Government of the People's Republic of Bangladesh
Ministry of Water Resources

River Bank Improvement Program (Phase I)

ENVIRONMENTAL AND SOCIAL ASSESSMENT

EXECUTIVE SUMMARY

March2015

Contents

List of Tables and Figures

List of Acronyms

ADB	Asian Development Bank
BDT	Bangladesh Taka
BOD	Biological Oxygen Demand
BRE	Brahmaputra Right-bank Embankment
BSM	Brahmaputra system model
BWDB	Bangladesh Water Development Board
CEAP	Construction Environmental Action Plan
CIIA	Cumulative and Induced Impact Assessment
CNGO	Coordinating Non-governmental Organization
COD	Chemical Oxygen Demand
CPR	Common Property Resources
CSC	Construction supervision consultants
DoE	Department of Environment
ECA	Environmental Conservation Act
ECC	Environmental Clearance Certificate
ECoP	Environmental Code of Practice
ECR	Environment Conservation Rules
EHS	Environment, health, and safety
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESA	Environmental and Social Assessment
ESDU	Environmental and social development unit
ESMP	Environmental Social Management Plan
FAA	Flood affected area
FAP	Flood Action Plan
FGD	Focus group discussion
GoB	Government of Bangladesh
GRM	Grievance redress mechanism
HH	Household
HSE	Health, safety, and environment
HYV	High yielding variety
IESC	Important environmental and social component
ILRP	Income and Livelihood Restoration Plan
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated pest management
IPMP	Integrated Pest Management Plan
IPoE	Independent Panel of Experts
IUCN	International Union of Conservation of Nature
IWM	Institute of Water Modeling
NGO	Non-governmental organization
O&M	Operation and maintenance
OP	Operational Policy
OHS	Occupational health and safety
PCR	Physical Cultural Resources
PMU	Project Management Unit
RAP	Resettlement Action Plan
RBIP	River Bank Improvement Program
RS	Resettlement site
SAP	Social Action Plan
SDP	Social Development Plan
TDS	Total dissolved solids
VEC	Valued Environmental Component
WB	World Bank
WBG	World Bank Group

1. Introduction

The River Bank Improvement Program(RBIP or the Program) is a proposed three phased project, by the Government of Bangladesh (GoB), for reconstruction of Brahmaputra Right Embankment (BRE)to protect about 4.8 million people living on 275,000 ha of floodplains in the north western region of Bangladesh from inundation resulting from extreme flood events and protect the river bank from on-goingerosion. RBIP-I or Phase I (the Project) of the Program will specifically focus on improving flood and erosion control within a 50km of the priority reach of the Jamuna right bank located about 17 km upstream of the Jamuna Bridge. The program has threemajor interventions: (a) reconstruction of the BRE; (b)construction of river training structures through long revetments and strengthening of existing river training works; and (c) construction of a highway on the countryside of the new embankment. The RBIP-1 covers the first two interventions in the priority reach. A comprehensive Environmental and Social Assessment (ESA) has been carried out for the Project and presented in six volumes of environmental and social documentation. ThisExecutive Summary presents a summary of the potential environmental and social impacts of the Project.Mitigation measures are described and included in environmental and social management plan (ESMP) to address potential impacts as well as to enhance the environmental and social benefits of the project.

1.1. Background

Erosion and flooding issues of the lower Brahmaputra or the Jamuna River. The lower Brahmaputra, named Jamuna in Bangladesh is one of largest sand-bed braided rivers in the World. The Jamuna was originally a small distributary channel of the Brahmaputra and originates about 10 km downstream of the Teesta confluence with the Brahmaputra.Sometime during the late 17th century, due to avulsion (change of course), Brahmaputra River started flowing into the present course of theJamuna River. During the last two centuries since the avulsion the Jamuna has been undergoing several morphological changes like increasing its width and pursuing westward migration mainly due to neotectonics and the 1950 Assam earth quake. In the last 40 years, the Jamuna has been constantly migrating westward and additionally widened by 50% from 8 to 12 km. These morphological changes have led to erosion of thousands of hectares of fertile cultivable floodplains every year rendering thousands of people landless and homeless. In addition to unpredictable riverbank erosion, floods are the other major natural hazard. While typically 20% of the country is flooded during the annual monsoon, severe floods have inundated up to two thirds of the country.The bankerosion of the Jamuna is expected to increase in future due to continued neo-tectonic activity, unstable geomorphological conditions in the Brahmaputra catchment area and increased flood volumes due to climate change.

Brahmaputra Right Embankment and Bank Protection Works. During the mid-1960s about 180 km of flood embankment was built on the right bank of the Jamuna, historically known as Brahmaputra Right Embankment (BRE), to protect about 240,000 ha of floodplain from annual flooding and foster agricultural growth. However, due to ongoing riverbank erosion, this embankment had to be frequently retired (rebuilt behind the former alignment) in places up to nine times. Often the riverbank erosion during the flood season resulting in to breaching of the embankments which in turn resulting in to flash flooding and damage of standing crops, houses and public infrastructure in areas typically 50,000 ha in size. To address the riverbank erosion of the Jamuna, the government has so far constructed, since the 1980s, about 56 km of riverbank protection on the right bank.

Environmental effects of BRE and bank protection works. Protection of floods through BRE has resulted in significant agricultural production in the region. However, the BRE has acted as a barrier to lateral fish migration between the Jamuna and floodplains and hydrological connectivity between the Jamuna and *khals* (small rivulets) and *beels* (depressions on floodplains), which are major floodplain fish habitats. This has caused significant reduction in the production of floodplain fisheries and affected the livelihoods of the fishermen.

Need for reconstruction of BRE. The original BRE had a setback of about 1.5 km from the Jamuna'sright bank and it was assumed to have bank erosion life of 25-30 year span. In the 1970s the

embankment started to fall under sporadic erosion attacks. During the 1980s, the frequency of the BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which could cause bank-line erosion rates of several hundred meters per year in early stages of bend formation. To prevent flooding, these breaches were typically closed by local BRE retirements at about 200 meter setbacks. As a result of this minimal setback distance the BRE has been retired several times in many places and at present perhaps only 50 km of the original BRE has remained in place. Currently, many long stretches of the BRE are very close to the river-bank line. Between 1973 and 2014, nearly 88,000 ha arable floodplain land was lost to the river, and nearly 2,800 ha of homestead land eroded, displacing an estimated population of 168,000 people. This displacement has had negative effects on the riparian residents, who generally have high poverty levels, and crowded low-quality dwellings with restricted access to civic amenities and roads. Regular episodes of flooding and river bank erosion continue to threaten the integrity of the BRE, causing subsequent displacement and exposing large rural and urban areas, such as Sirajganj, to destructive flooding and inhibiting economic growth. The cost of average annual damages resulting from the bank erosion and breach of the BRE is estimated to be about US$ 158 million and include (i) loss of about 200 ha of floodplain land, including 104 ha of agriculture land, (ii) loss of about 1105 houses and damage of about 51,735 houses, and (iii) damage of about 7000 ha of paddy crop. Hence there is an urgent need for reconstruction of existing degraded BRE and secure it against river bank erosion to prevent further breaching of the BRE and the need for future retirements,

Flood and Erosion Victims: The loss of cultivable and homestead land from erosionhave made the floodplain dwellers virtually destitute. Historically, a large number of the displaced families have settled as squatters on the BRE or moved to slums in bigger cities like Dhaka. These families eventually join as part of the growing number of landless people due to erosion and displacement. The settlers on the BRE are generally very poor as visible from the settlements with temporary houses made with wood often salvaged from their previous homes, with bamboo fenced and straw with corrugated tin sheet roofs. These families live under a constant threat of eviction as well as further erosion of embankment putting additional stress, especially on female family members. While the embankment is often the last resort for these families, the many settlements compromise the maintenance and structural integrity of the embankment. It is apparent, that people living along the Jamuna not only suffer vulnerabilities and risks on a physical but also on an economic, social, environmental and informational level. Therefore, re-housing/resettlement, livelihood, social, gender and health measures as well as improved forecasting and preparedness are required to avoid and/or reduce future risks and enhance the economic and social well-being of the people in the floodplain. The floodplain victims narrated many stories of losses, displacements and homeless ness during social surveys and a sample of such story is presented in Box 1.

1.2. The Proposed Program and Project

The GoB through Bangladesh Water Development Board (BWDB) is preparing the RBIP to reconstruct the existing degraded BREand secure it against riverbank erosion along 140km length from the Teesta River to the Jamuna Bridge.The Project (RBIP-I) will cover a 50 km long priority reach between Simla and Hasnapara. BWDB has approached the World Bank for financing the Program. BWDB is also planning to reconstruct the remaining sections of the BRE through an Asian Development Bank (ADB) funded project.

Location:The location map of the RBIP and RBIP-Iis shown in Figure 1.

Proposed works:The physical works that are proposed for the RBIP-I are as follows:

- Rehabilitation of 12 km of existing embankment and construction of 38 km of new embankment;
- Strengthening of 18.55 km of existing bank protection works and construction of 18.01 km new bank protection works through revetments;
- Upgrading of 6 spurs;

- Construction of 4 new fish passes cum regulators to restore the ecological connectivity between the floodplains; and to provide supplementary irrigation water in the floodplain areas during the flood/monsoon season in case of long dry spells; and
- Construction of 2 new regulators across the embankments to provide supplementary irrigation

Implementationperiod:The program will be designed and implemented in three phasesover a period of 10 years. RBIP-I covering 50 km priority reach will be implemented in Phase I over a period of 5 years. Phase IIcovers the remaining 87 km while Phase IIIfocuses on and the construction of a highway on the countryside of the reconstructedembankment.

1.3. The Environmental and Social Assessment

Studies and documentation:Thisexecutive summary on ESA is based on field studies and data collected between 2014 and 2015 by variousconsultant teams hired by BWDB. These studies have produced three volumes of environmental documentation, (i) Environmental Management Framework (EMF) for the entire Program, (ii) Environmental Impact Assessment (EIA) for the priority reach, and (iii) Environmental Baseline for the entire program; and three volumes of social documentationgrouped under Social Action Plan (SAP), (i) Volume 1 Project Context, Socio-Economic Baseline, Consultations and Communication Strategy (ii) Volume 2 Resettlement Action Plan (RAP), and (iii) Volume 3 Social Development Plan (SDP). All these documents are available under separate covers and were disclosed in BWDB website.

Contents of the present document:After a description of the Bangladesh legal and administrative framework and the applicable World Bank policies in chapter 2, a project description is presented in chapter 3, followed by a discussion of project alternatives in chapter 4. A description of the physical, biological and socio-economic environment is given in chapter 5. Climate change aspects are discussed in Chapter 6. Potential adverse effects of the project are described in chapter 7 and potential cumulative impacts and concerns associated with other river management projects are presented in chapter 8. Possible mitigating measures to offset, reduce or compensate potential negative impacts of the project are included in the ESMP that is summarized in chapter 9. Finally, chapter 10 provides an overview of all stakeholder consultations and activities for disclosure and access to the information.

1.4. Composition of Study Team

Design and Independent consultants:The EIA study has been carried out by a multi-discipline team of international and national experts. The design team has contracted International Union of Conservation of Nature (IUCN) to prepare the EIA and EMF. However, as World Bank policies require that EIA be carried out by an independent team from the project design team, two independent individual consultants hired by BWDB to review and provide guidance on the work of the IUCN team as they carry out their work, as well as to update and supplement the IUCN drafts as required to meet international standards and prepare the final EIA and EMF in accordance with Bank requirements. An Independent Panel of Expert (IPOE) for environmental study was also involved for ensuring the quality of the study.

Environmental study team: The EIA team comprised ofDr. VenkataNukala (EIA advisor and independent reviewer), Mr. Mohammad Omar Khalid (international team leader), Mr. Mohammad ShahadMahabub Chowdhury (Fish Specialist), Mr. Sunil BaranDebroy (Water ResourcesSpecialist), Ms. BushraNishat (Climate Change Specialist), Dr. Monirul Khan, (Social Specialist), Dr. Nowsher Ali Sarder (Agriculture Specialist), Prof. Dr. Monirul H. Khan(WildlifeSpecialist),and Mr. JunaidKabir Choudhury (Ecologist).

Social study team: The social team consisted of Dr. Mohammad Zaman (international team leader), Dr. HafizaKhatun (Resettlement Specialist), Dr. Md. HumayunKabir (Social Survey and Safeguard Specialist),KhairulMatin (Resettlement Specialist),SharifulIslam (Consultation Specialist), Dr. Mohammad Maniruzzaman (Social Assessment Specialist),Minhaz Anwar (Communication Specialist),Dewan Ali Arshad (Livelihood Specialist),ShamimaPervin (Gender

Specialist),AnwarulHoque (Public Health Specialist) and SolveigHaupt (Public Health Specialist/International).

Box 1. Story of a flood and erosion victim – " a rich man in the morn is destitute by dark"

Amir Hossain is a former elected member of the local government system. He was a man of good economic standing and considered a *bhadralok* (elite) in local standards. Amir was weeping all the time while telling hisstory. He recalled that one night in September 1994 at 2.00 am, his son rushed to him and said that there was nothing left between the river and their house due to sudden bank erosion and breaches in the embankment. When he rushed outside with his son they could only save two people. The river washed away the remaining 59 persons in their settlement. The river used to be miles away from their house. The forces of floodwater washed away the soil underneath the riverbank and then the top of the bank line collapsed with all those who lived on the embankment.

Amir had 10 acres of land and employed many agricultural labourers. They used toharvest about 10 tons of rice every season. He was the only son of his father. But then the Jamuna took away their land and everything else. Amir Hossain's case epitomizes the local proverb: *nodirekulbangeokulghoreeitonodirkhela, sokalbelar raja arbhai fakir sondhabela* (breaking this bank, building that bank, this is the river's lark; it makes the rich man of the morn a destitute by dark).

At the beginning, he recalled, he hesitated to reach out for help due to his social status, but after a few days he asked for help to each and every one he knew. After two years, he eventually ended up with work at a factory in Dhaka with some of his family members. In his old age, he is now supported by his son (a member of semi-policeforce who is guarding the border). He mentioned that most of his neighbours work as wage labourers, as there are no other opportunities to earn a living. He wantthat the river widening must be stopped and said, "we want to give whatever need for the RBIP to secure our lives."

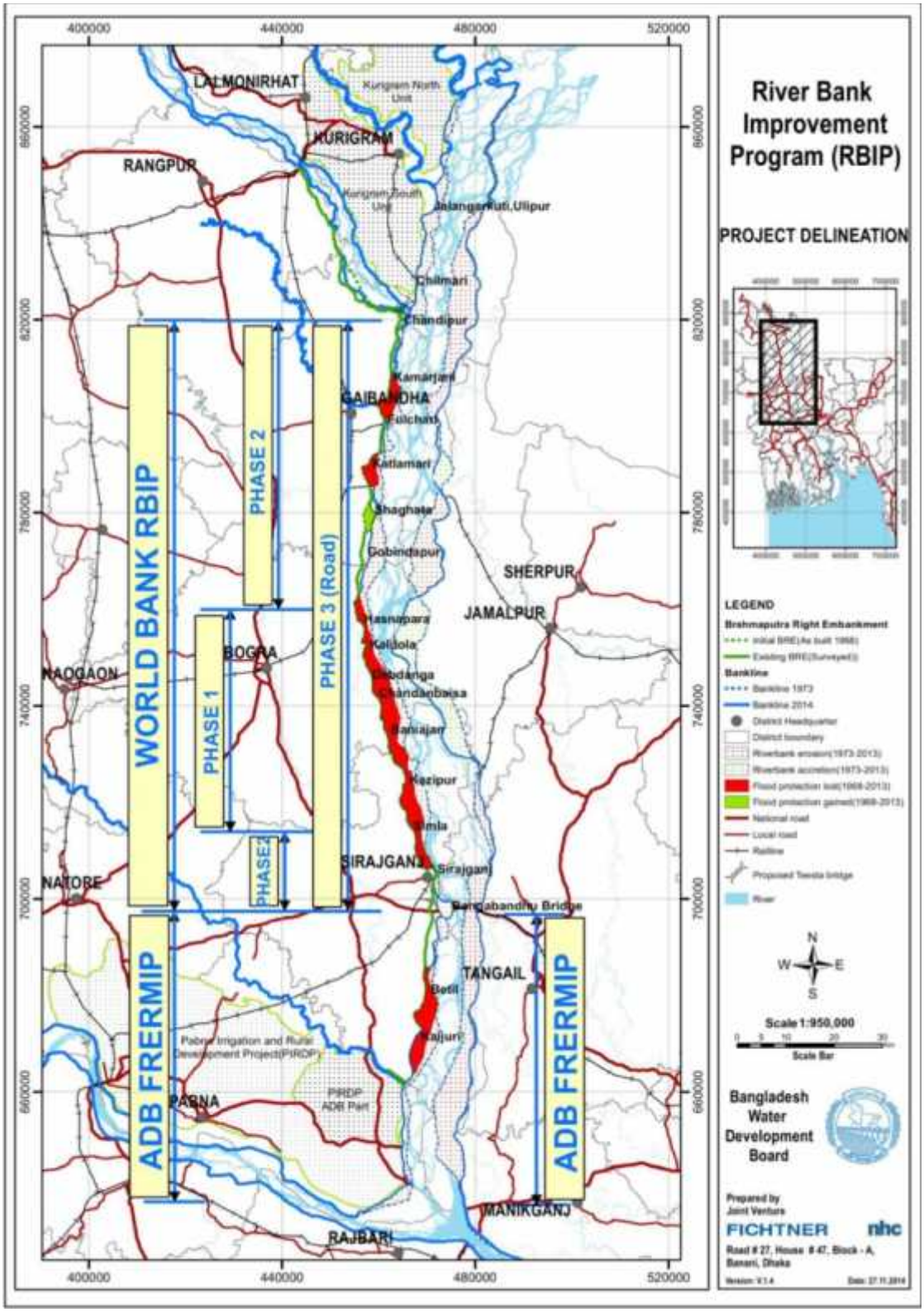


Figure 1: Location of Priority and Remaining Works under RBIP

2. Policy, Legal and Administrative Framework

2.1. Applicable Legislation and Policies in Bangladesh

BangladeshEnvironmental Conservation Act, 1995 and amended in 2010: The Environmental Conservation Act (ECA) of 1995 is the main legislative framework relating to environmental protection in Bangladesh. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. This Act has established the Department of Environment (DoE), and empowers its Director General to take measures as he considers necessary which includes conducting inquiries, preventing probable accidents, advising the Government, coordinating with other authorities or agencies, and collecting and publishing information about environmental pollution. According to this act (Section 12), no industrial unit or project shall be established or undertaken without obtaining, in a manner prescribed by the accompanying Rules, an Environmental Clearance Certificate (ECC) from the Director General of DoE.

In accordance with this Act, the RBIP-I will need to be cleared by DoE before commencing the project following procedures given in the Environment Conservation Rules (ECR) 1997 (discussed below).

Other Relevant Acts, Laws and Rules in Bangladesh: Other legislationrelevant to the proposed project are listed below.

- Bangladesh Environment Conservation Rules (ECR), 1997 empowers the GoB to declare ecologically critical areas, classification of industries and projects into various categories, procedures for issuing the environmental clearance certificate, and determination of environmental standards;
- Water Act 2013 is based on the National Water Policy, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh
- Bangladesh Wildlife (Protection and Safety) Act 2012protects 1,307 species of plants and animals; and mandates imprisonment and fines for wildlife poaching, capturing, trapping, and trading;
- Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)regulates the hunting, killing, capture, trade and export of wild life and wild life products. It designates a list of protected species and game animals. It empowers the Government to declare areas as game reserves, wildlife sanctuaries, and national parks to protect the country's wildlife;
- Protection and Conservation of Fish Act (1950)provides power to the government to: make and apply rules to protect fisheries; prohibit or regulate erection and use of fixed engines; and construction of temporary or permanent weirs, dams, bunds, embankments and other structures. The Act prohibits: destruction of fish by explosives, guns, and bows in inland or coastal areas; destruction of fish by poisoning, pollution, or effluents. The Act prescribes the seasons during which fishing is allowed, prohibits fishing during spawning periods, and specifies officials having authority to detect breaches of this Act;
- The East-Bengal Protection and Fish Conservation Act (1950), as amended by the Protection and Conservation of Fish (Amendment) Ordinance (1982) and the Protection and Conservation of Fish (Amendment) Act (1995), provides for the protection and conservation of fish in inland waters of Bangladesh;
- The Forest Act of 1927 as amended in 1989 grants the government several basic powers, largely for conservation and protection of government forests, and limited powers for private forests. The 1927 version of the act was amended in 1989 for extending authority over "any [Government-owned] land suitable for afforestation";

- The Private Forest Act of 1959 allows the Government to take over management of improperly managed private forest lands, any private lands that can be afforested, and any land lying fallow for more than three years;
- Embankment and Drainage Act, 1952consolidates the laws relating to embankments and drainage providing provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water;
- The Bangladesh Labor Act, 2006 provides the guidance of employer's extent of responsibility and workmen's extent of right to get compensation in case of injury by accident while working.

Relevant National Policies and Plans:The national policies relevant to the proposed project and its environmental and social assessment are briefly described below.

- National Water Policy (1969) aims to provide guidance to the major players in water sector for ensuring optimal development and management of water;
- National Water Management Plan, 2001 (Approved in 2004)envisions to establish an integrated development, management and use of water resources in Bangladesh over a period of 25 years;
- The National Land Use Policy (NLUP), enacted in 2001, aims at managing land use effectively to support trends in accelerated urbanization, industrialization and diversification of development activities;
- National Agriculture Policy, 1999 aims to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable food security system for all. The policy particularly stresses on research on the development of improved varieties and technologies for cultivation in water-logged and salinity affected areas. The policy also recognizes that adequate measures should be taken to reduce water-logging, salinity and provide irrigation facilities for crop production;
- National Integrated Pest Management Policy enable farmers to grow healthy crops in an increased manner and thereby increase their income on a sustainable basis while improving the environment and community health. To achieve these objectives, the integration pest management(IPM) Policy aims to pursue the following strategies: to expand IPM on a sustainable basis by establishing a national IPM program; and to facilitate co-ordination of all IPM activities in Bangladesh;
- National Fisheries Policy, 1996 focuses on aquaculture and marine fisheries development (i) Biodiversity will be maintained in all natural water bodies and in marine environment, (ii) Chemicals harmful to the environment will not be used in fish shrimp farms; (iii) Environment friendly fish shrimp culture technology will be used; (iv) Expand fisheries areas and integrate rice, fish and shrimp cultivation; (v) Control measures will be taken against activities that have a negative impact on fisheries resources and vice-versa; and (v) Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

International Treaties signed by Bangladesh:Bangladesh is a signatory to a number of international environment-related treaties, conventions, declarations and protocols. The following are the relevant international treaties and conventions to which Bangladesh is a party:

- Convention on Biological Diversity, Rio de Janeiro (1992);
- United Nations Framework Convention on Climate Change, Rio de Janeiro (1992);
- Vienna Convention for the Protection of the Ozone Layer, Montreal (1987);
- Convention on Wetlands of International importance especially as Waterfowl Habitat, Ramsar (1971) and its amending protocol, Paris (1982);
- Convention on Conservation of Migratory Species of Wild Animals (1979);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington (1973);

- Convention concerning the Protection of World Culture and Natural Heritage (World Heritage Convention) (1972);
- International Plant Protection Convention (1951); and
- Kyoto Protocol (1997) and Copenhagen Accord (2009) on climate change.

2.2. Environmental Procedures

Environmental Impact Assessment:In accordance with the Bangladesh Environmental Conservation Rules, theflood protection works are designated as red category and hence an EIA is to be prepared.

EIA Approval:The ECR'97 describes the procedures for obtaining Environmental Clearance Certificates (ECC) from the Department of Environment for different types of proposed units or projects. Any person or organization wishing to establish an industrial unit or project must obtain ECC from the Director General. The application for such certificate must be in the prescribed form together with the prescribed fees laid down in Schedule 13, through the deposit of a Treasury Challan in favor of the Director General. The fees for clearance certificates have been revised in 2010. Rule 8 prescribes the duration of validity of such certificate (one year for redcategory) and compulsory requirement for renewal of certificate at least 30 days before expiry of its validity.

2.3. World Bank Safeguard Policies

The World Bank's environmental and social safeguard policies relevant to the project include the following:

Environmental Assessment (OP 4.01):The proposed RBIP-I has been classified as Category A, since some of the potential impacts are likely to be significant and diverse. The World Bank requires an environmental and social assessment for all environmental screening "Category A" projects proposed for Bank financing, in order to ensure that these projects are environmentally and socially sound and sustainable. In accordance with the requirements ofOperational Policy (OP) 4.01, environmental and social assessment has been carried outand ESMP prepared to mitigate or minimize all potential adverse environmental and social impacts. Significant environmental issues were already mainstreamed in the project planning and design by adopting fish passes for facilitation of fish migration and use of clay material from the toes of the proposed embankments to reduce environmental footprints.

Natural Habitat (OP 4.04):The Jamuna has rich aquatic biodiversity. The activities under the proposed project could potentially alter the natural habitat hence this policy is triggered. Habitat restoration and enhancement measures are included in the project to mitigate and or compensate any adverse impacts on the natural habitat.

International Waterways (OP 7.50):This Policy is triggered since the Brahmaputra/Jamuna is an international waterway. However, as Bangladesh is the most downstream country the Brahmaputra/ Jamuna and the proposed project is not expected to adversely change the quality or quantity of water flow to the other riparian countries.

Pest Management (OP 4.09):Though increase in agriculture production (hence an increased usage of chemical pesticides and fertilizers) is not included in the project objectives, such a consequence of the project cannot be ruled out since the enhanced flood protection to be provided by the proposed project may induce changes in agricultural pattern that may in turn cause increased usage of agro-chemicals. Hence this policy is triggered.To address this eventuality, linkages will be developed with the already on-going integrated pest management (IPM) initiatives in the region.

Physical Cultural Resources (OP 4.11):As part of the environmental and social assessment studies for the project, a full baseline assessment has been carried out, including consultations, to identify any physical cultural resources (PCR) in the project influence area. This assessment has revealed that the Project will need to relocate 20 mosques, four temples, one church, six *Eidgahs* (place for offering Eid prayers) and two graveyards however none of these resources require any special protections warranting a PCR management plan as per the policy. The mosques, temples and *Eidgahs* will be

reconstructed and graves relocated as an integral element of the resettlement action plan (RAP) and in full consultation with project-affected persons. In addition, the 'chance find' procedures are also included in the EMP.

Involuntary Resettlement (OP 4.12):The Project requiresabout 340 ha of land acquisition as well as displacement of 3,628 households (15,558 persons). A Resettlement Action Plan (RAP) has been prepared in line with relevant Bangladesh laws and OP 4.12.

In addition, the following policies and guidelines have been taken into account in the project design:

Access to Information: This policy sets out the Bank's requirements for disclosing and sharing information.The policy reaffirms the Bank's commitment to transparency and accountability in its activities for promoting development effectiveness and poverty reduction. The EIA, EMF and SAP and this Executive Summary have been disclosed at BWDB website in addition to sharing them with the stakeholders including the local community. These reports are also disclosed in the World Bank InfoShop. A national level public disclosure meeting was held in January 2015.

Environmental Health and Safety Guidelines: The World Bank Group Environment, Health, and Safety (EHS)General Guidelines (2007) contain performance levels and measures for development of industrial projects that are considered to be achievable in new facilities at reasonable costs by existing technology.

Gender Policy (OP 4.20): The World Bank's Gender Policy aims to reduce gender disparities and enhance women's participation in the economic development of member countries. During the social assessment, gender aspects have been considered and women's participation has been ensured as far as possible while carrying out the stakeholder consultations. A gender action plan has been prepared as part of the Social Development Plan under the SAP.

Environmental and social policies of the World Bank that are not applicable to the project include:

Indigenous People (OP 4.10):There are no indigenous communities residing in the project influence area and therefore this OP is not triggered.

Forestry (OP 4.36): The policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. Though the proposed project will support some compensatory tree plantation on the re-constructed embankment, this OP is not triggered since the project is not located in any forested area and will therefore not have any direct or indirect impact on forests. The tree plantation on the embankment will nonetheless be carried out fully in compliance with the paragraph 7 of OP 4.36 on plantations.

Safety of Dams (OP 4.37):The dam safety Policy is not triggered since embankments will not qualify as 'dams'. Nonetheless, while the embankments do not qualify as 'dams', many of the same risks and concerns associated with potential dam failure are also relevant in the context of the embankments. The project has therefore convened an IndependentPanel of Experts (IPoE) to provide guidance on diverse project aspects including technical, environmental and social.

Projects in Disputed Areas (OP 7.60): Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrower and one or more neighboring countries. This policy is not applicable, since the project is not located in or near any disputed territory.

2.4. Compliance Status with Bangladesh Legislation and World Bank Policies

The present compliance status of the project with Bangladesh legislation and World Bank safeguard policies is indicated in Table 1.

Table 1: Compliance of Project with GoB Legislation and World Bank Safeguard Policies

	Legislation/Policy	Actions Taken to Comply
GoB	Environmental Conservation Act	BWDB will submit the EIA report to DOE in mid-March2015 for environmental clearance
	International treaties	Verification of protected sites, Red List and protection of vulnerable habitats.
	Public information and disclosure	The draft EIA, EMF and SAP reportshave been disclosed on BWDB's website.Stakeholder consultation workshops were held in Dhaka to disclose the project information and environmental and social assessment in January 2015.
World Bank	Early screening and Scoping	Scoping consultations were held in the project area in August – September, 2014.
	Participatory approach	Key informant interviews, participatory rural appraisals, consultation meetings and focus group discussions were held.
	Integrate environmental and social assessment	Natural environment, public health, and social aspects are integrated in planning documents.
	Natural Habitats	Verification of protected sites and ecosystems, Red List and endangered flora and fauna has been done. Discussions with relevant district government departments and conservation NGOs were held on potential impacts and mitigation or compensation measures.
	Risk assessment	Health and safety risks for population and workers are identified in the EIAand will be included in an Occupational Health and Safety Plan; Environmental Code of Practices (ECoPs) – occupational health, labor –will be included in tender documents.
	Climate Change and floods	Impact of climate change effects are considered in estimating future flood levels and volumes. Embankment design considered a freeboard of 1.5 m to accommodate climate change impacts and other uncertainties.
	Cumulative Impacts	Cumulative impact assessment has been conducted as part of the EIA to cover the impacts of all existing and proposed embankment and river training structures, and anticipated river improvement programs in the Jamuna.
	Alternatives	Alternatives considered included: the "without project" case;alternatives tobank protection, embankment and roads, embankment materials and resettlement sites.
	Pollution	Baseline survey of environmental quality has been carried out. Stricter environmental standards were applied and ECoPswill be included in contractors' bidding documents.
	Physical Cultural Resources	No physical cultural resources are located in the project impact area. Relocation and reconstruction of community religious structures are covered in RAP.Chance find procedureswill be included in bidding documents.
	Gender	Gender consultations were carried out during social assessment and a gender action plan has been prepared as part of SAP
	Public Health	Public health aspects were studied and a public health action plan is prepared as part of SAP
	Consultation and access to information	Consultations have been held in all the project villages and with all the relevant stakeholders. The EMF, EIA and SAP reportshave been disclosed on BWDB website and WB InfoShop. Consultations have been held while conducting EIA and preparing EMF as well as RAP. A national level public disclosure meeting was held in January 2015 and similar meetings will be held in all sub-district headquarters. This ESA Executive Summary has been translated in to Bangla and placed on BWDB website and also in all sub-districtadministration offices in the project influence area.

3. Project Description

3.1. Background

Key Features of the BRE.The BRE comprises of 180 km embankment along the right bank of the Jamuna and 40 km of embankment along the right bank of the Teesta, the main tributary of the Jamuna in Bangladesh. The BRE was constructed in the 1960s, from Kaunia in Rangpur district to Bera in the Pabna district, to protect the 240,000 ha of surrounding area from flooding of the Jamuna and to improve agricultural production in the area.

Frequent Retirements of BRE.Originally the BRE had a setback distance of about 1.5 km from the Jamuna bankline. Over the years the embankment has been increasingly under attack from westward shifting of the river and consequent bank erosion, causing the embankment to breach at several locations. After such breaches, the embankment had to be retired from its original alignment and reconstructed. The retired embankments were typically constructed with around a 200 meter setback distance to prevent flooding. In many places, the embankment has been retired several times.Presently, only about 40kilometers of the original BRE remains intact upstream of Jamuna Bridge, and the overall setback distance is steadily reducing with more and more embankment length being within the reach of annual average erosion rates. Consequently, the integrity of the BRE is threatened and large areas of rural and urban areas are increasingly being exposed to the risk of flooding.

Bank Protection Works. Since the 1990s the BWDB has been constructing protruding river training structures such as hard points and groynes. Hard points at Sirajganj, Sariakandi, and Mathurapara, and a groyne at Kalitolawere constructed from 1995 to 1998. The structures were heavily damaged, first in 1998 and 1999 and repeatedly later, and have required ongoing maintenance and re-construction. Due to the high cost of the “hard points”, the BWDB developed a satisfactory alternative in the form of guiding revetments since the mid-2000s, which have demonstrated a lower failure rate and better protected the embankment steadily.

3.2. Project Objective

The overall program (RBIP) development objective is to reduce the adverse impacts of flooding and erosion along the right bank of the Jamuna, enhance sustainable management of the Jamunaand improve transport connectivity of the sub-region.The project-specific (RBIP-I) development objective is to improve flood and erosion management capacity, and increase protection against river flooding and erosion along the 50 km priority reach in the Jamuna right bank.

3.3. Program Area, Work Sequencing, and Key Components

RBIP Area and Selection of Priority Reach.The RBIP covers the rehabilitation of the existing 140km long BRE from the Teesta River to the Jamuna Bridge while the future ADB ‘Flood and Riverbank Risk Management Investment Program (FRERMIP) Project’will cover the remaining40km length of BRE from Jamuna Bridge to Chandpur. The 70km BRE reach from Jamuna Bridge to Hasnaparais under heavy erosional attack with frequent embankment breaching and retirements. Out of this, the 50-km length between Simla and Hasnaparais designated as a priority reach due to (a) high erosion rate (an average of 3.3 km of wide floodplain was eroded over the last 40 years), (b) risk of embankment breaching due to reduction of distance from the bank to embankment (The embankment setback distance has reduced from typically 1.5 km in 1973 to 390m in 2014), (c) risk of avulsion in to the Bengali River, which runs parallel to the Jamuna and over a length of some 15 km it is located as close as 350 m to the Jamunabankline, a distance that could be eroded in one year, and (d) presence of limited bank protection works.

3.4. Project Components

(a) Component A: Rehabilitation and Improvement of Brahmaputra River Embankment Scheme (US $472 million). This component would consist of the civil works required for embankment

rehabilitation and associated riverbank protection works. Details of the proposed interventions are given in Table 2.

Table 2: Proposed Interventions in RBIP-I

Intervention	RBIP -1
New Embankment	38 km
Upgrading Embankment	12 km
New Riverbank Protection	18 km
Upgraded Revetment	7.2 km
Upgraded Spur	6
Regulators	2
Fish Passes	4
Culverts	2

Component A1: Embankment Rehabilitation and Improvement (US$ 190 million). This subcomponent aims to increase community resilience to flooding by rehabilitating embankments along 50 km of the priority reach. The reconstructed embankment adopts a gentle alignment for two reasons. First, irregular embankment alignment induce sharp abruptions to flood water that generate deep scour at the toe of the embankment leading to failure. Second, the smooth alignment will allow for the development of road. The embankment will have at least 100 m set back distance from the riverbank to minimize disturbance to existing settlements and to protect from riverbank erosion. The cross section of proposed embankment is shown in Figure 2. The design features of the embankment include:

Height of the crestin the priority reach is typically 5.5m high with 96% of the length below 7.5m. The design flood level was determined through a series of hydrological calculations and hydraulic modelling of flow rates and water levels for a range of return periods. The flood level incorporates a climate change allocation. The embankment has been designed to incorporate an additional 1.5 m height, called freeboard, to account for uncertainty in flood statistics, wave run-up, morphological changes, local settlements or subsidence. The embankment provides a wide platform on the countryside, which is able to accommodate up to four lanes of highway. Future road options will be investigated during Phase II.

Drainage-the proposed embankment is designed for load combinations including earthquake, rapid drawdown, and seepage.

Fish Passes and Regulators-Past retired embankments contain no openings for water exchange between river and floodplain. The proposed reconstructed embankment will change this by providing two regulators and four fish passes in the priority reach. The regulators and fish passes will facilitate fish migration, assist supplementary irrigation during the flood season, and increase soil fertility and groundwater recharge.

Toe Protection-both toe lines will be protected from encroachment by placing open cell pavers along the river side and planting trees on the country side, so that farmers can't plough into the protective clay layer.

Width-subsoil conditions indicate that a wide embankment is needed to avoid geotechnical failure from seepage. The typical cross section will be between 60 and 70 m including a 2.5 m wide strip between land acquisition boundary and embankment toe line as a buffer.

Vegetation—the country-side embankment slope and a strip of the bench parallel to the road will be used for vegetation, not only as compensation area for tree plantation but to discourage

unauthorized settlement. The tree plantation is designed to be effective during the initial time with construction road and with modification also when a full two-lane highway is built. The crest of the embankment will be covered with open cell pavers to allow vegetation growth, fix the crest level, and discourage through traffic.

Setback Distance—the setback distance from the river will range from 100 to 700m, with 50 percent of the length below 400 m. The minimum distance of 100 m has been selected for geotechnical reasons: in case the riverbank fails locally, the failure boundary needs to be far enough from the embankment to avoid compromising the flood protection and road.

Potential Failure from Overtopping—the safety of the embankment against failure from overtopping, either from waves or extreme peak flows, is increased by the wide paved road on the country side, which protects against retrogressive failure and sudden breach.

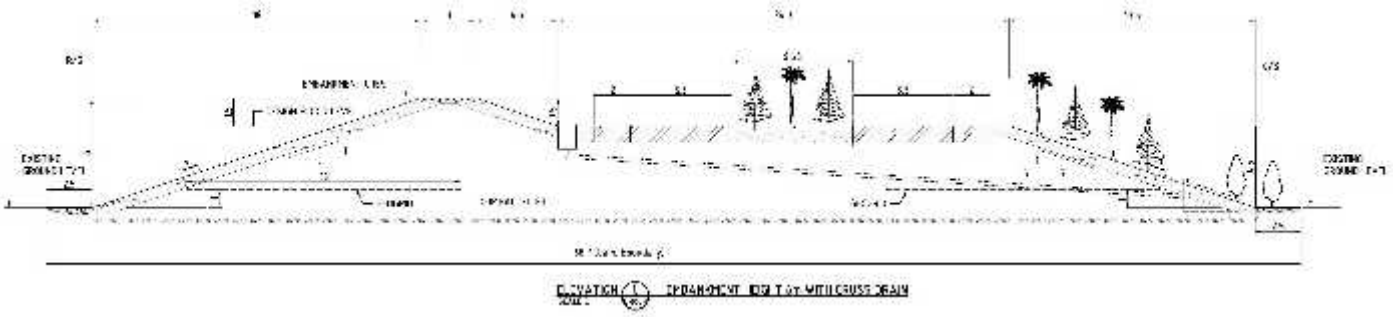


Figure 2: Typical Cross section of the proposed embankment

Component A2: Riverbank Protection (US$ 282 million). This component aims to increase community resilience to bank erosion and provide increased protection against river attacks and embankment breaches along 50km of priority reach. The riverbank protection is designed to cope with the high energy flow along the right bank of the Jamuna and expected to lead to a more stable channel with flow parallel to the riverbank, which would favor navigation in future.

The riverbank above the low water level will be protected by concrete blocks and in some areas a new technology of grout-filled mattresses will be used. The underwater slope will be protected with four layers of robust end affordable sand-filled geotextile bags. Layout of bank protection works is shown in Figure 3.

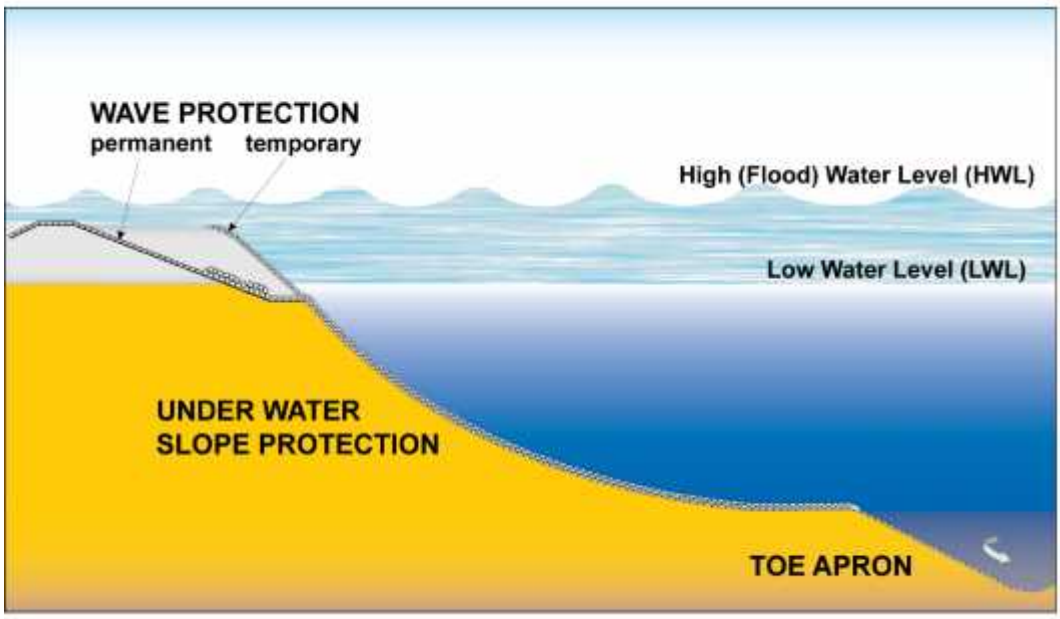


Figure 3: Layout of Bank Protection Works

The riverbank protection will be built to the highest standards applied to protect land largely used for agriculture, incorporating flat slopes above low water and wide aprons along the toe that reduce the risk of catastrophic failure. The bank protection works will also cover rehabilitation and strengthening of existing spurs and groynes.

(b)Component B: Land Acquisition and Implementation of Social and Environmental Management Plans (US$ 90million).This component will implement planned social and environmental programs to mitigate the social and environmental risks in the project, including resettlement, and provide development assistance to local communities in the project area.

Component B1: Social Action Plan (US$ 75 million). The aim of the Social Action Plan is two-fold. First, to mitigate the adverse social impacts of the project associated with acquisition of nearly 370ha and resettlement of affected people. This will cover the development of 15 resettlement villages to cover the large population living on the embankment and affected by the new alignment. Second, to promote local area and social development along the embankment through small-scale income and livelihood restoration, gender and public health action programs.

Component B2: Environmental Management Plan (US$ 15 million). All construction-related environmental issues would be addressed in the construction contracts; thus the cost of such measures is included in Component A. This component would include those aspects that will be considered separately. These include environmental monitoring of river and floodplain, fishery development programs, community activities pertaining to the optimization of fertilizer and agricultural process, which may intensify as a consequence of the more reliable environment. This will also cover the social and environmental planning for future phases of the program.

(c)Component C: Institutional Strengthening, Capacity Building of BWDB, Technical Assistance and Training and Future Project Preparation and Strategic Studies (US$ 33 million).This component will cover consulting services for project implementation and will cover the following two subcomponents.

Component C1: Institutional Strengthening of BWDB and Advice, (US$ 18 million). This subcomponent would build capacity of the BWDB to carry out effective operation and maintenance (O&M) programs of the embankment scheme with road and the associated riverbank protection work. The component comprises: Procurement Panel and a Panel of Experts, effective river survey system and a comprehensive Embankment Asset Management System

Component C2: Future Project Preparation and Strategic Studies (US$ 15million). This subcomponent would support the preparation of Phase II and III, as well as other strategic studies to address technical, financial, or management issues, mitigation measures, pilot projects and preparation of future projects of strategic importance to river management that may be identified during program implementation.

(d) D:Construction Supervision, Monitoring and Evaluation of the Project Impacts and Social and Environmental Management Plan (US$ 55 million). This component will cover consulting services for project implementation. This includes: (i) Construction Supervision and Implementation Support, (ii) Third Party Monitoring and Evaluation of Project, and supervision of implementation of EMP, SAP, RAP; and (iii) Project Management Support.

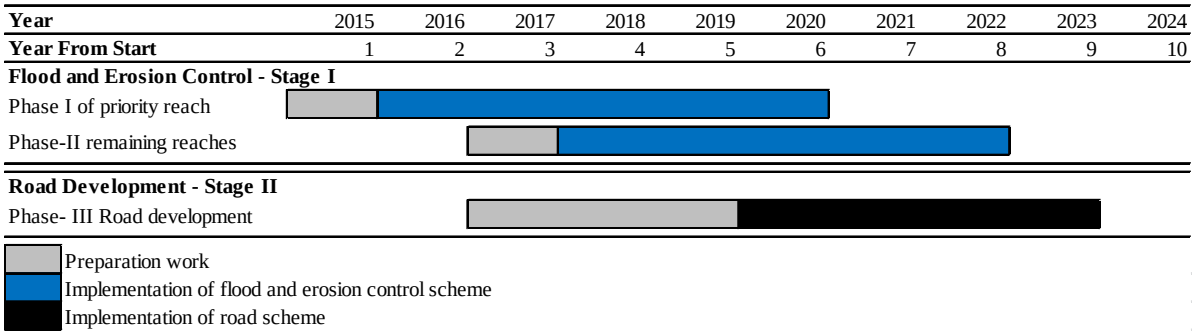
3.5. Construction Material and Sources

The construction materials required for embankment, road, river bank revetment, and other project components will include earth, geo-bags, hard rock, sand, geo-textile, stone-chips, brick chips, asphalt, cement, steel for concrete reinforcement, road furniture, and other accessories. Some of these materials will be obtained from within the project influence area: sand from the river bank and earth from the existing embankment. Other materials such as cement, steel, and brick chips will be procured from local/national markets, whereas some of the materials such as hard rock and asphalt

may have to be imported. Average labour requirement per day during construction is270. These will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machinery operators, drivers and skilled and unskilled labor. Unskilled workers will be mainly hired locally.Construction camps for each construction site are to be established by the contractor. The contractor will select the location of the camp through consultation with the local union parishad chairman and the local community. Moreover, they will have to obtain permission from the authorized BWDB representative.

3.6. Construction Schedule

The construction of Phase Iis planned to be completed in five years. A summary construction schedule for all phases is shown below.



3.7. Project Cost

The cost of Phase I, II and III are estimated to be USD 650 million, USD 840 million and USD 270 million, respectively. The details of estimated project cost of RBIP-Iis shown in Table 3.

Table 3: CostEstimate of RBIP-I

Project Cost by Component and Subcomponent		Total million USD
Component A: Rehabilitation and Improvement of Brahmaputra River Embankment Scheme		**472.0**
A1	Embankment Rehabilitation and Improvement	190.0
A2	Bank Protection and Revetment	282.0
Component B: Implementation of Social and Environmental Management Plans		**90.0**
B1	Social and Resettlement Management Plan	75.0
B2	Environmental Management Plan	15.0
Component C: Institutional , Capacity Building of BWDB, Technical Assistance and Training and Future Project Preparation and Strategic Studies		**33.0**
C1	Strengthening of BWDB, Independent Panel of Experts and Technical Assistance	18.0
C2	Future Project Preparation and Strategic Studies	15.0
Component D: Construction Supervision, Monitoring and Evaluation of the Project Impacts and Social and Environmental Management Plan		**55.0**
D1	Construction Supervision and Implementation Support	30.0
D2	Third Party Monitoring and Evaluation of Project, and Supervision of EMP, SAP, RAP	5.0
D3	Project Management Support and Audit	20.0
Total Project Cost		**650.0**

4. Project Alternatives

4.1. No Project alternative

Damages from Jamuna Right Bank Erosion. A morphological model has been developed by the design consultant to study the historical trends in morphological changes of the Jamuna and its floodplain erosion, and to predict the future riverbank erosion for the next 30 years. The erosion of floodplains will in turn affect the agriculture land, residential and community structures.Annual damages from the Jamuna right bank are summarized below and total annual cost of these losses are estimated to be about US$ 18.3 million in 2015 prices.

- About 200 ha of floodplain land, including about 104 ha of agriculture landwill be lost annually to the river. The affected land also includes about 22 ha of water bodies that provide habitat for floodplain aquatic species and spawning grounds for migratory fish species.
- About 1,105 residential structures (93.5 percent structures are adobe/mud walled) will be lost annually to the river.
- About 5.7 non-residential structures such as schools and shops will be lost annually to the river.

Damages from Breach of BRE. Breaches of the embankment cause flooding of the floodplains damaging the standing *Aman* paddy(main crop in flood season), livestock, houses, and other social and physical infrastructure, and livelihood of the local communities. Historical data on annual flood damages of last 27 years was collected from local government offices and a summary of extent of these damages are presented below. It can be expected that without the project scenario, the extent of damages will be similar in future and total value of these damages would be about US$ 140 million (in 2015 prices).

- About 7,000 ha of *Aman* paddy is completely damaged and about 4,900 ha are partially damaged annually.
- About 396 livestock are lost each year.
- About 51,735 houses are damaged each year. About 80 percent of these houses are semi-permanent structures that are partially damaged and remaining 20 percent are temporary structures that are fully damaged.
- About 130 km of paved road, and 148 km of unpaved road would be damaged each year if there is no project.

Current approaches by BWDB to address Bank Erosion. In the absence of the proposed project, right bank erosion of the Jamuna would continue and damage floodplain agriculture land and settlements and infrastructure would also continue. The BWDB generally respond to these problems by (i) accepting the bank erosion and relocating the embankment periodically and repeatedly and (ii) emergency protection works to control the erosion and retirement of embankments. However, both these approaches are not acceptable, neither to the BWDB nor the local population due to their low reliability.

4.2. Alternatives for River Bank Protection

The concept of providing systematic protection started with the development of “hard points” in the early 1990s as part of the Flood Action Plan, Component 1 (FAP1). With the exception of construction at two locations, the technically demanding and expensive FAP1 strategy was not implemented by BWDB and alternative strategies were developed. As an alternative, the BWDB developed and implemented lower cost “groynes” from the end of the 1990s until the mid-2000s. While these were initially successful, eventually most of these groynes failed due to increasing protrusion and river attack. After repeated failures, BWDB gradually abandoned these groynes. From the early 2000s BWDB pilot-tested and implemented about 18 km of low-cost and more sustainable “long guidingrevetment” based on earlier FAP1 and FAP21 technologies. These long-guiding revetments

are systematically replacing the other options when those fail. These three options are considered for analysis of alternatives. In addition, one more alternative of building revetments in to the river is also considered.The revetments along the current banks are the preferred option due to reduced impacts on the river and char ecology and high protection from the bank erosion. While other three options (groynes, spurs, and revetments in to the river) are not preferable because of technical difficulties, high environmental impacts due to higher project footprints in the Jamuna and also high initial as well as recurring costs compared to other options

4.3. Alternatives for Embankment and Road

BWDB is mandated to build roads on flood embankments. It is common, world-wide practice to provide emergency access alongside flood embankments in order to provide better access to the area during emergencies. The embankment built under this program will have provision of a higher standard than the emergency roads alongside flood embankments due to its use for regional and inter-regional connectivity. Following four options are considered:

- Option 1: Widening of existing embankment with local road.
- Option 2: Reconstructed embankment with improved alignment on the floodplain with two-lane road at safe distance from the riverbank with a provision for toll collection.
- Option 3: Reconstructed embankment with improved alignment with separate four-lane highway as through road and adjacent local roads and bridges for crossing the highway.
- Option 4: Embankment on filled land in the river with separate four lane highway and local road connections similar to Option 3.

Option 4 is recommended recognizing the both current traffic needs and future development needs in the fast growing communication sector and also its potential for developing a toll road in future. The road will be developed initially for a two lane with a potential to widen for four lanes in future.

4.4. Alternatives for Embankment Material

Construction of embankment requires 12 million m^3 earth fill. Two possible sources of embankment material are: (i) soil excavated from the floodplains and agriculture land and (ii) sand extraction from the river bank with a cladding outer layer. The option of borrowing from floodplain's agricultural land is rejected due to availability of already scarce cultivation lands. The other option of sand extraction from the river will have some localized and temporary impact on the aquatic habitat during the extraction and these impacts can be minimized with the improved sand extraction methodology and locating the extraction points away from the sensitive aquatic habitats, and hence recommended. The sand to be extracted from the river will be very less compared to its annual sediment flow of 600 million m^3 and the lost sand will be replenished by the next flood season and hence the impacts from any sand extraction from the river will be temporary. The source of cladding material of the embankment is usually extracted from the floodplain agriculture lands. In the RBIP, the material from the unused embankments and top soil of from the toe of the embankment will be used as cladding material.

4.5. Alternatives forResettlement Sites

The project requires resettlement of about 3,328 households. Based on recent experiences in Bangladesh on similar projects on embankment rehabilitation and Padma Bridge, four alternatives are considered for planning of resettlement sites: (i) Alternative1: No Resettlement Site (RS). Affected households (hh) will be encouraged to relocate on their own with eligible compensation and assistance from the project and provision for additional incentives; (ii) Alternative 2: Large RS (for 300 to 500 hhs) to be development by the project; (iii) Alternative 3: Small Group (10 to 20 hhs) relocation by members of extended families; and (iv) Alternative 4: Small RS– within the same area with access to existing civic amenities. All alternatives, exception Alternative 2 on development of large resettlement sites will be followed up under RBIP-I.

5. Description of Environment

5.1. Physical Environment

Definition of thestudy area or project influence area:The influence area of the overall program has been derived considering areas that are likely to be directly or indirectly affected by the RBIP construction and operation activities, including but not limited to the extent the project would have impacts on the floodplain areas, lateral fish migration, hydrological, road network, and the project footprints. The boundary on the northern side is the confluence of the Teesta with the Jamuna and the southern side boundary is the Jamuna Bridge. The western side boundary is the entire floodplain area that will be protected from RBIP (up to Dhaka-Bogra-Rangpur highway) and eastern side boundary is the first major channel in the Jamuna, which is located about 1 to 2 km away from the current river bank.

Physiography: The physiography in this area is dominated by characteristics of the braided Jamuna River with meandering channels, chars (shoals) and alluvial floodplains. The Jamunatypically shows two to three channels per cross-section and a total width of 8 to 12 km.Chars are variable in time and space in terms of their geographic location. They survive through the constant interplay of erosion and accretion and only 25 percent of the chars of the Jamuna last more than 9 years. The flood plain areas extensively cultivated and also densely populated. Landuse in the project influence area is covered 7 percent by the Jamuna, 41 percent by agriculture, 49 percent by settlements and 3 percent by chars (159 chars in September 2014).

The Jamuna River:The Jamuna river drains an area of almost 0.57 million km^2, nearly four times the area of Bangladesh. Its main stem and many tributaries flow through four countries: China, India, Bhutan and Bangladesh. The hydrograph of the river is strongly seasonal with a long low water season between October and May (dry or low flow season) and a high water season between June and September (monsoon or high flow season) – driven primarily by summer snowmelt in the upper catchment and monsoon rainfall. The river usually peaks in July when the average maximum discharge is about 50,000 m^3/s. The mean monsoon flow of the Jamuna at Bahadurabad station was around 40,000m^3/s during the period from 1965 to 2006. During the dry season, the discharge is less than 10,000m^3/s and as low as 5,000m^3/s in early March. During the monsoon season, the monthly discharge varies from 30,000 to 50,000m^3/s.

Climate: The climate is sub-tropical in nature with three seasons namely summer/pre-monsoon from March to May, monsoon from June to October, and winter season from November to February. Maximum temperature occurs in the month of April (30ºC) and minimum temperature in January (21ºC). Average annual rainfall is around 1900 mm.

Hydrology: The major tributaries of the Jamuna in the project influence area are Bengali, Ichamati and Hurasagar. There are several small rivulets (known as *khals*) crisscross the floodplains. These *khals* are once connected with the Jamuna, but now lost connectivity after construction of BRE. *Beels* (the depressions in the floodplains) are the other major water bodies which receive flood waters from the rivers and monsoons.

Floods: While typically 20% of the country is flooded during the annual monsoon, severe floods have inundated up to two thirds of the country. The 1998 flood has the highest published discharge (103,129 m^3/s) on the Jamuna River which caused 1,100 deaths, rendered 30 million people homeless and damaged 0.5 million homes. Other major floods were occurred in 1954, 1974 (2,000 deaths), 1987 (2,055 deaths), 1988 (2,000 to 6,500 deaths and 40 million homeless), and 2004.

Inland Navigation: The Jamuna is categorized as Class II by Bangladesh Inland Water Authority, which means the river remains navigable throughout the whole year and links major inland ports or places of economic importance to Class-I routes. The available average draft in the Jamuna is 1.75m across the river and recent surveys show the minimum available water depth in the river from Sirajganj to Bahadurabad is 1m to 1.3m and from Bahadurabad to Chilmari is a 1.2m to 2.2m.

Geology: The soils in this region are usually grey silt loams and silty clay loams. The geology is dominated by quaternary sediments deposited by the Ganges-Padma and Brahmaputra-Jamuna-Teesta and their numerous tributaries and distributaries. The area is underlain by Tertiary and Quaternary sediments and recent alluvial deposits originating in the foothills of the Himalaya. The stratification of the sediments is generally composed of non-cohesive materials of sand and silt with patched of cohesive deposit of clay.

Seismicity: According to Bangladesh National Building Code, the Project area is located in Zone 3, which corresponds to a maximum earthquake of 6.5 g magnitude (for 2500 years return period) and an intensity of VII to VIII on Modified Mercalli Scale. According to this code, all the buildings in this zone are to be designed with 4.3 g (2/3 of maximum earth quake). For design of embankments and bank protection works in RBIP-1, a conservative estimate of 5g magnitude has been adopted by the design consultant considering liquefaction and slope stability issues.

Groundwater: In the floodplains, the groundwater occurs at shallow depths (1.2 to 3.8m) and is also being used extensively for drinking purposes. Total dissolved solids of groundwater near the banks of Indus generally ranges from 289 to 322 mg/l and other chemical constituents are within national drinking water quality standards. At some places, groundwater is also being used for irrigation.

Surface water quality: The water quality of the Jamuna is generally low in total dissolved solids, ranging from 48 mg/l in wet season to 85mg/l in dry season. However, the turbidity levels are very high.

Air quality: Ambient air quality in the influence area has shown exceedances in the suspended particulate matter when compared national as well as World Bank Group (WBG) EHS standards and of ambient air quality. Concentrations of particulate matter are particularly very high (ranging from 261 to 1,188 $\mu g/m^3$)exceeding ambient air quality standards of the WBG EHS (50 $\mu g/m^3$) and Bangladesh (200 $\mu g/m^3$).

Noise quality:Noise levels are generally within the national as well as WBG EHS standards. The night time noise levels were found in the range of 30 to 48 dB (national and WBG standards for night time noise level residential areas are 35 and 45 dBA, respectively), and day time noise levels were found in the rage of 34 to 51 dB (national and WBG standards for day time noise levels for residential areas are 45 and 55 dBA, respectively).

5.2. Biological Environment

General Biodiversity:The project influence area has rich aquatic biodiversity and chars provide habitat for migratory birds. About 17% of total species recorded in Bangladesh occur in the project area. These include 367 species of flora, 25 species of mammals, 255 species of birds, 36 species of reptiles, 15 species of amphibians and 156 species of fish.Among the animal species Ganges River Dolphin (Platanistagangetica) and Softshell Peacock Turtle are the endangered species located in the Jamuna. Based on extensive stakeholder consultations and literature review, it is understood that the Gharials are not present in the Jamuna. There are two types of migratory fish species in the Jamuna, hilsa (Tenualosailisha) and major carps, and both these species are commercially very important fish species in the Jamuna. Hilsa is an anadromousfish that lives in sea and migrate to the Jamuna and the Padma reportedly as far as up to India for breeding. Carps migrate from the Jamuna to the floodplains along with the floodwaters for spawning. Construction of BRE has historically restricted the migration of carps in to the floodplains.

Protected and sensitive areas: There are no protected areas in the project influence area; however, the Jamuna harbors some excellent habitats of the Ganges River Dolphin and wintering grounds of many migratory birds. The two newly-declared (declared in 2013) dolphin sanctuaries (Nagarbari-Mohanganj Wildlife Sanctuary - 408 ha, and Shilonda-Nagdemra Wildlife Sanctuary - 146 ha) are located outside and downstream of the project influence area.These sanctuaries were established to address ongoing threats on dolphin population such as (i) impact on habitat quality due to increased boat traffic and dredging activities, (ii) accidental tangling in fish nets and (iii) decline in fish prey.

During filed investigations in September 2014, 19 dolphins were encountered at three locations.Embayment's on the downstream of chars (known as *koles*) offer breeding habitat of many fish species and are known areas of conservation significance. Eight *koles* are identified in the priority reach.

Terrestrial ecosystems: The terrestrial ecosystem in the project influence area is dynamic and is heavily influenced by the water flow of the mighty Brahmaputra-Jamuna River System. It is dominated by the agricultural landscape and homestead areas, but there are also vast areas of *chars* that are mostly covered by sun grass, reeds and other natural vegetation. There is no riparian vegetation due to ongoing erosion of river banks. Terrestrial ecosystem supports about 25 mammal species such as Small Indian Mongoose, Golden Jackal, Indian Flying Fox, Jungle Cat and Asian Palm Civet. The habitat range of floodplain mammal species has been decreasing due to ongoing bank erosion. Trees around the agricultural fields and homesteads are dominated by exotic species such as eucalyptus and acacia.

River and Floodplain Wetland Ecosystems:The Jamuna and its tributaries provide habitat for numerous species of vertebrates and invertebrates. Most of those species are found throughout the Jamuna and also other rivers and floodplain systems in the country; for them the project influence area is not a critical biotope. The fresh water aquatic ecosystem ofJamuna River and its tributaries are the lifeline of the endangered dolphin and turtle. Chars act as nesting habitat of turtles. The connectivity of river and floodplain wetland is a corridor for migratory fish (to and from breeding and nursing grounds). The Jamunais also a corridor of migratory birds.

River and Charland Ecosystem: The young, vegetated charlands form a major habitat for the Bangladeshi vertebrate fauna: mammals, birds, reptiles and amphibians. The areas are relatively free from noise and other disturbances, whereas the mixed vegetation and the large number of water bodies support a rich hunting, feeding and roosting habitat. A range of waterfowl, both local and migratory, isdirectly or ecologically dependent on charland ecosystems. Chars, especially their submerged extensions, act as reproduction area for many riverine fish and crustacean species. Aquatic reptiles (including endangered turtles) lay their eggs in the sandy beaches. Given the shortage of land in Bangladesh, stabilized charlands are quickly occupied by farmers and fishermen, profiting from the natural richness of these new and fertile lands.

Bird Migration:Huge congregation of migratory winter birds can be seen during November-March in the floodplains and chars of the Jamuna. Winter birds from the Himalayas, Central Asian highlands and faraway places like Siberia move to relatively warm swampy lands in Bangladesh including the project influence area to escape the freezing cold, and feed on various animal and plant food that are abundant in the mudflats, sandflats, rice fields and other areas. Usually, migratory waterbirds fly in north-south direction.Birds start arriving from early November and stay till March-April. An estimated 500,000 birds of about 150 species (mainly ducks, waders and warblers) travel to Bangladesh each winter.The major threats to migratory birds are habitat degradation, introduction of exotic species, and hunting. Due to continued human population growth, these threats are very prominent in the wetlands particularly in the inland freshwater wetlands of Bangladesh.

Fish:The Jamuna is an important source of fresh water fish in Bangladesh. In a braided river like the Jamuna, fish favorable environment generally exists around the stable river banks, braided channels, deep channels, near shallow chars and embayment in the chars (*koles*). While in the floodplains the beels and khals are major fish habitats. About 156 fish species are recorded in the Jamuna, out of which 89 commercially important and 53 nationally threatened. Hilsa and carps constitutes the major share in the Jamuna catch.

Fish Migration: Carp fishesmigrate laterally from the Jamuna to the inundated floodplains adjacent to the river channel during the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species drift downstream and enter the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young migrate to the main river channel in order to avoid the harsh conditions of the floodplain during

the dry season.Migration of adult major carps in the Jamuna River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the southwest monsoon, and continues until the end of July; juvenile fish migrate back to the Jamuna coinciding with the receding of water in October. Connecting *khals* between the Jamuna and other water bodies are vital for sustaining successful fish migration at different seasons. The migratory requirements of the carps are: (i) velocity from 0.3 to 1.2 m/sec and depth from 1 to 3 meter Currently the fish migratory routes are blocked by the BRE which resulted in to great loss of floodplain and river fisheries and the livelihood of fishermen.. The potential migratory routes that can be restored are identified during field studies. Four such sites were identified in the priority reach.

Fisheries:Both capture and culture fisheries types exist in the project influence area. Annual total fish production in the priority reach has been estimated at about 8,500tonnes. River contributes the largest share of this production followed by floodplain, *beels* and *koles*. Fish production from *khals* is insignificant as most of those are either dried up during peak dry season or remain closed by flood control structures. The fish production of the Jamuna has been declined by about 3,200 tonnes in last 30 years, primarily because of increased fishing pressure and a decrease in the extent of floodplain habitats caused by the construction of flood control, drainage and irrigation systems, and the consequent obstruction of movement of fry and fingerlings from rivers. More than 3,500 fishermen have been identified during the catch assessment survey along the right bank. Fishing is one of the available livelihood opportunities for most of the landless people of the project influence area.

5.3. Social and Economic Environment

Demography:The overall RBIP impact area falls under nine upazilas(sub-districts) in three districts. The priority area belongs to four upazilas namely, Kazipur, Sirajganj Sadar, Sariakandi and Dhunat. The total population of all upazilas in RBIP is 2.9 million and RBIP-1 is 1.4 million. The average population density of the projectupazilas (1,078 persons per sq. km) is similar to that of the country as a whole. The more erosion- and flood-prone and less urbanized Fulchari, Sariakandi and Kazipurupazilas have lower population density than the Sirajganj Sadarupazilas where district headquarter is located. The population is almost exclusively Muslim (97%). Average household size is about 4.

Income and Occupation: Based on socio-economic surveys in the project area, nearly half of all households have an income below the Bangladesh poverty line of 6,367 BDT (about 80 USD) per month. Majority of households (HHs) make their income through day labour, mostly in agriculture (896 HHs or 972 persons) or construction (658 hhs or 722 persons), work their own land (644 HHs or 697 persons) or work in transport (474 HHs or 498 persons). Only very few households depend directly on farming from land along the river as a source of income as most of them lost their land to the river. Unemployment is a real problem for these communities, especially for women and young people. The average monthly incomes for most common occupations are as follows: (i) agricultural worker BDT 5,149, (ii) construction worker BDT 5,802 (iii) agriculture landowner BDT 6,362 and (iv) transportation BDT 5,992.A total of 1,342 persons receive currently some type of social support, mostly a stipend or allowance for the elderly.

Education: The overall education level is low. Eleven percent of the women in respondent households reported to be illiterate, while another 30% of respondents can only sign their name and 24% have grade I to IV level of education. So, female functional literacy is only about 35% against national level literacy of 49% women. Male functional literacy is 41% compared to and 54% nationally. These imply that despite having schools, many children, particularly boys need to work to support their familyand girls get married off early

Health Services:Most households (about 45%) consult a pharmacy for common diseases, which are in reality medicine shops in the informal sector found at any bazar. They are easily accessible thanks to their proximity and long opening hours. Medicine shops enjoy great popularity as people do not need to pay for the consultation as with formal or informal health care providers, the medicine shops charge only for the medicines sold. About 20% seek help at the Health and Family Planning Center or

the upazila health complex (14%). Absenteeism, lack of doctors and lack of quality are common problems in the public health sector. The journey to the nearest district hospital that can manage more severe cases and illnesses becomes often a challenge for these communities who lack resources for transportation and need to rely on a debilitating road system.

Agriculture: The floodplain areas are traditionally fertile land with alluvium deposit but generally less productive due to depth of flood water level during the monsoon. Before construction of BREin the 1960s the traditional crops grown in the area are broadcast *aman*[1] rice (low yield potentials 1.5 – 2 t/ha during productive year), *Aus* rice also with low yield and local *aman* rice that was mostly vulnerable to flood damage. Some other crops like grass pea, corn, gram pulse, chili, and sugarcane were the crops in the dry season. The farmers were very poor and under threat of migration from their locality due to lack of livelihood support. After construction of embankment the scenario of crops and cropping and the livelihoods of people have started to change. The flood plain areas became productive and started to produce good local *aman* rice reducing the areas of broadcasted deep-water *aman* rice. The dry land crops like vegetables and oilseeds started to occupy the areas of corn/gram pulse and sugarcane. At present the farmers are mostly cultivating High Yielding Varieties (HYV) of Transplanted *Aman* and HYV *Boro* rice instead of local low yield potential varieties, Ausalmost wiped out from the area. The yield of rice has increased from 1.5 – 2.0 t/ha to 3.5 – 6.0 t/ha. Similarly the production per unit area of other popular crops potentially increased. Farmers use large amount of chemical fertilizers as of other areas of the country. The rate of fertilizer use per ha generally varies from farm to farm based on fertility status of plot and financial base of the producers. The major chemical fertilizers used in the area are Urea, TSP, MoP and Gypsum. Urea is widely used in *boro* rice, potato, maize, jute and other crops. The use of pesticides depends on the degree of pest infestation.

[1] Three types of rice is grown in the country: Aus rice either transplanted or broadcast cultivated in pre-monsoon period (Mar to June); Aman rice either transplanted or broadcast in monsoon period (July to Oct); and Boro rice cultivated in dry/winter season (Nov to Feb).

6. Climate Change Considerations

Climate change scenario of Bangladesh: Climate change may result in increased rainfall intensities, rise of future sea levels, and higher temperature and wind speeds. These changes may in turn result in to increased flood volumes, river water levels and velocities, which are all factors that may affect the design of the RBIP. Climate change projections for Bangladesh were available through studies carried out on regional scale by IPCC (2007), IWM (2008) and BSM (2014). However there are lot of uncertainties in these projections and estimation of river flows from these projections using simplified assumptions will further add to overall uncertainty.

Rainfall projections: The monsoon rainfall is predicted to increase by 5 percent in 2039 and by 13 percent in 2069. Due to climate change the maximum rainfall may increase, for a 100-year return period event, to 372 mm for 1-day period and to 514 mm for 2-day period. The increased rainfall intensities can affect the entire hydrology of the Ganges Brahmaputra Meghna basin.

Temperature projections: Maximum, mean and minimum temperatures can rise between 2° and 4° C by the year 2100. The maximum temperature can reach values of 43.9° C in 2050 and 46.6 ° C in the year 2100 in the once in hundred year event.

Future sea level rise: Sea level rise in the Bay of Bengal is the combined effect of global sea level rise, local changes in sea level due to ocean density and circulation changes and possible subsidence or uplift of the delta. Three possible scenarios for sea level rise in the year 2100 are: (i) a high-end, low-probability estimate of sea level rise of 0.98 m; (ii) a low-end estimate of sea level rise of 0.26 m; and (iii) a pragmatic mid-range estimate of sea level rise of 0.60 m. The influence of water level rise from these three scenarios would not expect to reach up to RBIP site, which is located about 400 km inland.

Wind forces: Cyclone intensities may increase by 10 to 20%. Wind forces can increase to 110 km/hr and during cyclones even up to 126 km/hr.

Scouring and Erosion: Higher volumes of water and increased discharge due to climate related changes would also effect bank erosion as well as scouring.

Discharge: Increased discharge is expected due to increased rainfall and potential glacial melting. This increase must be quantified to determine the design flood levels for RBIP-I.

Flood volumes: Based on flood frequency analysis of historical flows of Jamuna at Bahadurabad, the design discharge of RBIP, a flood event of 100 year return period, is estimated at 109,000 m^3/s. Due to climate change peak discharges at Bahadurabad are expected to increase between 6 and 16 percent. Due to climate change, the flood discharge of 100 year return period would increase between 116,000 m^3/s and 126,000 m^3/s.

River water levels: Water levels and velocities of the Jamuna will increase due to increased flood volumes. Due to climate change, the river water levels in the RBIP area will further increase between 0.2 to 0.3 m for a 6 percent increase flood volumes and between 0.3 to 0.4 m for a 16 percent increase in flood volumes.

Climate change adaptation in RBIP design: A 100-year flood is generally adopted in Bangladesh for design of major flood embankments and river training works. A 6 percent increase to this 100-year flood is considered for the design of RBIP to accommodate future flows from climate change. The design water level for the embankments is proposed to increase to 0.5 m to accommodate increased water levels from climate change. In addition another 1 m of freeboard is recommended to account for more severe flood events and uncertainties in future hydrologic and morphological changes as well as wave run-up. Hence a total free board of 1.5 m is recommended to the design water level. In addition climate change adaptation is also considered for the following key design parameters:

- **Scour depth**: The scour depth based on increased flows was calculated to be 33 m for guiding revetments. This scour depth was based on the design flow that has accounted for climate change.
- **Design velocity**: The design velocity based on increased flows due to climate change was calculated to be 3.4 m/s for guiding revetments.
- **Hydraulic Structures**: The impact of climate change on regulators and other hydraulic structures has been incorporated in the design elements mainly considering a six percent increase in the design flow. The same is the case for hydraulic structures for road works which have all been designed for a higher standard, considering the increased rainfall and flood volumes from climate change.

7. Potential Impacts and Mitigation Measures

7.1. General

The RBIP can be considered as an environmental improvement project since it will (i) address the ongoing erosion and flooding problems and their impact on floodplain ecology (ii) protect about 4.8 million people living on 275,000 ha of floodplains from inundation resulting from extreme flood events, (iii) protect the river bank from further erosion, which otherwise will erode annually about 200 ha of floodplain land, and (iv) bring significant positive effects for the people and economy of one of the most poverty stricken areas of the country. The existing BRE has acted as a barrier and disconnected the Jamuna from its floodplains sincethe 1960s, which has resulted in great loss of floodplain fisheriesand also livelihood of fishermen. The RBIP will address these historical impacts associated with the BRE by (i) restoring fish migratory routes from the Jamuna to floodplains through building of fish passes, (ii) restoring hydrological connectivity between the Jamuna and floodplains through regulators, and (iii) restoring losses in floodplain fisheries through a comprehensive fisheries development program. The negative impacts associated with the implementation of RBIP will mostly result from the construction activities.

7.2. Impact Assessment Methodology

Potential environmental and social impacts were identified on basis of review of feasibility study reports, field visits and stakeholder consultations. The significance of potential impacts was assessed using the following criteria:

Impact Magnitude: The potential impacts of the project have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as: (a) duration of the impact; (b) spatial extent of the impact; (c) reversibility; (d) likelihood; and (e) legal standards and established professional criteria.

Sensitivity of Receptor: The sensitivity of a receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic.

Assigning Significance: Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in Table 4.

Table 4: Significance of Impact Criteria

	Sensitivity of Receptors			
Magnitude of Impact	**Very Severe**	**Severe**	**Mild**	**Low**
Major	Critical	High	Moderate	Minimal
Medium	High	High	Moderate	Minimal
Minor	Moderate	Moderate	Low	Minimal
Nominal	Minimal	Minimal	Minimal	Minimal

7.3. Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in Section 7.2 above. A summary of these impacts and their significance is presented in Table 5.

Table 5: Potential impacts and their significance

Impact from various activities	Magnitude	Sensitivity	Significance Prior to Mitigation	Residual Significance
Impacts related to Project siting				
Control of Riverbank Erosion	Major	-	High positive	High positive
Improved flood protection	Major	-	High positive	High positive
Land cover and land use changes	Major	Mild	Moderate negative	Low negative
Loss of natural vegetation and trees	Major	Mild	Moderate negative	Low negative
Loss of riverbank/aquatic habitat	Medium	Mild	Moderate negative	Low negative
Loss of flood plain habitat	Major	Severe	High negative	Low negative
Drainage congestion and water logging	Medium	Mild	Moderate negative	Low negative
Land acquisition and resettlement	Major	Severe	High negative	Low to moderate negative
Loss of agriculture	Major	Severe	High negative	Low to moderate negative
Impacts on Community Facilities and Places of Religious Significance	Major	Severe	High negative	Low to moderate negative
Blocked access because of road and embankment	Major	Mild	Moderate negative	Low negative
Improved road connectivity	Major	-	High positive	High positive
Environment impacts during construction phase				
Impacts of borrowing of material (sand extraction)	Major	Severe	High negative	Low negative
Air pollution	Medium	Mild	Moderate negative	Low negative
Noise	Medium	Mild	Moderate negative	Low negative
Water pollution	Major	Severe	High negative	Low negative
Soil contamination	Major	Severe	High negative	Low negative
Solid wastes and hazardous wastes	Major	Severe	High negative	Low negative
Impacts on aquatic habitat	Major	Severe	High negative	Low to moderate negative
Impacts on floodplain habitat	Major	Severe	High negative	Low negative
Impacts on *charland* habitat	Minor	Low	Minimal	Minimal
Site clearance and restoration	Medium	Severe	Moderate negative	Low negative
Social impacts during construction phase				
Impacts on cultural heritage	Medium	Mild	Moderate negative	Low negative

Impact from various activities	Magnitude	Sensitivity	Significance Prior to Mitigation	Residual Significance
Impacts on community facilities	Medium	Mild	Moderate negative	Low negative
Occupational health and safety	Major	Severe	High negative	Low to moderate negative
Community health and safety	Major	Severe	High negative	Low to moderate negative
Environmental impacts during O&M				
Changes in river morphology	Nominal	Severe	Minimal Negative	Minimal negative
Loss of ecological connectivity	Major	Severe	High negative	Low negative
Drainage congestion and water logging	Medium	Mild	Moderate negative	Low negative
Generation of solid waste	Major	Severe	High negative	Low negative
Air pollution	Medium	Mild	Moderate negative	Low negative
Noise generation	Medium	Mild	Moderate negative	Low negative
Water pollution	Medium	Mild	Moderate negative	Low negative
Risk of embankment breaches	Major	Very Severe	Critical	Low to moderate negative
Social impacts during O&M				
Changes in agricultural pattern	Medium	Mild	Moderate negative	Low negative
Community health and safety	Major	Severe	High negative	Low to moderate negative

7.4. Environmental impacts from Project Siting

Control of River Bank Erosion: During the last four to five decades, the Jamuna has been undergoing strong metamorphosis in width, bank erosion, braiding intensities. The riverbank erosion not only causes loss of land, but also attacks the already dilapidated BRE, causing frequent beaches that in turn result in flooding of the BRE-protected floodplain causing substantial losses to private and public assets as well as crops and cultivation fields. The revetment works envisaged under the proposed RBIP will help avoid the losses described above and will result in saving of about US $ 17.33 million per year – the annual losses that are likely to take place caused by the riverbank erosion if no protective measures are undertaken.

Improved Flood Protection: Originally, the BRE had a setback distance of about 1.5 km from the Jamuna's river bankline. Over the years the embankment has been increasingly under attack from bank erosion causing the embankment to breach at several locations. After such breaches of the embankment, it needs to be retired back away from its original alignment and reconstructed. The rehabilitation of existing and construction of new embankment will greatly improve the effectiveness of this structure against floods. In addition, the squatters will be removed from the embankment (after the payment of compensation) allowing effective monitoring and maintenance of the new embankment once constructed. This will greatly reduce the risks of embankment breaching or over-topping hence significantly increasing the protection of the area from floods and associated losses.

Land Cover and Landuse Changes: Improved flood protection from RBIP may result in to improved cropping pattern with increasing trend of high value crops. Based upon the changed cropping pattern and increased yield, there will be an increase in the agricultural income from the project influence area. It is estimated that there will be a net increase of more than BDT 2 billion (USD 25 million) per year in the agriculture income from the project influence area. While the increased agricultural income will positively impact the livelihood of the local farmers, the changes in cropping pattern will potentially cause an increased use of agro-chemicals. The increased use of agro-chemical can potentially cause an enhanced level of soil and water contamination and pose health hazards for the farm workers and also for the nearby communities. The integrated pest management programs (IPM) are already under implementation in Bangladesh. Linkage with these programs will be facilitated to address any increase usage of agro-chemicals in the area. In addition to the above, an integrated pest management plan will be prepared by the RBIP during the project implementation but before its completion.

Loss of natural vegetation and trees: About 170,000 trees will be cut during site preparation works. Most of the tree species comprises timber (e.g. eucalyptus and acacia) and horticultural species (e.g. mango, jackfruit). Except for the economic value of eucalyptus and acacia, these species have no significant benefit for the ecosystem. A compensatory tree plantation will be carried out along the slopes of embankment. About 140 ha of land is available for this purpose. A limited number of tree species have been proposed for the compensatory plantation in view of the ease of management and in accordance with the WB OP 4.36. About 2500 trees (1875 timber and 625 fruit species) will be planted per hectare; hence a total of about 350,000 trees will be planted along the priority reach.

Loss of Riverbank/Aquatic Habitat: Revetment works may potentially impact about 102 ha of river bank area, which can be an aquatic habitat during high flow season. However, this part of the aquatic habitat is regularly eroded because of the frequent riverbank erosion. Hence the revetment will not result in any additional loss of aquatic habitat. The aquatic habitat can also be potentially affected if sediments and pollutants from the construction sites and camp sites are released in the water bodies.Since most of the potentially negative impacts of riverbank revetment on the aquatic habitat are expected to be temporary in nature, and since the revetment is likely to provide habitat for some aquatic species, as stated earlier, no mitigation measures are identified ex-ante for this activity. Habitat monitoring will however be initiated during the construction phase and will be continued thereafter to fully understand the impact of revetment on the aquatic habitat.

Loss of Floodplain Habitat: The embankment works will affect about 340 ha of terrestrial habitat however most parts of this area is completely modified and is currently either under cultivation or included in built-up area (homesteads, other physical infrastructure). Since its construction in 1960s, the BRE has been acting as a barrier, disconnecting large area of floodplain from the river. This has brought changes in the natural ecosystems of floodplain dependent on the flood waters resulting in great loss of biodiversity and natural resources, as well as livelihood opportunities for the communities. Four potential areas within the priority reach have been identified where re-establishing of ecological connectivity will greatly help in restoring the biodiversity of the area particularly facilitating the fish migration, which in turn will enhance the fish production in the beels, khals, and other water bodies of the floodplain. The increase in production is estimated to be about 1,880 tonnes per year.

Drainage Congestion and Water Logging: Construction and or rehabilitation of the embankment may potentially block some water channels (khals), which provide ecological connectivity in addition to facilitating irrigation/drainage. Some regulators were constructed across the original embankment constructed as part of the BRE however many of them have either been blocked or not functioning properly. As a result some cultivated lands particularly near Baliaghuri in Sirajganj are facing drainage congestion and water logging problems. In the absence of mitigation, similar impacts would be expected due to the proposed project works. Similarly, there is a possibility of water logging / drainage congestion between the old embankment and the new one to be constructed under RBIP. Appropriate operating procedures and a maintenance plan will be implemented to operate and maintain these structures to address the drainage congestion and water logging problems in the area.

In addition, culverts will be constructed across the old embankment at appropriate places to ensure proper drainage of the area.

7.5. Social impacts from Project Siting

Land Acquisition and Resettlement: The project will affect about 4,236 households comprising of 18,235 people from whom 3,628 households (15,558 people) will be physically displaced. It will affect a total of 18,235 people (male 9,253 and female 8,982) including arable land owners, residential and commercial structure owners etc. Among those affected, about 2,030 households will suffer from economic displacement due to loss of agricultural land, trees and pond. To implement the project about 370 ha various categories of land will need to be acquired. Apart from land acquisition, some GOB land especially BWDB existing embankment will be used for project interventions. Along the priority reach, a total of 5,751 entities have been affected by the project from which 3,480 residential households, 148 business units, 84 residence-cum business and 78 community properties will be physically displaced. Apart from this 1,437 households are losing only agricultural land plots. A summary of these impacts isgiven in Table 6.

Table 6: Summary of Resettlement Impacts

Impacts/Types of losses		Sirajganj		Bogra		Total
		Sirajganj Sadar	Kazipur	Dhunat	Sariakandi	
A.	**Alignment Length and Required Land Acquisition**					
1.	Total length of alignment/km	5.595	13.276	7.895	22.759	**49.525**
2.	Required Land acquisition in ha including resettlement site (50 ha)	40.23	94.67	57.04	178.03	**370**
B.	**Number of physically displaced HHs requiring relocation**[2]					**3,628**
1.	Affected Residential HHs only	164	812	424	856	2,256
2.	Affected Business HHs only	04	60	29	55	148
3.	Affected Residential & Business HHs only	04	39	03	38	84
4.	Affected Residential & Agricultural land only	00	02	02	15	19
5.	Affected Residential Structure & Land other than Agricultural	93	212	259	557	1121
B.1.	Number of person required relocation	1,264	5,006	3,116	6,172	**15,558**
B.2	Average HH Size	4.75	4.45	4.34	4.03	4.28
C.	**Number of Affected units requiring relocation (other than item 2 and 4 of B)**					
1.	Affected CPRs	7	9	18	44	**78**
2.	Affected sallow tube-well	0	01	03	02	**06**
3.	Only trees affected HHs	62	156	95	278	**591**
4.	Affected Fish Pond only	01	00	01	09	11
D.	**Affected HHs loosing agricultural plots only**					
D.1.	Number of HH's losing agricultural plots[3]	171	369	648	249	**1437**
D.2.	Affected population due to loss of agricultural land	953	2,189	3,386	1,498	8,026
D.3.	Average HHs size	5.57	5.93	5.22	6.08	5.70
E.	**Additional data by categories (already embedded in A,B,C& D)**					
1.	Number of total affected HHs (B+C+D.1)	437	1,494	1,366	1,779	**5,751**
2.	Number of affected population(B.1+C+D.2)	2,492	7,926	6,648	9,234	**23,584**
3.	Total no. of trees on private land	14341	37719	31376	53504	136940
4.	No of trees affected on government land	475	12971	5924	14650	34020
5.	Number of wage labourer affected	27	57	75	77	128
E.1.	**Total number of Vulnerable HHs**					**2762**
1.	Female Headed HH	34	170	80	182	466
2.	Poor HH	90	316	247	650	1303
3.	Land Less HH	57	337	148	231	773

[2] Refers to affected HHs and Businesses to be relocated
[3] No relocation required

Impacts/Types of losses		Sirajganj		Bogra		Total
		Sirajganj Sadar	Kazipur	Dhunat	Sariakandi	
4.	Elderly headed HH	17	45	51	74	187
5.	Disabled HH	2	12	3	16	33
F	Severely Affected Households					
1.	HH Losing >10% of their income due to loss of productive lands	12	58	19	111	200

Out of the 370 ha affected land, 74% is agriculture land, 17% is homestead land and the rest is bamboo groves and orchards. The loss of land will be compensated by replacement value based on current market prices and standing crops. To relocate 3,628 affected households, 15 resettlement sites will be constructed with all basic infrastructure facilities such as water supply, sanitation, internal roads, drains, mosques, and schools. Cash compensation will be provided for households who opt for self-relocation and provisions are made in RAB budget for augmenting civil amenities in host villages.

Loss of Agriculture and Other Sources of Income: The project interventionsin the priority reach are likely to affect 276 ha of agricultural land and a total of 232 business structures. About 94% percent of the agricultural plot owners will lose less than 10% of their income due to loss of agricultural land. Due to linear type acquisition process, 92% land owners are losing land partially and 98% will be losing land less than 50 decimal of land (one decimal is equal to 40.46 m²). Therefore, project impact over land is moderate. The loss of land will be compensated by replacement value based on current market prices (plus government stamp duty fee) and standing crops.

Out of total affected households of 5751 (for all losses, see item E in above table), only 200 households will lose more than 10% of their income. The major impact on livelihood will be mostly from relocation of 148 shops/kiosks – about 95% of them are on the current embankment. In addition128 laborers will lose their jobs temporarily and most of them are unskilled. The following provisions are included in RAP: (i) severely affected households will receive additional cash compensation; (ii) laborers will receive cash compensation and job opportunity during construction period, (iii) training on poultry, fisheries farming and new skill development training will be provided, and (iv) additionalenhancement measures through livelihood and restoration programs.

Impacts on Community Facilities and Places of Religious Significance: The project interventions in the priority reach is likely to affect a total of 74 common property resources such as community facilities mosques, temples, and graveyards (however none of these facilities require any special protections warranting a PCR management plan as per the OP 4.11). The affected common property resources include where 20 mosques, 7 madrasahs, 4 temples, one church, 2 graveyards, 7 eidgahs and 20 schools. About 95% schools and mosques are tempaorary structures and can be easily dismantled and re-established. Due to erosion, these structures were shifted 2 to 8 times in the last 35 years. The project will reconstruct the affected facilities in complete coordination and participation of the relevant community and in a culturally- and socially-acceptable manner. Thegraveyards will be shifted to nearby locations with community participation.

Barrier/Severance Effect: The embankment will act as a barrier for the movement of the people between the country side and river side. Twelve local crossings (ramp cum stairs) to facilitate the movement of people, livestock and non-motorized vehicles and9 vehicular crossings are included on the embankment for the priority reach. Riverbank revetment may also potentially block access of the people to the river since slope of the concrete blocks can potentially make it difficult for the people and livestock to cross it. Stairs and ramps will be built on the bank protection works to access the river.

7.6. Significant Environmental Impacts during Construction

Impacts from Borrow Areas/Sand Extraction: For the entire works under the Phase I, about 12 million m^3 of sand (about 2.4 million m^3 of sand annually) would be needed over a period of 5 years for construction of embankment and filling of geo-bags for riverbank protection. The Jamuna carries about 600 million m^3 of sediment load annually and the proposed sand extraction will be only 0.4% of the sediment load. The sand extraction areas will rapidly be covered with fresh sediments hence

minimizing any long lasting impacts. However, during the construction phase, the sand extraction can potentially cause negative impacts on the habitat quality of dolphins and fish due to (i) generation of high sediment loads, (ii) disturbance of benthic habitat,(iii) noise from construction machinery, and (iv) accidental spillage of fuels and bilge water from construction boats. Potential risk of construction related boats collision with the dolphins is further discussed in the following paragraph on 'impact on aquatic and floodplain habitats'. Sand extraction from river bank will be carried out in an environmentally and ecologically safe manner. Only small quantities of sand will be collected from any single location and stretches of riverbank will be left undisturbed between the locations from where the sand is extracted – in order not to disturb long, unbroken stretches of river bank thus allowing the aquatic fauna to rejuvenate at the sand extraction locations. Sand extraction will not be permitted at or in the vicinity of sensitive habitats. Silt fences or sediment barriers will be provided around the sand extraction areas to prevent migration of high sediment loads. To address risks of accidental spillage of fuels and bilge water, the contractor will take utmost care to prevent such risks and will prepare an emergency preparedness plan to address these risks. The contractor will make booms, absorbents and skimmers available on site along with the trained personnel to recover the spilled oils from the water surface. No earth will be obtained from any cultivation fields; the existing embankments will be excavated to obtain the earth required for the embankment cladding.

Air Pollution and Greenhouse Gases Emissions from Construction Works: It is estimated that about 0.019 million tonnes of CO_2 will be emitted during the entire construction period from all the construction activities. The emissions from construction activities will deteriorate the ambient air quality and affect the public health. The dense populated areas and crowded market places (bazaars) are particularly vulnerable to these impacts. In addition, dust generated from the above activities will also have impacts on crops and livestock. Dust generation from construction sites will be restricted as much as possible and water sprinkling will be carried out as appropriate, especially at those places where earthmoving, and excavation will be carried out. Emissions from the construction equipment and traffic will comply with World Bank EHS guidelines.

Noise Pollution from Construction Works: Noise will be produced by vehicular movement, excavation machinery, concrete mixing, and other construction activities. Noise levels from construction activities will exceed the standards. The schools, religious places and crowded market areas are particularly vulnerable to the increased noise levels. Noise control measures will be implemented near the sensitive sites.

Water Pollution: During the construction phase, sand extraction and launching of geo-bags along the river bank can potentially cause some localized increase in water turbidity. However this increase in turbidity is not likely to have any significant impact on overall water quality and the aquatic fauna primarily because of its temporary and localized nature. The construction camps and other site facilities such as offices and warehouses will also generate substantial quantities of waste effluents. About 75,000 liters of waste water will be generated from the site facilities on a daily basis. Other possible causes of land or water contamination include accidental leakage or spillage of fuels, oils, and other chemicals, and waste effluents released from workshops and washing bays for vehicles. Any discharges to the river will be properly treated to comply with relevant standards before discharging.

Soil Contamination: Soils in the construction area and nearby lands that are used for agriculture will be prone to pollution from the construction activities, construction yards, workers camps and other construction areas. Fuel and hazardous material storage sites and their handling are also the potential sources for soil and water pollution. Improper siting, storage and handling of fuels, lubricants, chemicals and hazardous materials, and potential spills from these will severely impact the soil and water quality and also cause safety and health hazards. For avoiding and managing any accidental leakages and spillages, standard operating procedures (including the requirement of secondary containment for fuels, oils, and other hazardous substances), the contractors will be responsible to prepare and implement a waste and pollution management plan. For the effluents to be released from

workshops, camps, and offices, appropriate treatment arrangements such as retention ponds and septic tanks will be incorporated in the facility design.

Generation of Solid Waste and Hazardous Waste: Solid waste generated during the construction phase will include excess construction material such as sand and soil, faulty/damaged parts, metal scraps, cardboard boxes and containers, cotton swaths from workshops, and domestic solid waste from construction offices and camps. It is estimated that about 150 kg of domestic solid wastes will be generated daily from the construction camps and offices. Most parts of this waste will be bio-degradable. In addition to the above, small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils; chemicals, such as anti-freeze; contaminated soil; spillage control materials used to absorb oil and chemical spillages; machine/engine filter cartridges; oily rags, spent filters, contaminated soil, and others). It is imperative that such waste is responsibly disposed to avoid adverse environmental, human health and aesthetic impacts.Contractors will be required to prepare and implement a Waste and Pollution Management Plan in accordance with the WB EHS Guidelines and ECoP.

Impact on Aquatic and Floodplain Habitats: Sand extraction from the riverbank, launching of geo-bags, and placement of concrete blocks for the river revetment may potentially disturb the aquatic habitat by increasing the water turbidity. However embankment construction activities are not likely to have any direct impact on terrestrial or aquatic wildlife or their habitat since no sensitive ecological hot spots have been identified along the existing and proposed alignment for the key sensitive habitats in the area). However any accidental leakage, spillage of contaminants, or dumping of solid waste/debris on land or in water bodies can potentially affect these habitats. The potential impacts on the aquatic fauna can be at least partially addressed by not carrying out sand extraction and revetments along long, contiguous sections of the river bank at a time, as already described earlier.Silt fences, sediment barriers or other devices will be provided along the river training works to prevent migration of silt in to the river. Discharges from batching plants, construction yards and construction amps in to the river will be contained. Any discharges to the river will be properly treated to comply with relevant national standards before discharging. Construction-related boat movement (for sand extraction and revetment works) will be restricted to within 500 m of river bank, which should minimize their impact on river dolphins. Motor boat speed will be limited to 15 km/h in accordance with best international practices. Pingers will be used to chase away dolphins form the construction areas thus minimizing the chances of any collision.

Impact on Charland Habitat: The construction activities are not likely to affect the wintering birds that are mainly found in the chars (shoals) since these chars are across the river channels and quite a distance away from the construction sites. If any sand extraction activities are located near chars, noise generated from these activities has a potential to affect the migratory birds. However, due to the vast habitat range of these birds along the chars in Jamuna, the project is not expected to have any impacts on the migratory birds. If any construction activities disturb their roosting, hunting and feeding grounds, they would move to another lesser or undisturbed areas without any difficulty. The contractors will be required to reduce the noise levels generated from the construction activities by providing mufflers or acoustic enclosures for high noise generating equipment. The Contractor will also raise awareness about the protection of birds among the work force to reduce impacts such as disturbance and poaching.Lighting from construction sites and construction camps may affect the visibility of night time migratory birds. To mitigate light pollution on the birds, the contractors shall use lower wattage flat lens fixtures that direct light down and reduce glare, and shall avoid use of flood lights.

Site clearance and Restoration: After the completion of the construction activities, the left over construction material, debris, spoils, scraps and other wastes from workshops, and camp sites can potentially create hindrance and encumbrance for the local communities in addition to blocking natural drainage and or irrigation channels. The contractors will be required to remove all left over construction material, debris, spoils, and other wastes from the construction sites. The camps sites

will be completely cleaned and restored in original condition to the extent possible. No waste disposal will be carried out in khals, beels and ponds.

7.7. Significant Social Impacts during Construction

Impact on Cultural Heritage: Many of religious structures will have to be relocated because of the reconstruction and rehabilitation of the embankment. The contractors will be required to prepare code of conduct to be followed by all site personnel - to respect religious beliefs and sites, and to conduct in a culturally appropriate manner. In addition, 'chance find' procedures will be followed in case of accidental discovery of any sites or artifacts of religious, historical, or cultural importance.

Impact on Community Facilities: A few schools and other community facilities exist along the embankment. The potential impacts of the project on these schools could include relocation, air quality deterioration, noise, and safety hazards. The construction activities can potentially damage the existing public and private infrastructures such as local roads, foot paths, and boat jetties. For noise, air quality, and safety hazard, the contractors will be required to ensure that activities in the vicinity of the sensitive receptors such as schools are carried out in a manner so as to minimize these risks (e.g., carrying out the construction activities after the school time). The construction site will be fenced near such places to minimize safety hazards. Safety signage will be placed and coordination will be maintained with the facility management as well as with the community to minimize the risks. Finally, any complaints of related to project impacts on the sensitive receptors will be addressed through the GRM described earlier.

Blockage of Local Roads/Routes/Jetties and Traffic Congestion: Construction activities for riverbank protection may potentially block/hinder access to boat jetties and also hinder the boat traffic. Similarly, construction works on the embankment may block local roads and routes and may prevent the local people to cross the construction area. Furthermore, the construction works and associated vehicular traffic may cause traffic congestion on local roads, particularly near local markets and boat jetties. The contractor will prepare and implement a traffic management plan (for both vehicular as well as boat traffic). Consultations with the local communities will be carried out on an on-going basis and the construction schedule will be discussed with them to ensure that blockage of the local routes is minimized. The construction works particularly at/near the boat jetties and local bazaars will be carefully planned to minimize hindrance to the local communities. The GRM described earlier will address any community grievances related to blocked routes as well. The contractors will be required to prepare and implement a traffic management plan that will be prepared in consultation with the local community and relevant officials.

Occupational Health and Safety: Generally the construction activities will involve large scale excavation, operations of heavy construction machinery and vehicular traffic. These activities may pose health and safety hazards to the workers at site during use of hazardous substances, lifting and handling of heavy equipment, operating machinery and electrical equipment, working near water or at height and more. The project will need fuels, oils, and asphalt during the construction phase. Inappropriate handling or accidental spillage/leakage of these substances can potentially lead to safety and health hazards for the construction workers as well as the local community.

Community Health and Safety: During the construction phase, the population living in close proximity of the construction area, people living in and around the potential resettlement sites, the construction workforce and individuals drawn to the area in search of income opportunities will be exposed to a number of temporary risks such as safety hazards associated with the construction activities and vehicular movement, exposure to dust, noise, pollution, infectious disease, and various hazards, including potential conflict with "outsiders" to the project influence area about employment and income. The influx and accommodation of a large work force will result in increased concerns for the health and safety of local population, including the spreading of sexually transmitted diseases such as HIV/AIDS. To address the safety risks for the construction workers, the contractors' HSE plan will include detailed occupational health and safety (OHS) procedures and protocols. Similarly, the HSE plan will also include measures and protocols to protect the nearby community against the risk of

accidents and mishaps. In addition, the ERP will also include procedures to be followed in case any accident does take place. Community awareness, warning signboards, and area fencing where possible will be some of the key elements of the safety protocols.

7.8. Environmental Impacts during Operation and Maintenance

Potential Changes in River Morphology and Erosion: The potential impactsof the revetment on river morphology may include stabilization and deepening of the river channel. These changes are mostly positive in nature, likely to take place over a long period of time and need to be regularly monitored for better understanding of the phenomenon. Furthermore, the morphological changes that may be caused by the proposed revetment will not extend beyond the few hundred meters downstream of the revetment. To better understand the cause and effect relationship of river bank revetment and morphological changes in the river, a long term monitoring program will be designed and initiated during the project implementation.

Generation of Solid Waste: Solid waste and hazardous waste will also be generated from road maintenance from removal of asphalt. This waste if not appropriately disposed has a potential to contaminate soil and water resources, thus negatively affecting communities as well as natural habitat. The BWDB will prepare an HSE Plan that will cover the appropriate disposal mechanism for various types of solid wastes.

Air Pollution from Traffic: Emissions from road traffic may affect the ambient air quality along the road embankment. Air quality modeling will be taken up during detailed design of road component to predict the air quality during O&M Phase. Annual greenhouse gasesemissions from future traffic will vary from 0.02 to 0.16 million tonnes. During design of road component (i.e., RBIP, Phase III), various options to reduce the traffic congestion will be considered to reduce traffic emission. These measures could include: (i) minimizing grade changes, at-grade crossings, and sharp curves which can promote congestion and (ii) design of roadway to shed water to minimize rolling resistance, as well as to enhance safety

Noise Pollution from Traffic: During operation, noise levels along the road on the embankment will be increased due to the higher traffic volume. Traffic noise will be a significant nuisance to the sensitive receptors such as schools and religious places located vary close to the road. The traffic noise levels will depend on road way profile, horizontal alignment, road and receptors elevation, number of lanes, average daily traffic with type of vehicles, speeds, receiver location, nature of intervening ground, and the presence of noise shielding elements. During design of road component, a detailed traffic noise modeling will be carried to out to design noise barriers (e.g. walls, vegetation) along the embankments to reduce the noise levels near sensitive receptors such as schools.

Water Pollution: Generally paved road increases the amount of impermeable surface area, which increases the rate of surface water runoff. Increased storm water flow rates can lead to stream erosion and flooding downstream; cause soil erosion, channel modification and siltation of streams. During the O&M phase, some localized increase in turbidity may take place during any maintenance works on the bank revetment. Similarly, the maintenance works can also generate a limited quantity of waste effluents. Appropriate storm water drainage arrangements will be included in the road design. The runoff will be released in a manner that it does not cause soil erosion. To address the potential issues associated with waste effluents generated by O&M activities, the HSE Plan prepared by the BWDB also mentioned earlier will include disposal mechanism for waste effluents as well.

7.9. Significant Social Impacts during Operation and Maintenance

Community Health and Safety: Similar to construction activities, significant community health and safety issues associated with the maintenance activities will include pedestrian safety, traffic safety and emergency preparedness. Pedestrians will be at greatest risk of serious injury from collisions with moving vehicles. Collisions and accidents can involve a single or multiple vehicles, pedestrians or bicyclists, and animals. Emergency situations most commonly associated during O&M phase will include accidents involving single or multiple vehicles, pedestrians, and/or the release of oil or

hazardous materials. During the O&M phase, the BWDB will be required to implement HSE procedures and prepare its own ERP. For the safety hazards associated with vehicular traffic on the embankment road, standard road signage and other safety measures such as zebra crossings and pedestrian walk-overs (bridges) are being included in the road design.

Risk of Embankment Breaches and Emergency Response Mechanism: Though the RBIP aims to strengthen the embankment, breaches can still take place because of a variety of reasons such as earthquakes and riverbank erosion. Such breaches in the post RBIP completion phase can potentially cause considerably higher losses than currently being incurred because of the intensified cultivation and increased area development that is likely to take place because of the enhanced protection against riverbank erosion and floods, as described earlier as well. The BWDB's O&M procedures include regular monitoring of the embankment and its structural integrity, ensuring that the breaches can be prevented.

8. Cumulative and Induced Impact Assessment

8.1. Objective

The GoB is planning to rehabilitate existing river training works and flood embankments along both right and left banks of the Jamuna, and also to construct new river training works and embankments. The GoBis also planning to undertake a huge $100 billion investment program, Capital Dredging Project, 'in all major rivers including the Jamuna for sustainable river managementthrough extensive dredging programs to control of river bed siltation and aggradation, land reclamation, and develop inland navigation.The objective of the current cumulative and induced impact assessment (CIIA) is to evaluate the combined effects of proposed developments both within and thefloodplains of the Jamuna River.

8.2. CIIA in Context of RBIP

Study Boundaries: In the context of RBIP, the spatial boundaries of CIIA have been based on the extent of floodplain area of Jamuna in Bangladesh. The length of Jamuna from Indian border to the Ganges (the Padma River) confluence is about 220km. The spatial boundary of the CIIA is the floodplain of Jamuna from Bangladesh border with India to the confluence of Jamuna with the Ganges. According to GoB development plans, rehabilitation and construction of embankments and river training works along both banks of Jamuna, development of a road network along the right bank, and integrated river management program and inland water transport are considered as future major developments in next 20 years; and hence these projects are considered for CIIA study.

Valued Environmental Components (VECs): The study focus on more relevant valued environmental components (VECs) related to river management programs of the Jamuna, which are morphology/erosion, flood affected area and aquatic biodiversity. The rationale for choosing morphology and flood affected area as VECs are: (i) the RBIP and other future development projects in the CIIA study area are primarily targeted to control erosion and flooding issues of the Jamuna, (ii) the impacts on floodplain and charland ecology are related to erosion and floods, and (iii) these can be modeled to a reasonable extent using the available information and knowledge.

8.3. Morphology

Background and Baseline conditions: The Jamuna, originally a small distributary channel of the Brahmaputra, originates about 10 km downstream of the Teesta confluence with the Brahmaputra. Sometime between 1776 and 1830, due to avulsion,most of the Brahmaputra River started flowing through the present course of the Jamuna River.During the last two centuries since the avulsion, the Jamuna River has been undergoing several morphological changes like increasing its width, achieving metamorphosis of its planform and pursuing westward migration mainly due to neotectonics and the 1950 Assam earth quake. In 1830, the river was a single channel meandering river with an average river width of 6.2 km. By 1930, the river shifted noticeably westward on average by 1.9 km and its average width (5.55 km) was somewhat narrower than that in 1830 (6.24 km). Between 1914 and 1973, the river continued migrating westward while widening significantly and metamorphosing from meandering to braided form largely due to the increased sediment inflow resulting from the Great Assam Earthquake of 1950. This period is marked by high rate of widening, high rate of westward migration of centerline and right bank, and high rate of erosion along the right bank (Table 7). By 1973, the average width of the river had reduced slightly, but rapid westward migration has been continuing till to date (Figure 4).

Table 7: Summary of the Jamuna right bank westward shift and changes in width

Period	Westward shift of right bank per year (m)	Change in average width (km)
1830 – 1914	19	-0.49
1914 – 1953	106	3.56
1953 – 1973	26	-0.47
1973 – 2010	45	2.98

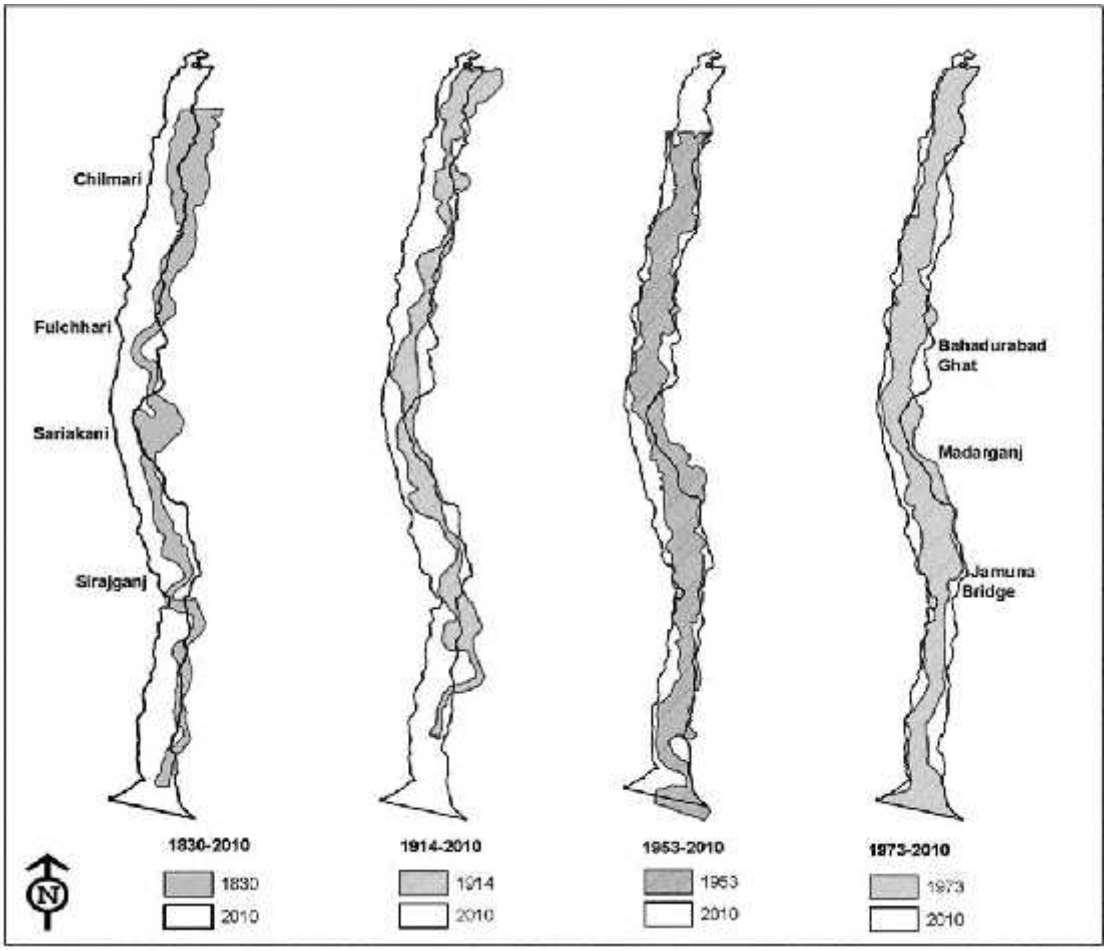


Figure 4: Bankline changes of the Jamuna River 1830 – 2010

Erosion and Accretion: The historical morphological changes in the Jamuna have led to significanterosion of floodplain and char land areas impacting floodplain and char dwellers. During last 40 years (1973 to 2014), about 88,000 ha of floodplain land was eroded on Jamuna due to its westward migration and widening. Only 18 percent of this eroded land is accreted along the banks. The extent of erosion and accretion along both banks during this period is given Table 8. The total area of the river is increased from 170,000 ha in 1973 to 230,000 in 2014 causing the following significant impacts:

- **LanduseChanges**: The widening on both banks during the last 40 years has converted around 73,000 ha of fertile floodplain land into low lying sandbars and river islands, land that could have provided living space for around one million people at the present population density.

- **Ecological Changes**: Changes associated with above landuse also significantly affecting the floodplain ecology, particularly the beels and other surface water bodies that provide habitat for floodplain aquatic species and spawning grounds for migratory fish species.
- **Population Displacement**: The morphological changes in Jamuna have caused forced displacement of about one million people in last 40 years and severely impacted their livelihood sources.

Table 8: Summary Erosion and Accretion along the Jamuna from 1973 to 2014

	Left Bank	Right Bank	Total
Erosion [ha]	-47,579	-41,089	-88,668
Accretion [ha]	+15,069	+882	+15,950
Total [ha]	-32,510	-40,207	-72,718

Future Trends: For the last 180 years, the morphological changes of Jamuna River have primarily occurred due to extreme natural events such as earthquakes and neo-tectonics. Two such events, avulsion in the end of 19th century and Assam earth quake in 1950 have shaped the current morphology of Jamuna River. The future morphological changes are also expected to depend on similar neo-tectonics. Within the Brahmaputra Basin, continued neo-tectonic activity and further seismic events are likely to trigger further avulsions and sediment waves. Consequently, it must be expected that this great river will be disturbed in the future just as it has been in the past, leading to new adjustments of the fluvial system and morphological responses that are likely to cause suffering to hundreds of thousands of people. However, this process is not expected to continue for an infinite period of time.

Cumulative Impacts: Structural interventions in the form of hard points, groynes, or revetments are the most effective way to counter riverbank erosion. Since 1990s, various structural interventions have been built on both banks of Jamuna and have worked effectively. Erosion had halted at the locations of structures, but it had been continued at the upstream and downstream of the structures. The bank protection works other than revetments have been found to deflect channel flows and can induce erosion on both upstream and downstream of the protection works. While it is found that the revetments had little impact on the upstream and downstream areas. Apart from protecting the riverbank, protection works have the potential of attracting the flow and maintain channels along the revetments.

The cumulative effects of the bank protection works will be very beneficial in controlling further erosion of thousands of hectares of the Jamuna floodplains and displacement of hundreds of thousands of people. Based on the current trends of right bank erosion, it is expected that the projects would save about 14,000 ha of land from erosion and forced displacement of about 172,000 people.The channel flows will be controlled by the structures and it is likely that the channel will flow along the structure maintaining a higher depth. Further, stability of the channels and chars would be increased. Due to stabilized river banks, channels and chars, the cumulative effects on the ecological habitats of both river and charland would be very positive.

However, assessing the impact of structural interventions on a complex braided river like Jamuna is a serious challenge. Post-project monitoring can be very helpful in developing and gaining enhanced understanding of the river responses over time. BWDB, as part of its regular O&M, needs to carry out regular and comprehensive monitoring of bathymetry along the embankments and analysis of time-series of multi-spectral satellite images. From ecological point of view, a regular monitoring program on aquatic and charland biodiversity should be implemented and coordinated by BWDB , as well as baseline data collection along the left bank and in any other areas of proposed future intervention, so that a better understanding can be developed of the relationship between the morphological and land

use change effects and the region's aquatic and charland biodiversity This in turn will enable better regional planning in consideration of these effects.

8.4. Flood Affected Area

Background and Baseline Conditions: The Brahmaputra river drains an area of almost 0.57 million km^2, nearly four times the area of Bangladesh. Its main stem and many tributaries flow through four countries: China, India, Bhutan and Bangladesh.Water in the Brahmaputra River is the foundation for food production, hydropower generation and other ecosystem services for an estimated 130 million people living within the boundaries of its basin.The flow of the Jamuna is mainly generated from monsoon precipitationand snow/glacier melt in the Himalayas.Flooding occurs during the months from June to October commonly peaking between July and early September while the lowest water levels are experienced from January to March. The extent of flood affected area in Jamuna catchment area in Bangladesh is about 28,320 km^2. The mean monsoon flow of Jamuna at Bahadurabad station was around 40,000m^3/s during the period from 1965 to 2006. During the dry season, the discharge is less than 10,000m^3/s and as low as 5,000m^3/s in early March. During the monsoon season, the monthly discharge varies from 30,000 to 50,000m^3/s. The highest floods on the Jamuna River occurred in 1988, 1998, 2004 and 2007.

Future Trends: The flows and water uses in Brahmaputra are expected to change both in near term and long term future due to water development activities in the upstream riparian countries and future climate change. The water development activities can be broadly classified in to hydropower development and inter-basin water transfers.

- **Hydropower dam development.** Though there is a huge hydropower potential, Brahmaputra River's water resources have been largely undeveloped. Bhutan, China, and India are all interested in developing the untapped hydropower in the basin (both on the mainstem and the tributaries). About 39 dams are planned in Brahmaputra in which ten dams are currently under construction (total installing capacity is about six gigawatts):
- **Water diversion scenarios.** China and India are both considering trans-boundary water diversions to transfer water from the Brahmaputra Basin to water-scarce regions of their countries. China's plans include diversion of about 20 billion cubic meters (BCM) per year to 60 BCM per year through "Greater Western Route Water Diversion Project". Similar water transfer projects have been proposed in India to divert about 34.43 BCM of water from the Brahmaputra River basin to the Ganges Riverbasin through linked canals as part of a national-level River Interlinking Project.
- **Climate change**. The historical hydrologic regime is dominated by two different mechanisms: snow/glacier melt in the upper basin (the mountainous area mostly in China and Bhutan), and monsoon rainfall in the lower basin (the floodplains mostly in India and Bangladesh). Temperature increase and changes in precipitation patterns due to climate change will have different influences on these two mechanisms. Long-term observations (over 40 years) of temperature, precipitation and stream flow in the upper Brahmaputra basin all show increasing trends. This may be partially attributable to melt water from retreating glaciers in the region. In the lower basin, most studies anticipated increases in stream flow as an effect of climate change, resulting from increases in monsoon rainfall.

Cumulative Impacts: A Brahmaputra System Model (BSM) study was carried out byUniversity of Massachusetts(Yang et. al. 2014)[4] to model the basin-wide water resources management under climatic and social uncertainties. The model results suggest that when no water diversion occurs, the expected values of flood affected area (FAA) will increase by 23 percent, 33 percent and 54 percent for near, middle and far future compare to baseline. China's largest diversion (60 bcm/year) will

[4]Yang, Y. C. E., Wi, S. Ray P. A., Brown, C. M. and Khalil, A. F. 2014. Modeling water resources the Brahmaputra River under future climate and social uncertainties. In preparation.

reduce FAA by 28 percent, 21 percent and 5 percentfor near, middle and far future compare to baseline. India's largest diversion (30 bcm/year), although cannot reduce the FAA, will mitigate the increasing trend and FAA will increase by 2 percent, 11 percent and 31 percent for near, middle and far future compare to baseline under India's largest water diversions. The reduction in FAA will partially reduce the flood risk in Bangladesh. However, the reduction in FAA may not affect the agricultural productivity in Bangladesh since the irrigation in the country mostly met from rainfall and groundwater.

The cumulative effects of the proposed developments will reduce the risk of flooding in the Brahmaputra. However the flood embankments, if not properly designed to facilitate lateral fish migration between rivers and floodplains, will have a potential to impact the productivity of floodplain fisheries. In addition to structural interventions, the modern flood risk management non-structural types of measures particularly landuse controls. Further studies are required to develop integrated catchment area landuse planning. The development of integrated landuse planning is also critical to address unplanned developments in the region.

8.5. Aquatic Biodiversity

Baseline Conditions and Trend: The Jamuna and its floodplains arethe important source of both capture and culture fresh water fish in Bangladesh. Major habitats of capture fisheries are main river channels, khals and beels. These beels, khals and the Jamuna are naturally connected during floods and will act as migratory routes for the carp's fishes, which migrates to floodplains for spawning. The embankments constructed along the river bank have blocked this natural connectivity at many locations. The fisheries in the floodplains have been declining significantly since the construction of flood control embankments, which have blocked the migratory routes of carp fishes from the river to floodplains. The fish production in the Jamuna has also been declining since the construction of the embankments and also due to increased river and floodplain erosion (loss of floodplain habitat) and increased fishing pressure Annual total fish production decreased approximately 3,200 tonnes in last 30 years.

Cumulative Impacts: The flood embankments constructed sofar on the Jamuna has historically blocked the fish migration routes between the Jamuna and its floodplains. The proposed embankments under RBIP and other future projects will restore the connectivity of the migratory routes through installation of fish passes. In addition a comprehensive fishery development program will be implemented under RBIP for restoration of floodplain habitat through re-excavation of khals and beels, artificial stocking of fingerlings and capacity building of fishermen for sustainable harvesting and developing marketing facilities. All these activities are expected to increase the fish production in the Jamuna and restore the fish habitats.

Proposed dredging activities under the 'Capital Dredging Project' to improve and maintain navigation channels and land reclamation will have some impacts on the aquatic biodiversity of the Jamuna. Dredging activities will disturb the benthic habitat and the bottom fish feeders that depend on the benthic habitat. The sediments generated from the dredging activity will affect the water quality and in turn the quality of the entire river habitat. The water quality of the river will also be affected due to risk of oil spills from the barges and disposal of bilge water. There will be a risk of collision of dolphins with the barges and ships.

To address the cumulative impacts associated with the future dredging activities and also with induced environmental impacts (discussed in next section), fish and dolphin sanctuaries need to be established in the Jamuna. Detailed ecological baseline studies are recommended for the entire CIIA study area to be carried out during implementation of RBIP-I to identify suitable areas of sanctuaries and establishment of these sanctuaries.

8.6. Induced Environmental Impacts

The north western part of the country, particularly the floodplains are comparatively under -developed due to continuous threats of erosion and floods from the Jamuna. Construction of bank protection

works and flood embankments will lead improved investments and development in the region. Urbanization in Bangladesh is growing in rapid pace especially along the road and railway corridors. With the construction of the highway along the RBIP embankment a rapid uncontrolled and unplanned urbanization may take place around the Project influence area. Further, the construction of highway will further lead to road network development in the region. All these induced developments may trigger several environmental issues at local and regional level.

It is expected that the connectivity of the north-western part of the region with the rest of country will provide increased accessibility to markets, ports and growth centers. This will lead to development of business (including agriculture and fisheries), industry, communication, tourism, urbanization, etc. The induced development has both negative and positive impacts. The positive impacts are increase in the socio-economic conditions of the region through employment generation and poverty reduction. The negative impacts are (i) air and noise pollution due to construction activities, increase in traffic levels and industrial development, (ii) generation of wastes due to increased living standards, (iii) consequent health impacts due to pollution and waste generation, (iv) loss of biodiversity, and (v) land acquisition and resettlement. Most of these impacts could be avoided or managed through development of an integrated floodplainlanduse planning. A land use planning study is recommended as one of the component of the proposed 'Master Plan' study (under Component C2 of the RBIP-I) which will be carried out in parallel to Phase II feasibility study. This master plan study will focus on floodplain processes protectedby BRE through a floodplain modeling study; and develop a plan on future floodplain land use with necessary guidance and direction to implement this plan. The study will also identify potential ecosystem areas of conservation significance and ensure that any development activities will not impact the quality of these ecosystems.

9. Environmental and Social Management Plan

9.1. General

Various categories of mitigation measures:The ESMP includes various categories of mitigation measures and plans: (i) generic and non-site-specific measures in the form of environmental codes of practices (ECoPs) presented in Annex Iof the main EIA; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in Chapter 7; (iii) construction environmental action plan (CEAP) with site-specific and contract-specific management plans to be prepared bythecontractors; (iv) social action plans (SAP) covering RAP, income and livelihood restoration, gender and public health; and (v) environmental improvement plans.

Inclusion of ESMP in contract documents: In order to make the Contractors fully aware of the implications of the ESMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in EIA as well as WBG EHS guidelines. The Contractor must be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

Construction Environmental Action Plan: Contractors need to prepare site specific management plans to address various environmental issues, and to demonstrate the manner in which the Contractor will comply with the requirements of ECPs and ESMP. It will be reviewed and approved by construction supervision consultant (CSC) and project management unit (PMU) before implementation of construction works.

9.2. Institutional Arrangements

The proposed organizational structure under PMU for implementation of ESMP is shown in Figure 5.

Project Management Office (PMU)would be responsible for all aspects of project implementation including technical, operational, financial management, and overseeing the implementation of ESMP. The PMU will include an Environmental and Social Development Unit (ESDU), which will be headed by a superintending engineer as the director. The director will be supported by (i) Executive Engineer - Environment, (ii) Executive Engineer - Social and (iii) various environmental and social consultants. The responsibilities of the ESDU are: (i) supervising, facilitating and coordinating implementation of environmental and social plans including EIA and SAP; (ii) ensuring that contractors follow GoB regulations, World Bank Safeguard Policies, and other requirements mentioned in the EIA and SAP; (iii) identifying any issues of non-compliance and report these; (iv) suggesting mechanisms to link contractor performance in relation to the ESMP to the timing of financial payments, incentives or penalties; and (v) interacting with stakeholders for their concerns about the construction activities. In order to effectively manage the EA process and EMP implementation, the ESDU will be established and made operational before awarding the contract to contractor.

Construction Supervision Consultants (CSC) will be responsible for supervising the contractors for the implementation of ESMP. For this purpose, the CSC will appoint international and national environmental and social specialists, ecologists and an occupational health and safety specialist and environmental surveyors to ensure the ESMP implementation during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures. CSC will also hire the consultants and nongovernmental organizations to carry out additional studies and implementation of environmental and social plans not relevant to the contractors.

Contractors are also required to appoint appropriate number of environmental specialists, occupational health and safety specialists, environmental technicians, and community liaison officers for the implementation of ESMP in the field, particularly the mitigation measures. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects.

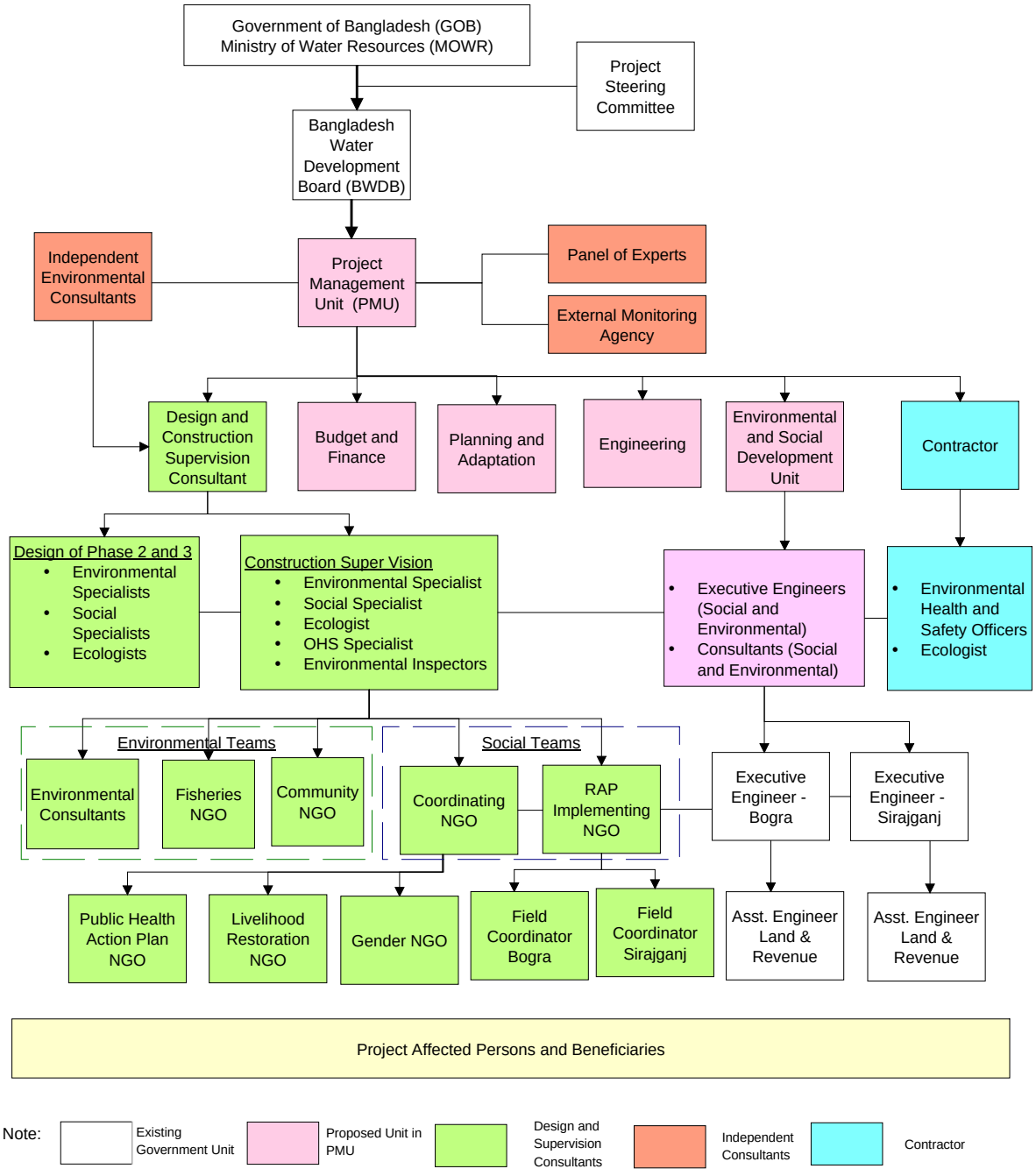


Figure 5: Proposed Institutional Structure for Implementation of RBIP

External Monitor will be recruited by PMU to carry out independent monitoring of implementation of ESMP. The external monitor will have environmental and social experts and shall carryout external monitoring and evaluation.

Independent Panel of Experts will be recruited by PMU to carry out independent top level monitoring of implementation of ESMP.

Design Consultants and Independent Environmental Consultants: The detailed design, including environmental and social assessment of Phase II and III will be carried out by the design consultants of Phase I, who will also act as CSC. Independent environmental consultants will be retained by the BWDB to advise, oversee and review of the environmental and social assessment to be carried out during Phase II and III.

9.3. Environmental and Social Management

(a) Environmental Codes of Practice

A set of environmental codes of practice (ECoPs) has been prepared for various environmental and social management aspects: ECoP 1: Waste Management; ECoP 2: Fuels and Hazardous Substances Management; ECoP 3: Water Resources Management; ECoP 4: Drainage Management; ECoP 5: Soil Quality Management; ECoP 6: Erosion and Sediment Control; ECoP 7: Top Soil Management; ECoP 8: Topography and Landscaping; ECoP 9: Borrow Areas Management; ECoP 10: Air Quality Management; ECoP 11: Noise and Vibration Management; ECoP 12: Protection of Flora; ECoP 13: Protection of Fauna; ECoP 14: Protection of Fisheries; ECoP 15: Road Transport and Road Traffic Management; ECoP 16: River Transport Management, ECoP 17: Construction Camp Management; ECoP 18: Cultural and Religious Issues; ECoP 19: Workers Health and Safety; The Contractors will be contractually obligated to comply with these ECPs, presented in 'Annex I' of the EIA.

(b) Site-specific Plans in CEAP

The following site-specific plans will be prepared by thecontractors to manage and mitigate/reverse potential adverse environmental impacts:

Sand Extraction Plan will be prepared and implemented by the contractors on the basis of the ECoPs and the mitigation measures given in EIA. The Plan will describe among others the methodology to be adopted, restrictions to be followed, prior survey to be conducted, and documentation to be maintained for the sand extraction. The Plan will be submitted to the CSC for their review and approval before initiating the sand extraction activity**.**

Pollution Prevention Planwill be prepared and implemented by the contractors on the basis of the ECoPs and WBG EHS Guidelines (2007) that will be part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Waste Disposal and Effluent Management Plan will be prepared and implemented by the Contractor on the basis of ECoPs, EIA and WBG EHS Guidelines (2007). The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Drinking Water Supply and Sanitation Plan: Separate water supply and sanitation provisions will be needed for the temporary facilities including offices, labor camps and workshops in order not to cause shortages and/or contamination of existing drinking water sources. A Plan will be prepared by the contractors on basis of the EMP and ECoPs, which are part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Occupational Health and Safety Plan will be prepared and implemented by thecontractors on the basis of the WBG EHS Guidelines (2007), ECoPs, and other relevant standards. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Traffic ManagementPlan will be prepared by thecontractors after discussion with BWDB and authorities responsible for roads and traffic. The Plan will be submitted to the CSC for their review and approval before contractor mobilization. The Plan will identify the routes to be used by the contractors, procedures for the safety of the local community particularly pedestrians, and monitoring mechanism to avoid traffic congestion.

Construction Camp Management Plan will be prepared for each construction camp. The Plan will include the camp layout, details of various facilities including supplies, storage, and disposal. The Plan will be submitted to the CSC for their review and approval before camp establishment.

Fuel and Hazardous Substances Management Plan will be prepared by thecontractors on the basis of ECoPs as well as the mitigation plans given in EIAand in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets. The Plan will

include the procedures for handling oils and chemical spills. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

In-stream Construction Works Management Plan will be prepared by the contractors to address the environmental concerns associated with use of motor boats and barge mounted equipment on the basis of the mitigation measures given in ECoPs and EIA. The plan will address risk of spills, collision with dolphins and safety of construction workers. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Emergency Preparedness Plan will be prepared by the Contractor after assessing potential risks and hazards that could be encountered during construction. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

(c) Social Action Plan (SAP)

Resettlement Action Plan (RAP): The Project will require about 370 ha of land and affect a total of 15,558 persons for the construction of embankment. The social impacts largely include loss of residential and agricultural land, residential, commercial and communal structures, as well as loss of income and livelihoods. To address and mitigate these relocation and resettlement impacts, the Resettlement Action Plan (RAP) has been prepared. RAP has been designed as a "development" plan, therefore the overall objective of the RAP is to restore and/or improve the living standards of the affected persons from pre-project level.

Social Development Plan (SDP): The overall objectives of the SDP are to (i) Mitigate any negative social impacts related to the implementation of RBIP Phase I – Priority reach and to (ii) Support the overall development of the population in the Project area that lives a precarious life along the eroding river in respect to their livelihood, gender and public health status. The SDP is a 5-year program that encompasses a livelihood restoration and development, a gender mainstreaming as well as public health action plan for project-affected people and beneficiary communities. The SDP will cover the following programs and these programs will be implemented by various NGOs:

- **Income and Livelihood Restoration Programs (LARP) :**Two major strategies will be pursued: 1) to restore income and livelihood of the directly project-affected population in short-term, and 2) to ensure sustainability of ILRP and long-term livelihood improvements. A number of interventions have been planned to support each strategy: i) Cash assistance to support lost income, ii) Assistance to re-establish businesses, employment in construction site and construction-supported sector as well as iii) Special assistance for vulnerable groups are planned to support strategy 1. To support strategy 2, the sustainability of the ILRP and long-term livelihood improvement, the following interventions have been designed: i) Community participation in tree, medicinal plantation and social forestry on embankment sides, ii) Fostering the cultivation of high value vegetables, iii) Improving the productivity of livestock sector, iv) Improving productivity of poultry sector, v) Improving the productivity of fisheries, vi) Training of skilled labor, vii) Installation of solar home systems and viii) Grants to support livelihood enhancing projects.
- **Gender Mainstreaming:** Five strategies have been derived from the gender analysis and impact assessment which will each be supported by a number of interventions. The strategies are as follows: i) Promote women's participation in design and implementation, ii) Enhance employment opportunities for women, iii) Ensure gender responsible resettlement measures, iv) Provide services and safeguards against social and health vulnerabilities, v) Enhance capacity on gender mainstreaming within BWDB. Key interventions are to i) Involve women in all important project committees for RBIP, ii) Give preference to women interested to seek employment as part of the RBIP including social forestry as part of the embankment maintenance, iii) Provide special assistance to female headed householdsduring resettlement, iv) Raise awareness on health issues and human trafficking, v) Provide skill training for birth attendants/community health workers and vi) Capacity building on gender mainstreaming for BWDB.

- **Public Health:** The key interventions will encompass i) Information Education and Communication programs on HIV/AIDS, tuberculosis, sexually transmitted diseases, assault, pollution, noise, road traffic and hand-washing, nutrition, 5 danger-signs of pregnancy, ii) Capacity development for public health staff on RBIP related risks/diseases, iii) Construction traffic safety measures, iv) Water-sealed slap latrines in resettlements sites and old embankment, v) Clean cooking stoves in resettlements sites and old embankment, vi) Safe tube wells in resettlements sites and, as required, on old embankment, vii) Skill training including health workers/birth attendants, viii) Prevention and management of pesticide poisoning as well as x) Women-friendly health services.

Communication Strategy:A formal communication strategy is prepared for the project to lay out various communication needs and outreach tools and explain the responsibility of PMU to convey the awareness of the project impacts and its impacts to various stakeholders. A key aspect of this strategy shall be the communication of any project related impacts

(d) .Environmental Improvement Plans

Biodiversity Conservation: Detailed ecological studies will be carried out, during implementation of Phase 1, both within the Jamuna river boundaries and on the floodplains alongside both river banks to broaden the existing baseline data. The EIA of Phase 1 has identified eight potential sites of fish conservation and three locations of dolphin conservation in the priority area. The proposed study will confirm these locations and identify additional locations of conservation significance (in the river, and or chars/shoals or the floodplains) and prepare detailed conservation plans. These plans will be implemented during Phase II. A competent agency (consulting firm/institution/NGO) will be hired to carry out the studies. The agency will also be responsible for biodiversity monitoring during construction and post construction period.

Floodplain fisheries development:The flood embankments along the right bank of the Jamuna have historically affected the lateral fish migration from the Jamuna to floodplains and have caused significant loss of floodplain fisheries and livelihood of fishing community. A comprehensive fisheries development program is proposed to restore the historical loss of floodplain fisheries. This program will consist of the re-excavation of khals and beels for improving the connectivity, artificial stocking of fingerlings, capacity building of fishermen for sustainable harvesting of fisheries, providing fishing gears and development of adequate marketing facilities. The program also covers formation and training of water management cooperative associations for operation and maintenance of fish passes and regulators. A fishery NGO will be responsible for implementing these plans.

Community plantation development will be carried out near the resettlement sites, riparian areas, beels, and char lands. A community NGO will be responsible for implementation of these activities.

9.4. Overview of Impacts and Mitigating Measures

An overview of all impacts and mitigating measures, including responsibilities and monitoring requirements, is given in Table 9.

Table 9: Overview of Impacts and Mitigation

Impacts/Issues	Mitigation Measures	Time Frame	Cost (USD x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
RBIP – PHASE I (overall impacts)							
Rehabilitation and new construction of embankments and bank protection works	- Desirable outcome of the project	2018 onwards	375	Contractor	BWDB	- Area protected against erosion and flooding	Yearly
ENVIRONMENTAL IMPACTS DUE TO PROJECT SITING							
Land cover and land use changes (increased pesticide use)	- Linkages with ongoing pest management programs	2018 onwards	In budget of EMP	PMU	CSC, PMU	- market study	Yearly
Loss of natural vegetation and trees	- compensatory tree plantation	2016-2021	In budget of EMP	PMU	CSC, PMU	- trees cut and trees planted	Yearly
Loss of riverbank/aquatic habitat	- habitat restoration through plantation development	2016-2021	In budget of EMP	PMU	CSC, PMU	- habitat area restored	Yearly
Loss of flood plain habitat	- installation of fish passes - floodplain fisheries development	2016-2021	In budget of EMP	PMU	CSC, PMU	- monitoring through underwater camera	Yearly
Drainage congestion and water logging	Limit motor boat speeds to 15 km/hr	2016-2021	In budget of EMP	PMU	CSC, PMU	- area water logged	Yearly
Land acquisition and resettlement	- implementation of RAP and social development programs	2016-2021	In budget of SAP	PMU	CSC, PMU	- documentary evidence	Quarterly
Loss of agriculture	- implementation of SDP	2016-2021	In budget of SAP	PMU	CSC, PMU	- progress of livelihood restoration	Quarterly
Impacts on Community Facilities and Places of Religious Significance	- Implementation of traffic Management; safety measures	2016-2021	In budget of SAP	PMU	- CSC, PMU - Local authority	- Facilities lost and restored	Quarterly
Blocked access because of road and embankment	- construction of pedestrian (stairs & ramps) and vehicular crossings	2016-2021	In budget of SAP	Contractor	CSC, PMU	community complaints	Yearly
ENVIRONMENT IMPACTS DURING CONSTRUCTION PHASE							
Impacts of borrowing of material	Compliance with sand extraction plan	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Sites approved	At the beginning of works
Air pollution	- pollution prevention and implementation of ECoPs	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Plan approved and community complaints	Quarterly
Noise	Noise control measures	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Plan approved and community complaints	Quarterly
Water pollution	- Pollution prevention and control plan	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Plan approved	Quarterly
Soil contamination	- pollution prevention and	2016-2021	In Contractors	Contractor	CSC, PMU	Plan approved	Quarterly

Impacts/Issues	Mitigation Measures	Time Frame	Cost (USD x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
	control plan		budget				
Solid wastes and hazardous wastes	- waste management and pollution control plan	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Plan approved	Quarterly
Impacts on aquatic habitat	- sand extraction plan	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Sites approved	Before extraction
Impacts on floodplain habitat	Tree plantation	2016-2021	In budget of EMP	Contractor	CSC, PMU	Trees planted	Quarterly
Impacts on *charland* habitat	Tree plantation	2016-2021	In budget of EMP	Contractor	CSC, PMU	Tress planted	Quarterly
Site clearance and restoration	Site restoration and landscaping	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Sites established and cleared	After construction
SOCIAL IMPACTS DURING CONSTRUCTION PHASE							
Impacts on cultural heritage	Code of conduct to construction workers	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Community complaints	Quarterly
Impacts on community facilities	Relocation of community facilities	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Sites restored	Quarterly
Occupational health and safety	Implement health and safety, and emergency response plan	2016-2021	In budget of Contractor	Contractor	CSC, PMU	Accidents	Quarterly
Community health and safety	Public health action plan	2016-2021	In budget of SAP	Contractor	CSC, PMU	Accidents	Quarterly
ENVIRONMENT IMPACTS DURING O&M							
Changes in river morphology	Long term monitoring and response measures	2018 on wards	BWDB annual budget	BWDB	BWDB	Erosion and accretion	Annually
Loss of ecological connectivity	Proper operation and maintenance of fish passes	2018 on wards	In budget of EMP	Consultants	BWDB		Annually
Drainage congestion and water logging	Proper operation and maintenance of regulators	2018 on wards	In budget of EMP	Consultants	BWDB	Community complaints	Annually
Generation of solid waste	Implementation of waste management plan	2018 on wards	BWDB annual budget	BWDB		Waste generated	Annually
Air pollution	Roadside plantation	2018 on wards	BWDB annual budget	BWDB		Community complaints	Annually
Noise generation	Noise control measures	2018 on wards	BWDB annual budget	BWDB		Community complaints	Annually
Water pollution	Storm water drainage	2018 on wards	BWDB annual budget	BWDB		Working condition of drainage pits	Annually
Risk of embankment breaches	Regular monitoring and maintenance	2018 on wards	BWDB annual budget	BWDB		Length maintained	Annually
SOCIAL IMPACTS DURING O&M							
Changes in agricultural pattern	Integrated pest management programs	2018 on wards	In budget of EMP	Consultants	BWDB	Agricultural statistics	Annually
Community health and safety	Implement health, safety and environment plan	2018 on wards	In budget of SAP	NGOs	BWDB	Interviews	Quarterly

9.5. Monitoring Plan

Proposed monitoring plan to be carried during implementation of the project to ensure contractors compliance with the mitigation measures is given in Table 10 along with the monitoring indicators and frequency. CSC will be responsible for supervision of implementation of the plan.

Table 10: Effects Monitoring Plan

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Sand extraction	River bank	Visual inspection to ensure the depth of excavation from the river bed is limited to 3m; and extraction carried out in long stretches	Weekly	Contractor	CSC
Pb, Cd, Cr, Cu, Zn, Mn, As, Se Hg, and oil/grease	Riverbed within the project boundary	Laboratory analysis of material for screening for metals and oil/grease	Before sand extraction	Contractor through a nationally recognized laboratory	CSC
Soil Pollution	Embankment	Visual inspection that filling is through several compartments	Beginning of earth filling works	Contractor	CSC
	Embankment and material storage sites	Ensure no contaminated effluent is leaving from the filling area to the nearby agricultural lands	Weekly	Contractor	CSC
Erosion	Side slopes	Visual inspection of erosion prevention measures and occurrence of erosion	At the end of filling activity	Contractor	CSC
Hydrocarbon and chemical storage	Construction camps	Visual Inspection of storage facilities	Monthly	Contractor	CSC
Damage to local roads	Approach Roads to the construction sites	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC
Traffic Safety	Haul Roads	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	Contractor	CSC
Air Quality (dust, smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (e.g., spraying of waters) are in place.	Daily	Contractor	CSC
	Asphalt Plant	Visual inspection to ensure asphalt plant is located >500 m from residential areas	Monthly	Contractor	CSC
	Material storage sites	Visual inspection to ensure dust suppression work plan is being implemented	Monthly	Contractor	CSC
	Sensitive	Continuous monitoring with	Quarterly during	Contractor	CSC

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
	receptors along construction corridor	the help of appropriate instruments and analyzers	he construction hase		
Noise	Construction sites	Physical inspection to ensure good standard equipment are in use; Noise measurement using noise meter	Weekly	Contractor	CSC
	Construction sites	Visual inspection to ensure ear plugs are in use by the construction workers	Weekly	Contractor	CSC
		Ensure work restriction between 21:00-06:00 close to the sensitive locations	Weekly	Contractor	CSC
Water quality (As, Mn, Fe, and coliforms)	Locations of tube-well installation	Depth of tube well should be more than 300m. Test water for arsenic, iron and manganese before installing of casing. If the quality is found not suitable further deepening will be done.	During drilling of wells	Contractor trough a nationally recognized laboratory	CSC External Monitor
	Near sensitive sites	Laboratory analysis	Monthly during construction hase	Contractor trough a nationally recognized laboratory	CSC
Plantation	Embankment/ road	Visual inspection to ensure plantations in green areas and other designated sites.	Monthly	Contractor	CSC
Waste Management	Construction camps	Visual inspection that solid waste is disposed at designated site	Monthly	Contractor	CSC
Drinking water and sanitation	Camps, offices	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Weekly	Contractor	CSC
Flora and Fauna	Sensitive habitats in Project influence area	Survey and comparison with baseline environment	Six-monthly	Contractor through nationally recognized institute	CSC, M&E Consultant, BWDB
Fish migration	Khals, beels and river	Survey and comparison with baseline environment	Six-monthly	Contractor through nationally recognized institute	CSC, M&E Consultant, BWDB
Cultural and archeological Sites	At all work sties	Visual observation for chance finds	Daily	Contractor	CSC, M&E Consultant, BWDB
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	Contractor	CSC, M&E Consultant, BWDB

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Safety of workers Monitoring and reporting accidents	At work sites	Usage of Personal Protective equipment	Monthly	Contractor	CSC, M&E Consultant, BWDB
During Operation and Maintenance					
Surface Water Quality (TDS, Turbidity, pH, DO, BOD, CODetc.)	At the baseline monitoring sites	Sampling and analysis of surface water quality	Six-monthly	BWDB through a nationally recognized laboratory	BWDB
Pesticide residue in soil and water	Cultivation fields, khals and beels	Laboratory analysis	Six-monthly	BWDB through a nationally recognized laboratory	BWDB
Air Quality (Dust PM_{10}, $PM_{2.5}$)	At the baseline monitoring sites	24 hours Air quality monitoring	Yearly	BWDB through a nationally recognized laboratory	BWDB
Flora and Fauna specially fisheries	Sensitive habitats in Project influence area	Detail species assessment and compare with baseline	Yearly	BWDB through a nationally recognized institution	BWDB
Agriculture	In the project influence area	Compare the production with the baseline	Yearly	BWDB through a nationally recognized institution	BWDB
Operation of regulators and fish passes	In the project influence area	Visual inspection and public feedback	Yearly	BWDB	BWDB

9.6. Capacity Building

The environmental and social trainings will help to ensure that the requirements of the ESMP are clearly understood and followed by all project personnel. The primary responsibility of providing these trainings to all project personnel will be that of the contractor and Supervision Consultants. The trainings will be provided to different professional groups separately such as managers, skilled personnel, unskilled labors, and camp staff.

9.7. External Monitoring

The BWDB will engage an independent consulting firm to conduct external and independent monitoring of the EMP implementation. The main purpose of the external monitoring will be to ensure that all the key entities including EDSU, CSC, and contractors are effectively and adequately fulfilling their designated role for EMP implementation and that all the EMP requirements are being implemented in a timely and effective manner.

9.8. Grievances

The project will establish a grievance redress mechanism (GRM) for addressing grievances and complaints received from the project-affected persons. The fundamental objective of GRM will

be to resolve any project-related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of the social and environmental action plans. Another important objective is to democratize the development process at the local level and to establish accountability to the affected people. The procedures will however not pre-empt a person's right to go to the court of law. Under the GRM, two grievance redress committees (GRCs) will be formed: local grievance redress committee (LGRC); and project grievance redress committee (PGRC). Most of the grievances would be resolved at LGRC while a few might be forwarded to PGRC.

9.9. Reporting

The ESDU with assistance from CSC and contractors will produce environmental monitoring reports and will be submitted quarterly during the construction period and annually for three years after completion of construction. In addition ESDU will also prepare semi-annual reporting for OHS related issues. One year after completion of construction, the ESDU will submit a Project Completion Environmental Monitoring Report which will summarize the overall environmental impacts from the Project to all the co-financiers. The External monitors will submit the quarterly reports throughout the contract time, impact evaluation report at the end of each year and finally a completion Report at the end of contract period.

9.10. Cost of ESMP

The cost of implementing the EMPis USD 20 million and SAP is USD 65million. Details of EMP and SAP costs are given in Table 11 and Table 12.

Table 11: ESMP Implementation Cost Estimates of RBIP-I

Project Component		Description	Amount, million USD
A. Rehabilitation/Civil Works	1	Contractors Budget (for development of management plans, staff, training, etc.)	1.00
	2	Air, noise and water quality monitoring during construction (quarterly for 5 years)	0.50
	3	Tree plantation development and maintenance along embankments	1.00
B. Implementation of EMP	4	Baseline Ecological Studies, development of conservation plans and biodiversity monitoring during construction and operation (5 years), training to workers, monitoring of sand extraction sites	2.00
	5	Implementation of conservation plans prepared as part of the above studies (e.g. fish sanctuaries in koles, bird sanctuaries in chars, dolphin sanctuary in river)	3.00
	6	O&M of fish passes (an agency to form and train the management communities, operation and maintenance, and monitoring equipment such as under water cameras)	1.00
	7	Fisheries development in the floodplains (improving connectivity of khals, artificial stocking of fingerlings, capacity building in sustainable harvesting, awareness raising, development of market facilities)	2.00
	8	Community Plantation development and maintenance (in resettlement sites, beels, riparian areas, etc.)	1.00
	9	Integrated pest management	1.00
	10	Resettlement sites management (O&M costs for sanitation and waste management, staff, etc.)	0.50

Project Component		Description	Amount, million USD
	11	Additional studies and Support	2.00
	12	Contingencies	1.00
C. CSC and M&E Consultants	13	CSC Environmental Staff	1.50
	14	Independent Environment Consultants/M&E	0.50
D. PMU and Capacity Building	15	PMU Environmental staff	1.00
	16	Capacity building and institutional strengthening	0.50
		TOTAL	**20.00**

Table 12: SAP Cost Estimates of RBIP-I

Sub Component	Total in USD (million)
Compensation and RAP implementation	57
Income and Livelihood	2.63
Gender Mainstreaming	0.65
Public Health	2.8
SDP/CNGO Implementation costs	1.71
Consultation	0.032
Communication Strategy	0.41
Total	**64.81**

10. Stakeholder Consultations and Disclosure

10.1. Overview

Extensive consultations were carried out by the both social and environmental study teams during the project preparation. Initial consultations were held during Augustand September 2014 to share the project objectives and terms of references of the proposed EIA study. Second round of consultations are planned during January and February 2015 to disclose the results of EIA. Consultations involved multiple methods – for example, key informant interviews, village wise meetings, focus group discussions and workshops. Details of participants consulted are given in Table 13and they include (i) affected communities and population around the project area, (ii) farmers and fishing community, (iii) national and local government authorities responsible for district administration, rural development, agriculture, fisheries, wildlife and environmental protection, and (iv) nongovernmental organizations.

Table 13: Number of Persons Covered in Various Consultation Meetings

	Activities	No. of participants
1.	Focus group discussions (353 meetings)	4,166
2.	Consultation meetings (164 meetings)	7,200
5	National consultation workshop at Dhaka	117
Total		**11,483**

10.2. Consultations Feedback

A summary of main issues raised with various stakeholdersand how these issues are addressed and incorporated are shown in Table 14 and Table 15.

Table 14: Key Issues Raised and Plans to Address the Issues

Environmental and Social Aspects	Description of Views and or Concerns	Action Plan
Flooding and inundation	Frequency of BRE breaching is increasing, more areas are under risk of flooding.	Reconstruction of BRE under RBIP will address these issues
River Erosion	On varying scale river erosion destroys homestead and cultivable land	River bank protection is included in RBIP
Water logging	With dysfunctional regulators, water logging taking place, sometimes embankment obstructs flow of water, cultivation is hampered	Rehabilitation of existing and construction of new regulators is included in RBIP
Crop destruction	Frequent floods destroy valuable crops	The proposed interventions under RBIP will address these issues
Flood and drought	Twin problems are taking place in some areas. Long dry spells in the monsoon season affect the crop production.	Flooding will be controlled by the embankments. To address long dry spells, supplementary irrigation facility is provided through fish passes and regulators.
Blocked fish migrationroute and lack of fish cultivation	Inappropriate regulators, embankment, or lack of regulator affects fish migration route and its	Rehabilitation of existing and construction of new regulators is included in RBIP;

in floodplains	cultivation	Excavation of khals and beelsarealso proposed.
Connectivity of river and other water bodies on floodplains	A number of places cited connectivity severely disturbed	Rehabilitation of existing and construction of new regulators is included in RBIP. Re-excavation of khals and beels are also proposed.
Land compensation mode	Proper compensation rates; early payment of compensation; compensation for all losses	A comprehensive RAP is prepared
The Jamuna is moving towards - Bangaliriver	If avulsion of Jamuna in to Bangali river takes place, several thousand hectaresof floodplain land will be lost	This reach is considered in the priority reach of RBIP and bank protection measures will be implemented in Phase I.
Promoting surface water irrigation	Ground water irrigation facing problem thus surface water irrigation preferred in some areas ; government officials in Water Board and Agricultural Extension also underlined such need	Supplementary irrigation facilities through regulators and fish passes are proposed.
Inadequate regulators	Need for better fish migration, clear water logging and irrigation	Rehabilitation of existing and construction of new regulators is included in RBIP
Regulator maintenance	Inappropriate operation and inadequate maintenance of regulators can undermine the very objectives of these structures	Water user management committees will be formed and trained to operate and maintain the regulators and fish passes.
Water and air pollution	Local communities could be adversely affected by such pollution	EMP will include measures to minimize such impacts. Monitoring will also be carried out.

Table 15: Concerns Expressed by various stakeholders in the Priority reach area

Stakeholders Type	List of concerned raised	Responses and mitigation measures under the Project – Summary
Women on the embankment	i. Shelter during flood; ii. health and sanitation; security at RS sites; iii. need for education and empowerment; and iv. livelihood sources and training for employment	i. Bank protection and revetment work will be undertaken by the project; ii. RS site-specific committees will be responsible for site security; and iii. Project will hire a nationally experienced Coordinating NGO (CNGO) to work with local NGOs to deliver SDP over a 5-year period.
Wage Laborers	i. Employment opportunity in the project; ii. livelihood and income sources at RS site; iii. training for alternative income and small businesses	iv. Affected persons with ID will get employment on a preferential basis in the project civil work; v. the contractor will mostly hire local laborers; and vi. SDP for income and livelihoods for the project area people.
Land owners	i. Protection from any further erosion; ii. proper and market price for land;	i. Revetment work by the project; ii. replacement value for land as well as other assets as per project policy; iii. multiple options for resettlement,

	iii. options for resettlement on individual and family basis; iv. compensation for structures and other assets	including provision for self-managed resettlement by the affected families.
Vulnerable Groups	i. Protection from riverbank erosion; ii. RS site location; iii. livelihood opportunities at RS sites; and iv. tracking for income and small business	i. Revetment work by the project; ii. Over 8 RS sites along the first 50 km so that people can remain within their extended "communities" and benefit from social capital; iii. SDP for employment and income in post-resettlement period.
Business owners	i. Compensation for loss of business; ii. compensation for loss of business structures	iii. The project entitlement matrix will cover both loss of structure and loss of businesses.
Community Leaders	i. Protection from erosion; ii. Proper compensation to affected persons, including resettlement of the embankment dwellers; iii. Proper flood warning and forecasting for local people; iv. Toll system for the 2-land highway	i. Revetment works by the project; ii. Replacement value for land and other assets; iii. all affected persons will be eligible for relocation and resettlement at project costs; iv. BWDB isestablishing a system of early warning ; and v. toll rate will be discussed with the communities in due course.

10.3. Disclosure

A national stakeholder consultation workshop was held on 25th January 2015 to disclose the ESA reports. This meetingwas held at Dhaka, at which respective relevant district organizations and institutes were invited. The consultation meetingwas also attended by affected community, BWDB officials, and local civil society representatives. Similar disclosure meetings will be held at four locations in the priority reach at the sub-district headquarters. The ESA summary has been translated intoBengali. Both the environmental and social documentswere disclosedon the website of BWDB on 5February 2015 and World Bank InfoShop on 16 February 2015.