on leased land of 1.12 acres.

4.5 Protection, Maintenance, and Platform Development

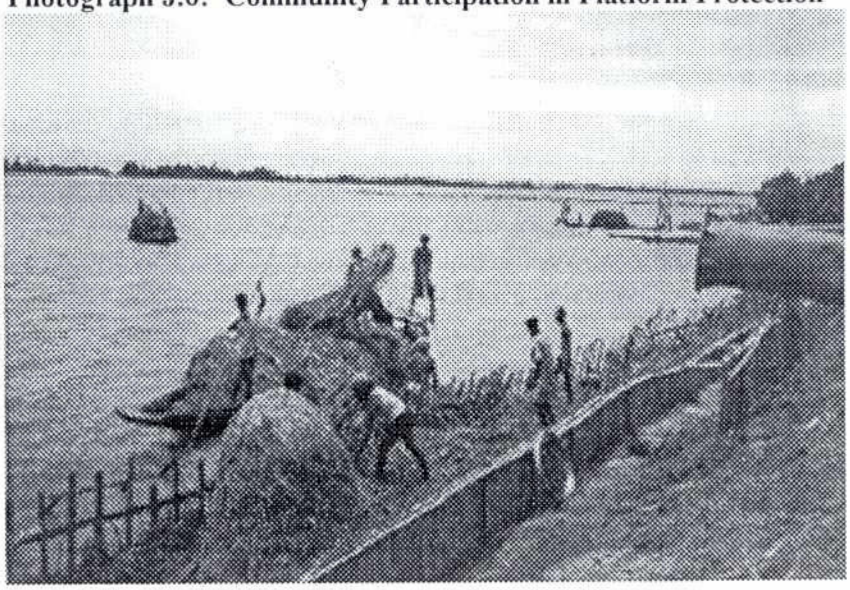
Following completion of the Contractor's involvement in construction and basic protection of the dykes, NERP assumed direct management for protection and maintenance in the first monsoon period. This was done through community groups. In Kakailseo, where the platform is protected from wave erosion because of its position in the "center of the village", protection activities consisted of providing routine repair for erosion caused by rain cuts. In Gazaria, where the long western wall of the dyke was exposed to severe monsoon wave erosion, village people were contracted to provide platform protection. They used the traditional method of a bamboo frame to hold densely packed vegetation against the earthen wall of the dyke.

The work of assisting the community to develop their platforms was planned for the post-monsoon period. Beneficiary HHs were trained in land-use planning, soil productivity, and topsoil management. Drainage problems both on and outside the platforms were managed with earth leveling and filling. As new houses are constructed on the platform, HHs will be assisted to install improved water and sanitation facilities. Special assistance has been or will be provided under the KKCDMP to resettle homestead-less families on the new platforms. There are 6 such families at Kakailseo and 12 at Gazaria. Those at Gazaria have already been resettled.

Women have not been selected by male elders as members of the Kakailseo and Gazaria village committees. In any case, women's' involvement in male-dominated committees is usually minimal. However, it is expected that motivated and trained beneficiary groups will provide a venue for women' real and valuable participation in community platform protection, maintenance, and development.

The communities' role in providing protection of the village platforms is illustrated below:

Photograph J.6: Community Participation in Platform Protection



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4.6 Lessons Learned

4.6.1 Site Selection and *Khas* Land

The pilot project experienced difficulties in corresponding the "socially ideal village" with the "technically ideal site". This was particularly the case at Anandapur where river dredging was desirable but where *khas* land could not be obtained to resettle landless HHs. It was illegally occupied by a powerful village elite.

Future projects for development of village platforms or raising of agricultural land will frequently face the *khas* land issue along the Kalni-Kushiyara River. Construction and resettlement of the landless on acquired *khas* land may be possible with the support of powerful judicial and executive government machinery. Alternatively, *haor* land may be acquired through the government for the construction of platforms for landless communities.

4.6.2 Land Dedication and Cost Sharing

A major lesson learned has been the willingness of communities to dedicate land for the construction of homestead platforms. In the *haor* area of Bangladesh, high land is a valuable resource. Homestead land on the new Kakailseo and Gazaria platforms is estimated by its owners to have increased 10 times in value.

In future platform construction projects, the mere willingness of communities to dedicate land can no longer be considered a major criteria for site selection. Those who will directly benefit from the new platform land should be required to contribute towards its development. Contributions could include cash, material, or labor for construction of the disposal chamber. It may also involve land dedication for settling homesteadless HHs or payment of a land-improved tax to government bodies. At the very minimum, future platform beneficiaries should share costs for platform Protection and maintenance.

4.6.3 Platform Alignment and Community Planning

The Kakailseo and Gazaria platforms were constructed in one dry season, limiting the preparation time for communities to reach a consensus. The final platform alignments could only be done when the monsoon water receded, leaving very little time for the communities to fully consider the implication of the platform within the total village configuration. Many of the construction disruptions and some of the post-construction mitigation problems could have been avoided had there been time in the pre-construction period to fully educate and consult HHs in all *paras* of the village.

In future projects, the schedule of aligning the platform and constructing the disposal chamber should be preceded by adequate lead time to allow the community to reach consensus about the location of the platform site within the community. Final platform design and alignment should only be made after all *paras* of the community have been consulted about such shared civic facilities as drainage ditches, roads, irrigation canals, graveyards, and access to schools and markets.

4.6.4 Village Committees

Although they are not unlike other committees in rural Bangladesh, the platform committees in Gazaria and Kakailseo did not perform well in matters where they were required to serve civic interests beyond their personal interests. Nevertheless, a committee, constituted by the community in the form they find to be expedient, is the essential institutional body for management of the village platform. The committee will only be functional when it can command support from the village's politically influential leadership.

Future committees could be restructured based on "platform use". The majority of committee members should be platform beneficiaries. Other members should represent portions of the community which will either receive common benefits or be disadvantaged unless civic interests are taken into consideration.

4.6.5 Gender Issues

Targeting platform beneficiary women in homestead production will contribute to an increased economic value of the platform. Women's' participation in protection and maintenance and their capacity to influence community decision making can only be achieved by targeting them in gender-specific groups.

The engagement of women as earth construction labor has provided an ideal entry point to target poor women in the project area. Labor opportunities on the disposal chambers have been utilized by landless women to provide a consistent earning, reduce dependence on moneylenders, learn new skills, and gain confidence for participation in the labor market. Both male and female labor groups were hired by the contractor and NERP had no influence in determining the terms of their engagement.

In future projects, the labor arrangements for disposal chamber construction could be changed to one of male and female labor contracting societies. They should be managed by the project implementers rather than engaged by the contractor. The female labor participation target for chamber construction, dressing, and platform protection could be raised to 25% through female labor contracting societies. The economic impact on women's' labor groups can be strengthened when project implementers have a six month lead time before construction to work with labor groups. This will allow time to develop a group savings pattern.
Development Agency (CIDA), January 1996.

5. INSTITUTIONAL CONTEXT

During the preparation and/or the implementation of the Pilot Dredging Project, a number of institutions participated in the project or interacted with NERP. These are:

- Bangladesh Water Development Board (BWDB)
- Bangladesh Inland Water Transport Authority (BIWTA)
- Ministry of Forest & Environment (MOF&E)
- Ministry of Land (MOL)
- Local GOB Officials and Elected Representatives

5.1 Bangladesh Water Development Board (BWDB)

The BWDB is responsible for project implementation in the water resources sector. In the case of the Pilot Dredging Project, since the project had to be completed in one season, implementation was carried out by NERP on behalf of the BWDB. However, the BWDB still had the following major responsibilities:

- review and approval of pilot dredging Implementation Plan;
- review and approval of tender documents;
- participation in contractor's selection and contract award;
- ensuring availability of dredges; as those were in short supply since dredging became a national priority at the time of project implementation;
- coordination of and consultation with relevant GOB agencies both in Dhaka and in the field;
- monitoring of dredging operations, and
- deputation of two BWDB Engineers for construction supervision throughout the whole implementation phase.

Although the dredging work was successfully executed, it has been concluded that it would be preferable, for large scale implementation to rely on international or local dredging contractors who own their own equipment as opposed as renting it from a GOB agency.

5.2 Bangladesh Inland Water Transport Authority (BIWTA)

The BIWTA is responsible for the maintenance of classified navigation channels in the country. The Kalni-Kushiyara River is a classified channel. It was therefore necessary for NERP to obtain BITWA's approval for the design of the river channel to be dredged as well as formal clearance for dredging.

NERP maintained a good liaison with BIWTA from the inception of the project. BIWTA provided good cooperation and also empowered the Superintending Engineer, Dredger Division of BIWTA to act on behalf of BIWTA for consultation and discussions. The river channel bed design was approved at a tripartite meeting organized by BWDB and held between BIWTA, BWDB and NERP. This was followed in due course by the formal approval by BIWTA of the dredging itself.

The BIWTA is expected to play a major role in the KKRMP both during the implementation stage, to review channel design and provide clearance for dredging and during the O&M phase, as they will be responsible for maintenance of the navigation channel.

5.3 Ministry of Forest & Environment (MOF&E)

During the implementation of the pilot project, NERP contacted the Department of Forestry in Habiganj in order to review their annual development program and enquire about the availability of water tolerant trees, particularly *hizol* and *koroch* saplings. DOF staff indicated they did not have a program to produce saplings of water tolerant trees. As a result, NERP obtained the required saplings from CONCERN, an NGO operating in the vicinity of the project area.

The future project will require a substantial number of *hizol* and *koroch* saplings for the protection of homestead platforms against wave actions. Therefore, it is suggested that the Department of Forestry be contacted and involved at the beginning of the pre-construction phase in order to plan and provide the required saplings on time.

Ministry of Land (MOL)

The MOL has the overall responsibility for *khas* land. However, in the field, allocation of *khas* land is done through the intervention of the Deputy Commissioner (DC) who liaises with the MOL. In Kakailseo, six landless families were to be resettled on a small piece of *khas* land located along the northern boundary of the platform. The initiative was proposed following a request by those families to the CIDA Mission in 1995 and the Kakailseo platform committee subsequently promised to resettle these six families on this land. NERP contacted the DC of Habiganj to allocate the land and at time of writing this report, the transfer process is underway.

In the KKRMP, it is proposed to allocate some *khas* lands to build platforms on which landless families will ultimately be resettled. Moreover, a substantial of amount of private land will also have to be acquired. Therefore, it is proposed that the MOL be involved in the KKRMP from the beginning of the project, in order to facilitate allocation of *khas* land , acquisition of private land , and resettlement issues.

5.4 Local GOB Officials and Elected Representatives

During the implementation of the pilot project, several issues arose related to land dedication, alignment of confinement chambers, negotiations with the communities, compensations and safe storage of construction material.. In several instances local elected representatives (Union Chairman), district and *thana* officials (DC & TNO) were consulted at their offices and involved at construction sites in the resolution of conflicts and issues.

For a larger project such as the KKRMP, local elected representatives and GOB administrative Officials (DC, TNO, Assistant Commissioner of Land) must be involved from the beginning to resolve possible conflicts between platform beneficiaries or between platform beneficiaries and people not directly, to identify and select *khas* land, to resettle landless families and to ensure safe storage of construction material.

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6. PROJECT COSTS

Budget allocation, expenditures to December 1996 and requirements to May 1997 are presented in Table J.3. The Technical Assistance costs are for NERP professional staff only. Budget and expenditures for support staff and expenses (travel, allowances, guesthouse rental) are allocated to the general Management/Administration component of NERP Work Breakdown Structure.

Table J.3: Summary of Pilot Dredging Project Budget and Expenditures

Item	Budget Allocation		Expenditure as of December 96		Requirement to May 1997	
	(Tk)	(CDN$)	(Tk)	(CDN$)	(Tk)	(CDN$)
River Dredging and Homestead Platform Construction	53,242,303	1,717,494	53,182,625	1,715,569	0	0
Environmental Management Plan	8,397,000	270,871	4,022,248	129,750	4,246,400	136,981
Technical Assistance	27,266,000	879,548	20,768,600	669,955	2,260,500	72,919
Total	**88,905,303**	**2,867,913**	**77,973,473**	**2,515,274**	**6,506,900**	**209,900**

REFERENCES

FPCO, 1992: "*Guidelines for Project Assessment*", Flood Plan Coordination Organization, Government of Bangladesh, May, 1992.

NERP, 1996 a): "Kalni-Kushiyara Pilot Dredging project Implementation Plan,", Northeast Regional Water Management Project (NERP), Canadian International Development Agency (CIDA), January 1996.

NERP, 1996 b): "Kalni-Kushiyara Pilot Dredging project Annex B, Environmental Management Plan (EMP)", Northeast Regional Water Management Project (NERP), Canadian International Development Agency (CIDA), January 1996.

FIGURES

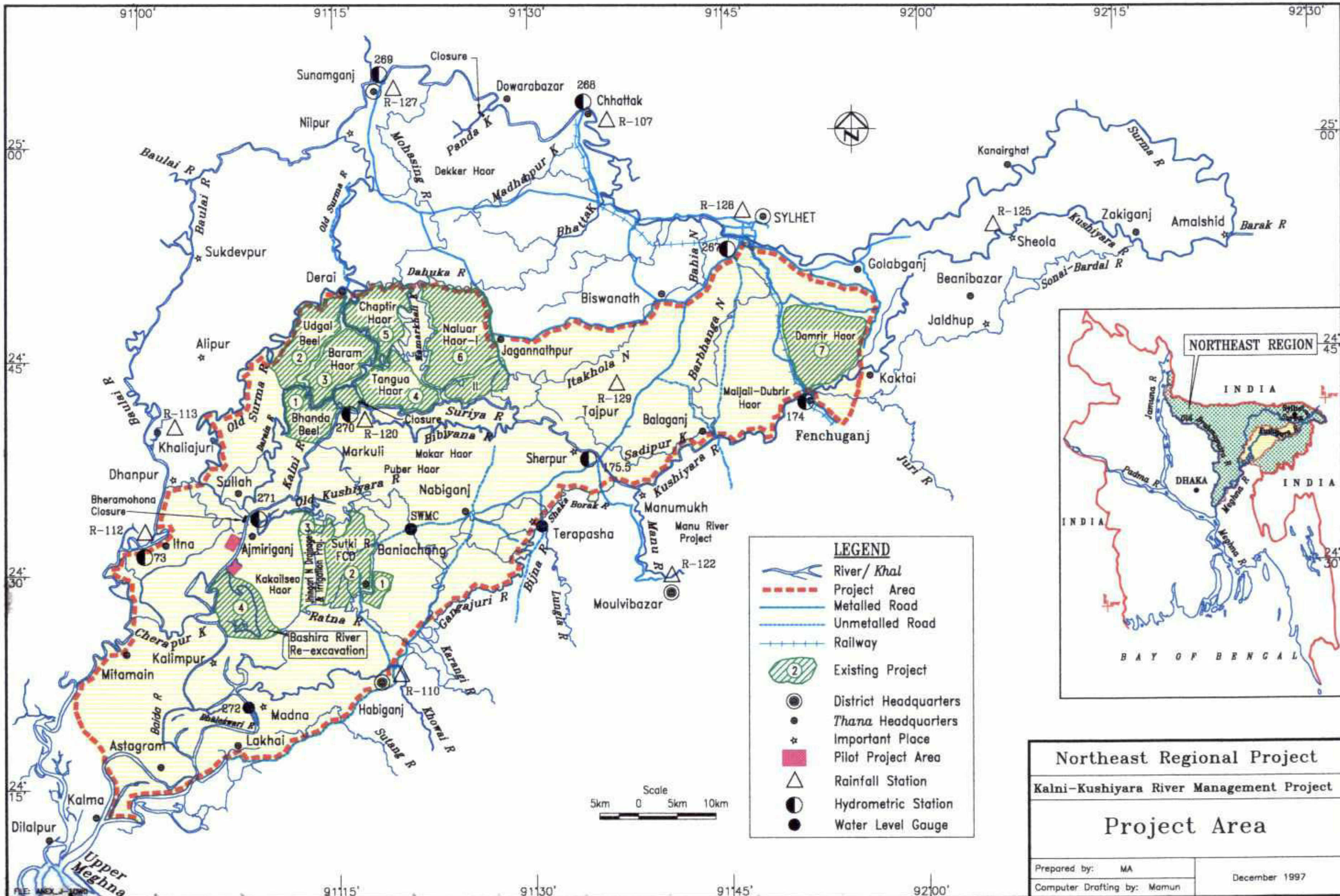
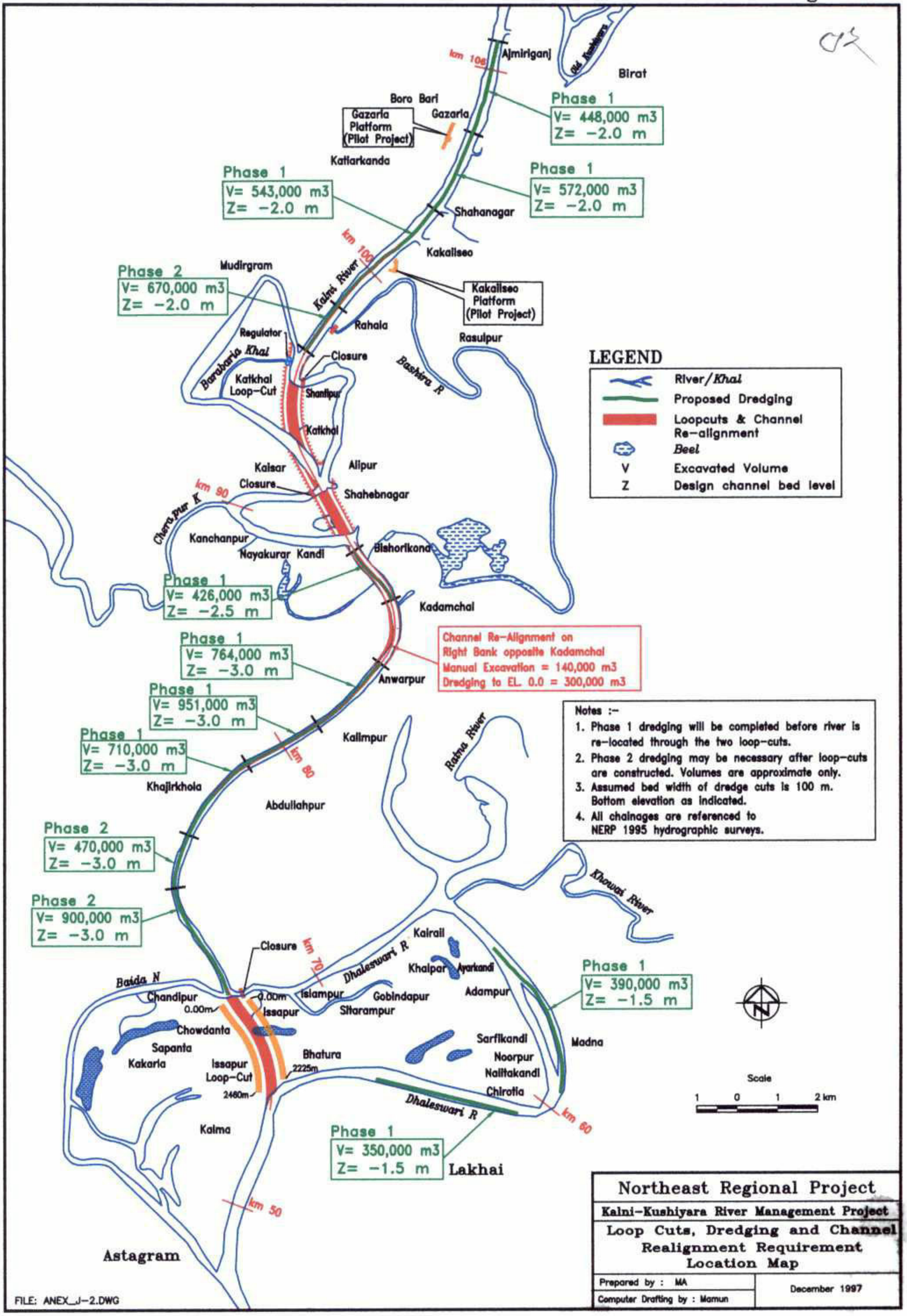

LEGEND
River/ Khal
Project Area
Metalled Road
Unmetalled Road
Railway
Existing Project
District Headquarters
Thana Headquarters
Important Place
Pilot Project Area
Rainfall Station
Hydrometric Station
Water Level Gauge
Scale
5km 0 5km 10km
NORTHEAST REGION
INDIA
DHAKA
BAY OF BENGAL
Sunamganj
Chhattak
Dowarabazar
SYLHET
Sheola
Zakiganj
Amalshid
Kanairghat
Golabganj
Beanibazar
Jaldhup
Kaktai
Fenchuganj
Biswanath
Jagannathpur
Tajpur
Balaganj
Sherpur
Manumukh
Manu River Project
Moulvibazar
Terapasha
Nabiganj
Baniachang
SWMC
Markuli
Mokar Haor
Puber Haor
Derai
Nilpur
Sukdevpur
Alipur
Khaliajuri
Dhanpur
Sullah
Ajmiriganj
Bheramohona Closure
Itna
Kakailseo Haor
Bashira River Re-excavation
Kalimpur
Mitamain
Madna
Lakhai
Habiganj
Astagram
Kalma
Dilalpur
Upper Meghna
Udgal Beel
Baram Haor
Chaptir Haor
Naluar Haor-I
Tangua Haor
Bhanda Beel
Damrir Haor
Maijail-Dubrir Haor
Dekker Haor
Sutki R FCD
Closure
Northeast Regional Project
Kalni-Kushiyara River Management Project
Project Area
Prepared by: MA
Computer Drafting by: Mamun
December 1997

Figure J.1

Figure J.2



Ajmiriganj
km 106
Old Kushiyara
Birat
Boro Bari
Gazaria
Gazaria Platform (Pilot Project)
Phase 1
V= 448,000 m3
Z= -2.0 m
Katiarkanda
Phase 1
V= 543,000 m3
Z= -2.0 m
Phase 1
V= 572,000 m3
Z= -2.0 m
Shahanagar
km 100
Kalni River
Kakailseo
Kakailseo Platform (Pilot Project)
Mudirgram
Phase 2
V= 670,000 m3
Z= -2.0 m
Rahala
Rasulpur
Regulator
Barabaria Khal
Closure
Bashira R
Katkhal Loop-Cut
Shantipur
Katkhal
LEGEND
River/Khal
Proposed Dredging
Loopcuts & Channel Re-alignment
Beel
V Excavated Volume
Z Design channel bed level
Kaisar
Alipur
Closure
km 90
Shahebnagar
Cherapur K
Kanchanpur
Nayakurar Kandi
Bishorikonda
Phase 1
V= 426,000 m3
Z= -2.5 m
Kadamchal
Channel Re-Alignment on Right Bank opposite Kadamchal
Manual Excavation = 140,000 m3
Dredging to EL. 0.0 = 300,000 m3
Phase 1
V= 764,000 m3
Z= -3.0 m
Anwarpur
Phase 1
V= 951,000 m3
Z= -3.0 m
Notes :-
1. Phase 1 dredging will be completed before river is re-located through the two loop-cuts.
2. Phase 2 dredging may be necessary after loop-cuts are constructed. Volumes are approximate only.
3. Assumed bed width of dredge cuts is 100 m. Bottom elevation as indicated.
4. All chainages are referenced to NERP 1995 hydrographic surveys.
Kalimpur
Ratna River
Phase 1
V= 710,000 m3
Z= -3.0 m
km 80
Khajirkhola
Abdullahpur
Phase 2
V= 470,000 m3
Z= -3.0 m
Khowai River
Phase 2
V= 900,000 m3
Z= -3.0 m
Kairail
Closure
km 70
Dhaleswari R
Khalpar
Ayarkandi
Baida N
Chandipur
0.00m
Islampur
Gobindapur
Sitarampur
Adampur
Phase 1
V= 390,000 m3
Z= -1.5 m
Issapur
Chowdanta
Sapanta
Kakaria
Issapur Loop-Cut
Bhatura
2225m
2460m
Sarfikandi
Noorpur
Nailtakandi
Chirotia
Madna
Scale
1 0 1 2 km
Dhaleswari R
km 60
Kalma
Phase 1
V= 350,000 m3
Z= -1.5 m
Lakhai
km 50
Astagram
Northeast Regional Project
Kalni-Kushiyara River Management Project
Loop Cuts, Dredging and Channel Realignment Requirement Location Map
Prepared by : MA
Computer Drafting by : Mamun
December 1997
FILE: ANEX_J-2.DWG

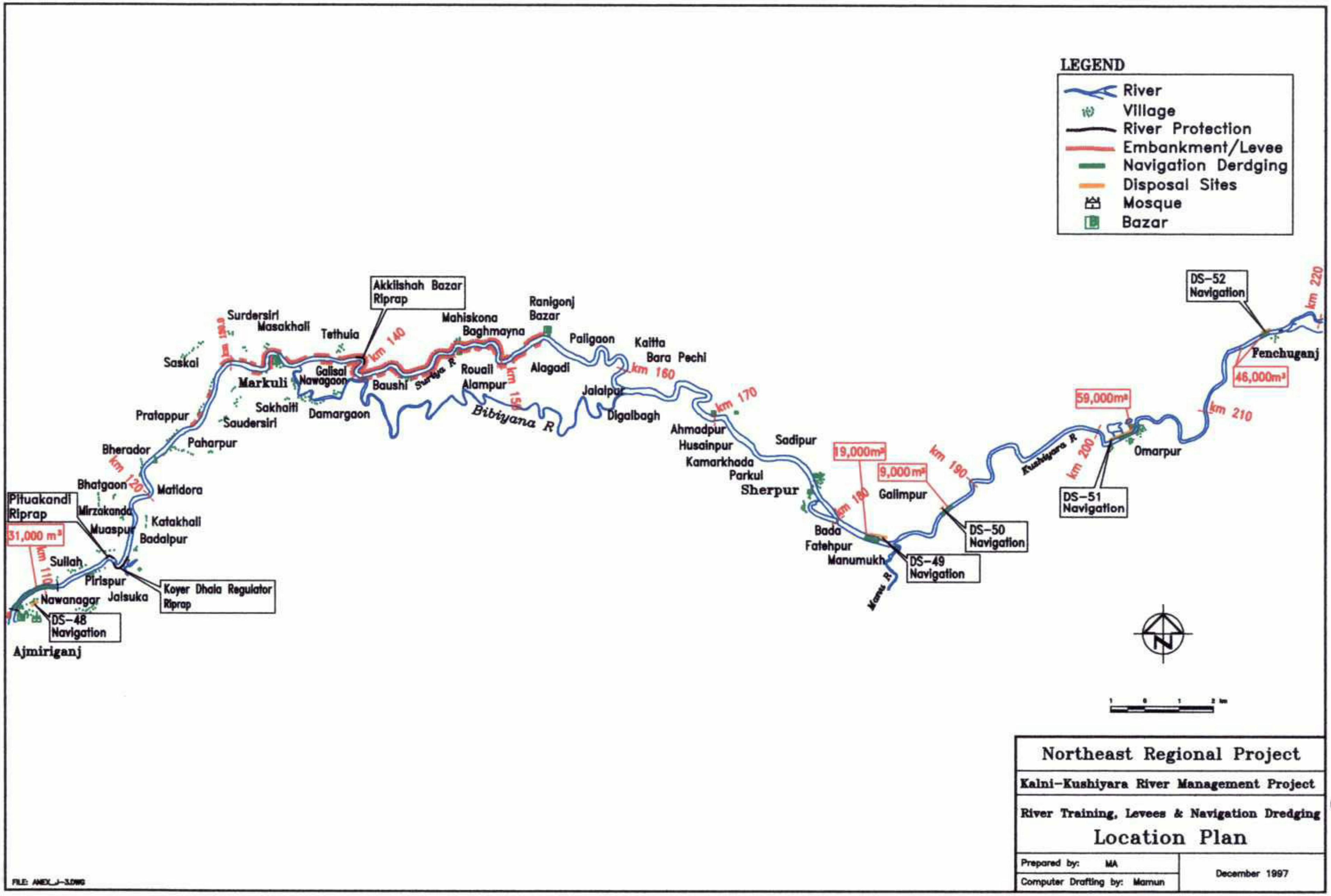
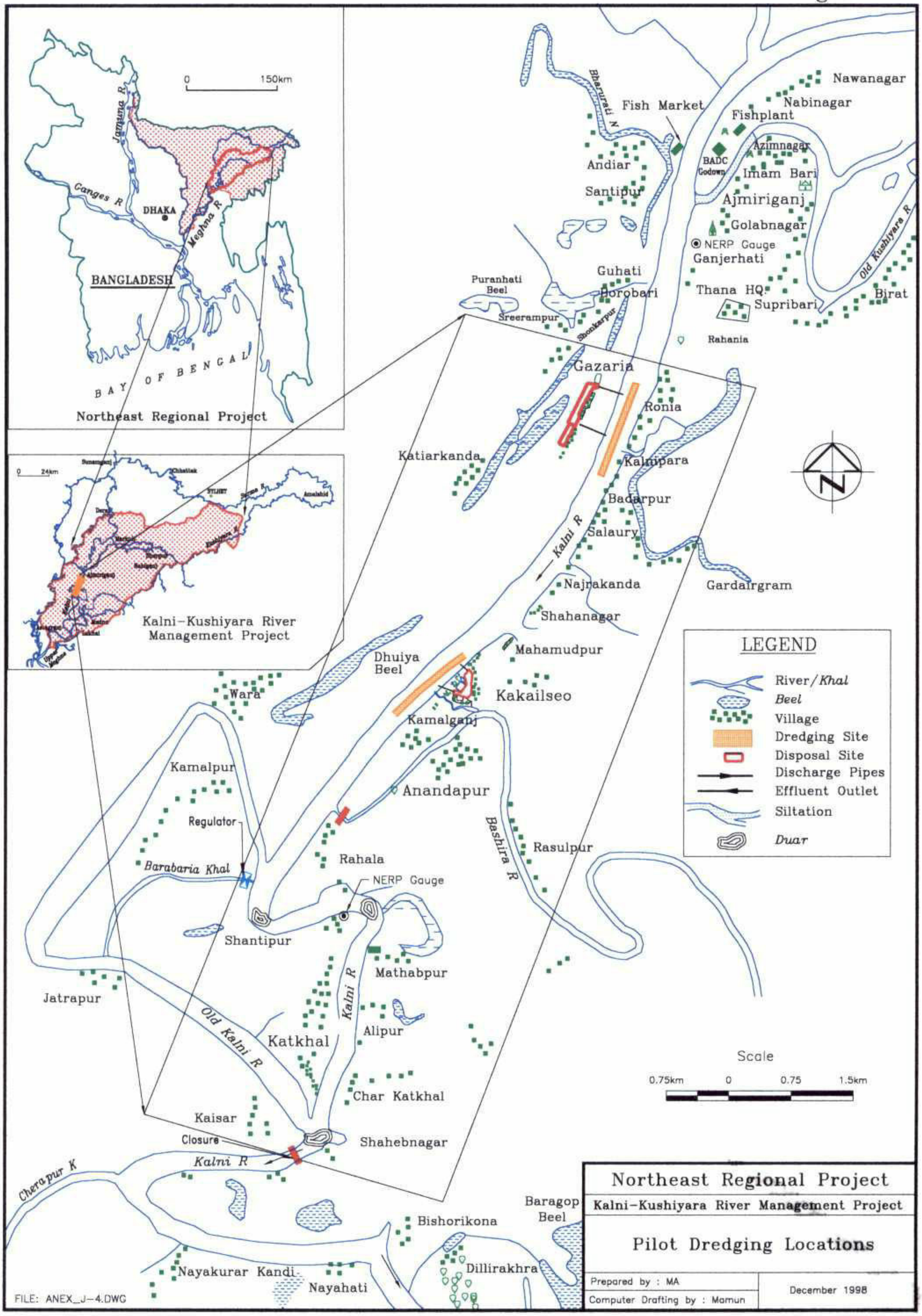
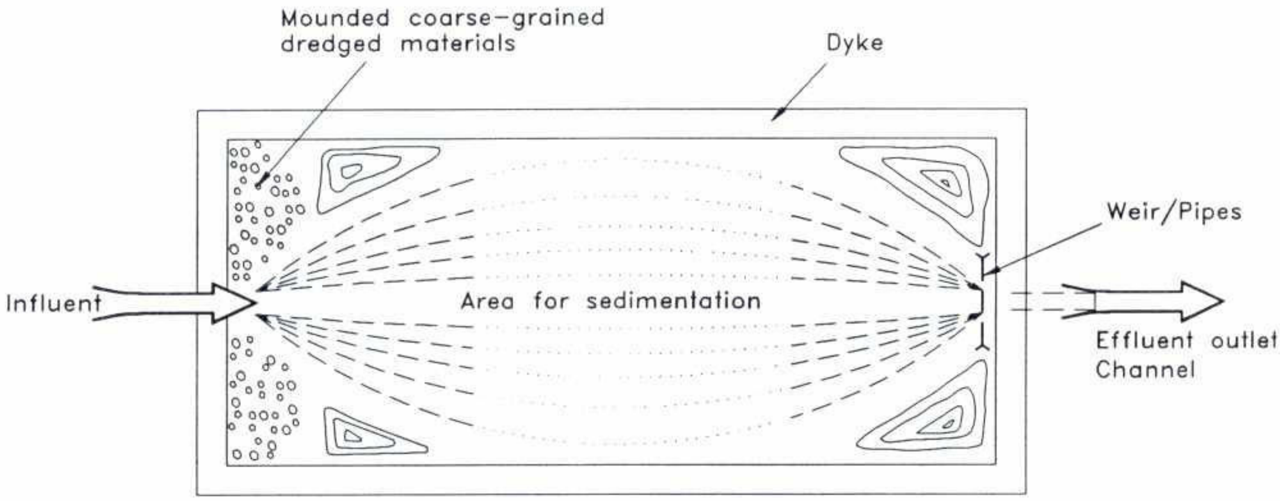

LEGEND
River
Village
River Protection
Embankment/Levee
Navigation Derdging
Disposal Sites
Mosque
Bazar
DS-52 Navigation
km 220
Fenchuganj
46,000m³
km 210
59,000m³
Omarpur
km 200
Kushiyara R
DS-51 Navigation
km 190
DS-50 Navigation
19,000m³
9,000m³
Galimpur
km 180
Bada
Fatehpur
Manumukh
DS-49 Navigation
Manu R
Sadipur
Sherpur
Parkul
Kamarkhada
Husainpur
Ahmadpur
km 170
Kaitta
Bara Pechi
km 160
Jalalpur
Digalbagh
Paligaon
Ranigonj Bazar
Alagadi
Bibiyana R
Mahiskona
Baghmayna
Rouail
Alampur
km 150
Surma R
Akkilshah Bazar Riprap
km 140
Baushi
Tethuia
Galisal
Nawagaon
Damargaon
Surdersiri
Masakhali
Markuli
Sakhaiti
Saudersiri
Saskai
Pratappur
Paharpur
Bherador
km 120
Matidora
Bhatgaon
Mirzakanda
Muaspur
Katakhali
Badalpur
Pituakandi Riprap
31,000 m³
km 110
Sullah
Pirispur
Jaisuka
Koyer Dhala Regulator Riprap
Nawanagar
DS-48 Navigation
Ajmiriganj
Northeast Regional Project
Kalni-Kushiyara River Management Project
River Training, Levees & Navigation Dredging
Location Plan
Prepared by: MA
Computer Drafting by: Mamun
December 1997
FILE: ANEX_J-3.DWG

Figure J.3

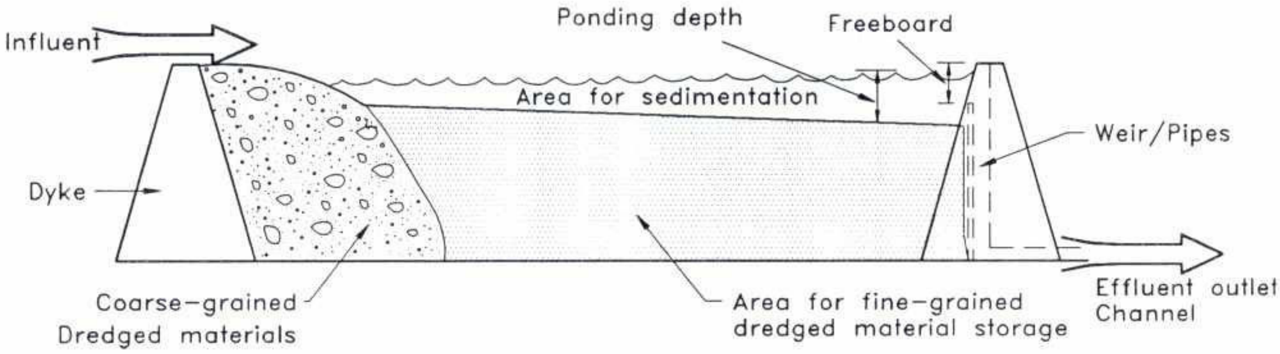
Figure J.4



BANGLADESH
DHAKA
Ganges R
Jamuna R
Meghna R
BAY OF BENGAL
0 150km
Northeast Regional Project
Kalni-Kushiyara River Management Project
Nawanagar
Nabinagar
Fish Market
Fishplant
Azimnagar
Andiar
BADC Godown
Imam Bari
Santipur
Ajmiriganj
Golabnagar
NERP Gauge
Ganjerhati
Old Kushiyara R
Guhati
Puranhati Beel
Borobari
Thana HQ
Supribari
Birat
Sreerampur
Rahania
Gazaria
Ronia
Katiarkanda
Kalmpara
Badarpur
Salaury
Kalni R
Najrakanda
Gardairgram
Shahanagar
Mahamudpur
Dhuiya Beel
Wara
Kakailseo
Kamalganj
Kamalpur
Anandapur
Regulator
Bashira R
Rasulpur
Rahala
Barabaria Khal
NERP Gauge
Shantipur
Mathabpur
Jatrapur
Old Kalni R
Kalni R
Katkhal
Alipur
Char Katkhal
Kaisar
Closure
Shahebnagar
Kalni R
Cherapur K
Baragop Beel
Bishorikona
Dillirakhra
Nayakurar Kandi
Nayahati
LEGEND
River/Khal
Beel
Village
Dredging Site
Disposal Site
Discharge Pipes
Effluent Outlet
Siltation
Duar
Scale
0.75km 0 0.75 1.5km
Northeast Regional Project
Kalni-Kushiyara River Management Project
Pilot Dredging Locations
Prepared by : MA
Computer Drafting by : Mamun
December 1998
FILE: ANEX_J-4.DWG



(a) PLAN

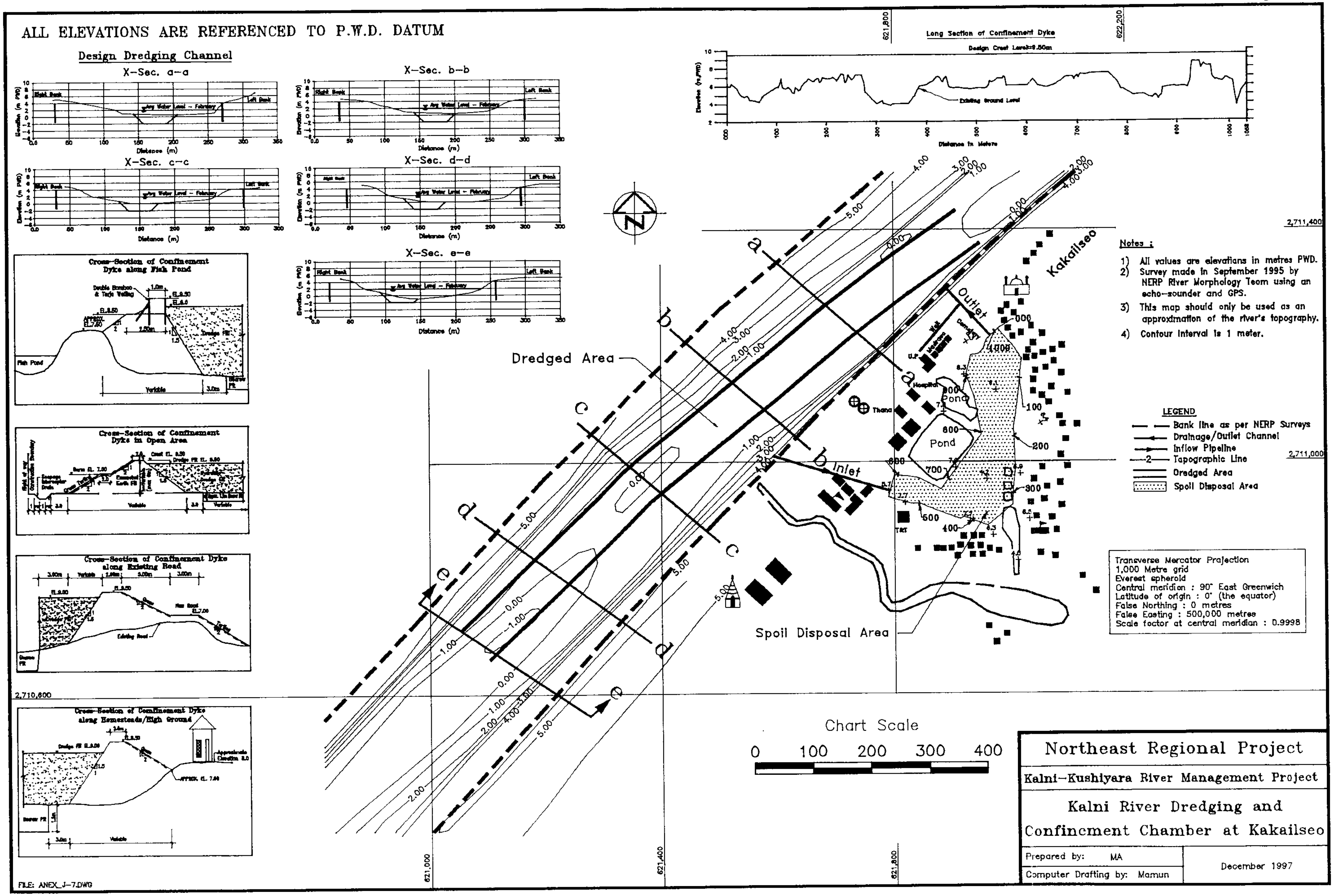


(b) CROSS SECTION

Northeast Regional Project	
Kalni-Kushiyara River Management Project	
Main Features of Confined Disposal Chamber	
Prepared by: D.G.M.	December 1997
Computer Drafting by: Mamun	

FILE: ANEX_J-5.DWG

Figure J.6



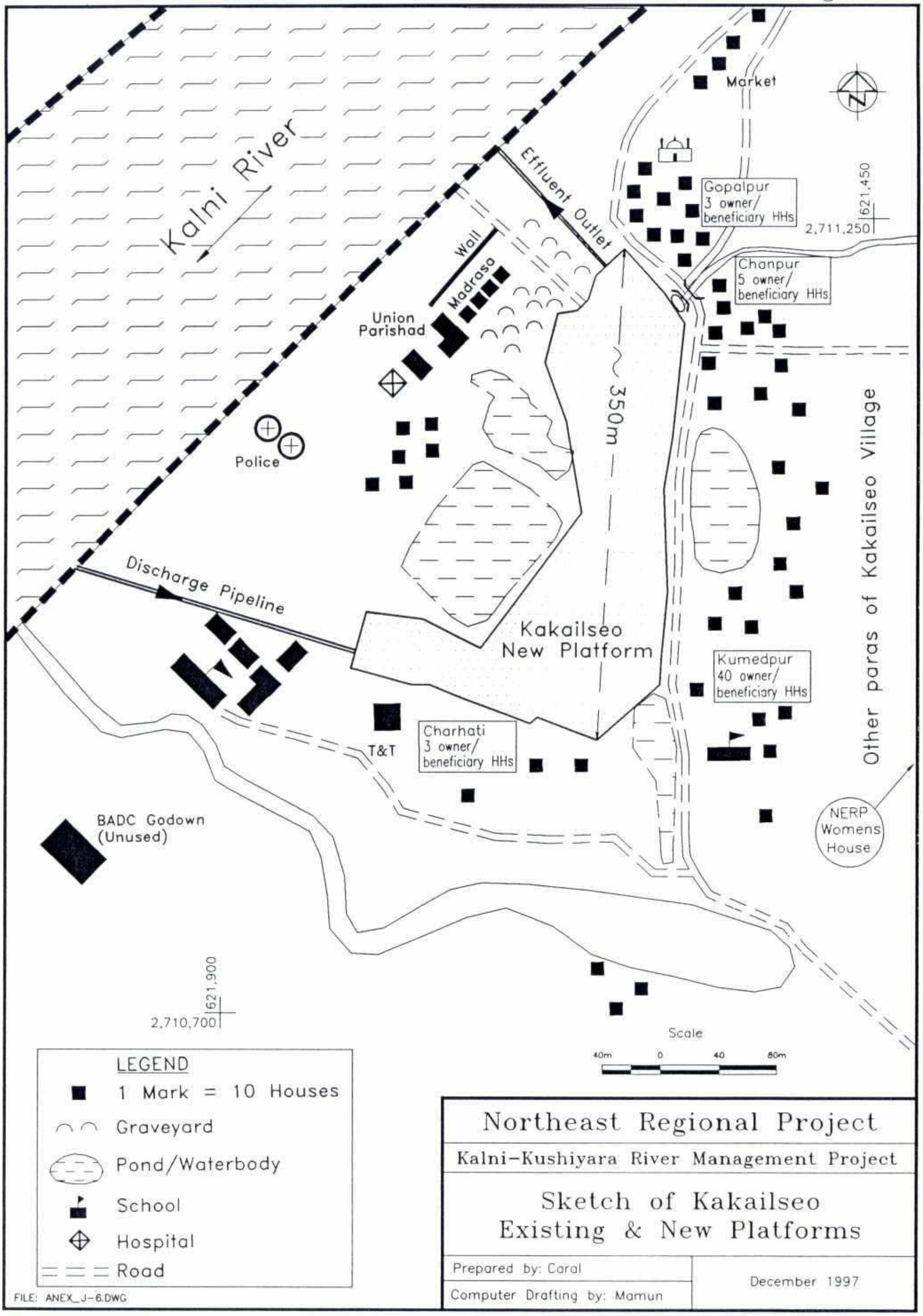
Northeast Regional Project

Kalni-Kushiyara River Management Project

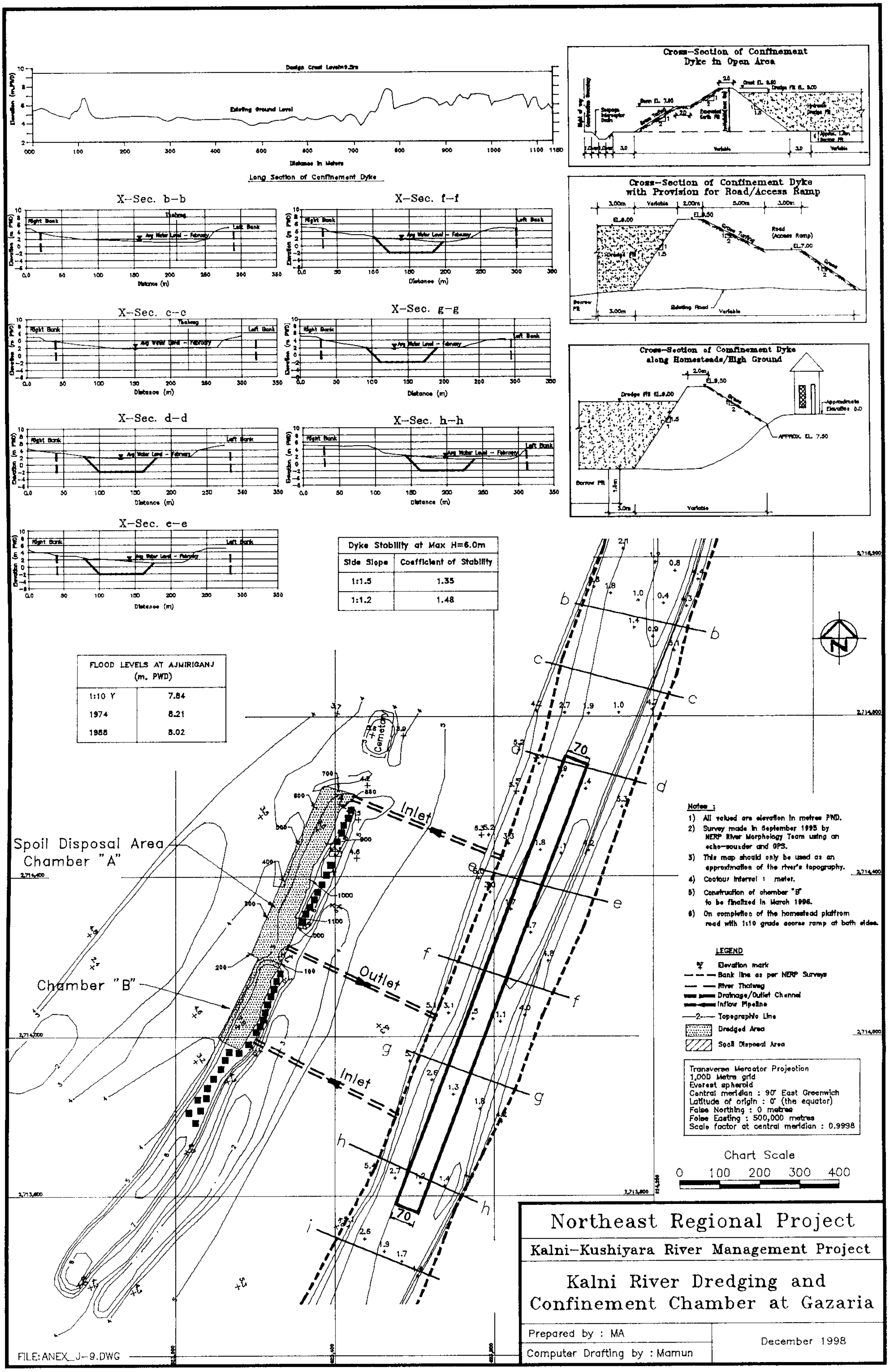
Kalni River Dredging and Confincment Chamber at Kakailseo

Prepared by: MA	December 1997
Computer Drafting by: Mamun	

Figure J.7



Kalni River
Effluent Outlet
Market
Gopalpur
3 owner/
beneficiary HHs
621,450
2,711,250
Chanpur
5 owner/
beneficiary HHs
Wall
Madrasa
Union
Parishad
Police
~ 350m
Other paras of Kakailseo Village
Discharge Pipeline
Kakailseo
New Platform
Kumedpur
40 owner/
beneficiary HHs
T&T
Charhati
3 owner/
beneficiary HHs
BADC Godown
(Unused)
NERP
Womens
House
621,900
2,710,700
Scale
40m 0 40 80m
LEGEND
1 Mark = 10 Houses
Graveyard
Pond/Waterbody
School
Hospital
Road
FILE: ANEX_J-6.DWG
Northeast Regional Project
Kalni-Kushiyara River Management Project
Sketch of Kakailseo
Existing & New Platforms
Prepared by: Carol
Computer Drafting by: Mamun
December 1997



Dyke Stability at Max H=6.0m	
Side Slope	Coefficient of Stability
1:1.5	1.35
1:1.2	1.48

FLOOD LEVELS AT AJMIRIGANJ (m, PWD)	
1:10 Y	7.84
1974	8.21
1988	8.02

Northeast Regional Project

Kalni-Kushiyara River Management Project

Kalni River Dredging and Confinement Chamber at Gazaria

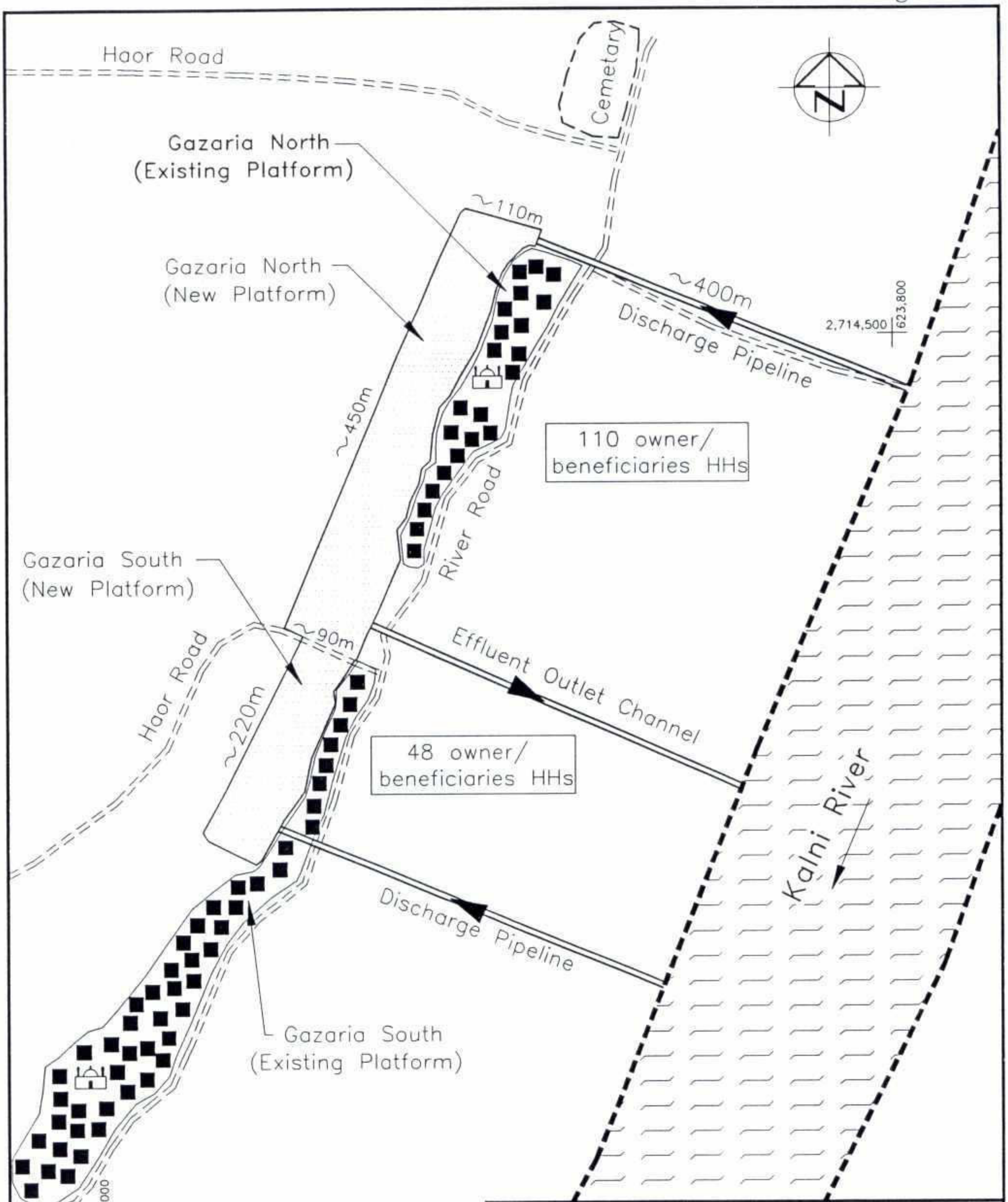
Prepared by : MA

Computer Drafting by : Mamun

December 1998

Figure J.8

Figure J.9



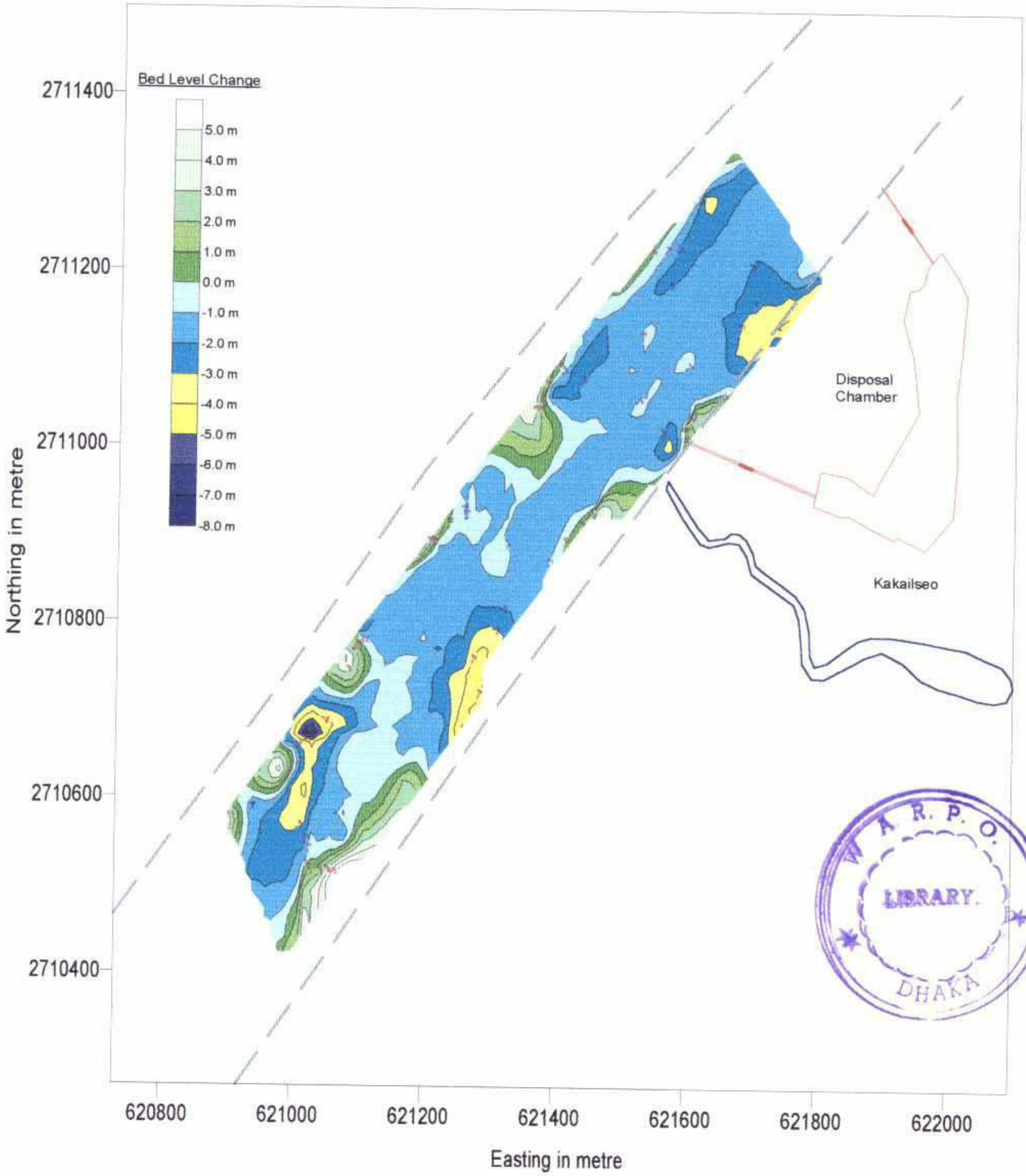
Northeast Regional Project

Kalni-Kushiyara River Management Project

Sketch of Gazaria N. & S. Existing & New Platforms

Prepared by: Carol	December 1997
Computer Drafting by: Mamun	

Figure J.10

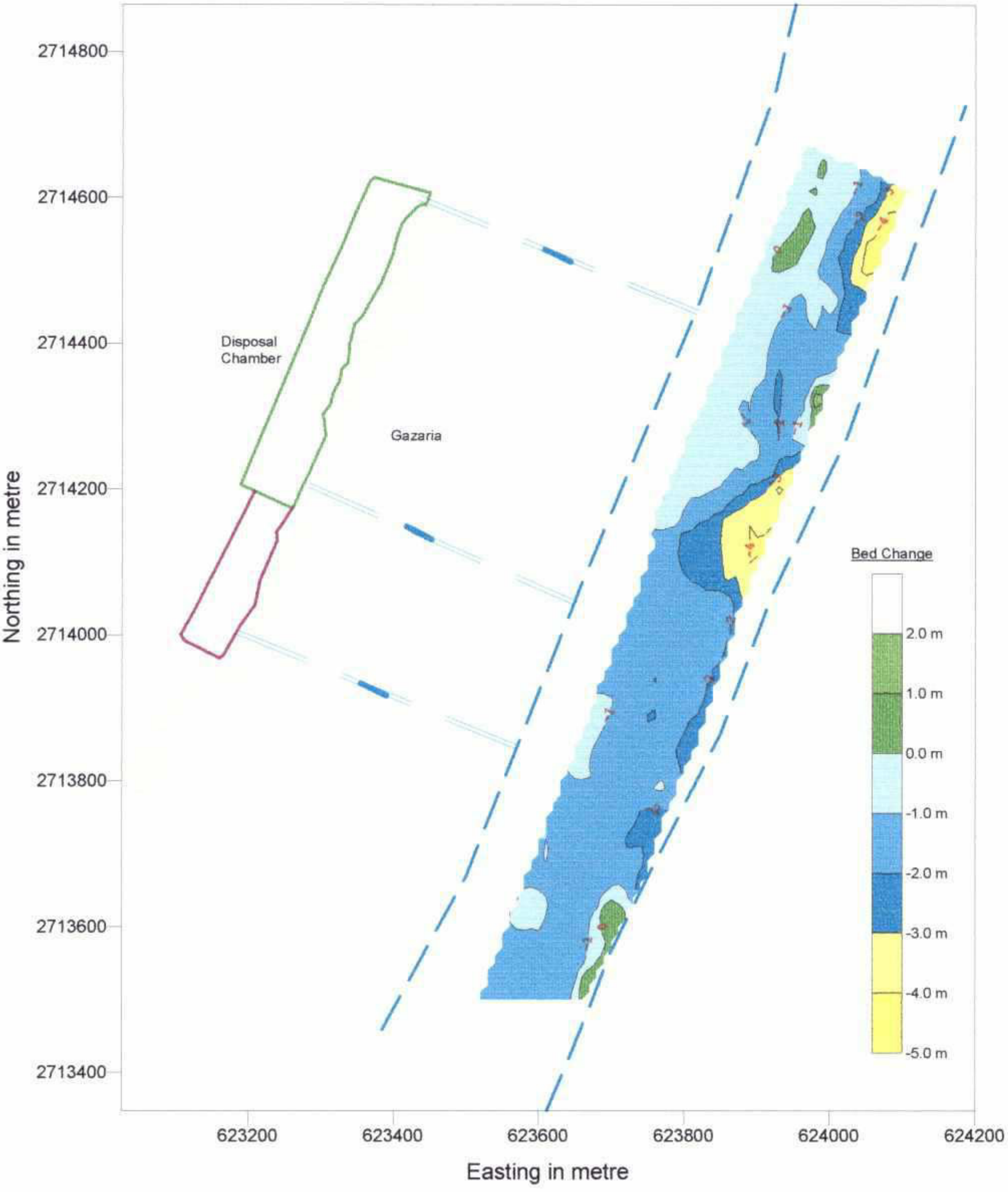


Kalni River Bed Level Changes at Kakailseo
September 96 - September 95

Kalni-Kushiyara River Management Project

Prepared by: Tarek, File: KAK1.SRF

Figure J.11



Kalni River Bed Level Changes at Gazaria
October 96 - September 95

Kalni-Kushiyara River Management Project

Prepared by: Tarek, File: GAZ1.SRF

APPENDIX J.1: ENGINEERING

TABLE OF CONTENTS

LIST OF TABLES

1. PLATFORM CONCEPTS AND SELECTION

The pilot project includes 2 basic structural components:

- construction of confinement chambers, and
- dredging of the Kalni River channel and filling the confinement chambers with the dredged spoils.

1.1 Confinement Chamber Design Concepts

Confinement chambers are the disposal facilities for the dredged river spoil (Figure J.5). Their sizes is calculated to accommodate the design dredging volume. The chambers are designed to contain and trap 94% of the dredges' effluent solids.

A confinement chamber includes the following components:

- confinement dykes;
- effluent outlet (weir);
- effluent outlet channel;
- drainage/seepage interceptor channel.

1.1.1 Confinement Dykes

Confinement dykes are earthen embankments designed to withstand the combined internal pressures of soil and water without exterior support. In the Pilot Dredging Project, to minimize both cost and damage to the surrounding cultivable area, the design specified that the dykes would be constructed with soil excavated from the base of the chamber. After construction, grass would be planted along the exterior slopes to prevent erosion during the monsoon season.

1.1.2 Effluent Outlet

The effluent outlet is a drainage structure composed of a weir or steel pipes placed opposite the influent pipes. The outlet is designed to maximize retention time of the deposed materials and regulate the release of ponded water from the confinement chamber.

1.1.3 Effluent Outlet Channel

The effluent outlet channel is an earthen channel designed to return the effluent from the confinement chamber to the river. To permit drainage, its section is raised above the river level, and depending on land topography is either constructed in cut or fill. The fill section requires strong dykes on both sides to prevent the effluent from spilling into the surrounding area. This is needed to prevent crop damage and reduce environmental hazard.

1.1.4 Drainage/Seepage Interceptor Channel

The drainage/seepage interceptor channel is excavated around the outer perimeter of the disposal chambers. Its function is to contain seepage and spills of sandy material. While seepage through dykes is a normal phenomenon, spill of the dredged sandy material could damage the adjacent land and crops.

1.2 Dredging and Filling

The dredging and filling operation involves dredging shoals from the river channel, hydraulic transportation of the material from the river to the confinement chamber through a pipeline and deposition of the solid material into the confinement chamber.

The project deployed two 18" Cutter Head Dredges equipped with 1150 BHP pumps. The dredges pumped the slurry across the water surface through floating pipeline, and over the land into the confinement chambers through shore pipeline. The shore pipeline had to be raised above the expected flood water levels with *sal bollah* piles, bamboo, and sand bags.

1.3 Preparatory Works and Investigations

1.3.1 Reconnaissance Survey

A preliminary reconnaissance survey was carried out by in June 1994. The area under consideration had already been identified by the pre-feasibility study. During the survey, it was noticed that the frequency of channel shifting and bank breaches was gradually increasing. Discussions with local people and preliminary engineering analyses indicated that the most appropriate location for pilot dredging would be in the 24 km reach downstream of Ajmiriganj. Extensive monsoon flooding occurs I6 to 7 months each year n this region.

1.3.2 Social Survey

Four Community Organizers (COs) worked in the proposed pilot area between July and December 1994 to seek public opinion on the disposal of dredged river spoil. They identified 40 potential disposal sites. The social survey confirmed the genuine interest of the communities to raised their village platforms. Extension of their existing platforms would provide extra space for homesteads, school playgrounds, market places, graveyards, and pathways for circulation during the monsoon period.

1.3.3 Preliminary Site Selection

Two criteria were adopted in the selection of suitable sites:

- a community should request a platform, and
- there should be a shoal restricted dry season navigation in the immediate vicinity of the community.

After consultation, 5 potential sites were selected. Their location is presented in Figure J.4 and proposals for these sites are summarized in Table 1.

1.3.4 Public Consultation Meeting

A public consultation meeting was held at Ajmiriganj on 30 January 1995 to discuss the potential dredging sites identified by NERP. Local people unanimously accepted the proposal and agreed to further detailed studies; it was also decided that between three and five village platforms could be constructed with the available resources and in the available time.

1.3.5 River Survey

Detailed hydrographic charts of the river were prepared in September 1994 and March 1995. Shortly before the sites were finalized, a second survey was carried out in September 1995 to determine the location of shoals and river bed levels after the 1995 monsoon.

1.3.6 Topographical Survey

Second Order Leveling Bench Marks which were installed in the Northeast Region in 1994 were used as references for project river and land surveys. Additional bench marks were constructed for the topographical survey of the five sites identified for construction of homestead platforms.

Surveys of the proposed platform sites and surrounding areas were carried out in April and May 1995. Topographic maps were made using AUTOCAD and used for the preparation of the preliminary design.

Table 1: Village Platform Sites (preliminary selection)

Site	Platform Location	Village Benefits
Gazaria	right bank 4 km downstream of Ajmiriganj	extend all 110 HHs; join the *paras* of Gazaria North and South
Shahanagar	left bank 5 km downstream of Ajmiriganj	extend 23 HHs; raise passage to Kakailseo market
Kakailseo	left bank 6 km downstream of Ajmiriganj	extend 51 HHs; raise school ground
Anandapur	right bank 7 km downstream of Ajmiriganj	construct a new village platform for 34 landless HHs on *khas* land
Katkhal	right bank 14 km downstream of Ajmiriganj	extend 18 HHs; raise land for market extension

1.3.7 Land-use Survey

Between December and February 1994 a survey was conducted along the 50 km reach between Markuli and Madna. The survey documented land-use in a 1.5 km strip on both sides of the river. *Mauza* maps showing plot numbers and a set of questionnaires were used to record the data. Information was collected regarding:

- crop area, crop pattern, harvest, yield, and marketing;
- flood inundation time and damage;
- irrigated area, irrigation units and period, and cost;
- settlements, infrastructure, and roads;
- rivers, canals, and permanent water bodies, and
- vegetation.

1.3.8 Biological Survey

The biological survey was done during the period December 1994 - June 1995 and considered both the terrestrial and aquatic environment. Several villages and permanent water bodies near the Kalni River between Markuli and Madna were visited to determine their suitability as potential disposal sites.

1.3.9 Sediment Quality Survey

Samples of river bed material were collected on September 9, 1994 near Gazaria and below Kakailseo and sent to the Environmental Engineering Laboratory, BUET for an assessment of sediment quality. Test results of Bulk Sediments are given below:

Gazaria:	sand 65%, silt 32%, clay 3%
Kakailseo:	sand 50%, silt 47%, clay 3%

Elutriate tests were performed on each sample. These tests were developed by the US Environmental Protection Agency as a means for assessing the release of contaminants from sediments during dredging. The tests involve mixing the sediments and water form the dredge site for a prescribed period in order to simulate the agitation produced by dredging, then separating the solids from the elutriate. The elutriate is then analyzed to see whether nutrients and/or contaminants were released from the sediments into the water column. In their evaluation report BUET laboratory concluded *"Comparing the test results of the river water, supernatant form Elutriate tests, and sediments, it can be concluded that the dredging operation will not release additional nutrients or toxic elements to the river water".*

Certain contaminants, such as pesticide and some heavy metals, could not be easily tested at BUET. Therefore, two additional samples were collected in March 1995 and send to chemex laboratories, Vancouver, Canada for detailed testing. The sediment was collected from the Kalni River with a grab sampler. Sample 1, located about 1 km downstream of Kakailseo village, consisted of fine-medium sand, with a trace of silt. Sample 2, located about 1 km upstream of Gazaria village, consisted of silt and fine sand. Based on the results of earlier bed material sampling, these samples were representative of the range of sediments likely to be encountered during dredging. Leaching tests indicated that heavy metals such as Arsenic, Cadmium, Chromium, Copper, Lead and Nickel were under detection limits while Zinc was found to be present in very low concentrations (0.01) mg/l). Organic compounds were also determined in very low total concentrations and, for most of them, were below the limit of detection. Polyaromatic Hydrocarbons (PAHs) were generally all under the limits of detection or else in sufficiently low concentrations to be below the "Background Level" or the "No-Effect Level". Polychlorinated Biphenyls (PCBs) and Organochloride Pesticides were all under the limits of detection. Mineral oil and grease content were also very low (less than 0.025%), as were Total Carbon Content (0.52% for Sample 1 and 0.7% for Sample 2).

Based on all of these results, the sediments in the Kushiyara River can be considered as "uncontaminated". Therefore, the use of this material for homestead or agricultural purposes would be permitted without limitation under existing environmental guidelines in Bangladesh and Canada.

1.4 Evaluation of Preliminary Sites

1.4.1 Gazaria

A project at Gazaria would benefit all households (HHs) and join the two *para*s of the community. The *para*s were separated by erosion in 1988 floods. From a technical perspective, there may be more problems here than at the other sites associated with loss of fine sand during pumping.

1.4.2 Shahanagar

Construction of a platform at Shahanagar would improve the living conditions of some HHs and the general community. A shoal is located on the bank opposite the disposal site. The floating pipeline placed across the river would unfortunately be a serious obstruction to navigation during construction (approximately three months). This location was dropped from the pilot dredging project.

1.4.3 Kakailseo

The project at Kakailseo would generate important community benefits by linking the market to the school and raising the land of 51 existing HHs. Furthermore, the ground level at Kakailseo is higher than at the other four sites, allowing construction to start earlier as the land emerges during the post-monsoon season.

1.4.4 Anandapur

Removal of the existing shoal at Anandapur would benefit navigation, the existence of *khas* land would simplify the implementation of a platform, and the sandy bed material at this site would be suitable for dredging operations. One technical constraint is that sections of the bar may emerge during the dry season, making it difficult to effectively operate the dredges. It is the only one of the five sites where a new village platform could be constructed to settle landless families on government *khas* land. However, this land is occupied by the elite. Until the landless HHs of Anandapur are able to take possession of the land awarded to them by the government, they are not willing to dedicate it to platform development. Because of this, it was decided that the land should not be developed to the exclusive advantage of the elite group. This site was dropped from the pilot dredging project.

1.4.5 Katkhal

Katkhal is the smallest of the five sites and, although direct benefit from raising land would accrue to only a few HHs, the community would expand their school site and market facility. There do not appear to be any major technical problems associated with dredging or platform construction.

1.5 Recommended Pilot Dredging Sites

Kakailseo, Gazaria, and Khatkal were the sites recommended for the pilot dredging project on the basis of the above evaluation.

2. DESCRIPTION OF RECOMMENDED SITES

2.1 Kakailseo

The site is located on the left bank of the Kalni River in Habiganj District, about six kilometres downstream of Ajmiriganj. The village is a principal market centre in the area and is relatively developed. It has a police camp, a high school, a dispensary, and a communication centre. The existence of a depression in the centre of the village causes deep floods during the monsoon season, separating outlying *para*s from each other and impeding access to the school and Kakailseo market (Figure J.7).

The perimeter of confinement dykes includes about 570 m of full section dyke aligned with the road to the east, and 710 m of *tarja* walling with partial dyke to protect the existing homesteads (Figure J.6). Platform details on the basis of preliminary designs are summarized in Table 2.

The dredged material was to be excavated from the left side of the Kalni River channel, starting about 100 m downstream of the site and progressing downstream (south). Filling of the disposal chamber was carried out from near the radio tower. The effluent was discharged directly to the Kalni River through a small, natural, northerly flowing channel.

Platform layout in relation to the existing village is shown in Figure J.6.

2.2 Gazaria

The site is located in Kishoreganj District about four kilometres downstream of Ajmiriganj, between 350 and 400 m off the right bank of the Kalni River. The village is exposed to prolonged flooding and is completely surrounded by water for up to five months of the year (Figure J.9).

During the 1988 flood Gazaria experienced considerable erosion, which divided the village platform into northern and southern portions. It also suffers from annual wave erosion on its western (*haor*) side, and is consequently very narrow, typically only 10 m wide. The inhabitation is very dense; houses are packed so closely together that there is no courtyard space for grain drying. During the monsoon, HHs from the village lowlands move to higher ground, resulting in even more people sharing the already inadequate space with livestock and straw stacks.

To repair the 1988 flood damage, it was proposed to connect the Gazaria South and Gazaria North villages with a continuous platform. The new platform is built adjacent to the existing Gazaria platforms. Details of the preliminary design are summarized in Table 2. Figure J.9 shows the layout of the Gazaria platform.

The perimeter of confinement dykes includes 980 m of dyke with a full earth section and 470 m of small dykes along the existing homestead (Figure J.8).

The dredged material was excavated from the right side of the Kalni River channel, progressing upstream (north). The spoil entered the disposal chamber from the northern end and the effluent was collected at the southern side. The effluent was discharged to the river by a 350 m long channel excavated through paddy fields.

2.3 Katkhal

The Katkhal village is located on the right bank of the Kalni River about 14 km downstream of Ajmiriganj. The village is a principal commercial centre of the area, supporting a daily circulation of approximately three thousand persons. The proposed site borders the Katkhal market and broadens the platform by about 120 m on the western side.

The perimeter of the Katkhal disposal chamber included about 400 m of full section earthen dyke in an open area, and 150 m of partial dyke with bamboo and *tarja* walling along the existing village and market area. Platform details on the basis of preliminary designs are summarized in Table 2.

Excavation was planned to be from the right side of the Kalni River channel, leaving the left side open for navigation. The filling of the chamber would progress from south to north with the effluent water draining through an existing channel.

Table 2: Summary of Platform Salient Features

Name	Confinement Chamber			Confinement Dyke	
	Area (ha)	Volume (m^3)	Fill Height (m PWD)	Length (m)	Volume (m^3)
Gazaria	6.2	310,000	8.9	1,450	58,480
Kakailseo	4.6	174,000	8.9	1,320	18,453
Katkhal	1.6	70,000	8.9	550	17,632
TOTAL	**12.4**	**554,000**		**3,320**	**94,565**

Note: Fill height includes 20 cm long-term settlement

3. PLATFORM DESIGN CONCEPTS

In March 1995, the platform sites were inspected by the NERP multi-disciplinary team. Village committees were formed to establish the uses of the platforms and to select beneficiaries. From this information, a preliminary design for each site was made to estimate dredging and construction volumes, costs, area of the platform, number and types of beneficiaries, and land-use and environmental impacts. The resulting data were used for the preparation of tender documents.

3.1 Design Data Sources and Investigations

3.1.1 Water Levels

The BWDB measures the water levels at Ajmiriganj six times daily (station #271, four kilometres upstream of the proposed pilot dredging sites); data from this station were used for establishing the hydrologic conditions and the preliminary designs. Historical maximum, minimum, and mean water levels are given below. Table 3 provides the mean monthly water levels and Table 4 provides the peak water levels for various return periods.

Historic Levels:

Maximum Recorded (1974)	8.21 m PWD
Minimum Recorded (1968)	0.90 m PWD
Mean	4.08 m PWD
1988 Flood	8.02 m PWD

Table 3: Mean Monthly Water Levels

Water Levels at Ajmiriganj (m PWD)											
Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
2.6	3.9	5.5	6.6	6.9	6.7	5.8	4.2	2.6	1.9	1.8	1.9

Table 4: Peak Water Levels

Data Source	Return Periods (m PWD)					
	1:2 year	1:5 year	1:10 year	1:25 year	1:50 year	1:100 year
BWDB	7.11		7.76	8.05	8.25	8.44

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3.1.2 Discharges

There are no discharge stations on the Kalni River; the nearest is on the Kushiyara River at Sherpur (Station # 175.5). Table 5 shows a wide fluctuation of daily discharges, varying from 28 to 2960 m^3/sec over the course of one year. Mean monthly discharges are presented in Table 6.

Table 5: Recorded Mean Daily Discharges

River	Station	Range of Daily Discharges (m^3/sec)		
		Minimum	Mean	Maximum
Kushiyara River	Sherpur	27.7	681.7	2,960.0

Table 6: Monthly Discharges (m^3/sec)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mini	69	166	419	1147	905	679	328	112	71	45	45	37
Mean	318	621	1240	1621	1511	1280	811	291	144	97	86	115
Max	870	2265	2252	2141	2268	1903	1706	721	249	137	162	445

3.2 River Channel Bed

The pre-feasibility investigation described a program of channel bed improvements over a length of about 50 km. Due to budget limitations, approximately 2 km could be dredged under the pilot project. Since this scale of dredging operations would not have a significant effect on the river channel bed, a meeting was held between BWDB, BIWTA, and NERP to discuss methods of optimizing project impact. It was agreed that only shoals were to be removed and that dredging would be carried out to a depth which would provide 1.8 m (Class II Channel) draught during the dry season. This corresponds to about -1.5 m to -2.0 m PWD of the river channel bed.

The channel width was designed to be 60 m which corresponds to a double pass by an 18" suction dredge (the net width of the cutter head swing is 30 m). Figures J.6 and J.8 show the Dredging design sections for the river reaches opposite Kakailseo and Gazaria.

3.3 Confinement Chamber Design

The design of confinement chambers consists of two components:

- height of the confinement chamber, and
- size of the confinement chamber.

Height of Confinement Chamber
The design flood level for the Gazaria, Kakailseo, and Katkhal homestead platforms was based on a 1 in 10 year monsoon flood plus a freeboard of 90 cm. On the basis of these criteria, the

design surface elevation of the homestead platforms was 8.70 m PWD (7.76 + 0.90 = 8.66 m PWD, refer to Table 3). The chambers were filled to 8.90 m PWD to account for 20 cm of long-term settlement.

Size of Confinement Chambers

The size of a confinement chamber depends on the dredged volume, the settling time of dredged materials, land availability, and availability of soil for dyke construction. Due to a high ground water table, particularly during the post-monsoon season, the depth of excavation to obtain soil for the dykes was limited to about 1.5 - 2.0 m from the existing ground surface.

The preliminary size of a confinement chamber was established by balancing the design dredge volume with the estimated availability of earth for dyke work. The size was subsequently adjusted to correspond to the exact amount of earth taken from the excavation.

3.4 Confinement Dykes

Two types of dykes were built for confinement chambers: full section earthen dykes in the open areas, and partial section dykes with bamboo and *tarja* walls along the existing homesteads, where there was insufficient space for the full section.

The height of dykes was fixed at 9.5 m PWD. This included the design height of 8.70 m PWD (refer to section 3.3), a freeboard of 30 cm, and a ponding depth of 60 cm, which was necessary for effective settling of solids within the chamber.

The design sections of confinement dykes are as follows:

***Full Section Earthen Dyke*:**

-	crest elevation	9.50 m PWD
-	crest width	2.0 m
-	exterior side slope	1v : 2h
-	interior side slope	1v : 1.5h
-	height	up to 6.0 m

Partial Section (with tarja walling) Dyke:

-	crest elevation	9.50 m PWD
-	crest width	1.0 m
-	exterior side slope	1v : 1.5h
-	interior side slope	vertical wall
-	height	up to 1.7 m

For protection against erosion, the exterior side slopes were turfed with *durba* grass. The moisture in the dyke (from seepage) would provide favourable conditions for the turf grass to develop a strong root system before the arrival of the flood season.

3.5 Drainage and Disposal of Effluent

To allow the sediments the maximum time to settle, the outflow pipes were placed opposite the effluent inlet pipes, maximizing the effluent travel distance. To encourage drainage, during excavation the ground surface of the disposal chamber was sloped toward the outflow point(s).

The effluent discharged to the river through excavated canals or existing drainage channels.

Excavated canals had 1.0 m nominal depth, 1.0 m bed width, and 1:1 side slopes.

4. IMPLEMENTATION PLAN AND ENVIRONMENTAL MANAGEMENT PLAN

Implementation of the pilot dredging project included 2 components:

- execution of civil works, and
- execution of the Environmental Management Plan (EMP).

4.1 Execution of the Civil Works

The civil works comprise all activities related to the construction of homestead platforms and river dredging. This includes:

- removal of major shoals by dredging and the deposition of the dredged materials into the confinement chambers, and
- construction and maintenance of the containment dykes and effluent outlets.

The civil works were executed by a single contractor through proper tendering and contracting .

4.2 Execution of the Environmental Management Plan (EMP)

The Environmental Impact Assessment (EIA) for the pilot project was prepared according to the FPCO *guidelines* (FPCO, 1992). The guidelines recommend the preparation of an EMP for project construction. The EMP should include mitigation, compensation, and the development of a monitoring plan. It was not possible to conduct a full EIA for the pilot project in the available time. As a result the EMP was developed from the knowledge and experience of the professionals involved in the project. NERP organized tripartite meetings with BIWTA and BWDB to co-ordinate the timely implementation of the pilot project. Authorization in principle was obtained from BIWTA on 6 December 1995.

With the exception of some activities under the responsibility of the Contractor, EMP implementation was under the responsibility of NERP and executed by local contractors.

The environmental activities related to the EMP are presented in the Environmental Appendix (Appendix J.2).

5. TENDERING

5.1 Pre-qualification of Dredging Firms

Registered Bangladeshi hydraulic dredging firms/contractors were invited to apply for pre-qualification for the dredging of the Kalni-Kushiyara River channel. Advertisement for dredging of about 300,000 m^3 appeared in two English dailies, the Bangladesh Observer and Daily Star, and in two *Bangla* dailies, the Daily Janakantha and the Ittefaq, on 27 and 28 February 1995. There was no response.

The Invitation for Pre-qualification of Dredging Firms was published again in the same dailies between 25 March and 1 April 1995. The volume of dredging was increased to 600,000 m^3 to attract some interest. One company registered in Bangladesh and two registered in India responded..

5.2 NERP Review of the Applying Companies

The following applications were received:

- Basic Engineering Ltd. (Bangladeshi);
- M/S Dependable Industries (Indian), and
- Dharti Dredging and Construction Ltd. (Indian).

Basic Engineering Ltd. *(Bangladeshi)*
The company does not own hydraulic dredging equipment; in the past it carried out river dredging works using dredges rented from the BWDB Dredger Directorate. The company attached a letter from the Executive Engineer, Narayanganj Dredger Directorate, BWDB Narayanganj, stating: "We shall be willing to rent out one or more Nos. of Dredges on hire charge basis, subject to availability, if you procure the job" (dredging of the Kalni-Kushiyara River channel).

M/S Dependable Industries *(Indian)*
At present the company is not registered in Bangladesh. The time needed to obtain the required permits is uncertain, and their equipment is not sufficient to complete the required works within the specified time.

Dharti Dredging and Construction Ltd. *(Indian)*
The position of this company does not differ from that of the previous company.

As only one company met the requirements, NERP contacted the BWDB Dredge Directorate about the possibility of participating in the competitive bidding. BWDB stated that they do not normally participate directly in tender bids but, in the present case would present a proposal on the basis of the BWDB's approved rate, terms, and conditions.

5.3 Approval of Pre-qualified Contractors

CIDA requires that, for projects the size of the Kalni-Kushiyara River Pilot Dredging operations, the selection process for a construction contractor should be on a **competitive contract** basis, done by either of two ways:

1. Soliciting at least two valid bids from the "most suited" firms and accepting the lowest bid or the bid representing the best value, or

2. Soliciting at least three qualified persons or firms, on a representative list as determined by the contracting authority, and receiving at least one "fair value" valid bid.

The "most suited" is understood to refer to the technical excellence, qualifications, track record, and experience of short-listed firms.

Soliciting at least three firms
Initially NERP received three applications. As such, NERP could go for **competitive contract**, but the risk remained that the Indian companies could not get the required permits to operate in Bangladesh or could be delayed by several months, postponing the whole program. Moreover, there was no indication that the companies would acquire more equipment for NERP work.

Soliciting at least two valid bids
Only the BWDB Dredger Directorate and Basic Engineering Ltd. could be considered for this option and NERP submitted it for approval by CIDA and the BWDB.

BWDB approval was obtained in a meeting with NERP on 31 May 1995 and CIDA approval was accorded during CIDA Review Mission's visit to Bangladesh in June 1995.

5.4 Tender Documents

The tender document for the project comprised two parts:

- Part A - construction of confinement chambers, and

- Part B - dredging of the Kalni River channel and filling of the confinement chambers with dredged spoils.

Considering the short time available for project preparation and the nature of the work, it was elected to implement the project under a single contract executed by one contractor. Based on the preliminary design the tender was prepared for the dredging and construction of homestead platforms at Gazaria, Kakailseo, and Katkhal. Draft tender documents were completed and circulated for comments and verification to CIDA, BWDB, and FPCO in July and early August 1996.

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5.5 Invitation to Tender

The Notice Inviting Tenders for Dredging and Construction of Homestead Platforms under the Kalni-Kushiyara River Pilot Dredging Project was circulated on 22 August 1995. The date set for the opening of the tenders was 12 September 1996.

5.6 Review and Evaluation of Tenders

In response to the NERP Closed Tender Notice No. 1 of 1995-96, dated 22 August 1995, the two pre-qualified contractors expressed their willingness to participate in the competition and obtained the necessary tender documents. Both contractors attended the pre-bid review meeting held in the office of the NERP Team Leader on 5 September 1995.

Two tenders were received and opened in the presence of tenderers on 12 September 1995. The documents were scrutinized and checked for conformity with BWBD and CIDA regulations as outlined in the Instructions to tenderers.

The documents were both found to conform to BWBD and CIDA standards.

The quotations for Part "A" and Part "B" items 2 and 3 three were found to be reasonable and acceptable.

The quotations for Part "B" item 1, Mobilization and Demobilization, were found to be high.

The two tenders were close to one another and the figures were higher than NERP budget. In view of the high rates, it was necessary to scale down the pilot dredging work program, adjusting the contract price to account for the reduced volume of works and the high cost of Part “B” Item 1, Mobilization and Demobilization. It was recommended to accept the Tender of Basic Engineering Ltd., who had the lowest bid, and to initiate negotiations leading to the awarding of the contract. Table 7 provides a comparative summary of the two tenders.

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Table 7: Dredging Contract Cost

Item	Quoted Amounts (Tk)	
	BASIC ENG.	**BWDB DRG.**
Part "A"		
1. Construction of Confinement Chambers	4,277,160.00	4,314,438.00
Part "B"		
1. Mobilization/ Demobilization	19,252,584.28	22,343,188.31
2. Dredging and Filling of Chambers (3)	45,545,448.00	44,885,080.00
3. Stand-by/Idle Cost (18" Dredge)		
a. Short period	57,000.00	50,000.00
b. Long period	228,000.00	200,000.00
TOTAL	**69,360,192.28**	**71,792,706.31**
RANKING	Lower	

Note: there was 20% added onto the cost calculated to fill the disposal chambers in order to account for wastage and settlement. This conforms to the BWDB standards.

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6. DREDGING CONTRACT

6.1 Contract Negotiations

Basic Engineering Ltd. were informed on the conditional acceptance of their tender and were invited by letter to contract negotiations in order to reduce the tender bid and execute as much work as possible within the available budget.

6.2 Technical Analysis and Evaluation of the Dredging Component

In Bangladesh, only two organizations own dredges. These are the Dredging Directorate of the Bangladesh Water Development Board (BWDB) and the Bangladesh Inland Water Authority (BIWTA), both government agencies. Private contractors hire dredges from either agency in order to carry out relatively small contracts such as the Pilot Dredging Project. Moreover, these agencies have an official schedule of rates which are in excess of international rates, typically US$ 3.00-3.25, compared to US$ 2.00 for international tenders, including mobilization-demobilization. The volume of dredging made it uneconomical for Basic Engineering to bring a dredge from offshore, since about 700,000 m^3 was the break even point. Hence they quoted the BWDB rates plus a 14% mark-up to cover overhead and profits.

Basic Engineering Ltd. were informed that the tender submitted on 12 September 1995 would have to be revised to conform to the following parameters:

- the number of confinement chambers would be reduced from 3 to 2, Gazaria and Kakailseo, and the size of the Gazaria platform would be reduced;
- the maximum distance from the channel to the confinement chambers would be kept to under 915 m in order to maintain the BWDB's minimum dredging charges, and
- the volume of dredging would be reduced from 554,000 m^3 to approximately 424,000 m^3, depending on the available budget.

The Contractor revised his tender accordingly and in addition, lowered another major cost item, Mobilization and Demobilization, by about Tk 5.0 million. The contractor presented a new estimate, along with a detailed cost analysis. The original cost of Tk 69.1 million was reduced by Tk 16.3 million to Tk 52.8 million, a 24% reduction. The revised cost is approximately $1.64 million CDN. Table 8 summarizes the differences in quantities and cost between the original and the revised tender.

Table 9 presents the schedule of rates of the revised tender, including lump sum and unit rates items.

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Table 8: Basic Engineering Ltd. Tender Quotations

Item	Original	Revised	Difference	Remarks
Part "A" (Tk)				
1. Construction of Confinement Chambers	4,276,943	3,557,700	719,243	Kakailseo & Gazaria
Part "B" (Tk)				
1. Mobilization/ Demobilization	19,252,584	14,411,755	4,840,829	
2. Dredging and Filling of Chambers (3)	45,545,448	34,857,888	10,687,560	For 2 sites.
Total	**69,074,975**	**52,827,343**	**16,247,632**	

Note: there was 20% added onto the cost calculated to fill the disposal chambers in order to account for wastage and settlement. This conforms to the BWDB standards.

Table 9: Dredging Contract Schedule of Rates

Item No.	Item of Work	Unit	Rate tendered
	Part "A" (Tk)		
1	Construction of Confinement Chambers	%	9.00 Above
	Part "B" (Tk)		
1	Mobilization & Demobilization	L.S.	Tk 14,411,755
2	Dredging of Kalni River and Filling of Confinement Chambers	Tk/m^3	82.212
	Stand-by/Idle period Rates		
3	18" Dredge (1) for short period (1 hr to 1 day) (2) for long period (more than 1 day)	Tk/hr Tk/day	2,850 22,800

6.3 Recommendation

The recommendation took the following into consideration:

- it would be risky to mobilize only one 18" cutter suction dredge, which in theory could do all the work alone, because it would not be possible to tow a second dredge to the site during the dry season in case of a major breakdown of the first one;
- the size of the work was too small to attract competitors from foreign countries;
- the non-negotiable rental rates of BWDB represented a major item in the overall price, and
- the local conditions and working methods were different from those known in other countries.

It was recommended to accept the revised tender of Basic Engineering Ltd., dated 4 October 1995, for a total of Tk 53,242,303 (which included a supplementary provision of Tk 414,960 for dredge stand-by time due to potential environmental restrictions).

6.4 Approval and Award of Contract

CIDA and the BWDB approved NERP recommendations and the contract agreement between Basic Engineering Ltd., the Contractor, and NERP, appointed by the Bangladesh Water Development Board to act as the Engineer was signed on 11 October 1995.

The Work Order for Dredging and Construction of Homestead Platforms under the Kalni-Kushiyara River Pilot Dredging Project was issued to the Contractor on 15 October 1995.

7. FINAL PILOT DREDGING PROJECT

The two platform sites were examined in September 1995 by the NERP multi-disciplinary team and COs. Detailed hydrographic surveys were carried out, exploratory soil boring was conducted, and samples were taken from the river bed at both dredging sites in October 1995. This information was used in preparing final designs for each site. The designs were used to estimate dredging volumes and construction costs.

7.1 Detailed Design of Confinement Dykes

Side Slopes

The coefficients of slope stability were determined using the Goldstein analytical slip circle formula:

$$\eta = fA + (C/\gamma h)B$$

where:
η = coefficient of stability
$f = \tan \phi$ (angle of repose)
A and B are constants
C = soil cohesion in t/m^2
γ = soil specific weight in t/m^3
h = dyke height in m

The minimum coefficients of stability of slopes calculated for a maximum dyke height of six meters were:

- for the recommended inside slope of 1 : 1.5
  $\eta = 1.35$

The inside slope of confinement dykes was considered as a temporary structure since it was to be filled with dredged material:

- for the recommended inside slope of 1 : 1.2
  $\eta = 1.48$

As the recommended minimum stability factor for a flood embankment is 1.5 a 2.0 m wide berm was provided at 7.0 m PWD along the external dyke slope (Figures J.6 and J.8).

Dyke Crest Width

Taking into account the dyke stability during the final stages of filling and the provision of topsoil storage (clayey material) for future use as the platform cover, a 2.0 m crest width was adopted for confinement dykes.

7.2 Design of Confinement Chambers

To begin the final design process, the following laboratory testing was conducted:

- physical properties of river bed materials, and
- settling tests of river bed material.

The data were collected from 4 drill holes near Gazaria and 3 near Kakailseo; core samples were collected at 0.5 m intervals. The samples were visually classified in the field and retained for grain size analysis at a soils laboratory. Additional soil samples were collected during drilling to use for laboratory settling tests.

7.2.1 Results of Drilling Program

Kakailseo
All 3 boreholes showed similar stratigraphy: about 2.5 m of fine and silty sand overlying soft silt, silt and clay, or sandy silt. The top sand layer was relatively dense and usually contained less than 10% silt.

Gazaria
The 4 boreholes showed that the river bed consisted of a mixture of silt, silty sand, and silty clay. The sediment composition was variable, showing lenses of clean sand followed by soft, plastic, silty clay and silt. The sediments tended to be finer towards the shore and coarser in the deeper parts of the channel.

7.2.1 Settling Tests

Several of the fine silt or sandy silt samples from Gazaria were combined to make a representative mixture of the finer materials to be dredged. A sample (3.0 kg) of the material was mixed with water in a 23 litre cylinder; the initial concentration of the slurry was measured to be 176,650 mg/l. Sediment concentrations in the cylinder were measured at four different depths: 15 cm, 40 cm, 65 cm, and 115 cm from the water surface. It was found that the concentrations decreased very quickly in the top 65 cm of the cylinder and more slowly near the bottom.

After one hour, 84% of the sediment had settled; after 12 hours, 98%.

7.2.2 Size of Confinement Chamber

In order to meet the target effluent concentration, 94% of the sediment had to be trapped in the basin. The retention time required to achieve this degree of settling is about 3 hours. However, due to the shape of the basin and the chance for re-suspension, the actual time required for settling may have been longer. The US Army Corps of Engineers Manual (EM 1110-2-5027) recommends multiplying the theoretical time by a correction factor of 1.33 for the cases of Gazaria and Kakailseo. Therefore, the actual minimum retention time was about 4 hours. The corresponding minimum size of basin calculated to achieve this retention time was estimated as 0.72 ha. Both Gazaria and Kakailseo have higher surface area than the required minimum (4.2 and 3.1 ha respectively).

7.3 Land Dedication

Once the final designs were completed, the process of obtaining dedicated land for village platform construction was initiated. This consisted in the following steps:

- visual inspection and estimation of acreage of low areas within the village;
- discussion with all *para*s of the community to determine their willingness to dedicate land and to hear their ideas regarding platform development;

- identification of individual land owners and collection of documentation regarding dedication through the village committee, and
- obtaining the documentation for institutional and public land dedication through the village committee and the Union Council.

7.3.1 Kakailseo

Several issues related to land dedication at Kakailseo are of interest:

Dispute over ownership
Out of 51 people who dedicated land, 15 did not have clear title due to current court cases under the Government's Vested Property Act of 1974. The village committee decided that these people could dedicate land on the condition that they would eventually have to abide by Court's judgment on ownership. The final resettlement on the Kakailseo platform is therefore likely to be delayed by some years.

Late changes in platform design
The village committee initially obtained dedicated land on the basis of a platform designed in mid-1995. After the monsoon altered the land topography, the necessary design changes in platform alignment were presented in November 1995. The disappointment of land owners made it difficult for the committee to convince people to accept the altered design.

Dedication authority for school land
It was decided that in the case of government-owned school land, the Chairman of the school managing committee would be the legitimate authority to dedicate the land for development.

Differing priorities for platform sites
People living on the eastern side of the disposal site wanted to acquire spoil to fill a ditch to the east of the road. A second group wanted the site to extend west, up to the Telephone and Telegraph (T&T) tower. When the village committee was unable to choose between the two groups, the Union Council Chairman intervened to select the site near the T&T tower and the high school. The present site was chosen to extend homesteads for 51 owners and provide a raised school playing ground and flood-free passage during the monsoon.

7.3.2 Gazaria North

Several issues related to land dedication at Gazaria North are of interest:

Equal Platform Benefits
Since everyone would be a beneficiary HH there were no disputes related to the selection of the platform site.

The Problem with Graveyards
During the height of the monsoon, the Gazaria North graveyard is submerged, making burial there impossible. The village committee requested an extension of the platform to the north in order to raise the graveyard. NERP was unable to oblige due to budget limitations as well as the fact that placing disposal soil on the graveyard would disturb its sanctity. The community accepted this decision without dispute.

The Problem of Ownership at the Toe of the Dyke
Although all 110 HHs owning land on the old platform have dedicated land on the new platform, only a few of those HHs own agricultural land at the toe of the new platform. The land to the west is exposed to erosion from *haor* wave action. Any platform protection method planned along the outside toe of the dyke will have to deal with this ownership problem.

7.3.3 Gazaria South

Several issues related to land dedication at Gazaria South are of interest:

Unequal Platform Benefits
Approximately two-thirds of Gazaria South (202 HHs) will not benefit from the extended platform as they were not willing to dedicate their rice-growing land. Moreover, the construction budget was insufficient to build the platform along the full length of the village.

Lack of Consensus Before Construction
Now that they can see the benefits of an extended village platform, the non-beneficiary HHs of Gazaria South claim that they would have been willing to dedicate their agriculture land. In addition, they anticipate that the location of the newly constructed road is inconvenient.

8. CONSTRUCTION

During the layout of confinement dykes, on-site adjustments were made to accommodate land boundaries and avoid social conflicts. Final disposal site plans were prepared on the basis of actual alignment.

Due to a relatively high ground elevation (5.0 m PWD) at Kakailseo, post-monsoon drainage from the disposal site was completed by mid-November 1995. This allowed the construction of the confinement chamber to begin much earlier than at Gazaria, which has an average elevation of 4.0 m PWD and required until the first week of January 1996 to drain.

Pilot dredging operations were carried out by two 18" suction dredges (S.D. Titas and S.D. Kasalong) which were rented by the dredging contractor from the Dredger Directorate of BWDB. S.D. Kasalong arrived from Chittagong on 7 November 1995, and S.D. Titas arrived from Dhaka on 15 November 1995.

8.1 Kakailseo Site

The construction of confinement dykes at the Kakailseo site started on 22 November 1995 and was completed on 30 December 1995. The Kakailseo disposal chamber has an area of 3.1 ha and required 133,125 m^3 to fill it to the design height.

Since the Gazaria confinement chamber was not yet ready for filling, the filling operation at Kakailseo started with both dredges. The operation was carried out in stages by raising outlet pipes 1.5 to 2.0 m after the chamber had been filled to a desired elevation. After a stage was completed, the influent pipes were moved deeper into the chamber. This allowed for better drainage, gradual settlement of the fill material, and also reduced risk of dyke failure during construction.. Dredging with the two dredges started on 12 January 1996 until 27 February 1996 when S.D. Titas was sent to Gazaria. The dredging was completed on 12 April 1996, and the platform was handed over to the beneficiaries on 6 July 1996. Salient features related to platform construction and dredging are given in Table 10.

8.2 Gazaria Site

The Gazaria confinement chamber was divided into two compartments, chamber A and chamber B, in order to ensure the completion of work in the stipulated time frame. This division was due to the following reasons:

- the pump of one dredge broke down and importing a new one could have been subject to unpredictable delay, and
- the dredges' performance at Kakailseo showed that one machine could fill a chamber the size of chamber A within the stipulated time frame.

Chamber A was designed with an area of 3.3 ha and required 182,000 m^3 of dredged spoil to fill it to the design height. Construction of this chamber started on 4 January 1996 and was completed on 28 February 1996. Dredging started on 2 March 1996 and was completed on 25

July 1996. Gazaria platform A extended the homesteads of 110 families, and 12 families whose homesteads were eroded during the 1988 floods were also rehabilitated.

Gazaria chamber B has an area of 1.3 ha and required 67,000 m^3 of dredged spoil to fill it to the design height. Construction of the confinement chamber started on 3 March 1996 and was completed on 13 April 1996. Dredging started on 24 April 1996 and was completed on 8 August. The platform extended the homesteads of 51 families. Salient features related to platform construction and dredging operations for the chambers are given in Table 10.

Both platforms were handed over to village residents on 30 August 1996.

The project also improves dry season navigability of an approximately 1200 m reach in front of Gazaria and a 1000 m reach in front of Kakailseo.

Table 10: Platform Salient Features

Items	Kakailseo Site	Gazaria Site		
		Platform A	Platform B	Total
Area, (ha)	3.1	3.3	1.3	4.6
Fill Volume, (m^3)	133,125	182,000	66,840	248,840
Dyke Length, (m)	1009	1,125	529	1,654
Dyke Volume, (m^3)	36,590	51,673	31,239	82,912
Dredging Cost,(Tk)	10,944,500	15,360,100	5,469,000	20,829,100
Dyke Cost, (Tk)	2,074,925	2,930,250	1,771,475	4,701,725
Total Cost, (Tk)	**13,190,149**	**18,525,148**	**7,339,083**	**25,864,231**
Dyke				
Start	21-11-1995	4-1-1996	3-3-1996	--
Completion	30-12-1995	28-2-1996	13-4-1996	--
Total Working Days	52	31	60	91
Male Labor, (pers)	13,662	23,967	10,602	34,569
Female Labor, (pers)	3,701	2,744	7,704	10,448
Skilled Labor, (pers)	180	100	200	300
Total Labor, (pers)	17,573	26,811	18,506	45,317
Channel Design				
Channel Length(m)	820	1200	Same channel	--
Bed Width, (m)	60	70		--
Bed Elevation, m	-1.0	-1.0		--
Dredging Operations				
Start	12-1-1996	2-3-1996	24-4-1996	--
Completion	12-4-1996	25-7-1996	8-10-1996	--
Dredges Working				
Kasalong, (hr)	616	N/A	N/A	534
Titas, (hr)	172	N/A	N/A	1,258
Total Hours	**787**	**N/A**	**N/A**	**1,792**
Slope Protection and Low Land Filling (Tk)				**25,734**
Mobilization and Demobilization (Tk)				**14,411,755**
Removal of Dredge Pipes & Dyke Reconstruction at Gazaria Outlet (Tk)				**194,876**

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9. ENGINEERING MONITORING

The engineering monitoring program included the following field observations and surveys:

- monitoring suspended sediments (dredging sites, and upstream and downstream of dredging sites);
- monitoring the river channel bed (dredging sites);
- monitoring trap efficiency (disposal chamber);
- monitoring performance characteristics of the dredges;
- monitoring earthwork parameters for the confinement dykes.

9.1 Monitoring Suspended Sediments

Sampling

Suspended sediment concentrations and river discharge at Ajmiriganj, Markuli, and Sherpur have been measured by NERP once or twice per week since April 1995 as part of regular river engineering field studies. In December 1995, additional monitoring started specifically for the pilot dredging studies. This involved measuring the suspended sediment concentration twice weekly in:

- the dredge discharge line in the Kakailseo and Gazaria disposal chambers;
- the effluent outlet from the Kakailseo and Gazaria disposal chambers;
- Rahala (2 km downstream of the dredge), and
- Kadamchal (14 km downstream of the dredge).

For each riverine measurement, a 760 mm sample was taken at mid-stream from a boat with a US DH-76 depth integrating sampler. The river discharge was simultaneously recorded using a Price current meter.

Results

In general, the natural sediment concentrations in the river peak during the pre-monsoon or early monsoon season and then decline over the year. In 1995, the highest measured concentration at Ajmiriganj reached 1580 mg/l on June 19; the lowest concentrations occurred in the dry season (December - March), typically 40 - 100 mg/l.

Table 11 summarizes the concentrations in the river upstream and downstream of the dredge (at Ajmiriganj and Rahala, respectively). On most days, the effluent was diluted by a factor of 320 - 360 once in the river. Based on these values, the concentrations in the river would be increased by 2 - 35 mg/l.

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Table 11: Summary of Suspended Sediment Measurements at Kakailseo

Date	River		
	Discharge (m^3/s)	Concentration (mg/l)	
		Ajmiriganj	Rahala
Jan 17/96	180	52	55
Jan 22/96	174	44	79
Jan 25/96	164	26	102
Jan 29/96	158	44	99
Feb 1/96		24	76
Feb 5/96		34	41

One way to assess the potential impacts of dredging is to compare the amount of sediment returned to the river with the amount of sediment being transported by the river during the same time period. Assuming an average trap efficiency of 96% and a total chamber volume of 133,000 m^3, about 5,000 m^3 (or 4000 tonnes) of sediment was discharged to the river during dredging at Kakailseo. Based on the suspended sediment measurements at Ajmiriganj, the Kalni River transported about 100,000 tonnes of sediment during the three months of dredging (January - March). Therefore, the effluent from the dredging operations temporarily increased the suspended load in the river during this period by approximately 4%. By comparison, the total quantity of sediment transported by the Kalni River in 1995 was estimated to be about 10,000,000 tonnes; the overall impact of the sediment discharged from the disposal chamber is very small (0.04%) in comparison to the total annual quantity of sediment transported by the river.

Another way to interpret these results is to estimate the potential impacts of sediment re-deposition. If all of the sediment in the effluent was re-deposited in a typical *duar* (roughly 400 m long by 300 m wide), which is highly unlikely to occur since *duars* are situated in bends where strong secondary currents cause scour and sediment erosion, the total thickness of the deposit would amount to about five centimetres. By comparison, the NERP river survey program has documented natural scour and fill in some bends of up to three meters over a single year. Evidently, earlier concerns about *duar*s being in-filled with sediment from the dredging effluent are unfounded.

9.2 Monitoring River Channel Bed

Monthly hydrographic surveys at Kakailseo and Gazaria have shown that as of July 1996, the dredged channel has remained an average of one to two meters lower than it was prior to dredging. Additional monitoring after the monsoon is needed to assess the long-term performance of the dredge cuts. Weekly river surveys were also carried out at each dredging site during operations to monitor the progress of excavation. A river bed monitoring survey was carried out in October 1996 at each dredging site. The results are presented in Figure J.10 for the river reach located in front of Kakailseo and in Figure J.11 for the river reach located in front of Gazaria.

9.3 Monitoring Trap Efficiency

Sampling

To evaluate the trap efficiency of the disposal chamber, samples from the dredge inlet/outlet were taken by filling a one litre bottle at regular intervals. The samples were sent to the Surface Water Modeling Centre (SWMC) laboratory to determine the total suspended solids concentration.

At Kakailseo, 38 samples were collected in the period 17 January - 8 April 1996; at the Gazaria site 48 samples were collected in the period 11 March - 30 July 1996.

Results

The trap efficiency in the Kakailseo chamber ranged between 99% and 77%, averaging 94%. This is because lower trap efficiencies occurred during the last few days of filling, when retention time in the chamber was less than the four hours prescribed by the design. In the Gazaria chamber, the trap efficiency ranged between 99% and 80%, averaging 92%. Detailed results of the trap efficiencies of each disposal chamber are provided in Table 12.

Conclusions

The Kakailseo and Gazaria disposal chambers have effectively trapped most (91.6%) of the dredged sediment.

9.4 Monitoring Performance Characteristics of Dredges

Data Collection

NERP dredging inspectors monitored all the aspects of dredging operations including hours of operation, powerplant performance, mechanical problems, progress in channel excavation, and weather conditions. A standard form was developed to tabulate the daily collection of data. The dredging inspectors continued monitoring until the completion of filling operations.

Results

Table 13 shows that the two dredges were working at Kakailseo for a period of 2,208 hours (2-8 hr shifts) to fill a total volume of 133,125 m^3. On the basis of actual pumping hours, the efficiencies of these dredges are 41.8% and 23.4%, with a combined efficiency of 35.7%. This represents only 5.7 hours of pumping from 16 hours of work/dredge/day.

Table 13 also shows that the same dredges worked at Gazaria for a period of 4,064 hours to fill a total volume of 248,840 m^3. Individual performance characteristics of these dredges are 53.9% and 30.9%, with a combined efficiency 44%.

By comparison, a reasonable efficiency figure in a standard dredging operation is about 75%, considering time lost for spudding ahead, moving anchors. adding pipelines, maintenance of equipment, and minor mechanical breakdowns.

Table 12: Summary of Disposal Chambers Trap Efficiency

Date	Kakailseo Chamber				Date	Gazaria Chamber			
	Inflow (mg/l)	Outflow (mg/l)	Trap Eff. (%)	Avg. Trap Eff (%)		Inflow (mg/l)	Outflow (mg/l)	Trap Eff. (%)	Avg Trap Eff (%)
17-Jan-96	54163	841	98.44	93.8	11-Mar-96	135795	1263	99.07	91.6
19-Jan-96	217380	2765	98.73		14-Mar-96	39221	1939	95.06	
22-Jan-96	110605	12212	88.96		25-Mar-96	59062	4601	92.21	
25-Jan-96	123694	7658	93.81		28-Mar-96	123285	52025	57.8	
29-Jan-96	111024	5499	95.05		15-Apr-96	56696	6165	89.13	
01-Feb-96	218074	1748	99.2		23-Apr-96	216797	11465	94.71	
05-Feb-96	57250	3178	94.45		25-Apr-96	142003	6303	95.56	
12-Feb-96	87806	4874	94.45		06-May-96	119220	10812	90.93	
15-Feb-96	227326	6304	97.23		10-May-96	58363	7861	56.53	
26-Feb-96	78294	5221	93.33		13-May-96	83401	7988	90.42	
01-Mar-96	57264	3045	94.68		20-May-96	28219	3590	87.28	
07-Mar-96	59376	5851	90.15		23-May-96	67101	4886	92.72	
14-Mar-96	15770	3640	76.92		27-May-96	57521	4848	91.57	
18-Mar-96	120950	8863	92.67		03-Jun-96	120061	1232	98.97	
21-Mar-96	45467	5348	88.24		06-Jun-96	67367	1881	97.21	
28-Mar-96	181862	8634	95.25		10-Jun-96	64451	5439	91.56	
01-Apr-96	217260	6641	96.94		13-Jun-96	102106	8082	92.03	
04-Apr-96	109597	3215	97.15		17-Jun-96	198131	4467	97.75	
08-Apr-96	52987	1814	96.58		20-Jun-96	72639	5103	92.97	
					24-Jun-96	62362	5392	91.35	
					27-Jun-96	116976	5033	95.7	
					01-Jul-96	287686	2242	99.22	
					04-Jul-96	240964	1559	99.35	
					11-Jul-96	25004	5087	79.6	

Table 13: Performance Analysis of the Dredges

Name of Dredge	Period of Work	Possible Working Time 2-8 hrs Shifts	Actual Pumping Time (hours)	Efficiency (%)
Kakailseo Site				
S.D. Kasalong	11 January to 12 April 1996	1472	616	41.8
S.D. Titas	13 January to 27 February 1996	736	172	23.4
Gazaria Site				
S.D. Titas	2 March to 9 August 1996	2336	1258	53.9
S.D. Kasalong	24 April to 9 August 1996	1728	534	30.9

9.5 Monitoring of Earthwork Parameters

Observations

Observation of soil and water conditions at the confinement chamber sites started in September 1995 in order to determine the earliest possible date for the commencement of dyke earthwork.

At the Kakailseo site, where the ground elevation is about 5.0 m PWD, the soil became sufficiently dry for earthwork by mid-November; the construction of confinement dykes started on 21 November 1995 and was completed on 12 January. Soil in lower parts of the chamber remained saturated throughout the construction period.

At the Gazaria site, with ground elevation at about 4.0 m PWD, the soil remained wet until the end of December. The construction of confinement dykes started on 4 January, but lower areas (elevation about 3.0 m PWD) remained wet until the completion of work on 2 March 1996. Pumps were used at both sites to remove accumulated ground water.
The completed homestead platforms were jointly surveyed by NERP, BWDB, and the dredging contractor at the end of the filling operation. To determine the settlement of the dredged material placed in confinement chambers, the platforms were resurveyed at the end of the monsoon season and again during the dry season. Long-term platform settlement is expected to take place over a period of about three years.

Results

During the chamber filling operation, uneven settlement (not proportional to dyke height) and dyke deformation occurred, especially at sections where the dyke was constructed on wet ground or was composed of clayey material. At locations such as these, the outer slope became steeper due to interior soil pressure, but did not fail.
The crest elevations of the confinement dykes at each site were surveyed periodically to determine settlement. The results are provided in Tables 14 and 15.

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Table 14: Confinement Chamber at Kakailseo
Dyke Crest Elevations in m PWD

Chainage	Base Elevation	Date of Survey / Elevations		Remarks
		9/2/96	6/7/96	
0	6.80	9.47	9.37	
30	5.52	9.42	9.33	
45	4.24	9.13	8.83	pond, dyke toe undercut by public
60	4.69	9.07	9.00	
90	4.36	9.50	9.41	
136	6.20	9.37	9.25	
196	5.45	9.33	9.16	
200	6.09	9.36	9.21	
256	6.08	9.20	9.11	
300	6.38	8.94	8.86	Dyke constructed from wet silt/clay material over ponds
330	5.95	8.92	8.62	
350	4.32	8.82	8.77	
360	4.36	9.00	8.81	
375	3.80	8.89	8.91	
440	6.30	9.05	9.01	
475	4.20	9.34	9.10	
506	5.60	9.40	9.31	
550	5.39	9.44	9.29	
575	5.30	9.34	9.11	
600	5.42	9.28	9.06	
675	5.86	9.32	9.12	Partial section dyke
775	6.10	9.17	9.23	
875	5.65	9.33	9.31	
975	7.28	9.59	9.49	

Note: As the Kakailseo dykes had been improved several times during the filling operation by raising the crest level with sandy material borrowed from inside the chamber, the data shown above is not fully representative of the actual settlement.

Table 15: Confinement Chamber "A" at Gazaria
Dyke Crest Elevations in m PWD

Chainage	Base Elevation	Date of Survey / Elevations			Remarks
		1/3/96	12/4/96	28/5/96	
0	4.60	9.40	9.30	9.21	
50	4.81	9.34	8.91	8.84	
100	4.50	9.36	9.20	9.17	
150	4.45	9.14	9.13	9.13	
200	4.60	9.11	9.02	9.00	
250	4.34	8.92	8.87	8.87	Ditch
300	4.34	9.17	9.10	9.07	
350	4.95	9.19	9.09	9.07	
400	4.90	9.31	9.26	9.21	
450	4.85	9.20	9.16	9.10	
500	5.20	9.59	9.45	9.47	
550	7.00	9.44	9.35	9.46	
600	6.50	9.85	9.81	9.74	Homesteads, partial section dyke
650	6.44	9.93	9.93	9.89	
700	6.65	9.96	9.94	9.89	
750	6.20	9.37	9.28	9.22	
800	6.34	9.35	9.23	9.34	
850	6.90	9.88	9.76	9.71	
900	5.60	9.88	9.81	9.73	
950	4.58	9.69	9.57	9.54	
1000	5.00	9.40	9.12	8.99	
1025	4.55	9.32	9.23	9.06	
1075	4.10	7.89	7.72	7.56	Sector dyke
1125		7.89	9.38	9.32	Sector dyke raised

10. LESSONS LEARNED

10.1 Platform Alignment

Although an implementation project should be finalized well ahead of the construction date, the alignment of the platform can only be finalized on-site. This is due to peoples' changing perceptions and possible lack of appreciation of the actual dyke alignment shown on preliminary sketches. This issue is discussed in greater detail in Appendix J.3.

10.2 Dredging Contract

The following factors should be taken into consideration in the KKRMP:

- Unit dredging costs depend on the size of the project. In the KKRMP, several million M^3 will be dredged, attracting international contractors. In addition, some local contractors are currently acquiring their own equipment. It is expected that competitive international rates of the order of US$ 2 /m^3, including mobilization and demobilization will be achieved;

- the impossibility of night time navigation in some sections of the river, increases the towing time and the cost of tenders;

- It is imperative that floating equipment be towed to the job site as early as possible, before the water level is too low on some reaches. At the time of completion of the work, the water level may also be too low to permit the towing of equipment to the dredge's base. If there is any delay due to low water levels, idle rental time will accumulate, and

- depending on the conditions observed during dredging operations, environmental restrictions may increase the cost of the work.

10.3 Dredges and Dredging

The following were the lessons learned regarding the dredges:

- dredges should be mobilized by the end of October, while the water depths are still adequate;

- the dredges should be provided with heavy anchors in order to withstand flash floods;

- permanent stakes above the pre-monsoon flood level should be installed on the section of the river bank adjacent to the excavation, and floats should be provided along the river channel. These would give a baseline from which the excavation alignment could be checked;

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- on the basis of actual pumping hours, the dredges' output was 142 m^3/h, corresponding to an efficiency of 44% (Section 9.4). Major production delays related to mechanical shutdown, maintenance of dykes, and effluent outlet channels. In order to obtain optimal output, the relationship of these to the filling operation must be constantly monitored;

- the BWDB dredges had no vacuum gauge. This gauge is critical since it monitors the solid contents of the slurry. The leverman must adjust the suction power of the dredge according to the readings. On the pilot project dredges, the leverman only had the readings of the pressure gauge, which provides insufficient information to maintain optimal dredging. Both gauges should be provided and remain functional.

- the Contractor could not obtain more than 230 m of floating pipeline per dredge. Since the Gazaria chamber length exceeded 230 m, the contractor would have to install a shore pipeline (and floating pipeline) running parallel to the navigation channel on the river bank. One or two additional perpendicular pipelines are also needed to connect the dredge with the confinement chambers. When the dredge moves ahead, the operation is stopped in order to connect the floating pipeline to a new section of the shore pipeline. This situation should be corrected in the future;

- the contractor did not have "Y" discharge pipes. When the pipeline is to be extended into the confinement chamber, one branch of the "Y" is closed and a pipe section added while the other branch of the pipe is still discharging. In the absence of "Y" pipes, the local method of operation requires stopping the dredging operation each time the fill reaches the required height, forming a mound over a 90 m^2 area. Two lengths of pipe, supported by bamboo cribbing, are then added to the shore pipeline, requiring two to three hours. This lengthy procedure is usually done by simply placing the pipe directly on the fill. After adding pipe, the dredging operation is resumed to build another 90 m^2 of fill. This method is repeated for several layers of fill, until the basin is full. NERP's representatives asked the contractor to limit this to three layers. In the future, "Y" discharge pipes should be available to avoid those delays, and

- all shore pipes are flanged every six metres and connected by 16 bolts. This also causes delays. In modern dredging, shore pipes are tapered at one end and joined by ramming them together, forming an ergonomic butt connection requiring no hardware.

The type of dredge used for the pilot project is called a hydraulic dredge. It was selected because it can efficiently transport the dredged material a long distance with minimal cost and land-use disruption. Hydraulic dredges generally have low impact at the dredging site if pump pressure, cutter rotation speed, dredge head advancing speed, and depth of cut are closely controlled. Sediment re-suspension can be almost eliminated by balancing cutter speed with pump capacity. This also improves dredge performance, since all loosened or dislodged sediment is sucked up at the intake. Experience has shown that a variety of simple operating techniques can be used to match cutter head action to pump capacity:

- as a general rule, cutter head speed should always be kept to the minimum that yields an acceptable production rate. Reduced speeds are frequently more efficient, both environmentally and economically;

- slopes should be stepped rather than box cut. In fine non-cohesive material, a box cut left alone to slough itself into an angle of repose could cause substantial sediment re-suspension;

- large distances between cuts, very thick cuts, and very shallow cuts should be avoided. Deep cuts tend to bury the dredge head and may cause high levels of re-suspension if suction is not strong enough. On the other hand, if cuts are too shallow, the cutter tends to throw the sediment beyond the intake of the dredge;

- the leverman should swing the dredge so the dredge head will cover as much of the bottom as possible. This minimizes the formation of windrows that may become re-suspended by currents and by turbulence caused by the cutter head and dredge manoeuvres. Windrow formation can be eliminated by swinging the dredge in close concentric arcs over the dredging area;

- the skill of operators represents the most critical factor in terms of both dredging impact and production rate.

10.4 Confinement Dykes

Two types of dykes were constructed, a full section earthen dyke along open areas and partial section dykes along the existing homesteads.

Full Section Earthen Dyke

The dyke had internal side slopes of 1(h):1.5(v). This was found to be stable where dykes were constructed with silty sand and relatively dry silty clay. During the construction, internal slope failure occurred at certain locations due to the following reasons:

- construction of dyke from wet clayey soil (at Kakailseo chainage 300 - 360 m);

- excavation too close to the internal dyke toe, and

- construction of dykes over saturated soils and ponds.

Significant construction delays also occurred because the contractor had to reinforce the dyke with bamboo and *tarja* walls at these locations.

Dyke boundaries should be outlined with permanent stakes and construction supervised to ensure that the berm is maintained. Saturated soil should be removed from the lower parts of the embankments, and if further measures are necessary the internal side slopes should be made more shallow.

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Partial Dyke Sections
Two types of partial sections with *tarja* walls have been constructed: one along the existing homestead and the other on top of the new platform, supported by the dredged spoil. Neither section was satisfactory due the following reasons:

- during the rainy season, the dredged material spills over and percolates through the *tarja* wall. As a result the partial dykes at Kakailseo had to be repaired and reconstructed, and

- dredging had to be stopped to construct partial dykes on top of the dredged fill, and the dredged material was an unsuitable foundation.

These types of dykes should not be built in the future.

Dyke Settlement
Over a period of three months, the dyke settled over 50 cm. Once the filling operation starts, it is difficult to rebuild the dyke to its original height due to the unavailability of soil. Depending on the quality of the soil, settlement should be accounted for when designing the height of confinement dykes.

Dyke Stability
Dyke stabilization is a key project issue. Dyke erosion and spilling of the dredged material not only has an adverse impact on the adjacent land but also on peoples' perception of such development projects. Dyke protection is a must. On the long term, the dyke should be protected by. On the short-term, fences and *tarja* walls should be put in place until a strong and well-developed vegetation cover ensures efficient protection, especially against wave erosion.

10.5 Slope Protection

Slope protection with Loosely Woven Jute (hessian) Cloth
Placing of jute cloth on the face of the dyke was intended to allow the grass to grow through the cloth and form a more resilient dyke surface. The protection looked promising before the onset of flooding. When the paddies and pastures were inundated, cows and goats moved onto the dykes, ate the growing grass, and damaged both the cloth and dykes.

Field rats also took shelter under the cloth and burrowed in the body of the dyke. This poses a major threat to stability; the dyke crest has failed in several locations at Gazaria. Protection with hessian cloth is ineffective and should not be used in future works.

Protection by Tarja and Bamboo Fencing
Tarja fences were designed as wave breakers and laid over the *hessian* cloth. Dyke erosion started at the toe by undermining the sandy fill material and progressed upwards as the flood waters rose. The dyke lower slope and berm both failed.

Damage to the hessian cloth, undercutting of the dyke toe by farmers and poor workmanship contributed to the progression of erosion.. Protection with *tarja* and bamboo fencing was ineffective and should not be used in future works.

Protection by the Local Method
Chailla grass is used by local people for protection of homestead platforms. The grass is packed over the slope of the platform and retained with split bamboo to form a solid blanket resisting erosion from rain and wave action. This traditional protection method is more effective than the methods developed by NERP and it is recommended for temporary slope protection.

10.6 Drainage

When it rains, water accumulates on the platform and, as the dykes settle, runs over the unevenly graded platform surface and overflows the perimeter, forming rain cuts and eroding dykes, thus increasing the risks of dyke failure. Rain water should be collected in the middle of the platform and diverted to the outlets by a drainage channel or buried pipe.

Drainage from the Interface of the Old and New Platforms
At Gazaria, earthen dykes were constructed at the junction of the existing homesteads and the new platform. In places, this interrupted drainage on the homesteads. Some people filled the low pockets with earth, while others did not attend to the water logging. In these cases, NERP provided PVC pipes to drain the water. This solution was not satisfactory. Local depressions at the interface of old and new platforms should be filled by the Contractor construction in order to avoid drainage problems.

Drainage From the Adjacent Land
The Kakailseo platform configuration proposed by the local people did not permit drainage of effluent water through adjacent land. This was solved by realigning the eastern embankment and diverting the local drainage through an existing drainage channel. This was done with the consent of the local people and village committee. However, during the course of construction, this existing drainage channel was partially closed under the FFW (Food For Works) program, which created drainage congestion on the eastern side of the platform. Local approval for this type of work should be granted by the *thana* committee, which should be headed by the TNO.

Effluent Outlet Channels
Pre-monsoon floods caused the Gazaria effluent channel to breach in 2 places on 6 April 1996. Soil is scarce at this time of the year, and it took a long time to repair the channel. Effluent outlet channels must be built to withstand flash floods, particularly when passing through low areas and existing drainage channels.

10.7 River Dredging Activities

After the dredging at Kakailseo was completed in April 1996, the dredged channel did not fill in the remainder of the pre-monsoon season.. During the course of the dredging, several deep local holes were excavated (around El. -7 m); these filled in completely within a few weeks of the dredge moving to a new site. Excavating holes is clearly undesirable when the purpose of the work is to produce a specified channel grade and should be avoided in the future.

Sediments in the channel, particularly at Gazaria, had a variable composition. It became difficult to control the extent and depth of channel excavation when the dredge operators attempted to avoid dredging fine material, in order to increase the chamber filling rate. Areas containing predominately fine grained sediments should be avoided during future dredging programs. This means only limited maintenance dredging should be carried out upstream of Kakailseo.

In the reach between Ajmiriganj and Kakailseo the river bed aggrades during the monsoon and degrades during the dry season when the water is confined, the surface slope is steeper and velocities are higher. This seasonal shifting makes it difficult to predict the condition of the channel during the dry season when the only information is from surveys obtained during the monsoon or post-monsoon seasons. In addition, based on earlier surveys, it appears that the general river bed near Ajmiriganj has been affected by the channel shifting and instability in the reach between Shantipur and Cherapur Khal. After the channel shift of 1994, the river appears to have aggraded upstream of Shantipur and downstream of Kadamchal. The upper reach began degrading again in 1995 and has returned near its original (1993) level; the downstream reach has continued to aggrade. These bed level changes can mask the effect of any local dredging work.

Dredging during the monsoon season should be avoided since the river bed fills rapidly with fine sediment. The best time for dredging is during the dry season (December to April).

10.8 Disposal Operations

The overall trap efficiency of the disposal chambers was typically 96% (range 87% to 99%). There was good agreement between the observed trap efficiency and predictions made using design techniques developed by the US Army Corps of Engineers. The lower trap efficiencies occurred when the dredge encountered fine sediment (clay/silt); this problem was more common at Gazaria than at Kakailseo. The trap efficiency was also reduced during the last stages of filling when the retention time in the basin was shortened. However, this was successfully mitigated by installing *tarja* walls perpendicular to the direction of flow.

Calculations made on trap efficiency indicate that even when the Gazaria chamber "A" was filled to 90%, the trap efficiency remained at least 85%. Once a disposal chamber was 90% full, the trap efficiency decreased very rapidly, and trying to fill the chamber some more became very inefficient. It is recommended that, if silty sands are dredged, the project should be planned to deposit them first into the chamber. Withstanding this mitigation, the most efficient way to minimize the effluent concentration is to avoid dredging fine-grained sediment. At Gazaria the effluent solids concentration reached 21% (12,000 mg/l) on account of the fine river bed alluvium, when under average conditions it would be about 10 to 13% solids (3-5,000 mg/l).

Dredging had much less impact at Gazaria than at Kakailseo, because the operation continued through the pre-monsoon and monsoon seasons, when the river's discharge and incoming sediment loads increase significantly. For example, during the pre-monsoon season, the effluent from Gazaria was diluted by a factor of approximately 3000 and from mid-April, the rise in concentration due to dredging operations at Gazaria can be considered negligible. Dredging in the period February - March produces the greatest impact on water quality since the river discharge and natural sediment concentration are the lowest. Even so, the overall rise in sediment concentration downstream of the mixing zone remains very low.

11. DREDGING AND PLATFORM CONSTRUCTION COSTS

An amount of Tk 53,182,625 was spent to complete the construction of homestead platforms at Kakailseo and Gazaria by dredge spoil from the Kalni River against the tendered amount of Tk 53,242,303. A comparative statement of budgeted versus actual costs is summarized in Table 16. A detail cost breakdown is provided in Table 17.

Table 16: Comparative Statement of Dredging Costs

Item	Amount (Taka)	
	Dredging Contract	**Actual Costs**
1. Construction of Confinement Chamber	3,557,700	6,776,650
2. Mobilization/Demobilization	14,411,755	14,411,755
3. Dredging and Filling of Chambers	34,857,888	31,799,343
4. Dredge stand-by-time due to potential environmental restrictions (Provisional Item)	414,960	-
5. Removal of dredge pipes and reconstruction of dyke at Gazaria outlet		194,876
Total	**53,242,303**	**53,182,625**

Table 17: Actual Cost of River Dredging and Construction of Homestead Platforms

Item	Unit	Rate (Tk/Unit)	Quantity	Amount (Tk)
Construction of Chamber Dyke and Drainage Channel: Tendered Item				
1. Earthwork in filling for dyke construction for initial lead of 30 m and for the following lifts:				
a) 0 to 3 m height	m^3	29.92	15,454.47	462,397.74
b) 0 to 4 m height	m^3	31.49	21,587.98	679,805.49
c) 0 to 5 m height	m^3	33.07	8,588.42	284,019.05
d) 0 to 6 m height	m^3	34.64	77,266.30	2,676,504.63
2. Erection of bamboo profiles	No	103.06	72	7,420.32
3. Construction of bamboo and tarja wall	m^2	124.07	4208	522,086.56
4. Fine dressing and close turfing	m^2	5.80	19,189.08	111,296.66
5. Excavation for drainage channel	m^3	20.22	6,336	128,113.92
			Subtotal	**4,871,644.37**
Construction of Chamber Dyke and Drainage Channel: Non-Tendered Item				
1. Extra rate for every additional lead of 15 m or part				
a) 1 additional lead	m^3	2.05	41,057.25	84,167.36
b) 2 additional leads	m^3	4.10	9,742	39,942.20
c) 3 additional leads	m^3	6.15	8,135	50,030.25
d) 6 additional leads	m^3	12.30	3,395	41,758.50
2. Earthwork removal of Slushy earth	m^3	36.65	5,269	193,108.85
3. Construction of surface drain at Kakailseo	No	L.S	3	80,014.17
4. Emergency Closure at Gazaria outlet channel	-	L.S	-	7,550.32
5. Slope protection work by laying hessian cloth and other work	m	314.09	1021	320,685.89
6. Construction of tarja walling for following height:				
a) 2 m	m^2	273.00	1067	291,291.00
b) 0.8 m	m^2	109.07	804	87,692.28
7. Supply, fill and placing of gunny bags:				
a) with sand	No	12.85	3237	41,595.45
b) without sand	No	9.94	2000	19,880.00
8. Protection of berm from erosion by placing water hyacinth	boat	500.00	30	15,000.00
9. Bailing out of water from inside the confinement chamber of Gazaria	hrs	48.50	1500	72,750.00
			Subtotal	**1,345,466.27**
			Tendered +Non-tendered cost	6,217,110.64
			Add 9% as per contract	559,539.96
			Total	**6,776,650.60**
Dredging of Kalni River and Formation of Homestead Platform				
1. Dredging of Kalni River and Formation of Homestead Platform at:				
a) Kakailseo	m^3	82.212	133,125.00	10,944,472.50
b) Gazaria - Chamber A	m^3	82.212	186,835.24	15,360,098.75
c) Chamber B	m^3	82.212	66,523.60	5,469,038.20
d) Slope protection & low land filling	m^3	82.212	313.02	25,734.00
2. Mobilization & Demobilization	Lot	L.S		14,411,755.00
3. Removal of dredge pipes and reconstruction of dyke at Gazaria outlet	-	L.S	Lot	194,876.00
			Subtotal	**46,405,974.45**
			Grand Total	**53,182,625.05**

APPENDIX J.2: ENVIRONMENTAL COMPONENT

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DD8

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1. ENVIRONMENTAL MANAGEMENT PLAN

The EMP of the pilot project was developed in order to mitigate the adverse impacts of pilot dredging activities and enhance the positive impacts. Some EMP work was under the responsibility of the contractor and the remainder was executed directly by NERP. Environmental activities undertaken by the Contractor included construction of cross drainage and effluent outlets, platform drainage and dyke protection works, homestead damage repair, navigation lighting, and disaster management. Storage of sandbags and *tarja* walls as part of a contingency plan in the event of dyke failure was also the responsibility of the Contractor.

1.1 Environmental Activities Undertaken by NERP

Environmental activities undertaken by NERP included the activities following.

1.1.1 Drainage and Land Improvement Outside Platform

The Kakailseo platform configuration proposed by the local people prevents local drainage. The problem was brought to the notice of the community and a solution was agreed to by realigning the eastern embankment and diverting the local drainage through the existing drainage channel. This was done with the consent of the people and the village council. However, during the course of construction, this existing drainage channel was partially closed under the FFW (Food For Works) program, which created drainage congestion on the eastern side of the platform. The low pockets still remaining on the eastern side were filled up during the 1997 dry season.

1.1.2 Alternate Irrigation

The construction of shore pipeline and effluent outlet channels between the river bank and the disposal chambers disrupted existing irrigation systems. Alternate irrigation facilities involved reconnecting these distribution systems with steel pipes.

1.1.3 Road Overpasses

A bamboo bridge was provided in order to facilitate village communications interrupted by installing shore pipeline and effluent outlet channels.

1.1.4 Platform Maintenance & Monitoring

On an experimental basis, slope protection works at Gazaria were tested with *hessian* cloth. This measure did not prevent erosion of much of the lower berm. In fact, to some extent, it contributed to the erosion. Due to their effectiveness traditional protective measures of vegetation cover were subsequently adopted. The dykes were repaired during the 1997 dry season.

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1.1.5 Turbidity Tolerance Tests

Two types of tests were carried for this parameters:

- a physical laboratory test to determine the suspended sediment contents (in ppm or mg/l) in the inflow and outflow of dredged slurry (Appendix J.1, Table 12). The test was carried out to assess the effectiveness of the designed settling basins for trapping sediment. If the trap efficiency is found satisfactory, then the design can be adopted for a large scale dredging operation. The sediment concentration in the outflow dredge slurry can also affect aquatic fauna; and

- simple bioassay field experiments (NTU) were conducted daily to determine the water quality effecting the life of aquatic fauna.

The two tests are unrelated.

1.1.6 Crop Compensation

Compensation was provided to farmers where disruption of their existing crop was unavoidable. See Appendix J.3 for details.

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1.1.7 Bamboo Barrier and Water Hyacinth Belt

To mitigate the increase in water turbidity downstream of the dredges, an attempt was made to install a bamboo barrier with a water hyacinth mat around one of the dredges. The barrier collapsed under strong river currents. Turbidity samples also showed that the turbidity generated by the dredge's cutter head is marginal and almost all sediments are pumped through the pipeline. The concept was abandoned

Another concept tested, was that of installing a series of consecutive barriers into the river, at an angle to the shoreline, immediately downstream of the outlet pipes. The concept was tested at Kakailseo with the installation of three barriers respectively 20 m, 50 m and 80 m downstream of the discharge point, extending from the shoreline and towards the center of the river. The length of each barrier from upstream to downstream was respectively 20 m, 30 m, and 50 m. These consisted of jute curtains on a bamboo frame. In Kakailseo, these barriers proved very effective in settling the sediment rapidly to the river bottom. The concept was also implemented at Gazaria, but the barriers were unable to withstand the current and had to be abandoned.

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1.1.8 Topsoil Rearrangement

The EMP specified that topsoil on location of the future platforms would be scraped, stored away and later spread over the completed platforms. However there was insufficient soil within the confinement chamber perimeter to build the dykes. This shortage of soil was particularly acute at Kakailseo where the original ground consisted of a series of relatively deep ponds. Soil was in such short supply that whole sections on the outside of the dyke were supported by vertical *tarja* walls. Some of those sections eventually failed. The situation is now corrected and the Kakailseo dyke has an adequate slope (1 vertical : 2 horizontal).

The situation was not much better at Gazaria. In order to build the dykes as per the specifications, the ground inside the confinement chamber had to be dug to depths of 2 m. With minor exceptions, it was not possible to obtain earth from outside since all the land was under crop.

During the 1997 dry season, various village groups were contracted to level the platform surface and provide earth for topsoil. This soil was spread evenly to a depth of 15 cm and covered with straw.

1.1.9 Topsoil Quality Improvement and Green Manuring

The objective of green manuring is to improve the soil structure of the dredged spoil in order to protect the site from wind erosion and resulting health hazards and its productivity to develop kitchen gardens. The process consists in producing biomass on the platform by utilizing quick growing plants, mainly African *dhaincha* (sesbania sp.), provided the season permits, immediately after the completion chamber filling. When they are about 60 cm long, the plants are cut and mixed with the dredged spoil and then covered by 15 cm of topsoil. If the season does not permit the cultivation of *dhaincha*, straw and water hyacinth are substituted.

In the case of the Pilot Dredging Project, the African *dhaincha* season was over once chamber filling was completed. However, a small demonstration program was implemented in order to demonstrate the process of green manuring to the beneficiaries. However the plants did not grow to the required length. The following season, since the beneficiaries did not grow *dhaincha*, straw was substituted with good results.

1.1.10 Settling the Suspended Sediment with the Use of Alum

Alun, a suspended sediment precipitator, was tried on an experimental basis in the Gazaria North confinement chamber. It was concluded that, to be effective, large quantities of alum would be required and the cost could not be justified.. The installation of bamboo barriers inside the chamber to maximise the particles retention time proved to be an easier and a more efficient method than alum.

1.1.11 Water Quality Monitoring and Tests

Water quality monitoring was carried out during dredging at Kakailseo and Gazaria. Measurements included alkalinity, dissolved oxygen, hardness, pH, turbidity, and Secchi disk reading (an indirect measurement of turbidity). Details are presented in Section 2.1.

1.1.12 Dyke Protection

The slopes of the dykes were initially protected against rain and wave action with turf grass. Jute cloth was placed on the turf as supplementary protection. Within a few weeks, animals had destroyed some of the protection. It also proved ineffective against erosion and had to be eventually replaced by traditional protection.

2. ENVIRONMENTAL MONITORING

2.1 Water quality

2.1.1 Parameters Sampled

Water monitoring was carried out to determine the effect of dredging on total alkalinity, dissolved oxygen, hardness, pH, temperature, turbidity, and Secchi disk reading (an indirect measurement of turbidity). Results of the water quality monitoring at both sites are summarized below. Detailed numerical data are provided in Tables 1 and 2.

Total Alkalinity
Total alkalinity ranged from 25 mg/l to 125 mg/l at Kakailseo and from 16 mg/l up to 71 mg/l at Gazaria. The higher values measured in the inlet and outlet at both sites were most likely due to high concentration of suspended matter.

pH
pH values ranged from 7.3 to 7.8 and from 7.5 to 8.4 at Kakailseo and Gazaria respectively. At Kakailseo, pH measurements in the inlet and outlet were not different from the values measured in the river. At Gazaria, the high pH values in the inlet and disposal chamber seemed to be related to a high concentration of suspended matter.

Hardness
Hardness measurements did not vary considerably at either site. The values ranged from 26 mg/l to 57 mg/l, which is natural for river water.

Dissolved Oxygen
Very low dissolved oxygen values were observed in inlet water, disposal chamber (pool) water, and outlet water. The condition was more pronounced at Gazaria. However the measurements in the out-fall, immediately downstream of the outlet, showed a significant increase in dissolved oxygen. This is likely related to the strong mixing as the water was discharged on a bamboo platform. The readings in the river downstream of the outlet were slightly lower than the readings upstream.

Turbidity
Turbidity readings confirmed the estimated retention capacity of the chambers. Field observations indicated that the turbidity plume was narrow along the shore and extended for about one kilometre downstream of the outlet.

2.1.2 Results

Except for some readings at inlet and in the pools, where there was a marked dissolved oxygen depletion, none of the observed values was indicative of significant environmental problems. Except for the turbidity readings along the shore in the first 400 to 500 meters downstream of the dredges, data were typical of any river in the Northeast region. The effluent from the disposal chambers did not have significant impacts on the aquatic ecosystem.

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Table 1: Water Quality Monitoring - Summary of Results (Kakailseo)

Location	Alkalinity (mg/l)	Dissolved Oxygen (mg/l)	Hardness (mg/l)	pH	Temperature (°F)	Secchi disk reading (cm)
Inlet (n=3)	125.0	1.2	26.7	7.7	81.3	n/a
Pool (n=3)	27.3	4.0	26.7	7.3	80.3	5.7
Outlet (n=3)	117.7	2.7	33.3	7.5	80.7	n/a
Out-fall (n=4)	25.5	4.9	45.0	7.8	80.3	6.1
10 m U/S of outlet (n=3)	33.7	6.2	56.7	7.7	81.0	32.0
50 m U/S of outlet (n=3)	33.3	5.0	40.0	7.5	81.3	33.0
50 m D/S of outlet (n=3)	45.3	4.4	40.0	7.4	81.3	30.0
100 m D/S of outlet (n=3)	25.7	5.4	43.3	7.7	81.3	28.7
200 m D/S of outlet (n=3)	29.7	5.9	60.0	7.6	82.0	30.7
1000 m D/S of outlet (n=3)	27.7	5.9	63.3	7.7	81.3	32.3
Dredging site (surface level) (n=2)	34.5	6.1	35.0	7.3	82.0	31.0

Note: U/S - Upstream
D/S - Downstream

Table 2: Water Quality Monitoring - Summary of Results (Gazaria)

Location	Alkalinity (mg/l)	Dissolved Oxygen (mg/l)	Hardness (mg/l)	pH	Temp-erature (°F)	Secchi disk reading (cm)	Turbidity (NTU)
Inlet	71.3 (n=4)	0.2 (n=18)	35.0 (n=4)	8.4 (n=18)	82.9 (n=18)	n/a	21339.4 (n=16)
Pool	30.0 (n=4)	1.6 (n=4)	41.4 (n=4)	8.1 (n=4)	83.6 (n=4)	2.1 (n=3)	5926.0 (n=2)
Pool, middle of chamber	n/a	3.6 (n=9)	n/a	8.3 (n=9)	82.8 (n=9)	n/a	4622.0 (n=9)
Pool, northside of chamber	n/a	3.5 (n=4)	n/a	8.4 (n=4)	82.9 (n=4)	n/a	7721.0 (n=4)
Outlet	48.3 (n=4)	3.5 (n=32)	47.5 (n=4)	8.1 (n=29)	82.9 (n=30)	n/a	3482.3 (n=40)
Out-fall	34.0 (n=4)	4.5 (n=4)	57.5 (n=4)	8.2 (n=4)	84.0 (n=4)	2.2 (n=3)	n/a
10 m D/S of outlet	23.1 (n=4)	5.3 (n=3)	42.5 (n=4)	8.1 (n=4)	83.4 (n=4)	24.3 (n=3)	n/a
10 m D/S of outlet	n/a	n/a	n/a	n/a	n/a	n/a	3280.0 (n=2)
50 m U/P of outlet	30.3 (n=4)	5.1 (n=4)	53.8 (n=4)	8.1 (n=4)	84.0 (n=4)	27.3 (n=3)	n/a
50 m D/S of outlet	27.8 (n=4)	4.6 (n=4)	33.8 (n=4)	8.0 (n=4)	83.6 (n=4)	17.7 (n=3)	2190.0 (n=2)
100 m D/S of outlet	21.8 (n=4)	4.4 (n=13)	47.5 (n=4)	8.0 (n=13)	83.1 (n=13)	14.7 (n=3)	1936.3 (n=11)
200 m D/S of outlet	19.0 (n=3)	4.8 (n=3)	35.0 (n=3)	7.8 (n=3)	83.7 (n=3)	17.5 (n=2)	n/a
400 m D/S of outlet	n/a	4.3 (n=8)	n/a	8.0 (n=8)	82.9 (n=8)	n/a	934.8 (n=9)
1000 m downstream of outlet	16.7 (n=3)	4.7 (n=12)	43.3 (n=3)	7.9 (n=12)	83.0 (n=12)	15.5 (n=2)	354.0 (n=11)
Dredging site (surface level)	26.0 (n=3)	5.0 (n=3)	43.3 (n=3)	7.9 (n=3)	84.0 (n=3)	23.0 (n=2)	n/a
In normal haor water	n/a	5.1 (n=9)	n/a	7.6 (n=9)	82.9 (n=9)	n/a	73.6 (n=11)
In river water	n/a	5.4 (n=10)	n/a	7.5 (n=10)	83.3 (n=10)	n/a	102.6 (n=10)

2.2 Fish Tolerance Tests

2.2.1 Experiments

Turbidity, an indirect measurement of total suspended solids, is an important physical factor for all aquatic fauna. Total suspended solids of 20,000 parts per million (ppm) or more is considered lethal to fish.

To test the impact of turbidity in the effluent channels, fish were placed in cages in the river within the limits of the turbidity plume and periodically observed. Three fish species abundant in this section of the river were selected; one pelagic fish species, *Puti* (Puntius sophore), and two bottom feeder fish species, *Gulsha* (Mystus cavasius), and *Tergra*. No surface feeder species were used as those were not available at the time of experiment. Fish were kept in four bamboo cages (1 m x 0.7 m x 0.7 m) and placed at four different locations in the river.

Cage no. 1 was set 500 m upstream of the outlet and was used as baseline. Cages no. 2, 3, and 4 were set downstream of the outlet at various intervals (10 m, 50 m, and 100 m at Kakailseo and 10 m, 100, m and 200 m at Gazaria). Five to ten individuals of each specie were put together in each of the cages. The cages were placed within the turbidity plume for five to six consecutive hours and were lifted at intervals of approximately two hours to observe the fish.

Surviving fish were numbered and dead fish were examined. Two series of experiments were carried out at both Kakailseo and Gazaria. Experiment 1at Gazaria was carried out from 5 March 1996 to 7 March 1996 and experiment 2 from 14 March 1996 to 16 March 1996. At Kakailseo, experiment 1 was carried out from 18 April 1996 to 20 April 1996 and experiment 2 from 10 May 1996 to 12 May 1996. Three replications of each series were conducted, each one with a different conditioning time (the time the fish were kept in cages in an undisturbed area before the actual turbidity experiment would start). All the fish required for one series of experiments were caught and put in cage on day 1; then one replication was carried out each day for three days. Fish had either one hour, one day, or two days conditioning time. Due to lack of consistency in the experimental design, it was not possible to carry out a statistical analysis of the data. Tables 3 and 4 present the details of the experiments.

Table 3: Kakailseo Experiment 1 and 2

Cage No.	Distance from Dredge	Water Colour	Average Temperature	Dissolved Oxygen	Secchi Disk
1	500 m upstream, 1 m depth, and 5 m from river bank. Kept at the bottom.	light turbid/cloudy	80 F	6.4 ppm	26 cm
2	10 m downstream, 1.5 m depth, and 7 m from river bank.	very cloudy/turbid	26.7 C	7.9 ppm	18 cm
3	50 m downstream, the experi-mental cage was kept near the surface.	more or less turbid	26.7 C	5.1 ppm	24 cm
4	100 m downstream, the experimental cage was kept at mid-depth.	light turbid	27.2 C	6.1 pm	26 cm

Table 4: Gazaria Experiment 1 and 2

Cage No.	Distance from Dredge	Water Colour	Average Temperature	Dissolved Oxygen	Secchi Disk
1	500 m upstream, 5 m from river shore. Cage was set at mid-level.	light turbid	28.9 C	5.1 mg/l	102 NTU
2	10 m downstream,	very cloudy/ turbid	28.3 C	4,5 mg/l	3280 NTU
3	100 m downstream, 10 m distance from riverbank.	-	28.3 C	4,4 mg/l	1936 NTU
4	100 m downstream, the experimental cage was kept at mid-depth	light turbid/cloudy	28.3 C	4,8 mg/l	1100 NTU

2.2.2 Results

Very turbid water (10 m from outlet) was found intolerable only when fish were submitted to extended exposure; this situation is unlikely since fish would naturally swim away from such areas. In addition, field observations indicated that only small areas near the shore were exceedingly turbid. Detailed results are provided below and in Tables 5, 6, 7, and 8.

Results for short exposure periods (1 or 2 hours) associated with a short conditioning time (30 minutes to 18 hours) are probably the most indicative of actual effects. Fish are mobile and can easily avoid affected areas; they will move quickly to safer places. Short exposure experiments indicate very little difference between upstream and downstream survival rate. Out of a total of 240 fish exposed for 1 or 2 hours to different turbidity levels (different distances), 235 survived (98%) while 100% survived in the upstream control area.

For long exposure periods (3.5 up to 6 hours) and short conditioning time, there was no significant difference between the control group and the exposed fish. On the whole, 73% (58 out of 80) of the upstream non-exposed fish survived, while the survival rate was 72% (170 out of 240) for exposed fish.

For the longer conditioning time, the pattern was slightly different. For short exposure periods, 85.8% (67 out of 78) of the upstream non-exposed fish survived while the survival rate was 72.2% (169 out of 234) for the exposed fish (78% when excluding the station located 10 m downstream of the outlet). For the upstream non-exposed fish 36% (28 out of 78) survived the long exposure periods while the survival rate was 28% (65 out of 234) for the exposed fish (34% when excluding the station located 10 m downstream of the plume). Fish were clearly influenced by the experimental settings. The mortality rate increased with the conditioning time through the replications of each series of experiments. Fish were suffering from being kept in a cage as much as from being exposed to turbidity.

When considering all the conditioning times for the stations 10 m downstream of the outlet, 93% (147 out of 158) of the upstream non-exposed fish survived the short periods while the survival rate was 78% (124 out of 158) for the exposed fish.

When considering only the stations located at a distance greater than 100 m with no respect to the conditioning time, the results show that 54% (86 out of 158) of the upstream non-exposed fish survived the long exposure periods while 59% (93 out of 158) of the exposed fish survived. For short exposure, there is a very little difference: 93% (147 out of 158) of the upstream non-exposed fish survived the short exposure periods while 87% (137 out of 158) of the exposed fish survived.

Visual examination of fish (dead and alive) indicated that direct impact (such as clogging of gills) was found only at the 10 m downstream stations, where very high turbidity was recorded. Mortality at other stations was probably related to captivity.

In conclusion, the turbidity tolerance tests conducted following a short conditioning time showed that for short exposure periods, there is a very high survival rate: 98% of all fish exposed to different turbidity levels for 1 or 2 hours survived. Even exposed to high turbidity (10 m from outlet), 95% survived. For longer periods, there is no difference between the survival rate of upstream non-exposed fish and the one of exposed fish.

Table 5: Turbidity Tolerance Test in Kakailseo - Summary of Results (Experiment 1)

Conditioning time : 1 hour

Location	Survival following different exposure periods(# of fish)				
	Species	0 hour	1 hour	3 hours	5 hours
500 m up from outlet	*Puti*	10	10	9	7
	Gulsha	10	10	10	9
	Total	**20**	**20**	**19**	**16**
10 m downstream from outlet	*Puti*	10	8	8	6
	Gulsha	10	10	10	5
	Total	**20**	**18**	**18**	**11**
50 m downstream from outlet	*Puti*	10	10	10	8
	Gulsha	10	10	10	7
	Total	**20**	**20**	**20**	**15**
100 m downstream from outlet	*Puti*	10	10	10	10
	Gulsha	10	10	10	10
	Total	**20**	**20**	**20**	**20**

Conditioning time : 24 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	1 hour	3 hours	5 hours
500 m up from outlet	*Puti*	5	5	5	3
	Gulsha	5	5	5	2
	Total	**10**	**10**	**10**	**5**
10 m downstream from outlet	*Puti*	5	5	5	1
	Gulsha	5	5	5	2
	Total	**10**	**10**	**10**	**3**
50 m downstream from outlet	*Puti*	5	5	5	3
	Gulsha	5	5	5	4
	Total	**10**	**10**	**10**	**7**
100 m downstream from outlet	*Puti*	5	5	5	5
	Gulsha	5	5	5	5
	Total	**10**	**10**	**10**	**10**

Conditioning time : 48 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	1 hour	3 hours	5 hours
500 m up from outlet	*Puti*	5	5	4	1
	Gulsha	5	5	5	0
	Total	**10**	**10**	**9**	**1**
10 m downstream from outlet	*Puti*	5	5	3	0
	Gulsha	5	5	4	2
	Total	**10**	**10**	**7**	**2**
50 m downstream from outlet	*Puti*	5	5	0	0
	Gulsha	5	5	3	2
	Total	**10**	**10**	**3**	**2**
100 m downstream from outlet	*Puti*	5	5	0	0
	Gulsha	5	5	2	0
	Total	**10**	**10**	**2**	**0**

Table 6: Turbidity Tolerance Test in Kakailseo - Summary of Results (Experiment 2)

Conditioning time : 18 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	1 hour	2.5 hours	3.5 hours
500 m up from outlet	*Puti*	10	10	6	3
	Gulsha	10	10	8	5
	Total	**20**	**20**	**14**	**8**
10 m downstream from outlet	*Puti*	10	8	4	0
	Gulsha	10	10	7	4
	Total	**20**	**18**	**11**	**4**
50 m downstream from outlet	*Puti*	10	10	8	6
	Gulsha	10	10	10	7
	Total	**20**	**20**	**18**	**13**
100 m downstream from outlet	*Puti*	10	10	7	5
	Gulsha	10	9	9	6
	Total	**20**	**19**	**16**	**11**

Conditioning time : 18 + 24 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	1 hour	2.5 hours	3.5 hours
500 m up from outlet	*Puti*	5	4	3	3
	Gulsha	5	5	4	3
	Total	**10**	**9**	**7**	**6**
10 m downstream from outlet	*Puti*	5	2	0	0
	Gulsha	5	3	3	0
	Total	**10**	**5**	**3**	**0**
50 m downstream from outlet	*Puti*	5	5	3	3
	Gulsha	5	5	2	2
	Total	**10**	**10**	**5**	**5**
100 m downstream from outlet	*Puti*	5	4	3	2
	Gulsha	5	5	3	3
	Total	**10**	**9**	**6**	**5**

Conditioning time : 18 + 48 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	1 hour	2.5 hours	3.5 hours
500 m up from outlet	*Puti*	6	4	3	1
	Gulsha	4	4	3	2
	Total	**10**	**8**	**6**	**3**
10 m downstream from outlet	*Puti*	6	0	0	0
	Gulsha	4	2	2	0
	Total	**10**	**2**	**2**	**0**
50 m downstream from outlet	*Puti*	6	4	2	1
	Gulsha	4	4	3	2
	Total	**10**	**8**	**5**	**3**
100 m downstream from outlet	*Puti*	6	3	2	0
	Gulsha	4	3	3	2
	Total	**10**	**6**	**5**	**2**

Table 7: Turbidity Tolerance Test in Gazaria - Summary of Results (Experiment 1)

Conditioning time : 1 hour

Location	Survival following different exposure periods (# of fish)				
	Species	**0 hour**	**2 hours**	**4 hours**	**6 hours**
500 m up from outlet	*Puti*	10	10	10	8
	Gulsha	10	10	10	10
	Total	**20**	**20**	**20**	**18**
10 m downstream from outlet	*Puti*	10	10	8	5
	Gulsha	10	10	10	10
	Total	**20**	**20**	**18**	**15**
100 m downstream from outlet	*Puti*	10	10	10	8
	Gulsha	10	10	10	9
	Total	**20**	**20**	**20**	**17**
200 m downstream from outlet	*Puti*	10	10	10	9
	Gulsha	10	10	10	10
	Total	**20**	**20**	**20**	**19**

Conditioning time : 24 hours

Location	Survival following different exposure periods (# of fish)				
	Species	**0 hour**	**2 hours**	**4 hours**	**6 hours**
500 m up from outlet	*Puti*	5	4	4	3
	Gulsha	5	5	5	4
	Total	**10**	**9**	**9**	**7**
10 m downstream from outlet	*Puti*	5	3	2	2
	Gulsha	5	4	4	3
	Total	**10**	**7**	**6**	**5**
100 m downstream from outlet	*Puti*	5	4	3	2
	Gulsha	5	5	4	3
	Total	**10**	**9**	**7**	**5**
200 m downstream from outlet	*Puti*	5	3	3	2
	Gulsha	5	5	4	4
	Total	**10**	**8**	**7**	**6**

Conditioning time : 48 hours

Location	Survival following different exposure periods (# of fish)				
	Species	**0 hour**	**2 hours**	**4 hours**	**6 hours**
500 m up from outlet	*Puti*	5	3	1	0
	Gulsha	5	3	2	1
	Total	**10**	**6**	**3**	**1**
10 m downstream from outlet	*Puti*	5	2	0	0
	Gulsha	5	3	2	0
	Total	**10**	**5**	**2**	**0**
100 m downstream from outlet	*Puti*	5	2	1	0
	Gulsha	5	3	2	0
	Total	**10**	**5**	**3**	**0**
200 m downstream from outlet	*Puti*	5	2	2	0
	Gulsha	5	3	3	1
	Total	**10**	**5**	**5**	**1**

Table 8: Turbidity Tolerance Test in Gazaria - Summary of Results (Experiment 2)

Conditioning time : 30 minutes

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	2 hours	4 hours	6 hours
500 m up from outlet	*Puti*	10	10	9	7
	Tergra	10	10	10	9
	Total	**20**	**20**	**19**	**16**
10 m downstream from outlet	*Puti*	10	10	8	6
	Tergra	10	10	9	8
	Total	**20**	**20**	**17**	**14**
100 m downstream from outlet	*Puti*	10	10	10	7
	Tergra	10	10	10	9
	Total	**20**	**20**	**20**	**16**
200 m downstream from outlet	*Puti*	10	10	10	7
	Tergra	10	10	9	8
	Total	**20**	**20**	**19**	**15**

Conditioning time : 30 minutes + 24 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	2 hours	4 hours	6 hours
500 m up from outlet	*Puti*	5	4	2	1
	Tergra	5	5	3	2
	Total	**10**	**9**	**5**	**3**
10 m downstream from outlet	*Puti*	5	3	1	0
	Tergra	5	3	2	1
	Total	**10**	**6**	**3**	**1**
100 m downstream from outlet	*Puti*	5	4	3	1
	Tergra	5	3	1	1
	Total	**10**	**7**	**4**	**2**
200 m downstream from outlet	*Puti*	5	4	2	2
	Tergra	5	3	1	1
	Total	**10**	**7**	**3**	**3**

Conditioning time : 30 minutes + 48 hours

Location	Survival following different exposure periods (# of fish)				
	Species	0 hour	2 hours	4 hours	6 hours
500 m up from outlet	*Puti*	3	2	0	0
	Tergra	5	4	3	2
	Total	**8**	**6**	**3**	**2**
10 m downstream from outlet	*Puti*	3	1	0	0
	Tergra	5	2	2	1
	Total	**8**	**3**	**2**	**1**
100 m downstream from outlet	*Puti*	3	2	1	0
	Tergra	5	2	2	1
	Total	**8**	**4**	**3**	**1**
200 m downstream from outlet	*Puti*	3	1	1	0
	Tergra	5	2	2	1
	Total	**8**	**3**	**3**	**1**

2.3 Dolphin Observation Program

2.3.1 Observations

The dolphin observation program entailed daily observations by NERP field biologists. In addition to visual observations, interviews with some fishermen and boat owners were conducted.

2.3.2 Results

Not a single dolphin was seen in the river reach downstream of the dredging areas, either before or during the implementation of the project. The dredging activities were carried out in shallow water, while river dolphins concentrate their activities in the deeper sections of the river. There is no evidence that dolphin habitat was modified due to the dredging works.

The mitigation plan for the pilot dredging project included the installation of a bamboo barrier around the dredge. Its main function was to limit the dispersion of suspended sediments downstream. The barrier was also intended to keep aquatic fauna, especially dolphins, out of dredging areas.

There was no evidence of fish being caught by the dredge. Fish can easily avoid disturbed areas in the same way they avoid the large number of motorized boats and other disturbances every day..

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3. ENVIRONMENTAL LESSONS LEARNED

3.1 Sediment Quality

Based on the chemical analysis of sediments collected in the Kalni River in the vicinity of Kakailseo and Gazaria, the alluvium in the Kushiyara River can be classified as uncontaminated. Under North-American or European guidelines, this material can be used for homestead or agricultural purposes without restriction.

3.2 Installation of Bamboo Barrier

The concept of installing a bamboo barrier with a water hyacinth mat around a dredge, to settle sediments suspended as a result of the action of the dredge's cutter head, is totally ineffective and should be abandoned.

However the concept of installing jute curtains in the river downstream of the effluent pipes or channel is very effective, as long as the curtains can withstand the current. The concept merits further consideration and experimentation.

3.3 Effect of Turbidity on Fish

The experiments conducted on the effect of the turbidity plume originating from the confinement chamber outlet indicate that for all practical purpose, the effect is marginal.

3.4 Water Quality

Dredging has a marginal effect on water quality.

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4. EMP COST

The budget allocation for this component is Tk 8,397,000. A total of 21 items have been identified for EMP implementation . The item wise budget allocation is given in Table 9. The budget includes EMP items under the responsibility of the Contractor, bio-physical impacts and their mitigation covered in this Appendix, and socio-economic impacts covered in Appendix J.3.

By December 1996, an amount of Taka 4,022,248 was spent on the EMP. By May 1997, an amount of Taka 4,246,400 is estimated to be needed to complete the work. Budgets, actual expenditures to December 1996 and scheduled expenditures to May 1997 are detailed in Table 9.

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Table 9: EMP Budget and Expenditure as of December 96

Item	Original Budget (Tk)	Expenditure as of Dec/96 (Tk)	Fund Un-utilized (Tk)	Requirement to May/97 (Tk)	Revised Budget (Tk)
1. Cross Drainage & Effluent Outlet	458,000	458,000	0	0	458,000
2. Homestead Damage Repair	114,000	114,000	0	0	114,000
3. Navigation Lighting	171,000	171,000	0	0	171,000
4. Alternate Irrigation	20,000	0	20,000	0	0
5. Road Overpass	20,000	0	20,000	0	0
6. Homestead Settlement	268,000	0	268,000	78,000	78,000
7. Local Institution Strengthening	54,000	2,690	51,310	0	2,690
8. Women's Activities	285,000	221,524	63,476	45,000	266,524
9. NERP Staff Training on Gender	228,000	0	228,000	0	0
10. Women's Labour Group	344,000	0	344,000	76,000	76,000
11. Women's Platform Beneficiary Group	66,000	0	66,000	0	0
12. Platform Protection	290,000	480,375	(190,375)	1,750,000	2,230,375
13. Video Documentary	1,200,000	385,600	814,400	578,400	964,000
14. Monitoring Effect of Turbidity on Fish	200,000	4,530	195,470	0	4,530
15. Crop Compensation	50,000	114,578	(64,578)	0	114,578
16. Bamboo Barrier	2,033,000	120,468	1,912,532	0	120,468
17. Top soil Re-arrangement	400,000	0	400,000	1,447,000	1,447,000
18. Top-soil Quality/Test Monitoring	200,000	158,674	41,320	0	158,674
19. Storage of Sand/Soil Bags and Tarja	1,596,000	1,596,000	0	0	1,596,000
20. Water Quality Monitoring	400,000	194,809	205,191	0	194,809
21. Drainage Outside Kakailseo				272,000	272,000
Total	**8,397,000**	**4,022,248**	**4,374,752**	**4,246,400**	**8,268,648**
Unallocated					**128,352**

APPENDIX J.3: SOCIO-ECONOMIC AND GENDER

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1. THE NATURE OF THE SOCIO-ECONOMIC AND GENDER COMPONENT

This component has included all activities related to socio-anthropological studies, gender assessment and programming, social surveys, public consultations, local institutional assessment, community participation, and social impact monitoring.

The socio-economic and gender component has been integrated throughout the feasibility, implementation, and monitoring phases of the pilot platform project.

Some costs are presented in this appendix, for compensation and wages of labour groups. These costs are included in the EMP expenditures, Appendix J.2, Table 9.

2. SOCIAL AND GENDER PROGRAMMING

2.1 Pre-construction Phase

Between July 1994 and April 1995, the social team assigned for the pre-construction phase of the pilot project consisted of five male COs, supported by two Dhaka-based staff. The social activities consisted of eliciting public participation and identifying some 40 potential disposal sites in the wider Ajmiriganj area.

Between May and October 1995, the social activities consisted of preparation in five communities to:

- develop social criteria for site selection;
- analyze the social profiles of site communities;
- develop the format of village committees in Kakailseo, Gazaria, Shahanagar, and Katkhal;
- analyze the soci3al aspects of the Anandapur *khas* land, including ownership by title, land-use by occupation, and validation of court claims, and
- conduct social studies related to temporary and permanent out-migration, including the availability of female labour during the dry season.

2.2 Construction Phase

It was considered essential to have female staff on site to provide motivation and education to women's' labour and beneficiary groups. Three female COs were posted to the Kakailseo women's' staff house and assigned, along with two male COs, to Kakailseo and Gazaria. The field staff were supported by three Dhaka-based staff through intensive supervision and on-the-job training.

Formal training for the CO staff was provided in "Gender Components in Community Development" and "Village Capacity Building" in November 1995 and June 1996.

During the construction phase, the social team provided the social and gender analysis for NERP's technical staff and the communication linkage between the beneficiaries, the Contractor's site staff, and the female labour groups.

Between November 1995 and August 1996, the social and gender activities at the three construction villages of Kakailseo, Gazaria North, and Gazaria South consisted of:

- applying social criteria to select final sites;

- developing village committees to resolve conflicts related to land dedication, compensation payments, public land-use, and construction labour;

- negotiating agreement on land dedication for chamber and dyke construction and preparing related documentation;

- negotiating the compensation for crops, ponds, fruit trees, earth-fill outside the chamber, installation of pipelines, and house shifting;

- mobilizing female labour through discussion with women's' groups, male village elders, and religious leaders;

- advocating with the Contractor for equitable female labour rates and working conditions, including latrines, tubewells, shelters, and work-site safety;

- public safety education at the work sites at varying stages of dyke construction, and

- supervising village-based contracts for pre-monsoon platform protection using traditional methods.

2.3 Post Construction Phase

In the on-going post-construction period, 2 male and 3 female COs remain assigned to Kakailseo and Gazaria and are supported by 2 Dhaka-based staff..

The current set of social and gender activities were commenced in September 1996 and include:

- at Kakailseo, following the 1996 monsoon period, assist to complete post-construction mitigation measures including ditch filling, topsoil management, soil productivity, development of platform drainage, and public pathways;

- at Gazaria, following the 1996 monsoon period, assist to complete post-construction mitigation measures, including outlet channel closure, soil productivity, development of platform drainage, and public pathways;

- develop local institutional capacity through *thana* committees at Ajmiriganj and Itna and district administrations at Habiganj and Kishoreganj to support the pilot communities;

- develop alternate income-generating projects for 20 women's' labour groups and allocate labour premiums;

- develop protection and maintenance (P&M) training modules for platform beneficiaries and committees and conduct trainers' training for COs;

- train male and female beneficiary groups on land-use planning, topsoil management, soil productivity, plantation, nursery establishment, and P&M;

- train village committees in land-use planning and problem resolution;

- monitor social and gender issues specific to each community.

3. THE SOCIAL CHARACTERISTICS OF SELECTED SITES

The social criteria for the selection of village platform sites included:

- the willingness of the community or parts of the community to dedicate land for development;
- the configuration of public, private, and *khas* land on proposed sites and the relationship of its dedicators, and
- the beneficiaries' proposed use of land on the newly developed platforms.

The social characteristics of the platforms relate to:

- the location of the sites in the total village configuration, and
- the type and relationship of benefits accruing to individual land owners and the community as a whole.

The following is a description of the platform sites and their characteristics in socio-economic terms.

Kakailseo
Kakailseo is a large, squarely configured village, composed of 21 *paras* with approximately 3,000 households (HHs). The new platform is situated in the centre of the village, surrounded by only four *paras* with approximately 800 HHs. The land owners of the new platform consist of the government-affiliated high school and 51 HHs from the adjacent four *paras*.

Gazaria as a Whole
Gazaria is a linearly configured village, consisting of two *paras*, north and south, which were separated by flooding in 1988. The new platform is situated on the western or *haor* side of the existing platforms; it extends along the full length of Gazaria North and one-third the length of Gazaria South. The two adjoining chambers, built to contain the spoil of the two platforms, now constitute a single platform. The project replaces the eroded section and links the two *paras* of Gazaria.

Gazaria North
Gazaria North consists of 110 HHs. The land owners of the new platform consist of all 110 HHs who owned homesteads on the original platform.

Gazaria South
Gazaria South consists of 250 HHs. The new platform lies along one-third the length of the existing platform and therefore provides benefits to only 48 HHs.

Table 1 provides the social characteristics of the village platforms.

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Table 1: Social Characteristics of the Village Platforms

Village	Platform size (ha)	Total no. HHs	Number of beneficiary HHs	Direct benefits (only beneficiary HHs)	Community benefits (all village HHs)
Kakailseo	3.1	*814	51	Expand homestead land for economic benefits (paddy threshing & storage, cattle rearing, tree & vegetable plantation) & health benefits (water & sanitation). Expand school ground for sports and culture.	Create flood-secure monsoon passage to market and school. Communal space for paddy threshing. Flood-secure space for cattle during monsoon.
Gazaria North	3.3	110	110	Expand homestead land, as above. Create space for school and playing field.	Joining of 2 clusters of the same village to provide flood secure passage. Flood secure habitation for near-by villages during monsoon. Flood-secure space for cattle during monsoon.
Gazaria South	1.3	250	48	As for Gazaria North, as above	As for Gazaria North, as above

NOTE: * There are 814 HHs in the 4 *paras* surrounding Kakailseo platform. In all of Kakailseo village there are 21 *paras* and an estimated 3,000 HHs.

4. COMMUNITY DEVELOPMENT

4.1 The Village Committees - A Social Analysis

With facilitation from the COs, village committees were formed in Kakailseo, Gazaria North, and Gazaria South to represent the beneficiary HHs. The committees were selected by the village elite and for the most part, they were composed of the same village elite. Not all members of the village committees were beneficiaries. The committees' composition and significant relationships are discussed below.

The Kakailseo Committee
The Kakailseo committee is composed of 12 members, of whom five members, including Chairman, Secretary, and Treasurer do not own land on the new platform. This committee was selected by an influential person of Kakailseo, who is not a member of the committee but is called upon for final decisions concerning the Kakailseo platform.

The Gazaria North Committee
The Gazaria North Committee is composed of 12 members, all of whom are beneficiaries on the new platform. The village elders decided to appoint a wealthy village elite as committee chairman, even though he was known to be a difficult person with whom to work. Their strategy was to co-opt his support by inclusion, rather than to have to deal with powerful opposition if he was excluded. Following a clan-based dispute in Gazaria North, the committee has become severely divided. As a result the Union Council Chairman is continually called upon to settle disputes relating to the Gazaria platforms.

The Gazaria South Committee
The Gazaria South Committee is composed of five members, formed hurriedly when the decision was made to construct Chamber B. Although all five members have land on the new platform, this committee does not represent the interests of the majority of Gazaria South HHs who do not own land on the new platform..

Gazaria North and Gazaria South Relationship
Following the clan dispute in Gazaria North, the relationship of the two committees deteriorated. At one stage during the construction period, the Gazaria South people were unwilling to allow labour groups or supervisors from Gazaria North onto their platform. This was eventually solved by the committee's discussion.

4.2 The Christian Rumour Issue

In Kakailseo and Gazaria, there was a pervasive rumour that the pilot project's long-term objective was to convert people's religious beliefs to Christianity. It is likely that the Christianity rumour was initiated by a community faction in Kakailseo. It was alleged that NERP staff would build a church and office on the developed platform rather than return the developed land to the rightful owners. The Christianity rumour was aggravated by the people's perception that NERP must have an ulterior motive for developing valuable land, particularly as the beneficiary HHs had not been asked to contribute to platform development costs.

The Christianity rumour diminished the credibility of NERP social staff, particularly in training beneficiary groups on protection and maintenance. Several women's labour groups have refused to meet with the COs for discussion on group savings and income-generation.

The COs' community strategy has included eliciting support from the village committee and religious leaders. By the end of the construction, the intensity of the rumour had diminished. Following the handing over of the developed platform to beneficiary HHs in Kakailseo in June and Gazaria in August, the Christianity rumour has all but disappeared.

5. COMPENSATION

5.1 Community Negotiation and Compensation

The EMP calls for compensating landowners affected by the construction of dredge inlet channels, outlet channels, and platforms. The following payment was provided through the village committees:

At Kakailseo:

- tubewell replacement for domestic water lost as a result of filling a pond within the chamber;
- cash for a garden and trees lost by chamber fill;
- replacement costs for latrines.

At Gazaria North and South:

- cash for standing paddy crop destroyed by dredge inlet and outlet channels;
- cash for crop land purchased to obtain earth to complete the dyke wall;
- cash for standing paddy crop destroyed to obtain earth for an emergency repair of the dredge outlet channel;
- cash for moving houses.

At Gazaria South:

- replacement costs of a road displaced by the chamber wall;
- PVC pipes to tubewell owners to drain water collected as a result of the chamber wall at Gazaria North and South.

5.2 Compensation Costs

The compensation costs at Kakailseo, Gazaria North and Gazaria South are summarized in Table 2 and detailed in Tables 3, 4, and 5:

Table 2: Combined Compensation Payments

AREA	AMOUNT (Tk)
Kakailseo	28,196
Gazaria North	49,017
Gazaria South	60,447
Grand Total Compensation	137,660

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Table 3: Compensation Payment at Kakailseo

Item	No. of persons compensated	Amount (Tk)
Damage to fruit bearing trees	1	20,000
Loss of ponds	1	6,996 (1 tubewell)
Shifting latrines	2	1,200
Total Kakailseo Compensation		**28,196**

Table 4: Compensation Payment at Gazaria North

Item	Owner	Amount of land (decimal)	Rate of compensation (Tk. per decimal)	Amount (Tk)
Compensation for crop to provide earth for dyke	21	85	200.00	17,000
Standing paddy crop compensation for inlet pipe passage and outlet earth drain	21	145	162.50	23,562
House shifting	2	-	500.00 (per unit)	1,000
Haor road construction	-	-		-
Tubewell drainage	5	-	355 ft. pipe @ 21 Tk/ft.	7,455
Total Gazaria North Compensation				**49,017**

Table 5: Compensation Payment at Gazaria South

Item	Owner	Amount of Land (decimal)	Rate of Compensation (Tk per decimal)	Amount (Tk)
Compensation for crop to provide earth for dyke	46	160	162.50	26,000
Standing paddy crop compensation for inlet pipe passage and outlet earth drain	46	75	162.50	12,187
Standing paddy crop compensation for inlet pipe passage and outlet earth drain	46	78	200.00	15,600
House shifting	1	-	500.00 (per unit)	500
Haor road construction	-	-		4,500
Tubewell drainage	1	-	80 ft. pipe @ 21 per ft.	1,660
Total Gazaria South Compensation				**60,447**

5.3 Compensation Issues

Kakailseo
Compensation issues of interest in Kakailseo include the following:

- within the Kakailseo chamber there was sufficient earth for chamber wall construction, and therefore no compensation was required for crop loss outside the chamber;
- no compensation was paid for crop loss within the chamber because farmers were informed not to plant *rabi* crops;
- no compensation was required for dredging lines because the inlet channel was built on *khas* land and the outlet channel was built through an existing drainage channel;
- in the post-monsoon period, further costs will be incurred to correct the drainage problems caused by the construction of the platform. This will consist of filling and draining the large ditch in front of the eastern *para* and the smaller low area on the south-west corner of the platform.

Gazaria
Compensation issues of interest in Gazaria include the following:

- no compensation was paid for crop loss within the chamber because farmers were informed not to plant *rabi* crops;

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- as a result of the 14 low-lying ditches and the narrowness of the Gazaria South chamber, there was insufficient earth within the disposal chamber for the construction of the long perimeter dyke. Therefore, much of Gazaria's compensation cost was paid for crop loss outside the dyke to obtain the earth needed for chamber construction;

- as the platform was built approximately 400 meters in from the river, crop compensation was required for the long passage of the dredge inlet and outlet channels.

- crop compensation to obtain earth was required to repair a breach on the dredge outlet channel. As the standing crop was at a mature stage at this time, the land owners demanded a higher compensation rate;

- moving costs were incurred for houses that were obstructing construction of the dyke and village road;

- costs were incurred for draining existing tubewells caused by the construction of the chamber wall;

- costs were incurred to construct an earthen closure at the east end of the village road to prevent inundation from monsoon water;

- most of the HHs of Gazaria had *katcha* latrines on the *haor* side of the existing platform which were used temporarily during the dry season. NERP has not compensated for shifting these latrines during the platform construction because the resettlement plan calls for the provision of permanent, shared-cost latrines on the new platform;

- NERP has not compensated Gazaria HHs for dry season domestic water resource loss because the resettlement plan provides the construction of shared-cost tubewells after the platform has undergone enough settling.

6. WOMEN'S LABOUR GROUPS

6.1 The Enhanced Social and Gender Program

The contract for chamber construction stipulated that the Contractor was to use the maximum amount of local labour, of which 20% should be women. Nevertheless, there was scepticism as to the acceptability of engaging women in construction in the traditionally conservative area of Sylhet.

To implement this activity, NERP undertook a number of pro-gender activities through the Enhanced Social and Gender Program.

6.2 Motivation and Recruitment

During the preparatory stage, the availability of women's labour on a seasonal basis was documented. It was estimated that approximately 300 women, organized under groups with a traditional labour leader, would be available for earth-cutting during the dry season.

To recruit women's labour groups for each construction site, female and male COs discussed with women labour leaders and their male guardians to allay apprehensions related to working in construction for a Contractor who was not locally known.

6.3 Construction

In the context of the Enhanced Social and Gender program, support was targeted to the 21 female labour groups who came from Kakailseo, Gazaria, and six neighbouring villages, travelling distances up to three kilometres to work on sites on either side of the river. Women's groups were engaged in construction during the following periods:

- the Kakailseo site between November 1995 and January 1996;
- the Gazaria North site (Chamber A) between January and March 1996;
- the Gazaria South site (Chamber B) between March and April 1996.

6.4 Women's Labour Group Advocacy and Education

The Contractor and his staff had limited acquaintance with women in the working area. Aware of the need to engage 20% female labour, the Contractor was dependant on the female COs to relate directly with female labour in recruitment and problem solving on site.

Female and male CO staff worked closely and cordially with the Contractor and his field staff to promote and monitor adequate working conditions for female labour on all three construction sites. The following issues were frequently negotiated with the Contractor:

- promote the 20% quota for female labour;
- encourage the provision of adequate "work-fronts" for female groups at the sites;

- teach female labour the techniques of earth measurement and payment calculation;

- monitor the payments to female groups;

- promote the payment of equal wage rates for work of equal value (discourage the sub-contract basis of engagement which paid wage on a daily basis rather than on a volume basis);

- promote wage rates on the basis of volume, including differentiation for earth-cutting conditions (water seepage), carrying distances, and heights;

- promote the provision of tubewells, latrines, shelters, medical facilities, and night transportation for female labour groups.

6.5 Women's Labour Group Participation

The contract called for the maximum use of local labour, of which 20% should be female labour. Wage and working conditions and labour statistics groups were monitored.

- all of the labour utilized for chamber construction were local men and women;

- the 20% female labour quota has been exceeded; 23% of the total chamber construction labour force were women.

Female labour statistics are highlighted in Table 6:

Table 6: Female Labour Participation
(Data to May 1996)

Construction site	No of days worked	No of female groups engaged	Total No of female labour engaged	Total no. of male labour engaged	Total labour engaged	% of female labour engaged on 3 sites
Kakailseo	52	7	3,701	13,692	17,393	21.28
Gazaria A	31	8	2,744	23,967	26,711	10.27
Gazaria B	60	21	7,704	10,602	18,306	42.08
Total	**143**	**21***	**14,149**	**48,261**	**62,410**	**22.67****

NOTES: * 21 labour groups participated in the construction work on 3 sites.
** Female labour participation has been rounded to 23 %. It is a cumulative figure composed of both direct and sub-contracted labour engagements.

6.6 The Issue of Minimizing Women's Labour Through Male Sub-contracting

Through field studies in the preparatory stage, the COs had become aware of local methods of female labour contracting. There was a strong tendency for the village committees in Kakailseo and Gazaria to provide the COs with lists of female labour groups with the expectation that the committees could become sub-contractors for the groups.

The COs remained active throughout the construction phase to monitor the terms of women's labour engagements. Female labourers were engaged in two different ways: hired directly by the Contractor and sub-contracted to a local, male sub-contractor.

On the Kakailseo site the social team was able to promote direct engagement of female labour by the Contractor, rather than through local committees. On the Gazaria sites, the Contractor's staff favoured the use of village labour sub-contractors because they were easier to supervise.

On labour sub-contracts, female labourers were always paid on a daily rather than volume basis. Females' daily wage was always lower than that of men, on the assumption that women worked less because they took frequent breaks for domestic tasks. Although the social staff have protested the Contractor's use of local male sub-contractors to engage female labour, NERP's contract did not have any formal mechanisms to control these practices by the Contractor.

6.7 Women's Labour Group Monitoring and Payment

Tables 7, 8, 9, 10, and 11 relate to the terms of engagement of female labour at the Kakailseo and Gazaria sites. They describe both direct hire by the contractor and labour sub-contracting.

**Table 7: Female Wage Rate - Direct Hire by the Contractor
Kakailseo, (Data to May 1996)**

Period	Wage rate (Tk)	Wage paid to male (Tk)	Wage paid to female (Tk)	Nature of work	Remarks
21.11.95 to 4.12.95	500 per 1,000 ft^3	500	500	Earth cut and carry on dyke construction	
5.12.95 to 16.12.95	650 per 1,000 ft^3	650	650	,,	
21.12.95	Daily basis	50	30	Levelling dyke	
9.2.96 to 16.2.96	700 per 1,000 ft^3	900	700	Earth cut and carry on dyke	Men carried greater distance
Mid-Feb to mid-April 96	2 per bag	2	2	Sand bag filling	500 bags were filled

NOTE: In Kakailseo no work was done through the sub-contracting system.

Table 8: Female Wage Rate - Direct Hire by the Contractor Gazaria North, (Data to May 1996)

Period	Wage rate (Tk)	Wage paid to male (Tk)	Wage paid to female (Tk)	Nature of work
8.1.96 to 30.1.96	700	700	700	Earth cut and carry on dyke construction
5.2.96 to 8.2.96	700	700	* No female labour was hired during the period	,,

NOTE: *Male labour preferred to complete the last stages of construction.

Table 9: Female Wage Rate - Direct Hire by the Contractor Gazaria South, (Data to May 1996)

Period	Wage rate (Tk)	Wage paid to male (Tk)	Wage paid to female (Tk)	Nature of work	Remarks
10.3.96 to 27.3.96	700	700	700	Earth cut and carry on dyke construction	
1.4.96 to 10.4.96	800	800	No female labour was hired during the period	,,	Height and distance of earth carry was considered too great for female labour

Table 10: Female Wage Rate - Sub-contract to Villager Gazaria North, (Data to May 1996)

Period	Wage rate (Tk)	Wage paid to male (Tk)	Wage paid to female (Tk)	Nature of work	Remarks
15.1.96 to 28.1.96	Intra-village arrangement on daily basis	2 per linear ft.	30 per day	Earth levelling on dyke wall	Only Gazaria female labour. They worked fewer hours per day
1.2.96 to 8.2.96	,,	,,	,,	,,	,,

NOTE: When the sub-contractor hired female labour from his own village, lower female wage rates could neither be influenced by negotiation from labour outside the village nor from labour advocacy by the NERP COs.

Table 11: Female Wage Rate - Sub-contract to Villager
Gazaria South, (Data to May 1996)

Period	Wage rate (Tk)	Wage paid to male (Tk)	Wage paid to female (Tk)	Nature of work	Remarks
1.4.96	Intra-village arrangement on daily basis	50	30	Earth levelling on dyke wall	Only Gazaria labour. Rate differed on height of dyke wall
2.4.96/ 10.4.96	,,	50	35	,,	,,
11.4.96	,,	50	35	Earth work on out-let channel	Only Gazaria labour. Rate differed on distance of earth carry
12.4.96 /15.4.96	Female labour sub-contract by BASIC & negotiated by female COs	2,800 per 1,000 ft^3	2,800 per 1,000 ft^3	,,	Emergency earth work on out-let channel
16.4.96 /30.4.96	Intra-village arrangement on daily basis	80	50	Road levelling	Only Gazaria labour. Rate differed on distance of earth carry
12.5.96	,,	80	50	,,	,,

NOTE: When the sub-contractor hired female labour from his own village, lower female wage rates could neither be influenced by negotiation from labour outside the village nor from labour advocacy by the NERP Cos.

6.8 The Impact of Earth Construction Work on Women's Labour Groups

The construction of three disposal chambers has provided an income-earning opportunity for approximately 300 women over a four month period during the dry season of 1995 - 1996.

As a result of the labour opportunity afforded to them on construction sites, women labour leaders and workers have reported the following impacts:

Income-Earning in Construction
Although agricultural labour opportunities are intermittently available in the dry season, women labourers report the following major benefits from the consistent income they have earned in construction:

- in other years, women labourers were obliged to take high interest loans at the end of the dry season, principally for family food expenditures. This year they did not have to borrow from moneylenders until late in the monsoon season;

- group members from nine out of the 21 labour groups involved have been able to make savings for investment in such income-earning activities as duck rearing and cultivation of paddy, chilli, and sweet potato on leased land.

Knowledge Gained
Women's labour groups report that they have gained new knowledge from their experience on the construction sites. They have improved skills in:

- construction of dykes, roads, and channels, including earth cutting, earth carrying, compacting, dressing, and turfing plantation;
- earth measurement and payment calculation based on volume;
- labour rate negotiation, based on the work-face, the carry distance, and the cutting conditions, and
- labour negotiation by direct contract with the Contractor and sub-contracts made with local labour leaders.

Confidence Gained
Through their experience as construction labour, women have gained the confidence to:

- establish their position in the construction labour market by having confidence to measure earth volumes, negotiate rates and payments and work under different labour arrangements including mixed groups, and
-

seek labour opportunities beyond their own villages by travelling greater distances and across the river to unknown villages.

6.9 The Potential for a Women's Labour Contracting Society

The capacity of female labour groups to work well under their own sub-contracting arrangement was demonstrated by their work on the Gazaria outlet channel. As this work was considered an urgent repair, the Contractor requested NERP social staff to mobilize and supervise the female labour groups. Labour rates were negotiated on the basis of volume and raised to Tk. 2,800 per 1,000 ft^3 to provide incentive for quick completion of the work. Approximately two hundred women in nine labour groups worked for five days and several late nights to complete the work within the construction deadline. Knowing that they had a fairly-paid, volume-based contract, women arranged their time to cover their domestic duties. The contractor was pleased with the quality of the work and the capacity of women sub-contractors to meet the completion deadline.

7. PROTECTION AND MAINTENANCE - SOCIAL ASPECTS

7.1 Protection and Maintenance at the Completion of Construction

Following completion of the Contractor's involvement in construction and basic protection of the dykes, NERP have assumed direct management for the P&M work on both platforms during the first monsoon period.

Gazaria
The design for platform protection on the outside of the dyke initially consisted of up-right *tarja* walling and hessian cloth, interspersed with flood-tolerant saplings. It was held in place by bamboo strips. Constructed by the main Contractor, this protection was severely damaged by wave erosion in the monsoon's first storm on 7 June.

NERP then revised the protection design, based on the methods traditionally used for platform protection of *haor* communities. In Gazaria North and South, three village leaders, who are also platform beneficiaries, were contracted for construction of the revised platform protection. They used the traditional method known as *aar bandh*. This consisted of applying layers of tightly packed vegetative material closely against the earthen slope of the platform and holding the material in place by a bamboo frame. At this late stage in the season, it was impossible to obtain adequate quantities of *chailla* grass, which provides the best protection. However small amounts of *chailla* and *dhol kolmi* were used along with a large amount of *kochuri panna* vegetation. The local contractor was able to quickly mobilize the labour and boats necessary to acquire the vegetative materials and install the bamboo frame, at times working underwater at the toe of the dyke. NERP social and engineering staff have administered the protection contract for the Gazaria platform during the period July - October 1996.

Kakailseo
As Kakailseo is considerably less vulnerable to monsoon wave erosion than Gazaria, the *tarja* walling provided as platform protection was effective. For the first monsoon season (end October 1996), a four person maintenance crew, consisting of two men and two women, were locally hired for strengthening the *tarja* walling and providing routine protection and repair work for rain cuts and drainage. NERP social and engineering staff have directly managed the P&M for the Kakailseo platform in the period July - October 1996.

7.2 Follow-up Mitigation Activities

The follow-up P&M activities started in January 1997 and were completed by April 1997. They consisted of completion of platform mitigation, including topsoil management, soil productivity, and development of platform drainage and public pathways. At Kakailseo, a large and a small ditch were filled. At Gazaria, dismantling and storage of platform protection materials and closure of the outlet channel were completed.

7.3 Follow-up Protection and Maintenance

The social and gender activities will included:

- developing local institutional capacity by working with the *thana* Committees in Ajmiriganj and Itna and the District administration in Habiganj and Kishoreganj for support of the communities' platform maintenance and improved use;
- strengthening the three village committees to manage conflict resolution associated with resettlement of the improved platform;
- trainers' training for COs to deliver P&M training modules for village platform beneficiaries, and
- training male and female beneficiary groups (organized by neighbourhood *para*) in land-use planning, soil productivity, nurseries and plantation, and platform P&M.

7.4 Follow-up for Women's Labour Groups and Beneficiaries

Twenty women's labour groups were supported through group strengthening, training in income-generating skills, and allocation of labour premiums for alternate income opportunities.

Women who are household beneficiaries on the new platforms will be supported through training in nutrition and kitchen gardening, water and sanitation, and platform P&M. P&M training will include cultivation of flood tolerant saplings, grasses, and shrubs.

7.5 Follow-up Homestead Resettlement

For HHs owning land on the newly developed platforms, resettlement activities will include training in land-use planning and soil productivity.

7.6 Follow-up Resettlement of Homesteadless Families

Gazaria
The village committee at Gazaria North has committed to resettle 12 families on the extended platform space. These HHs had lost their homestead land from the 1988 flood but they did dedicate the agricultural land which they still owned in the disposal site.

The resettlement of homesteadless families at Gazaria was completed.

Kakailseo
The resettlement of six families without homestead land is expected to be problematic at Kakailseo, despite the fact that NERP has a verbal commitment from the village committee and the major power broker.

In Kakailseo the six families to be resettled neither owned nor were able to dedicate land or "eroded space" for new platform construction. These six female household heads have no customary claim to new platform settlement but may be settled on a charitable basis.

8. SOCIAL AND GENDER LESSONS LEARNED

8.1 Community Cost Sharing for Platform Development and Maintenance

As perceived by the public in riverine communities, a major lesson learned from the pilot project was the value of extending village platforms. In the *haor* area of Bangladesh, no resource could carry greater value than the creation of high land. At the pre-selection stage, all of the villages surveyed in a 24 km river reached were willing to utilize disposal spoil to raise and extend existing village platforms. In the pilot sites of Kakailseo and Gazaria, the community response has been one of overwhelming acceptance and demonstrated utility of raised and extended platform space.

The pilot project has demonstrated the platforms' technical viability and community acceptance. The pilot project was not designed to test concepts of community cost-sharing beyond the dedication of land for development. The extent to which cost-sharing will be feasible will be tested in Kakailseo and Gazaria through attempts to elicit community contributions for P&M. However, a difficult precedent must be overcome. To date, benefiting HHs have been provided with this valuable resource without cost.

For future platform construction and development projects, a cost-sharing policy could be developed. This could include contributions of cash, material, or labour for construction of the disposal chamber, land donations for settling homesteadless HHs, and payment of a land improved land tax to government bodies. At the very minimum, future projects must develop the cost-sharing mechanisms for platform protection and maintenance.

8.2 Land Dedication Agreements - the Community and NERP

The agreement which NERP signed with the village committee to obtain land for platform development merely indicated that certain land owners were providing particular numbered plots of land to NERP for construction of a platform. Upon completion of the work, NERP agreed to return the developed land to its owner. The term "land dedication" most accurately describes this type of agreement.

The multiple number of owners and the contested nature of some plots made it inadvisable for NERP to enter into separate agreements with individual landowners. Therefore, land dedication was agreed between NERP and the village committee who signed on behalf of the landowners. In the same way, the developed platform was returned to the committee for distribution to the landowners.

The written agreement which NERP had with the village committee was weak in the following ways:

- issues of liability were not addressed;
- the obligations of the land dedicators were not outlined;

- the legal base of the agreement may be in question because the agreement was signed by a village committee which was not formally constituted.

In future platform projects, agreements made with the land owners should address the following issues:

- liability - in the case of a major breach of the confinement chamber, resulting in the deposit of sandy material on agricultural land, the project's obligation to pay compensation should be defined. Compensation will be required for both platform land dedicators and non-platform land dedicators who own agricultural land outside the platform.

- responsibilities of platform beneficiaries - depending on the project's policy for cost-sharing, the agreement could specify household and community obligations to develop the disposal chamber, protect and maintain the platform, donate developed land to homesteadless HHs, and pay an improved land tax to government bodies.

- the legal foundation of the agreements - in light of the village committee's informally constituted nature. Consideration should be given to having the agreement with the village committee voted by a *thana* committee and the district administration. In cases where *khas* land is being developed, the Ministry of Land Administration and Land Reform must to be involved. Where platform developments will effect roads, culverts, and other municipal structures, a government department such as the Local Government Engineering Division must vet the agreement. They can be represented on a *thana* committee.

8.3 Site Selection, Platform Alignment, and Community Planning

The case of the Kakailseo drainage ditch illustrates problems related to site selection, platform alignment, and the community's role in planning. The post-construction drainage problem outside the platform has its origins in the dispute over site selection within Kakailseo and is related to the power relationships in the village. The problem was aggravated by other necessary changes in the platform alignment and the committee's incapacity to deal with these problems in the greater community.

Scheduling in future projects should consider:

- scheduling construction of civil works with adequate lead time for community-based discussion and consensus;

- presentation of alternate engineering designs and alignments for community discussion well ahead of the construction schedule;

- finalizing platform design and alignment only after all *paras* have been consulted regarding shared civic facilities such as drainage ditches, roads, irrigation canals, *ghats*, graveyards, and access to markets and schools, and

- thorough discussion on shared civic facilities with all *paras* of the community, regardless of whether they are direct project beneficiaries.

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8.4 Village Committees

A committee, constituted by the community in the form they find to be locally expedient, is the essential institutional body for management of the village platform.

Depending on the size of the village, its configuration, the amount of land to be filled, and the distribution of HHs receiving developed land, the committee's functional level will be improved by having a majority of platform beneficiary members. Non-benefiting *paras* of the community should be represented on the committee. Most importantly, the committee will only be effective when it can command support from the village's politically influential leadership.

Based on the pilot experience in all three communities, the committees' performance in problem resolution related to site selection, land dedication, and compensation negotiation was weak. Committees suffered from the following problems:

- inability to make civic decisions outside their personal or political interests;
- ineffective use of the training they had received;
- committee members tended to discuss with ad-hoc sections of the community rather than with platform beneficiaries or dissenting *paras*;
- committee members tended to interpret concrete technical or social information only in the context of their political or personal interest.

Within the political context of the local power structures, village committees can be strengthened in the following ways:

- structure a committee based on "platform use", drawing from the experience of "user-societies" in Bangladesh. The majority of members should consist of direct platform beneficiaries with representatives from other *paras* who utilize the platform for communal benefits;
- develop committee guidelines, outlining membership structure, selection procedures, change of committee procedures, obligations, and responsibilities;
- provide phased, facilitated training for committees including roles and responsibilities, communication, civic works, and land-use planning;
- train the committee to facilitate training to benefiting HHs and the larger community on a regular basis, using the defined content of a training module;
- provide committee members with a moderate honorarium for a few years in order to reduce their expectations to earn through construction labour or material contracts;
- provide village committees with comprehensive information regarding engineering design and alignment well ahead of the construction period;

- encourage committees to take the lead in arranging ceremonial functions and visitor tours to the platforms.

8.5 Land Acquisition

The pilot project was not designed with land acquisition in mind. Most cases were adequately handled either by land dedication during the construction period or by crop compensation paid on a one-time basis to acquire earth.

In future platform construction, the following issues related to land acquisition may be of interest:

- the pilot project did not experience the situation where a landowner would be asked to provide land without receiving a benefit from the platform. This would be the case in instances where an owner had land "under the chamber wall" but not on the platform.

- in Gazaria, the security of the platform will be greatly enhanced by extensive plantation outside the western wall. This long strip of *haor* land is owned by several cultivators who do not necessarily own land on the platform. Although it will be the responsibility of platform beneficiaries to provide protection for "their section" of dyke wall, they will not be allowed to plant on others' land. To ensure consistent plantation for the Gazaria platform, NERP may have to provide long-term compensation for crop loss along the toe of the western dyke. In future projects, land for a plantation program should be an integral part of the platform size.

- the case of re-housing 6 homesteadless families on the Kakailseo platform provides an example of the need for land acquisition. Unlike the Gazaria case for re-housing, the initiative for re-housing in Kakailseo did not come from the land dedicators but rather was a "one-off" request by landless families to the CIDA Mission in 1995. Although the committee has promised to resettle six HHs on a *khas* plot on the platform, those occupying the land may be unwilling to vacate the land for homesteadless families.[1]

for future projects, it may be possible to acquire private *haor* land through the government for the construction of platforms for landless communities. A second option would be to resettle landless HHs on *khas* land. This would likely require the support of powerful judicial and executive government machinery.

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In Kakailseo a common practice for land acquisition includes buying both agriculture and homestead land from impoverished female heads of household. Depending on the magnanimity of the acquiring landlord, such homesteadless households may then be temporarily and minimally accommodated on the owner's land. Women thus settled find the use of space on others' land to be so inadequate and insecure that they dare not risk any investment in kitchen gardening or poultry rearing.

8.6 Women's Labour Groups

An Entry Point

Although in the early planning stages there was scepticism concerning the involvement of women in the conservative Sylhet region, the pilot project experience demonstrates the viability of engaging local women for construction in the *haor* areas. Targeting poor women through labour opportunities was not viewed as a threat by the area's major power brokers. About 23% of construction labour was composed of women, eager for an income-earning opportunity.

Following such an ideal entry point, comprehensive gender-based initiatives can be developed to contribute to women's long-term development in remote riverine and *haor* areas.

An Impact

The labour opportunities provided by earth construction have been utilized by landless and destitute women to provide a consistent earning over four months, reduce dependence on money lenders in the months before the monsoon season, learn new skills related to earth construction, and gain confidence for greater participation in the labour market.

In the future, the economic impact on women's labour groups can be strengthened through an early beginning in their development of a savings program. To build these groups, social staff will require six months lead time before the construction begins.

Formal Mechanisms to Support Female Labour in Construction

The design of the pilot project lacked formal integration of the chamber construction component with the pro-gender component to promote female labour in chamber construction.

The construction contract had been awarded to a Contractor and as such, NERP's formal position with the Contractor did not allow for any particular monitoring or support for female labour groups. Nor did the contract itself have any penalty clauses that could be used to protect the women's labour quota, the terms of their engagement, or the working conditions.

The lack of formal integration of the pro-gender component into the construction contract resulted in an ambiguous relationship between NERP's engineers and the social team. The engineers' formal dealings with the Contractor did not include a pro-gender component. The social team was expected to promote the female labour quota without a structural relationship with the Contractor.

Strengthening the female labour component in future projects will require either:

- contractual quota clauses specifying female labour participation directly to the contractor;
- contractual penalty clauses for not meeting female labour quotas, the labour organizational forms of female participation, and working conditions on-site including medical treatment, and

- formalization of the implementing agency's process for monitoring, reporting, and taking remedial action related to female labour groups.

Or alternatively, labour arrangements could be changed in future projects to include:

- all chamber construction contracted to local labour societies and managed directly by the implementing organization;

- female labour groups negotiating their own wage as a female-managed labour contracting society. Based on the example of women's construction work on the Gazaria outlet channel, female labour groups can independently organize themselves to work efficiently and on schedule, and

- raising the female labour participation target for chamber construction and platform dressing and protection to 40% through female-managed labour groups.

A Pro-Gender Support System
The participation of female labour groups in a male-dominated infrastructure project requires a pro-active gender attitude on the part of the implementing agencies. The pilot project experience indicates that participation of female labour groups in the male-dominated construction sites was supported by:

- a contractual clause stipulating a quota of 20% female labour in construction;
- an intense field presence of trained female staff, and
- skilled advocacy training activities from a gender-orientated staff.

Strengthening the female labour component in future projects will require the additional support of:

- a thorough gender orientation for the infrastructure agencies and the contractor, and

- on-site review workshops during the construction period with all concerned implementing parties.

8.7 Social Monitoring

Social monitoring, when interpreted in the strictest sense, should mean recording social observations. This was not feasible for the pilot project as in all cases, social monitoring was applied with some form of interaction or interpretation. Social monitoring and implementation was done by the same group of workers.

In future platform projects, the social monitoring component should remain integrated with social implementation. Applied social monitoring will include the problem-solving element necessary for implementation.