Urban Development Directorate (UDD)

Ministry of Housing and Public Works

The People's Republic of Bangladesh

82, Segunbagicha, Dhaka-1000

FINAL REPORT

For

Providing Individual Consulting (National) Services as

Water Resources Management Expert

For

"Preparation of Development Plan for Benapole-Jessore Highway Corridor Project"

May 2017

Dr. Sujit Kumar Bala

Water Resource Management Expert

Institute of Water and Flood Management (IWFM)

Bureau of Research, Testing and Consultation (BRTC)

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EXECUTIVE SUMMARY

The Jessore-Benapole Highway is an essential life line of Bangladesh as well as of the Asian Highway. It is necessary to ensure possible required space for widening the existing highway while preparing the Development Planning of Jessore- Benapole National Highway. The total project area is around 324 sq. km connecting Benapole Land Port to Jessore District Town, where the areas of urban and rural parts are 130 sq. km and 194 sq. km respectively. The overall objectives of project were to prepare a development plan for Jessore-Benapole Corridor with some specific objectives. The expected outputs of the study were preparation of four working papers as - Working Paper 1: Hydrologic Characteristics of Benapole Jessore Highway Corridor; Working Paper 2: Hydrological Hazard assessment; Working Paper 3: Policy Guidelines for Land Use Planning and Hazard Mitigation and Working Paper 4: Initial Environmental Examination (IEE).

The Benapole Land Port, the end part of the corridor, is the largest and busiest port of the country and handles about 80% of the commercial traffics held between India and Bangladesh. Physical features of the Project area vary with locations and can be characterized as a broad deltaic plain prone to tidal flooding of the rivers existed in the region. Agricultural activities are highly developed and dependent upon the capital of Dhaka City. Each region is different by its own hydrological characteristics. The rivers in the South West region bear moderate slope loaded with high concentration of sediment loads. The prominent rivers of the region are the Kobadak, the Betna, the Nabaganga, Bhairab, Pussur, etc. The Jessore - Benapole National Highway Corridor intersects mainly the Kobadak and the Betna and numerous beels and baors and khals and canals. Engineering interventions and road networks changed substantially the hydrological features of the region.

The study requires different types of data such as hydrographic, topographic, hydrologic, and land use data etc. and were received and collected from different sources like hydrographic, topographic data has been provided by UDD to IWFM. These data have been be used for flood hazard assessment. The water levels of the surrounding rivers, measured by Bangladesh Water Development Board (BWDB) have been collected from the IWFM database. The water level data are used for carrying out flood frequency analysis for different return periods. The land use data has been derived from high resolution satellite image provided to IWFM by UDD.

The field visits to the Jessore-Benapole National Highway Corridor were made to see the adequacy of openings as well as hydrologic management of the corridor and carrying out of Initial Environmental Examination. The Jessore-Benapole National Highway Corridor has run through huge number of waterbodies like haor, baor, beel, local depressions, small and large drainage networks – khal and channels, water-occupied areas, ponds, river networks like the Kobadak, the Betna, the Mukteswari, the Hakur, the Betna-Khepupara system, Ziyar Khal etc. Srirampur Beel, Bodhkhana Beel, Bukbhara Beeel and many other waterbodies are very

prominent. The numerous existing haors, baors and beels around the corridor function as water storage reservoir for the corridor and play vital role in maintaining ecological and environmental health of the region. There is one big baor called Pachuar Baor created as a result of the Betna river meandering and it is close to Benapole Municipality. Now all these water bodies are turned into precious water resources for capture fish as well as for culture fisheries.

Discussions with local people on the way to the Jessore-Benaploe corridor revealed that the unprecedented flood of 2000 was a devastating one for the corridor as well as for the inhabitants. Some locations of the Jessore-Benapole National Highway were inundated and overtopped. The corridor should be upgraded considering the flood event of 2000.

The area of total water body along the corridor is about 7572 acres, which is 9.5 % of total corridor area. Tidal influence is very low in the rivers. There are about 463 cross dams on these rivers which block flow in the rivers. The status of water body in each upazila of Jessore Sadar, Jhikargacha and Sharsh was also seen independently. There are 1436ditches, 971ghers (fish culture), 9865 ponds, 5 rivers, 13 marsh lands, 22 lakes and 30 khals, 5 irrigation canals around and through the corridor.

The existing condition of drainage network of Jessore Sadar has been delineated from DEM using ArcHydro tool as can be seen in Figure 5.11. As this study is meant to be used for micro level planning, the adequacy of the drainage channels is not needed. The assessment of the adequacy of the drainage channels should be checked for designing the drainage network during implementation of the project involving design and construction of drainage channels. In such case, detailed rainfall-runoff analysis should be carried out for each municipality.

The hydrologic analysis was carried out for estimation of design flood level and involved frequency analysis with different probability distributions functions for the selected design return period. The historical data on annual peak water level are used for the purpose. The proposed Benapole-Jessore Highway Corridor runs over two rivers, namely the Kobadak and the Betna-Kholpetua. There are two water level gage stations in the corridor. The gage station of the Kobadak river is located at Jhikargacha (Station: SW 162) while the gage station of the Betna-Kholpetua is located at Navaron.

Five probability distribution functions (PDF) viz. Two-Parameter Log Normal (LN2), Three-Parameter Log Normal (LN3), Pearson Type III, (P3), Log Pearson Type III (LP3) and Gumbel (EV1) were used for frequency analysis. The design high water levels based on the best fitted PDF and corresponding to 2.33-, 5-, 20-, 50- and 100-year return periods are 4.77, 5.25, 5.91, 6.27 and 6.53 m PWD respectively.

The flood hazard has been assessed from the design flood magnitude as determined from flood frequency analysis with the help of open source GIS software and DEM. The flood frequency analysis were carried out to estimate design high water levels based on the best fitted Probable Distribution Fitted curves, corresponding to 2.33-, 5-, 20-, 50- and 100-year return period floods. Flood inundation maps were generated accordingly for the 2.33-, 5-, 20-, 50- and 100-year return period floods over the Jessore-Benapole Highway Corridor and show that for the mentioned return period floods, inundation gets over 41.65%, 55.54%, 74.36%, 85.31% and 92.45% of the corridor area respectively.

These Policy Guidelines were formulated considering the flood hazards i.e. generated for 2.33-, 5-, 20-, 50- and 100-year return period floods and inundation maps. The Policy Guidelines consider basic four criteria as inundation of the corridor area, up-gradation of the corridor, multipurpose uses of the corridor and protection of zone land under the corridor.

The proposed corridor is located in a tidal area and therefore the area is considered to be influenced by the impact of climate change in terms of both sea level rise and monsoon rainfall. According to the Fourth Assessment Report (AR4), IPCC (2007), the average rate of sea level rise was 0.18 ± 0.005 m/yr from 1961 to 2003. The sea level rise based on 23 tidal gauge records around the world from 1880 to 2000 and satellite altimetry data from 1990 to 2000 were seen. Trends of rise of sea level at three coastal stations of Bangladesh have been presented looked into where last 22 years historical tidal data, trends of rise of sea level are 4.0 mm/year at Hiron Point, 6.0 mm/year at Char Changa and 7.0 mm/year at Cox's Bazar. Hence the mean sea level rise over the Bangladesh coast is around 4mm/year or 0.4m/100 years.

An Initial Environmental Examination (IEE) of the proposed development of the Jessore-Benapole National Highway Corridor has been carried out. The Development Management Plan for Jessore–Benapole Highway Corridor includes 12 Union Parishads of Arabpur, Diara, Paurahsava, Upashahar, Jhikargachha, Chanchra, Godkhali, Panisars, Sharsha, Nabharan, Benapole, Ulashi and would guide need of future land use and infrastructure within the next 20 years. The main objective of the IEE was to conduct an environmental assessment, identify potential negative impacts, provide recommendations to minimize or mitigate negative impacts and enhance positive impacts.

The IEE has carried out the review of the relevant existing information/data and documents, provided a description of baseline data on physical, biological and socioeconomic characteristics of the proposed project sites along with area of influence, identified all relevant GOB applicable policies, laws and requirements that need to be complied with, assessed project-related impacts and recommend possible mitigation measures for the negative impacts and enhancement for the positive impacts; and formulate an Environmental Management Plan (EMP) to implement and monitoring the mitigation measures.

Accordingly, conclusions and recommendations were drawn based on the derived policy guide lines. Inundation should be focal issue for development plan of the Jessore-Benapole Highway Corridor, after which up gradation should follow both vertically (elevated corridor) and horizontally (increase of opening length of existing infrastructures) on the corridor. Multipurpose uses should be the philosophy and protection of land should be ensured where it is necessary.

CHAPTER ONE
INTRODUCTION

1.1 Background

Jessore-Benapole Highway is an essential life line of Bangladesh as well as of the Asian Highway. It is necessary to ensure possible required space for widening the existing highway while preparing the Development Planning of Jessore- Benapole National Highway. Unplanned growth in the planning area especially along the Highway is a common feature since time immemorial.

Development Management Plan for Jessore–Benapole Highway Corridor includes 12 Union Parishads of Arabpur, Diara, Paurahsava, Upashahar, Jhikargachha, Chanchra, Godkhali, Panisars, Sharsha, Nabharan, Benapole, Ulashi and would guide need of future land use and infrastructure within the next 20 years.

The project proposal was prepared for the development of the Jessore- Benapole National Highway. The area was delineated alone the Benapole-Jessore National Highway, considering the area of both side of 250 meter width from the centre line of National Highway, including the adjacent existing urban growth centers such as (i) Benapole Municipality area including Land Port, (ii) Nabharan Growth centre (iii) Sharsha Upazila Town area, (iv) Jhikargachha Upazila Town area and (v) Jessore District Town area.

The total project area is around 324 sq. km connecting Benapole Land Port to Jessore District Town, where the areas of urban and rural parts are 130 sq. km and 194 sq. km respectively. The project area is composed of twelve unions under three different Upazilas of Sharsha, Jhikargachha and Jessore Sadar.

1.2 Objectives

The overall objectives of project were to prepare a development plan for Jessore-Benapole Corridor with some specific objectives.

In the context of Individual Consultant as a Water Resources Management Expert, details of the specific objectives to be done were:

- To study sub regional water resource system;
- To study the condition of existing drainage system;
- To prepare land use planning guidelines considering hydrological situation of the project area;
- To make study over hydrological hazards of the area and prepare guidelines for hazard mitigation;

- To prepare flood prediction model of long, medium and short term (100, 50, 20 and 5-year period) for Project area;
- To prepare IEE (Initial Environmental Evaluation) for the area.

1.3 Scope of Work

In the context of Individual Consultant as a Water Resources Management Expert details of the work to be undertaken in this study are given in. The scope of work for the job under this study is limited to the following as per the Terms of Reference (Appendix A) in the Agreement signed between UDD and Individual Consultant, BUET:

- Direct observation through field visit of the study reach;
- Public consultation during field visit on the project corridor;
- Collection of data on existing setting of the project corridor;
- Collection and processing of secondary data from UDD and other organizations;
- Collection of people's opinion from local perspectives on drainage opening and length;
- Carrying out statistical analysis of water levels over the project corridor for determination of the water levels for different return periods and prepare a land use planning;
- Assessment of initial environmental examination for the project corridor;
- Consultation with UDD personnel during different phases of the study;
- Reporting on the study.

1.4 Expected Outputs

The Output of the component: water resources management of the project would be covered within four working papers; the first three with Interim report-I & Interim report-II and the fourth after Draft Final Report. The expected outputs of the study are as follows:

Working Paper 1: Hydrologic Characteristics of Benapole Jessore Highway Corridor

- A set up of sub regional water resources system and drainage network;
- A hydrological analysis;
- Estimation of Water Level for Different Return Period;
- Impact of Climate Change on Water Level

Working Paper 2: Hydrological Hazard assessment

- Introduction
- Water Level Gauges on the Corridor
- Estimation of Flood Inundation

Working Paper 3: Policy Guidelines for Land Use Planning and Hazard Mitigation;

- Introduction
- Flood and Land Zoning
- Multi Purpose Uses of Corridor

Working Paper 4: Initial Environmental Examination (IEE);

- Assessment of the changes in the existing natural setting due to development of the corridor;
- Prepare Environmental Management Plan (EMP) for the proposed project to reduce the negative impacts and ensure sustainable development.
- Outline of relocation and rehabilitation plan.

CHAPTER TWO
STUDY AREA

2.1 Proposed Study Area

The Jessore-Benapole National Highway Corridor, the study area, is shown in the Figure 2.1 below:

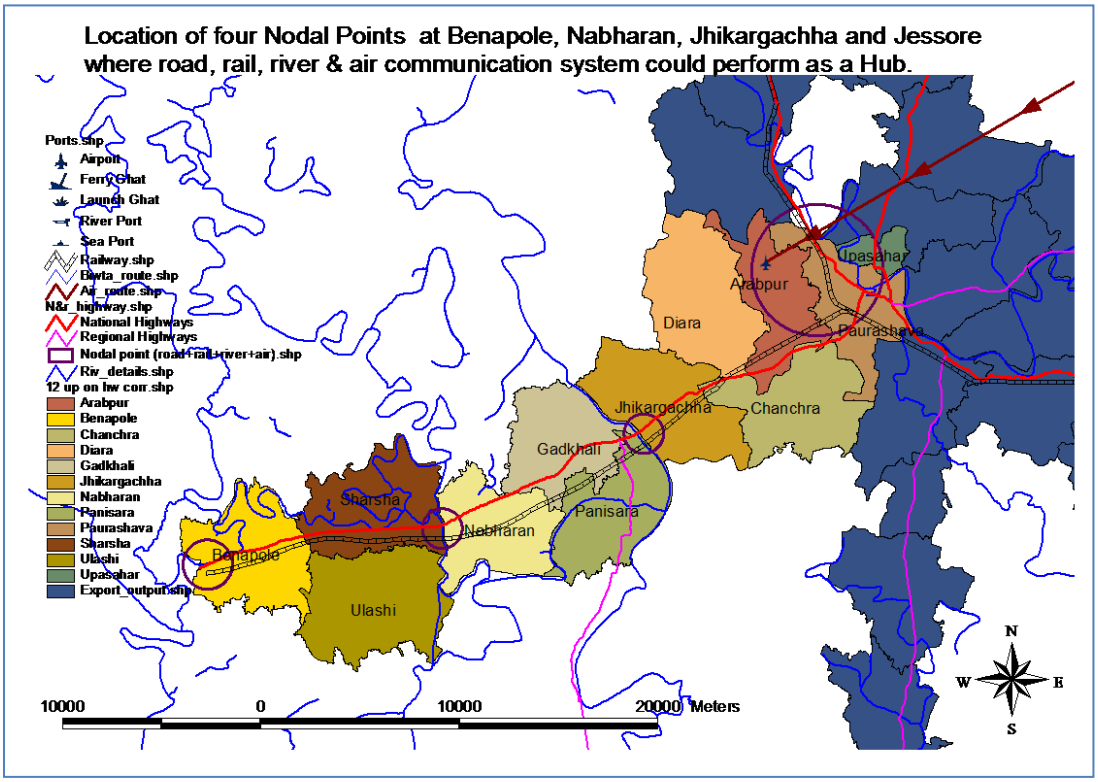


Figure 2.1: The Map of the proposed Jessore-Benapole Highway Corridor

The study area also includes 12 Union Parishads of Arabpur, Diara, Paurahsava, Upashahar, Jhikargachha, Chanchra, Godkhali, Panisars, Sharsha, Nabharan, Benapole and Ulashi under the Development Management Plan for Jessore–Benapole Highway Corridor. The four nodal points at Benapole, Nabharan, Jhikargacha and Jessore under the project are to be given special attention where road, rail, river and air communication system would perform.

2.2 General Description

2.2.1 Physical Features

The development of the Jessore-Benapole National Highway Corridor is to enhance the capacity traffic movements off the corridor. The Benapole Land Port, the end part of the corridor, is the largest and busiest port of the country. The port handles about 80% of the commercial traffics

held between India and Bangladesh. The importance of the Benapole Land Port is historical since time immemorial. Though it is the most important land corridor, still it has not been developed adequately. The project is a major step to the modernization of the corridor. The modernization of the Integrated Petropole Ware house at Benapole is also to be completed very soon. It would be directly connected with the Jessore-Benapole National Highway Corridor. As a result, the traffic time from the Petropole to Jessore-Benapole National Highway Corridor will be reduced sufficiently and traffic loads on the corridor will be increased several times. Traffic jams are anticipated to be enhanced. Moreover, the construction of the Padma Bridge is also to increase the traffic movement over the corridor.

Physical features of the Project area vary with locations. The proposed Jessore - Benapole National Highway Corridor comes under the South West Hydrological region of the country. The general physical feature can be characterized as a broad deltaic plain prone to tidal flooding of the rivers existed in the region. Agricultural activities are highly developed and dependent upon the capital of Dhaka City. The mode of development of infrastructures is also rapidly changing the region to its high commercial importance. Livelihoods, occupations, poverty, social and industrial development, forestry, soil, fishery, river network, etc., also are varying to a great extent in the region especially related with the Jessore - Benapole National Highway Corridor areas.

2.2.2 Hydrological Characteristics

Each region is different by its own hydrological characteristics. The rivers in the South West region bear moderate slope loaded with high concentration of sediment loads. The prominent rivers of the region are the Kobadak, the Betna, the Nabaganga, Bhairab, Pussur, etc. The Jessore - Benapole National Highway Corridor intersects mainly the Kobadak and the Betna and numerous beels and baors and khals and canals. Engineering interventions and road networks changed substantially the hydrological features of the region. The development of Jessore - Benapole National Highway Corridor is supposed to take into consideration of the present hydrological condition and accordingly predict hydrological hazards anticipated to be arisen as a result of the corridor development.

2.2.3 Socio-economic Activities

Socio-economic activities also vary in different regions. The South West region is well-known for agricultural activities. Vegetables, fruits, rice, wheat, potato, and many other agricultural products are sent to the capital from this region. Moreover, huge manpower is involved with the road transport and engaged in handling Benapole Land Port activities. The development The Jessore-Benapole National Highway Corridor is supposed to enhance all types economic activities. Construction of the Padma Bridge will also enhance the coastal developmental

activities leading to a vibrant socio-economic development. The delay in transport of the Benapole heavy cargoes, agricultural products will improve the quality of life of the local people. Intricate river networks, khals and beels are the water-occupied areas where road network are very important to eradicate poverty of that locality and improve their quality of life. The Jessore-Benapole National Highway Corridor development will increase socio-economic activities of the project areas and supposed to be changed very quickly with rapid urbanization all over the South West region.

CHAPTER THREE
APPROACH AND METHODOLOGY

3.1 Introduction

The total duration for carrying out the proposed study is nine months. During this period, several jobs concerning water related are completed. They are followings:

3.2 Field Visit

The field visits to the Jessore-Benapole National Highway Corridor were made on 26 November 2015. The present hydrological openings kept on the corridor were given special attention to see the adequacy of openings as well as hydrologic management of the corridor. Moreover, connections with the major haor-baor-beel and rivers with the corridor were also examined through physical inspections of the nearby rivers, khals and waterbodies, etc.

3.3 Data Collection

The study requires different types of data such as hydrographic, topographic, hydrologic, and land use data etc. Data types that were received and collected from different sources are given below:

The hydrographic data has been provided by UDD to IWFM. This data would be used from flood hazard assessment. The topographic data in form of Digital Elevation Model (DEM) shown in Figure 3.1 has been provided by UDD. The data would be used for the study for watershed analysis. Hydrologic data contain water level and rainfall data. The water levels of the surrounding rivers, measured by Bangladesh Water Development Board (BWDB) have been collected from the IWFM database. The water level data are used for carrying flood frequency analysis for different return periods. The rainfall data, measured by Bangladesh Meteorological Department (BMD), has been collected from IWFM database. This data would be used for rainfall analysis, if requires. The land use data has been derived from high resolution satellite image provided to IWFM by UDD. This data would be used for runoff and drainage analysis if drainage data are available. The watershed analysis involved catchment and drainage network delineation from DEM. The catchment and drainage network would be used for drainage study, if proper data are available. Open source GIS software would be used from deriving catchment and drainage network from DEM.

3.4 Hydrological Analysis

The hydrological analysis in the current study involves determination water level for a particular return period. The water levels for the design return period are determined by frequency analysis

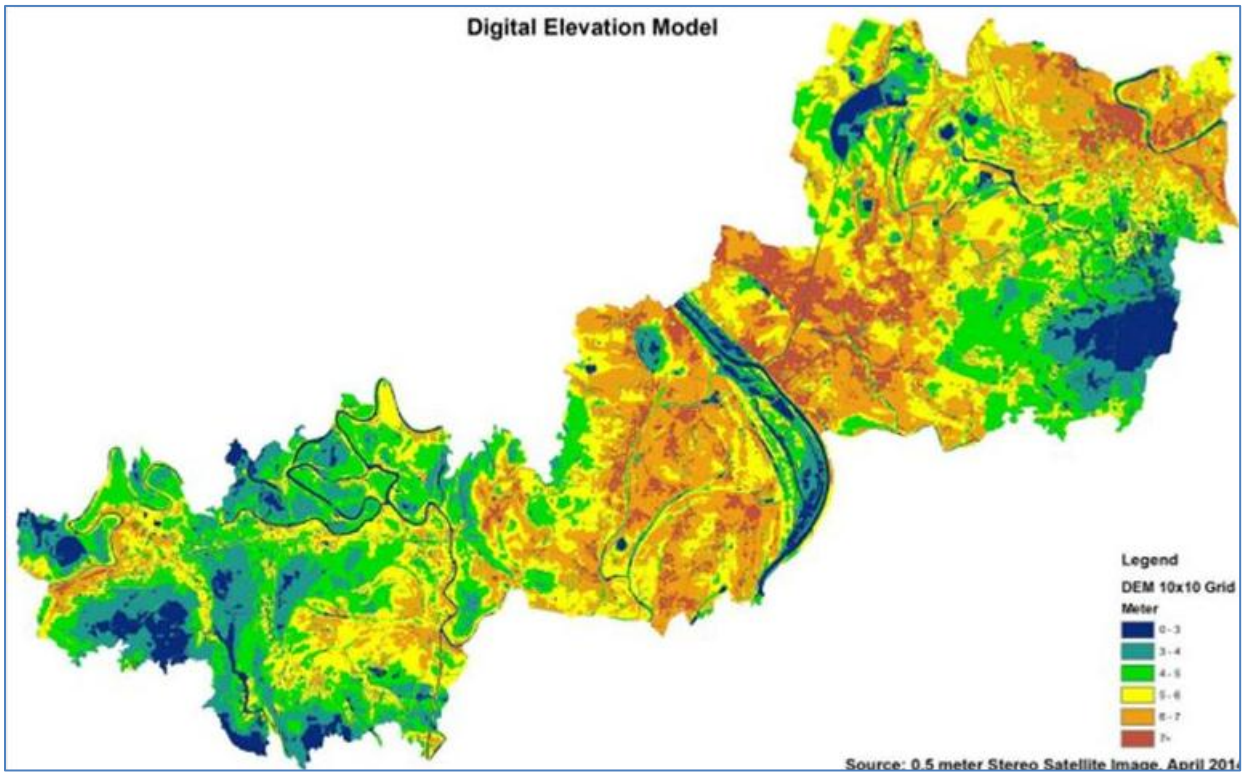


Figure 3.1: Digital Elevation Model

using suitable Probability Distribution Functions (PDF). In this case, several PDFs are tested based on probability plot correlation coefficient and the best fitted PDF are used to determine the design discharge and water level.

3.5 Hydrological Hazards Assessment

The dominant hydrological hazards in the study area are river flood and drainage congestion due to internal heavy rainfall. The flood hazard would be assessed from the design flood magnitude as determined from flood frequency analysis with the help of open source GIS software.

3.6 Initial Environmental Examination (IEE)

An assessment of the changes in the existing natural setting due to development of the development of the Jessore-Benapole National Highway Corridor will be carried out. An Environmental Management Plan (EMP) for the proposed projects to reduce the negative impacts and ensure sustainable development will be prepared. An outline of relocation and rehabilitation plan will be made.

The methodology proposed herein follows the EIA procedure recommended in the Environmental Assessment Guidelines for LGED projects (LGED, 2008).

CHAPTER FOUR
FIELD VISIT

4.1 Introduction

Field visit was made to the Jessore-Benapole Corridor by the consultant from the Institute of Water and Flood Management (IWFM) by Dr. Sujit Kumar Bala, Dr. Tarekul Islam and Dr. Saiful Islam for having practical knowledge about the condition of Jessore-Benapole National Highway. Mr. Maqsud Hashem, Project Manager from the Urban Development Directorate (UDD) also joined the field visit.

4.2 On the Way to Jessore Corridor

Field visit started from Jessore and ended at Benapole. Special attention was given to the rivers crossing the Jessore-Benapole Highway Corridor and the existing structures over the crossings. Moreover water bodies and their connections with the Jessore-Benapole Highway Corridor were also tried to understand. Photographs of several structures observed during the visit over the corridor on different locations along the high way are given below in Photographs 4.1 to 4.10:

Photograph 4.1: The Daratana Bridge over the Mukteswari River at Jessore Sadar and encroachments from both ends of the river.

Photograph 4.2: The Bridge over the Kobadak at Jhikargacha.

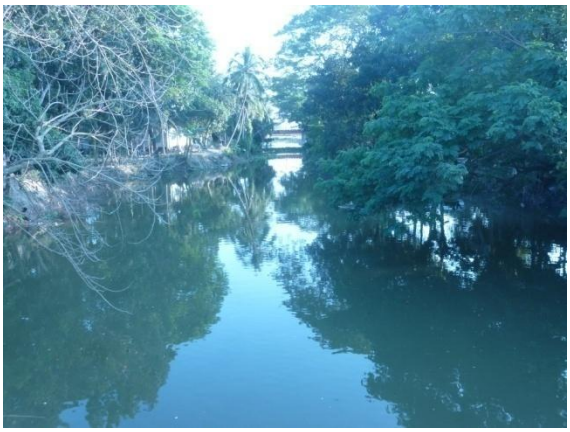
Photograph 4.3: The Railway and Road Bridge running parallel over the Kobadak at Jhikargacha.

Photograph 4.4: The Kobadak River at Jhikargacha.

Photograph 4.5: The Kata Khal, implemented by the British, connects Buk Vara Beel and the Kobadak.

Photograph 4.6: The water regulator structure - fish by pass and sediment trap (British design) at the mouth of Kata Khal joining the Kobadak at Jhikargacha.

Photograph 4.7: The newly constructed regulator (BWDB design) close to water structure (British design) at the mouth of Kata Khal joining the Kobadak River at Jhikargacha.



Photograph 4.8: Ziyar Khal near Benapole to pass flow from the Hakur to various beels and vice versa.

Photograph 4.9: Fish catch in the Ziyar Khal on the corridor near Benapole.

Photograph 4.10: Pachuar Baor on the Hakur River close to Benapole.

4.3 Interactions with Local People

Field visit to the Jessore-Benapole corridor was planned and scheduled as per priority set by the PD Office. After the approval of the scheduled date and direction of the PD from UDD,

consultant paid field visit to the Jessore-Benapole corridor. Necessary secondary information about the Jessore-Benapole corridor such as project appraisal reports were collected from the PD Office to know the preliminary information and assessments made by the UDD office. Consultant also maintains close contact with UDD Office in carrying out all types of field investigations and consultancy works.

Discussions were made with local people on the way to the Jessore-Benaploe corridor. The unprecedented flood of 2000 was devastating for the corridor as well as for the inhabitants. Some locations of the Jessore-Benapole Highway were inundated and overtopped. Many existing drainage openings seemed to be inadequate. As per local suggestions, the 2000 flood was a test case for the corridor. The corridor should be upgraded considering the flood event of 2000. It means the highway should be elevated vertically as well as horizontally i.e., existing openings should be widened.

CHAPTER FIVE
HYDROLOGICAL ANALYSIS

(*Working Paper 1: Hydrologic Characteristics of Benapole Jessore Highway Corridor)*

5.1 Geographical Setting

The Jessore-Benapole Corridor comes under the South-west and South-central region. This region is bounded by the Ganges and the Padma in the north, the Bay of Bengal in the south and Lower Meghna River to the east (Figure 5.1). At present, 99 rivers, including 5 trans-boundary ones, are flowing through this region. More than half of the region is influenced by the tide, and salinity intrusion is a common feature for several kilometers inland from the Bay of Bengal (BWDB, 2011).

5.2 Topographical Setting

As per topographic setting and based on elevation, the Jessore-Benapole Corridor passes through the middle part of the southwestern part of the delta. The corridor can be characterized by two distinct features. The elevated area at the northwestern tip has a higher gradient and mainly consists of the Ganges floodplain, as shown in profile of section SW-1. Next to this unit, there is a southwest to northeast aligned stretch of low lying area having minimum elevation below MSL, which is classified as the Gopalganj-Khulna Beels, located in between Haparkhali and Nunda Utra rivers in section SW-2 (Figure 5.2).

5.3 Historical Development

The region is a complex of inter-linked ecosystems in the delta of the Ganges-Brahmaputra Rivers. Delta progradation or delta building process is the most eminent feature of this region which is influenced by tectonic and seismic activities. The sediment generated by 1950 Assam earthquake is considered to have immense effect on this delta building process, especially on the topography of the estuary (Brammer, 2004). Moreover, erosion of the Himalayas, highland boundaries, avulsion of Brahmaputra has influenced the process. This active delta building process has impact on accelerating the dynamics of rivers and Meghna estuary of this region (Sarker M. A., 2013). The overall river system of this region was flowing eastward previously. But the rivers are now flowing westward due to the adjustment with the delta building process (Figure 5.3).

5.4 Sub regional water resources system and drainage network

The Jessore-Benapole Corridor passes through several water resources system and river (drainage) network which are shown in Figure 5.4. The prominent rivers cross through the

River System Map: South West Region

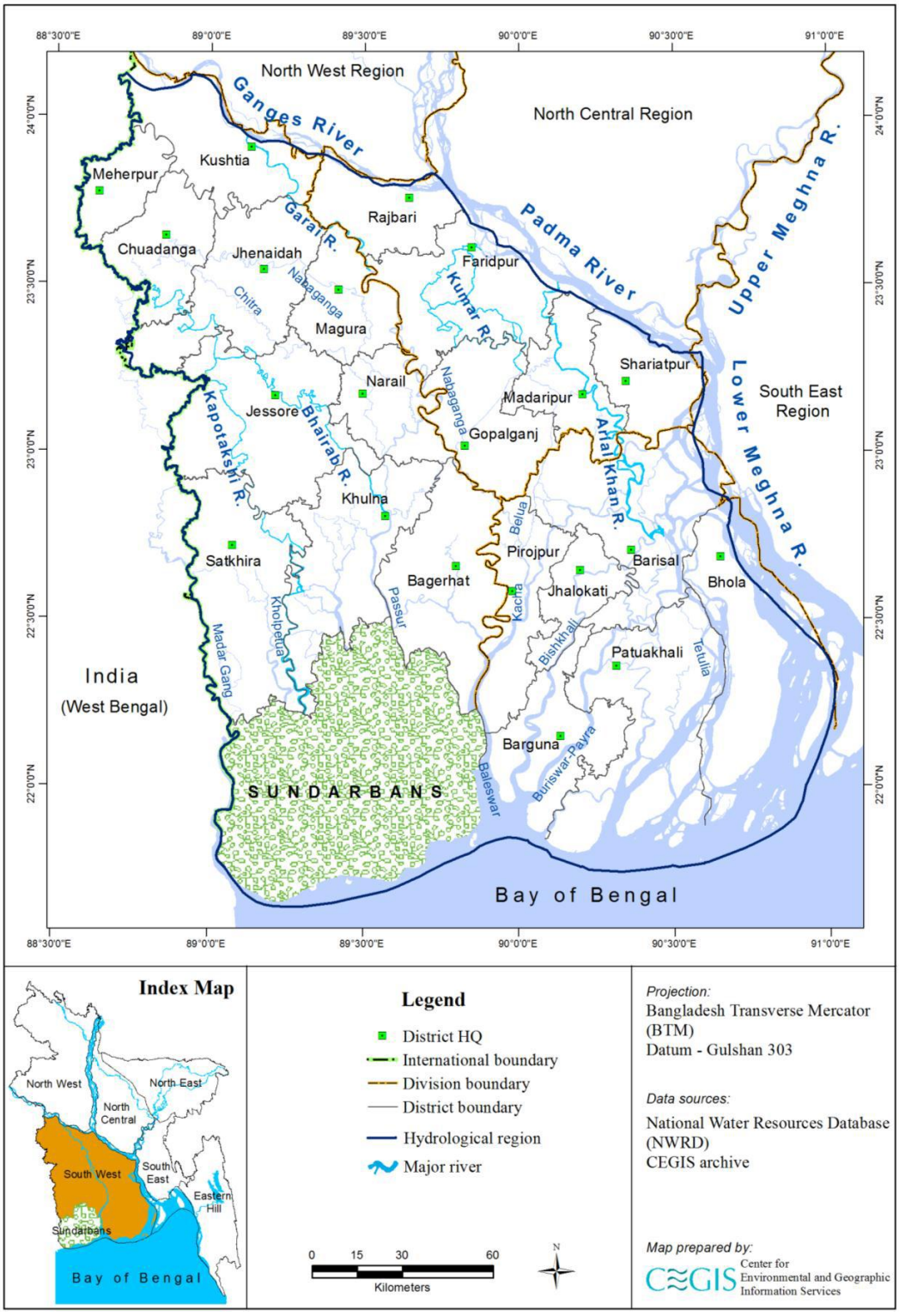


Figure 5.1: Rivers in the South-West and South-Central regions of Bangladesh

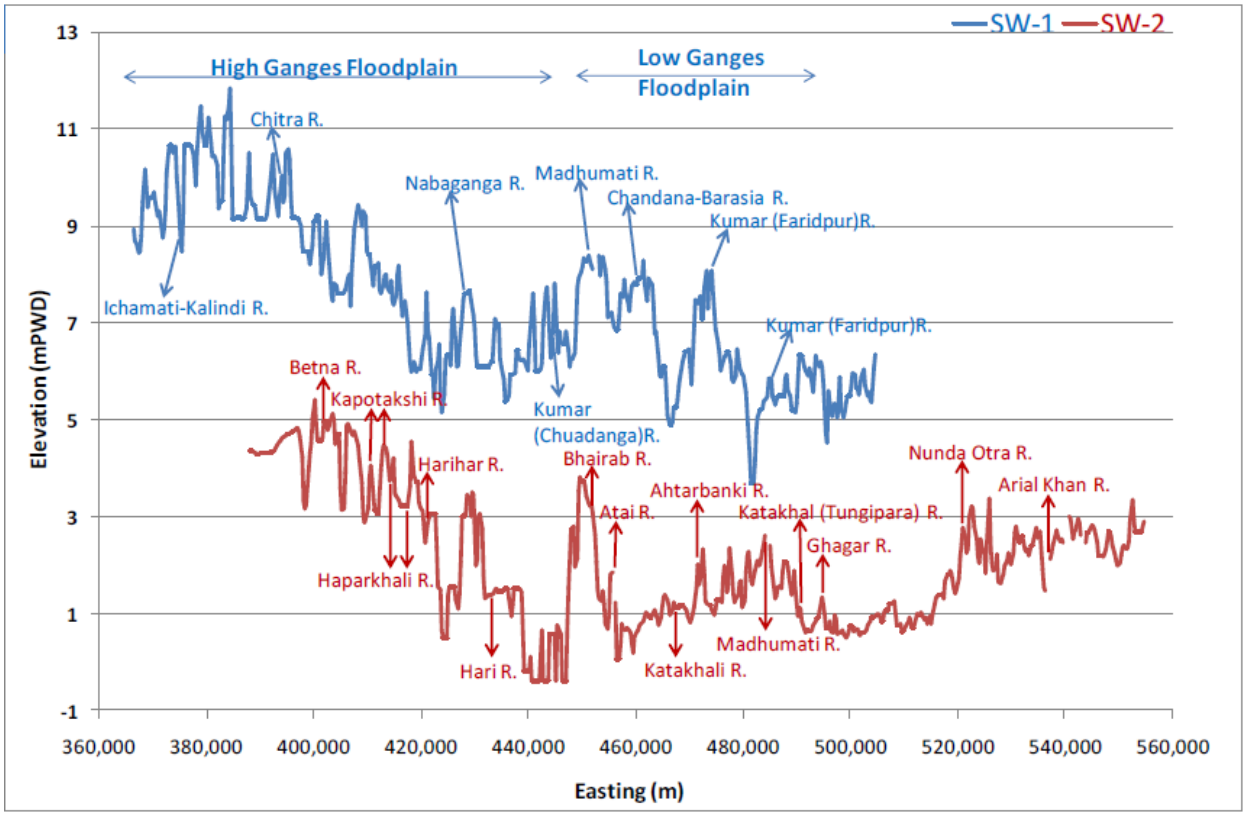


Figure 5.2: East-west surface profile in South-West and South-Central regions of Bangladesh

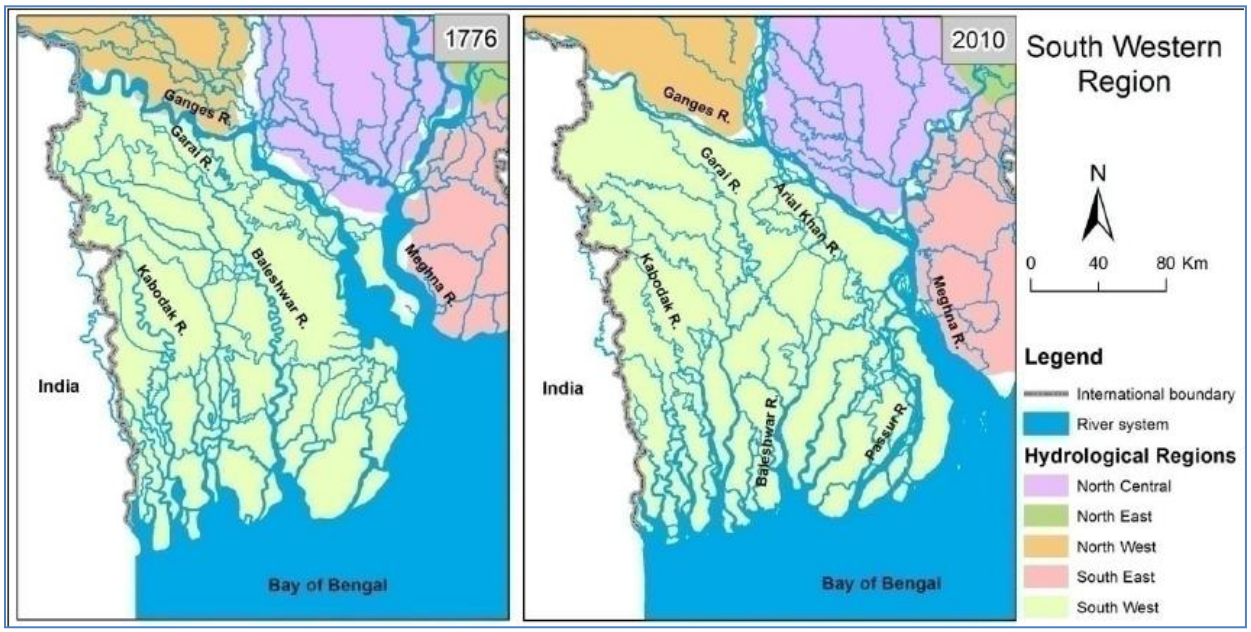


Figure 5.3: Historical evolution of rivers in South-West and South-Central regions

corridor are the Mukteshari, the Kapotakhha, the Betna and the Hakur at the border of the Benapole Municipality. There is also one existing Ziyar Khal in the Benapole Municipality area.

There are numerous existing haors, baors and beels around the corridor, which function as water storage reservoir for the corridor and play vital role in maintaining ecological and environmental health of the region. The famous of these water bodies are Bukbhora Beel, Srirampur Beel, Bodhkhana Beel along the corridor. There is one big baor created as a result of the Betna river meandering and it is close to Benapole Municipality. Now all these water bodies are turned into precious water resources for capture fish as well as for capture fisheries.

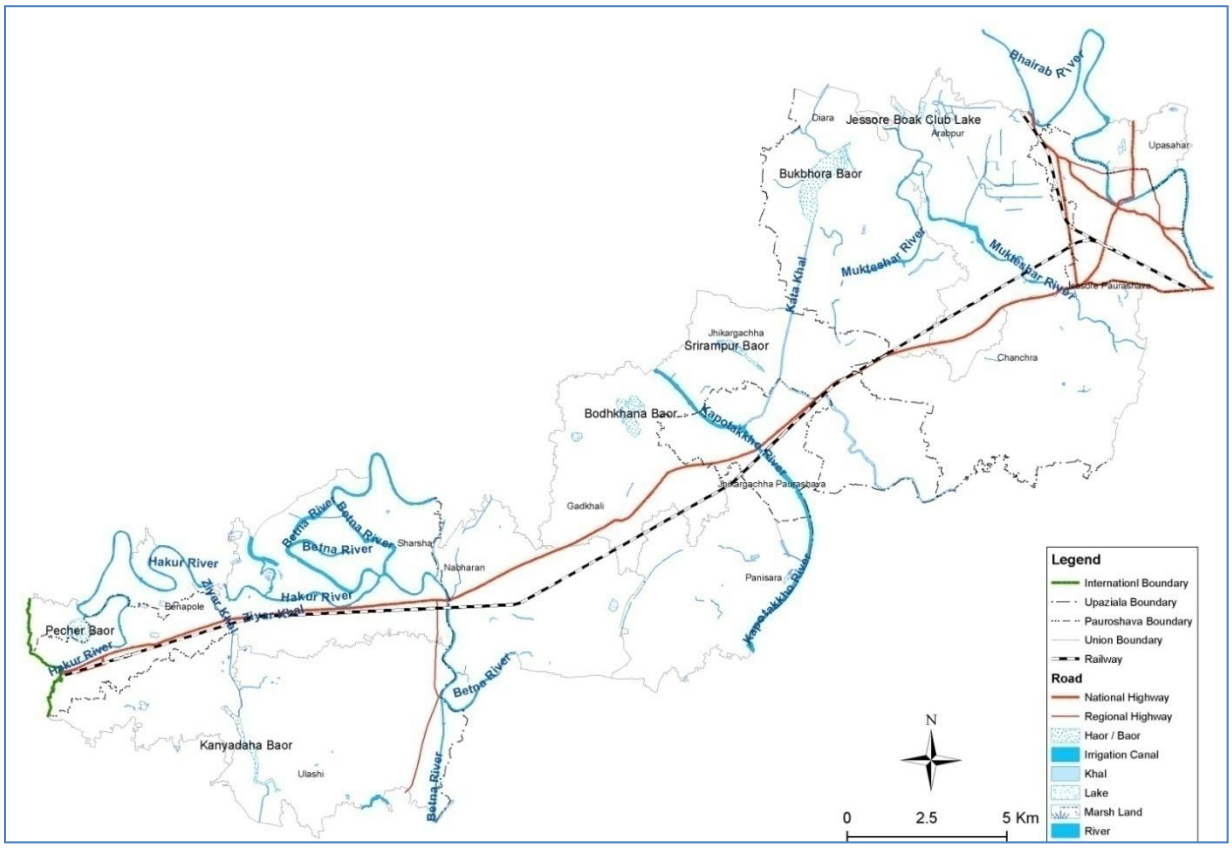


Figure 5.4: The water resources system and drainage network along the Jessore-Benapole Corridor

The Jessore-Benaploe Highway Corridor exists since long time ago and developments of the corridor have undergone various stages after centuries of interventions. As a result, the drainage system through the corridor has reached to a mature stage and usually functioned well except the historical unusual event of 2000 flood.

The area of total water body is about 7572 acres, which is 9.5 % of total corridor area. Tidal influence is very low in the rivers. There are about 463 cross dams on these rivers which block flow in the rivers. An inventory of water bodies and rivers was done by the survey group employed by the Project Director and is shown in Table 5.1 below.

Table 5.1: Statistics of water bodies.

Type	Total Number	Area (acre)	%
Baor/Haor		807.91	10.67
Borrow pits	3	1.91	0.03
Ditch	1436	415.71	5.49
Gher (only fish culture)	971	589.47	7.79
Irrigation canal	5	3.14	0.04
Khal	30	394.44	5.21
Lake	22	67.23	0.89
Marsh land	13	67.35	0.89
Pond	9865	3677.12	48.57
River	5	1547.26	20.44
Total	12421	7571.23	100

Jessore-Benaploe Highway Corridor comes under three Upazila namely Jessore Sadar, Jhikargacha and Sharsha Upazila. The water resources systems of the respective upazilas together with human interventions (cross dams) were also delineated to examine the status of water resources system of each upazila.

It is to be noted that almost every prominent rivers, secondary rivers and parts of water bodies' are intervened by construction of cross dams by local power groups where fish cultures practiced. Cross dams over the water bodies turn the area virtually dead water entities and eco-hydrological regimes are changed totally.

Healthy water ecology has been missing and mono fish culture has led to extinction of other eco-system services. As a result, the region has been suffering from social, biological, ecological, environmental degradations. To restore the vibrant eco-system services, such cross dams together with other unhealthy practices should be stopped and eliminated through integrated developmental activities. The water resources system of each upazila is shown in Figures 5.5 to 5.7. The water resources system showing cross dams, bridges, culverts, sluice gates over the system are shown in Figures 5.8 to 5.10.

The status of water body in each upazila of Jessore Sadar, Jhikargacha and Sharsha is shown in Table 5.2, 5.4 and 5.6, while status of interventions showing number of cross dams, bridge culverts and sluice gates in each upazila is shown in Tables 5.3, 5.5 and 5.7 respectively.

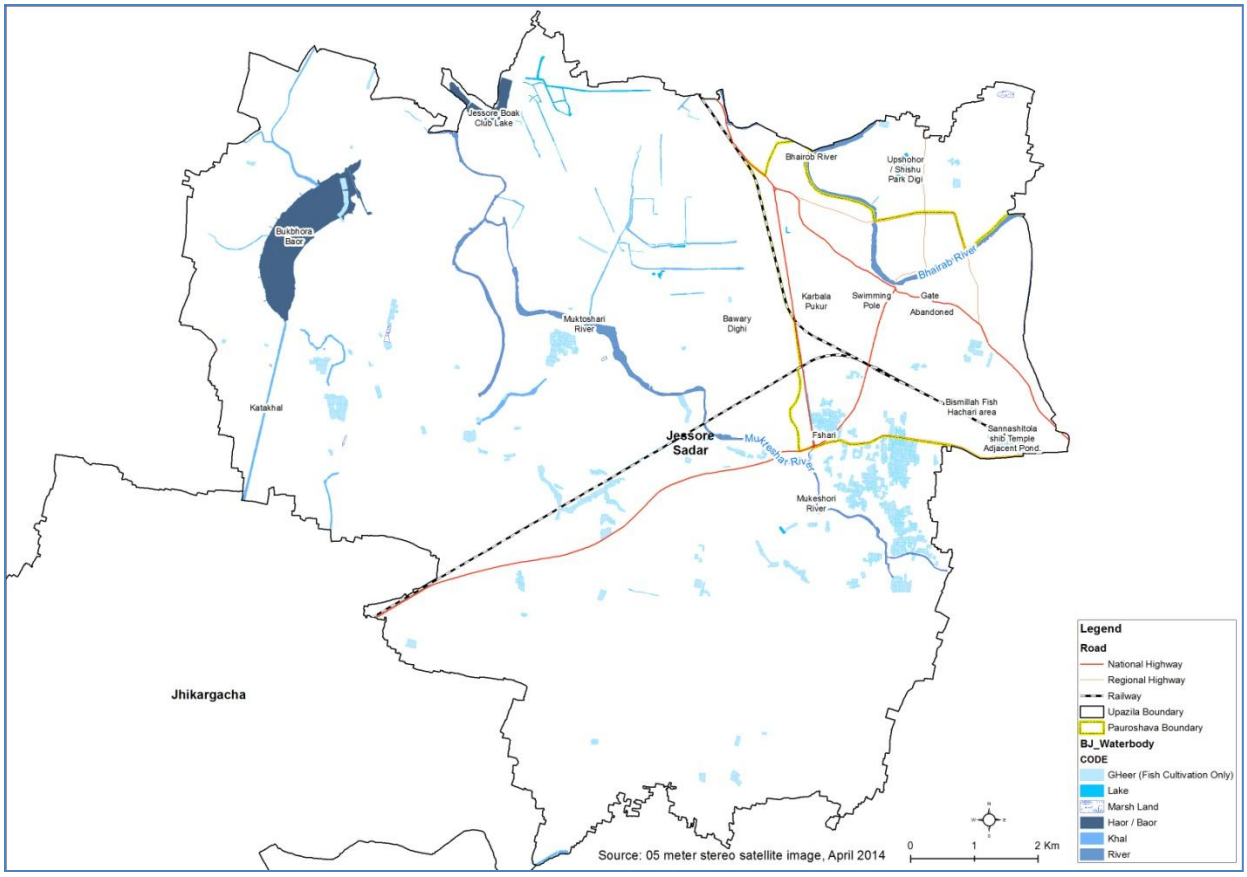


Figure 5.5: The water resources system in Jessore Sadar Upazila along the corridor.

Table 5.2: Statistics of water bodies in Jessore Sadar Upazila.

Water body	Jessore Sadar		
	Number	Area (Acare)	% (Area)
Baor / Haor	1.00	357.63	11.93
Ditch	655.00	190.96	6.37
Gher (Fish Cultivation Only)	1,079.00	590.08	19.69
Irrigation Canal	6.00	3.14	0.10
Khal	39.00	158.03	5.27
Lake	16.00	93.39	3.12
Marsh Land	9.00	10.66	0.36
Pond	3,548.00	1,206.00	40.24
River	2.00	386.98	12.91
Total	**5,355.00**	**2,996.88**	100.00

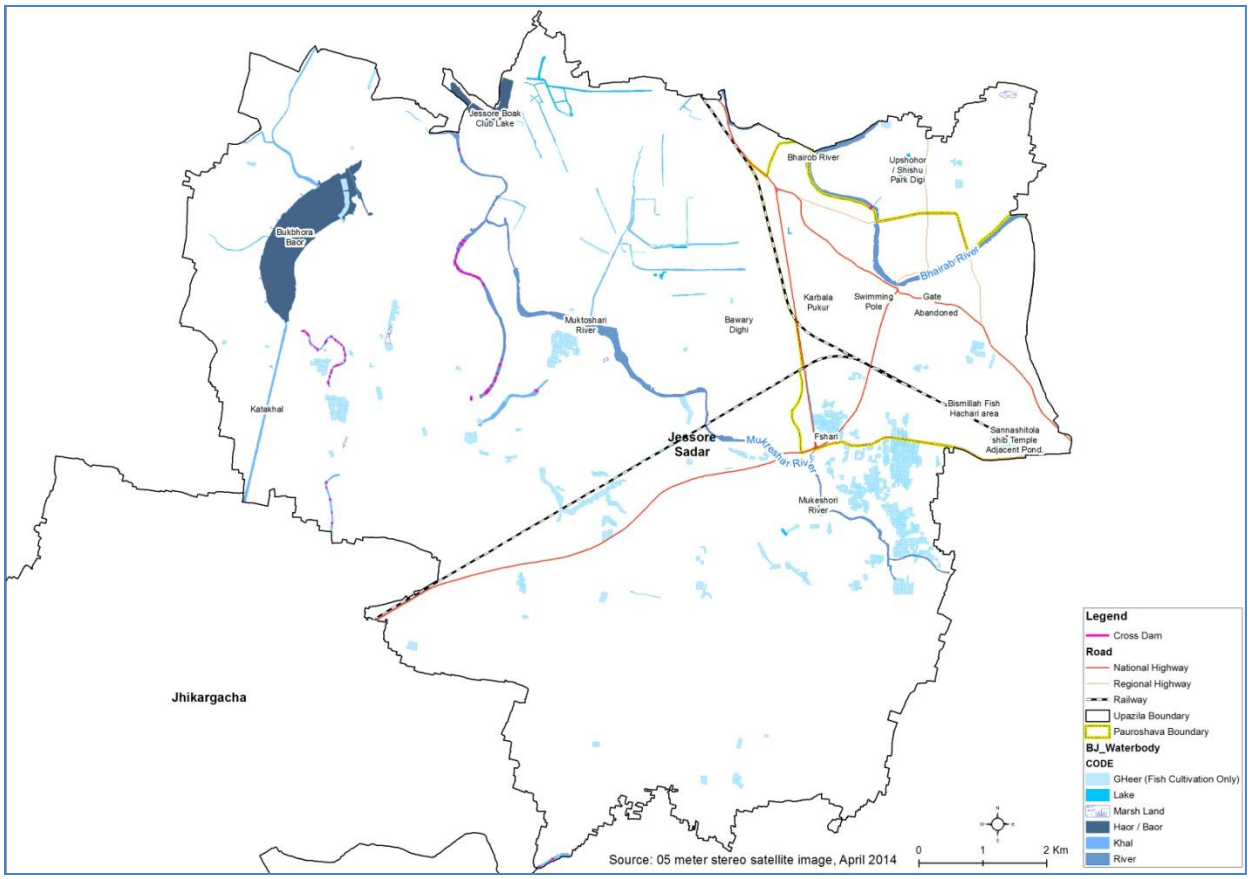


Figure 5.6: The water resources system with cross dams in Jessore Sadar Upazila along the corridor.

Table 5.3: Statistics of water bodies with cross dams, bridges, culverts, and sluices in Jessore Sadar Upazila.

Water body structure	Jessore Sadar
Bridge/Culvert	480
Cross Dam	75
Sluice Gate	4
Total	**559**

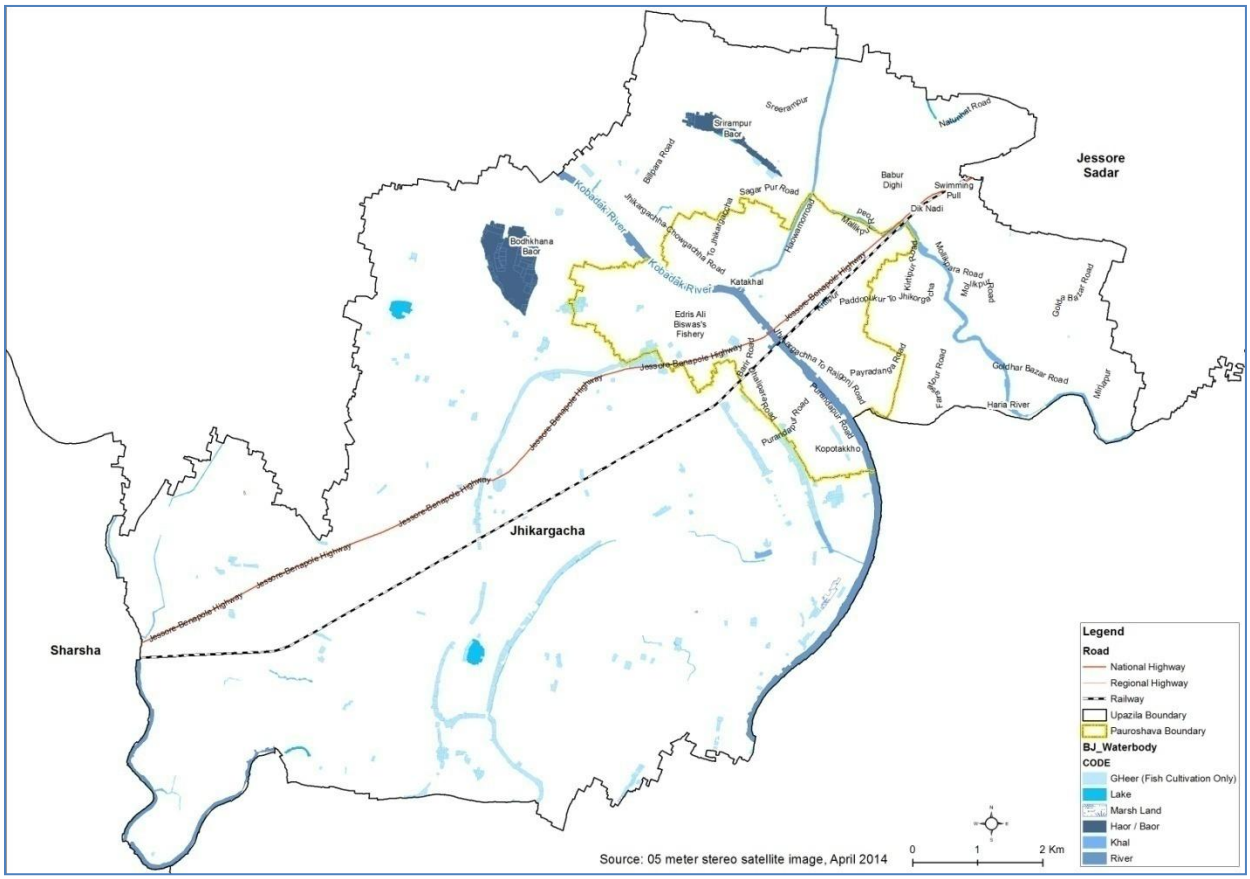


Figure 5.7: The water resources system in Jhikargacha Upazila along the corridor.

Table 5.4: Statistics of water bodies in Jhikargacha Upazila.

Water body	Jhikargacha		
	Number	Area (Acare)	% (Area)
Baor / Haor	3.00	273.74	11.49
Ditch	489.00	94.75	3.98
Gheer (Fish Cultivation Only)	750.00	517.54	21.73
Irrigation Canal	0.00	0.00	0.00
Khal	22.00	107.24	4.50
Lake	11.00	45.01	1.89
Marsh Land	5.00	13.52	0.57
Pond	2,689.00	809.95	34.00
River	3.00	520.13	21.84
Total	**3,972.00**	**2,381.88**	100.00

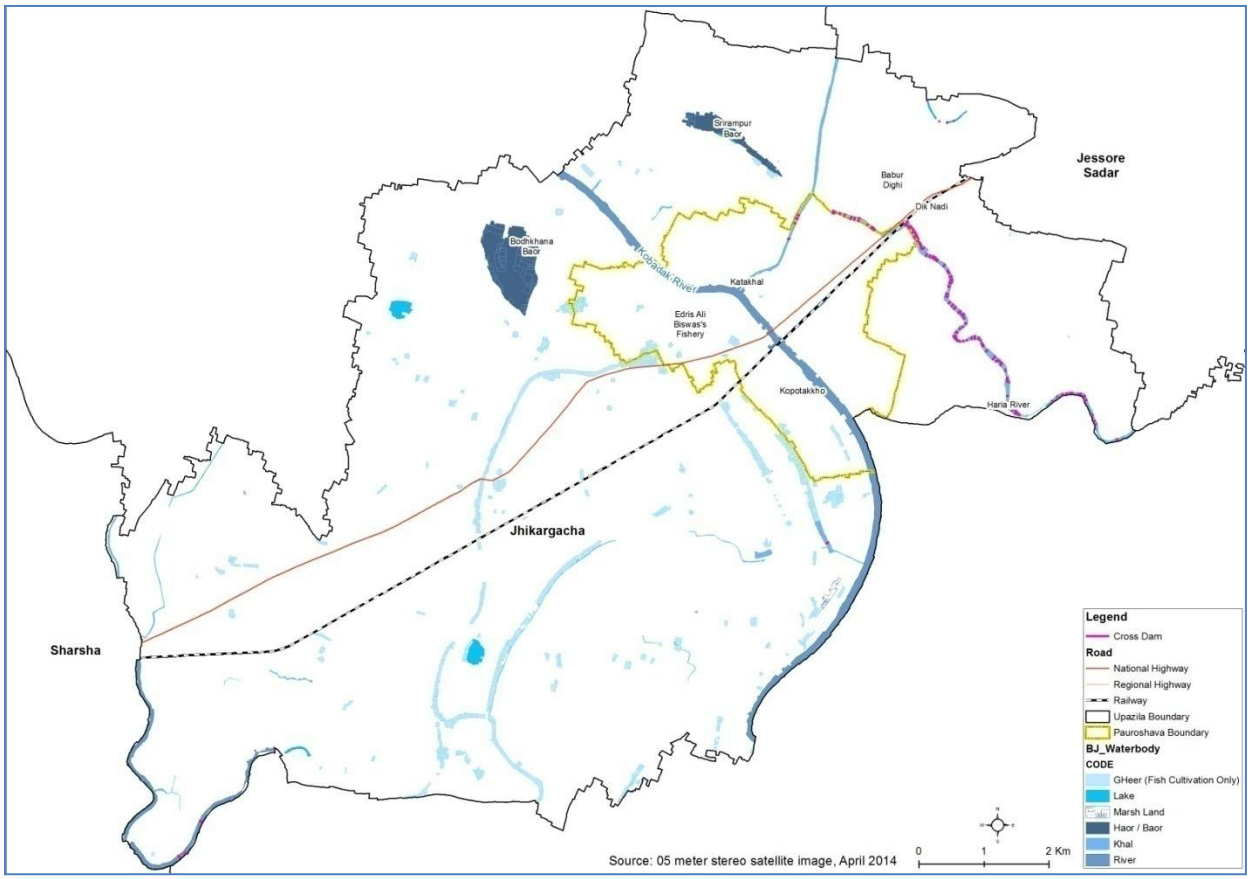


Figure 5.8: The water resources system with cross dams in Jhikargacha Upazila along the corridor.

Table 5.5: Statistics of water bodies with cross dams, bridges, culverts, and sluices in Jhikargacha Upazila.

Water body structure	Jhikargacha
Bridge/Culvert	156
Cross Dam	102
Sluice Gate	3
Total	**261**

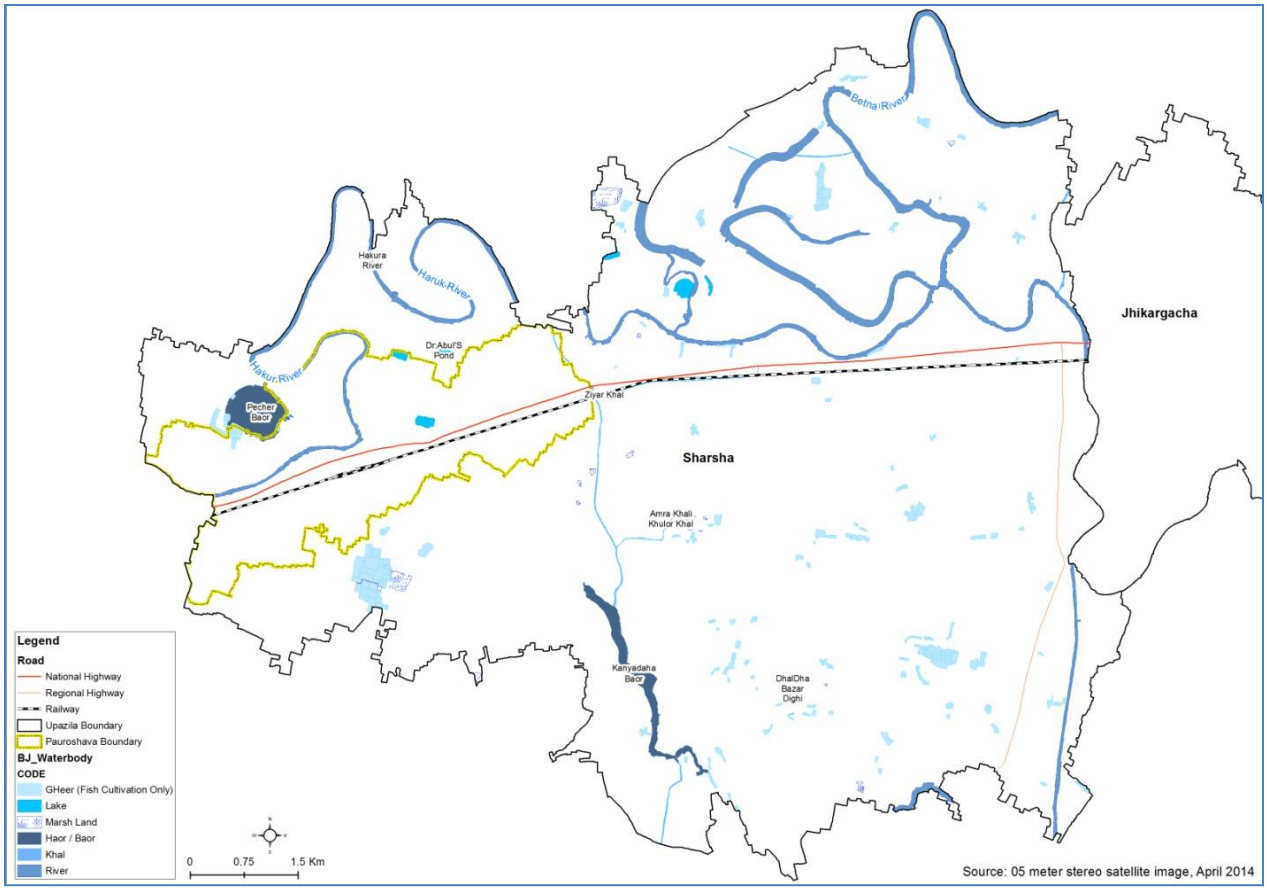


Figure 5.9: The water resources system in Sharsha Upazila along the corridor.

Table 5.6: Statistics of water bodies in Sharsha Upazila.

Water body	Sharshar		
	Number	Area (Acare)	% (Area)
Baor / Haor	6.00	308.46	13.59
Ditch	359.00	82.77	3.65
Gher (Fish Cultivation Only)	414.00	264.33	11.64
Irrigation Canal	0.00	0.00	0.00
Khal	10.00	55.67	2.45
Lake	17.00	45.79	2.02
Marsh Land	18.00	35.44	1.56
Pond	2,489.00	698.26	30.76
River	2.00	779.55	34.34
Total	**3,315.00**	**2,270.28**	100.00

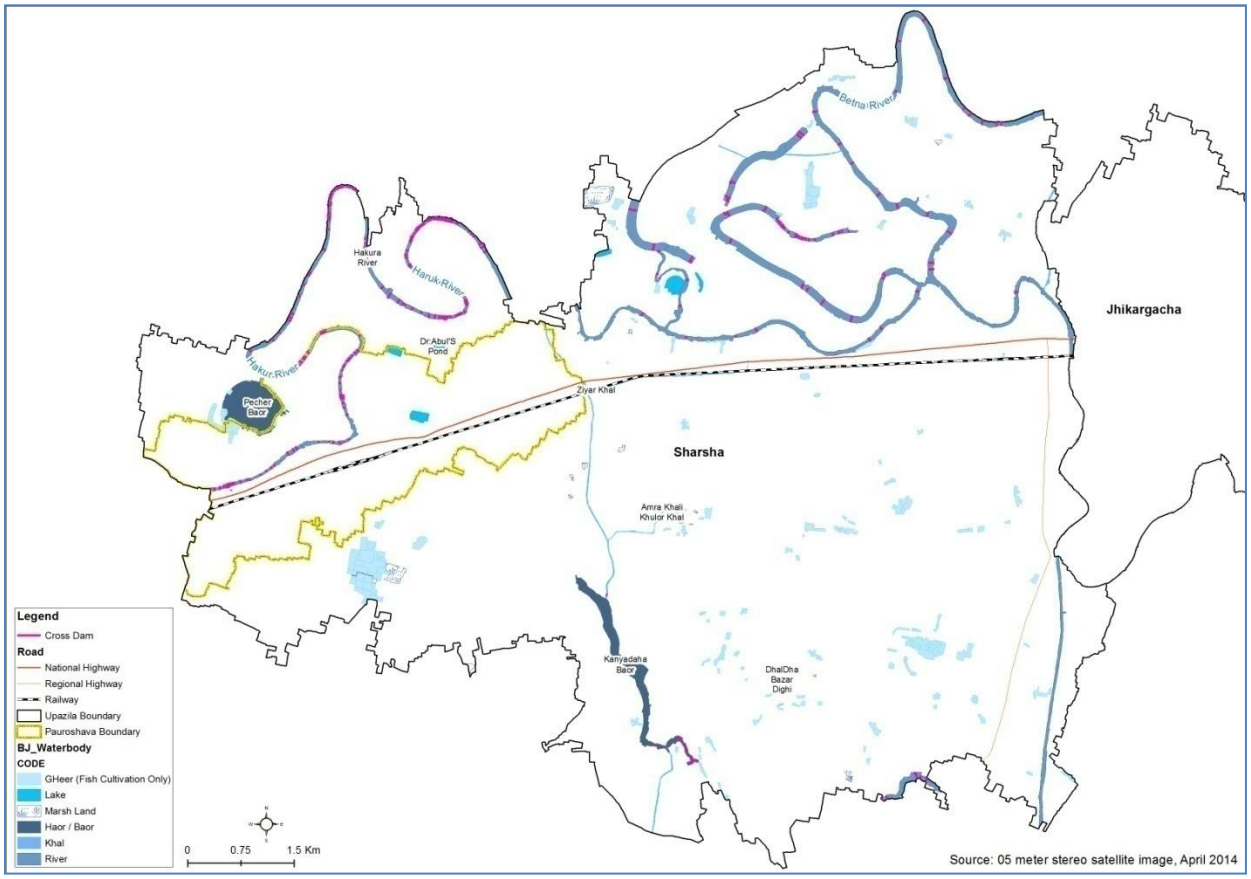


Figure 5.10: The water resources system with cross dams in Sharsha Upazila along the corridor.

Table 5.7: Statistics of water bodies with cross dams, bridges, culverts, and sluices in Sharsha Upazila.

Water body structure	Sharsha
Bridge/Culvert	260
Cross Dam	182
Sluice Gate	2
Total	**444**

The existing condition of drainage network of Jessore Sadar has been delineated from DEM using ArcHydro tool as can be seen in Figure 5.11. The drainage capacity could not be assessed as there is no cross-sectional data of the drainage channels. As this study is meant to be used for micro level planning, the adequacy of the drainage channels is not needed. However the assessment of the adequacy of the drainage channels should be checked for designing the drainage network during implementation of the project involving design and construction of

drainage channels. In such case, detailed rainfall-runoff analysis should be carried out for each municipality.

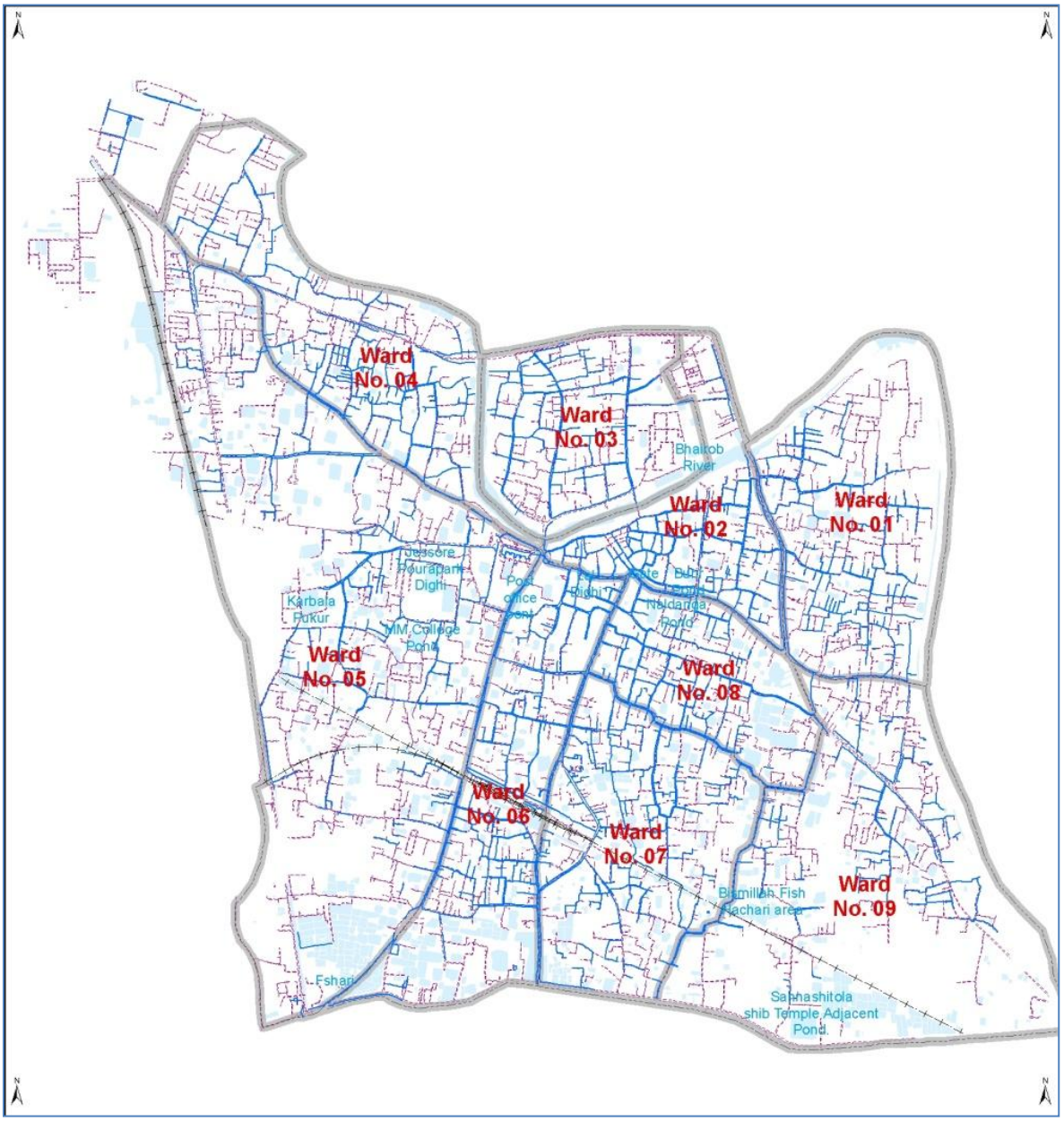


Figure 5.11: The existing drainage network of Jessore Sadar.

5.5 Hydrologic Analysis

The hydrologic analysis in this section focuses on estimation of design flood level. The analysis involves frequency analysis with different probability distributions functions for the selected design return period. The historical data on annual peak water level are used for the purpose.

5.6 Estimation of Water Level for Different Return Period

The proposed Benapole-Jessore Highway Corridor runs over two rivers, namely the Kobadak and the Betna-Kholpetua. There are two water level gage stations in the corridor. The gage station of the Kobadak river is located at Jhikargacha (Station: SW 162) while the gage station of the Betna-Kholpetua is located at Navaron. The gage stations are maintained by Bangladesh Water Development Board (BWDB). The data of the Betna-Kholpetua river at Navaron (SW 22) is not available at the server of BWDB at the time of preparation of this report and hence could not be used for flood level analysis.

Table 5.8 presents the historical annual maximum water level of the Kobadak river at Jhikargacha. The highest high water level and lowest low water level are found to be 5.45 and 0.61 m PWD, which occurred in 2000 and 1988, respectively. It is seen from Table 5.8 that the annual maximum water level at Jhikargacha shows upward trend (Figure 5.11). This data was treated for trend removal for subsequent frequency analysis. The de-trended data are shown in Figure 5.12.

Table 5.8: Annual maximum water level data of the Kobadak river at Jhikargacha.

Year	Water level, m PWD	Year	Water level, m PWD
1977	3.01	1995	3.44
1978	4.14	1996	3.74
1979	3.22	1997	4.04
1980	3.17	1998	4.40
1981	3.41	1999	4.03
1982	2.17	2000	5.45
1983	3.04	2001	3.88
1984	4.38	2002	4.39
1985	2.42	2003	4.77
1986	4.98	2004	5.27
1987	4.72	2005	4.55
1988	3.70	2006	4.59
1989	2.97	2007	4.74
1990	3.19	2008	5.28
1991	3.08	2009	4.35
1992	2.92	2009	4.81
1993	3.43	2010	3.80
1994	2.80	2011	4.99

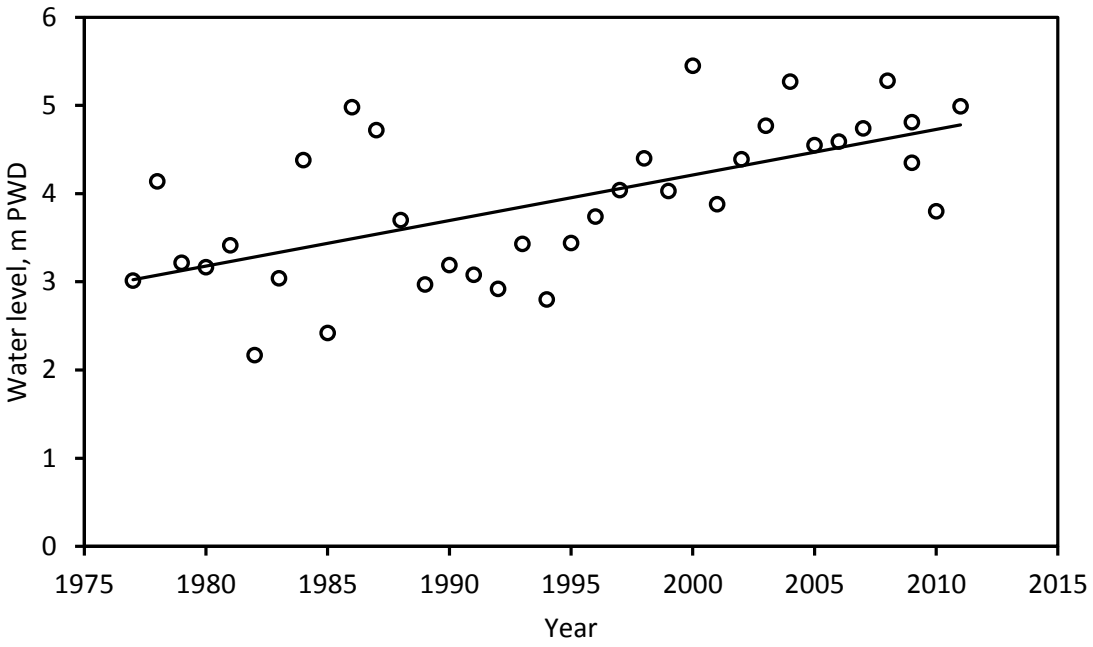


Figure 5.12: Upward trend in the annual maximum water level of the Kobadak river at Jhikargacha.

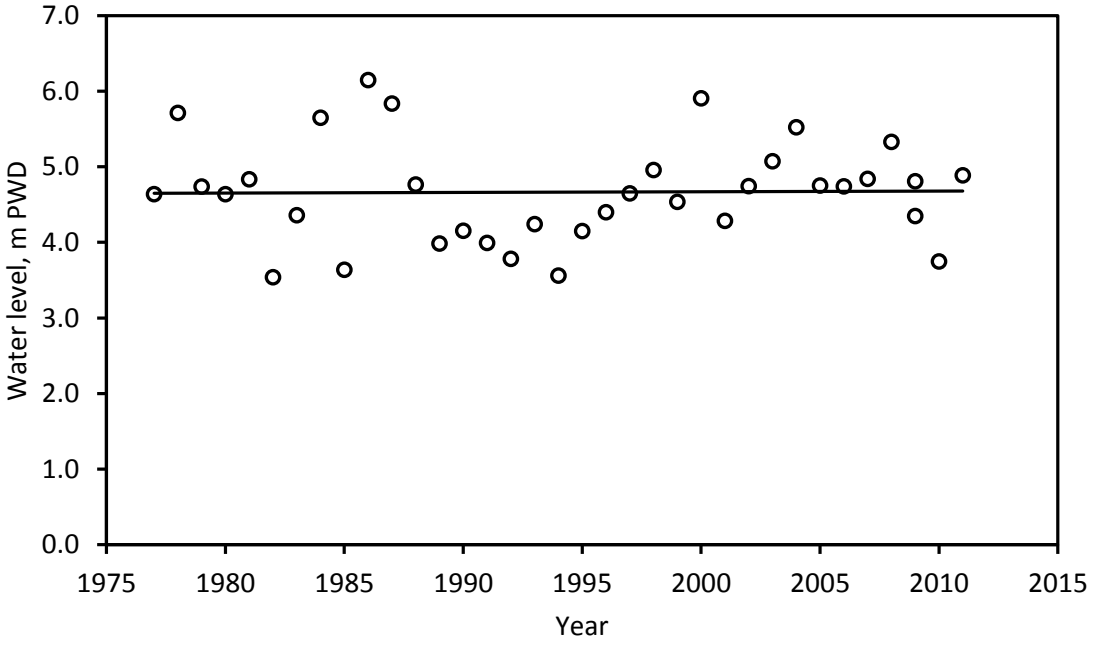


Figure 5.13: De-trended annual maximum water level of the Kobadak river at Jhikargacha.

Five probability distribution functions (PDF) viz. Two-Parameter Log Normal (LN2), Three-Parameter Log Normal (LN3), Pearson Type III, (P3), Log Pearson Type III (LP3) and Gumbel

(EV1) were used for frequency analysis. The PDFs were tested based on Probability Plot Correlation Coefficient (PPCC) (Filliben, 1975). Goodness-of-fit study based on PPCC is useful for assessing whether a proposed distribution is consistent with the at-site data sample (Stedinger et al., 1993). The test uses the correlation coefficient 'r' between the ordered observations and the corresponding fitted quantiles, determined by plotting positions for each observation. Cunnane (1978) plotting position formula was used to obtain the fitted quantiles. The best fitted PDF based on PPCC was used to determine the design water level.

The fitted PDFs and the corresponding values of PPCC for annual maximum water level of the Kobadak river at Jhikargacha are shown in Table 5.9. It is seen from Table 5.9 that the best fitted PDF is P3. The design high water levels based on the best fitted PDF and corresponding to 2.33-, 5-, 20-, 50- and 100-year return periods are 4.77, 5.25, 5.91, 6.27 and 6.53 m PWD respectively. The probability plot along with 90% confidence interval for the annual maximum water level is shown in Figure 5.13. It is seen that the observed values fall well within the 90% confidence interval of the fitted LN2 distribution for annual maximum water level.

As the water level data of the Betna-Kholpetua river at Navaron (SW 22) is not available, the water level data of the Betna-Kholpetua river at Kalaroa (SW 23) have been used for frequency analysis and the results have been transformed to Navaron with estimated slope of the river. Table 5.10 presents the historical annual maximum water level of the Betna-Kholpetua river at Kalaroa. It is seen from Table 5.10 that the annual maximum water level at Jhikargacha shows upward trend (Figure 5.14). This data was treated for trend removal for subsequent frequency analysis. The de-trended data are shown in Figure 5.15. Frequency analysis was carried out with the de-trended data (Figure 5.16). The results of the frequency analysis (Table 5.11) have been transformed to Navaron as shown in Table 5.12.

Table 5.9: Fitted PDFs and the corresponding values of PPCC for annual peak water level data of the Kobadak river at Jhikargacha.

PDF	Return period					PPCC	Rank
	2.33	5	20	50	100		
LN2	4.77	5.25	5.91	6.27	6.53	0.98852	1
LN3	4.75	5.21	5.84	6.19	6.43	0.98847	3
P3	4.75	5.22	5.84	6.18	6.42	0.98850	2
LP3	4.76	5.25	5.92	6.29	6.56	0.98844	3
EV1	4.67	5.15	5.93	6.42	6.78	0.97997	5

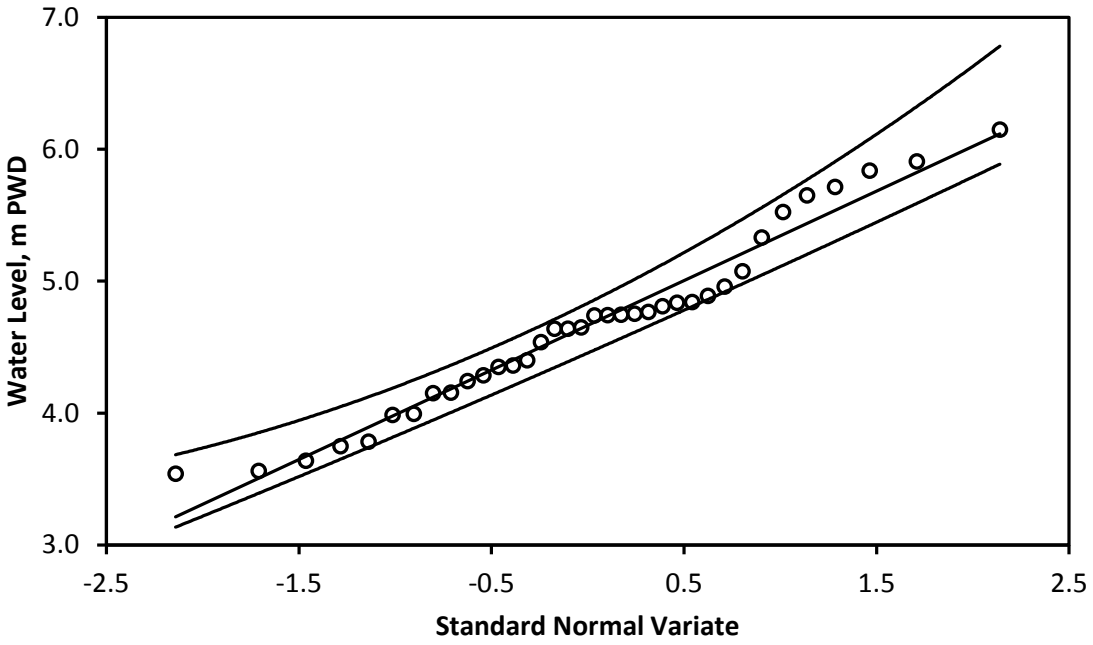


Figure 5.14: Probability plot alongwith 90% confidence interval of the fitted LN2 distribution to the annual peak water level data of the Kobadak river at Jhikargacha.

Table 5.10: Annual maximum water level data of the Betna-Kholpetua river at Kalaroa.

Year	Annual maximum water level, m PWD	Year	Annual maximum water level, m PWD
1968	3.23	1990	3.23
1969	3.95	1991	3.15
1970	4.36	1992	4.89
1971	3.58	1993	3.42
1972	3.15	1994	3.00
1973	2.70	1995	3.65
1974	2.96	1996	4.49
1975	2.59	1997	4.06
1976	2.60	1998	4.39
1977	3.21	1999	4.22
1978	-	2000	4.29
1979	3.08	2001	4.29
1980	3.11	2002	4.29
1981	3.20	2003	4.83
1982	2.25	2004	5.64
1983	3.04	2005	4.97
1984	3.69	2006	3.97
1985	2.81	2007	4.3
1986	4.23	2008	4.07
1987	3.61	2009	3.86
1988	3.43	2010	3.08
1989	2.93	2011	3.87

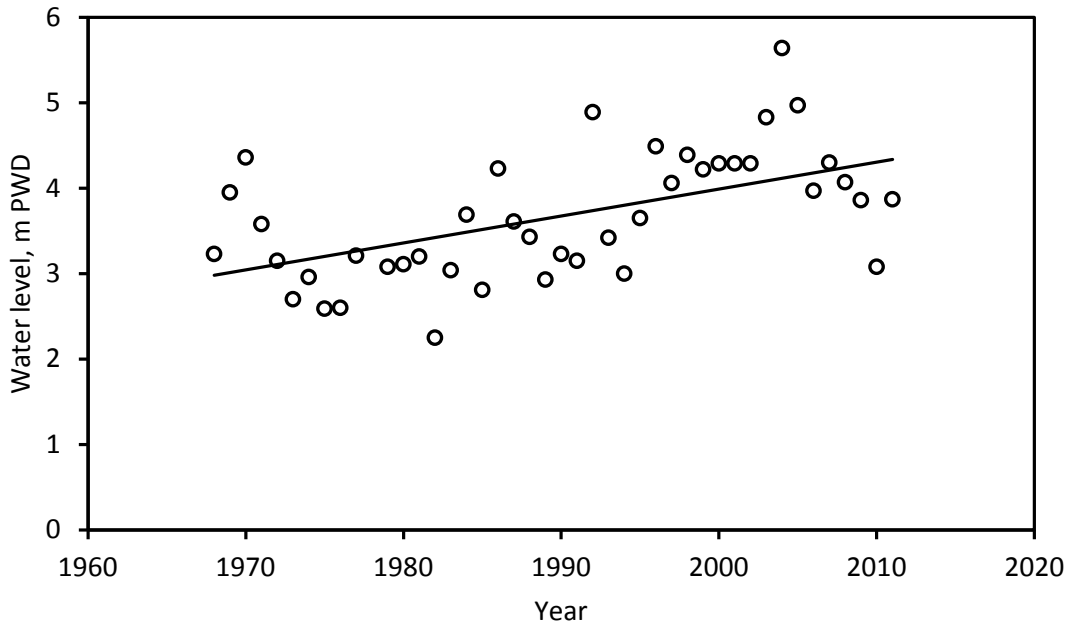


Figure 5.15: Upward trend in the annual maximum water level of the Betna-Kholpetua river at Kalaroa.

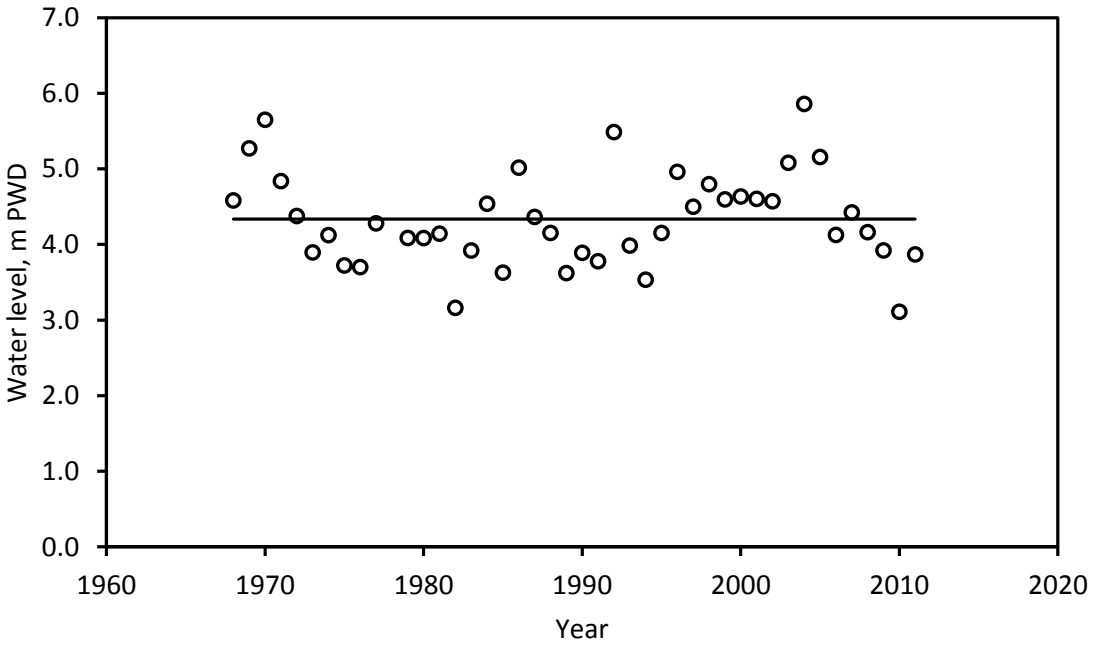


Figure 5.16: De-trended annual maximum water level of the Betna-Kholpetua river at Kalaroa.

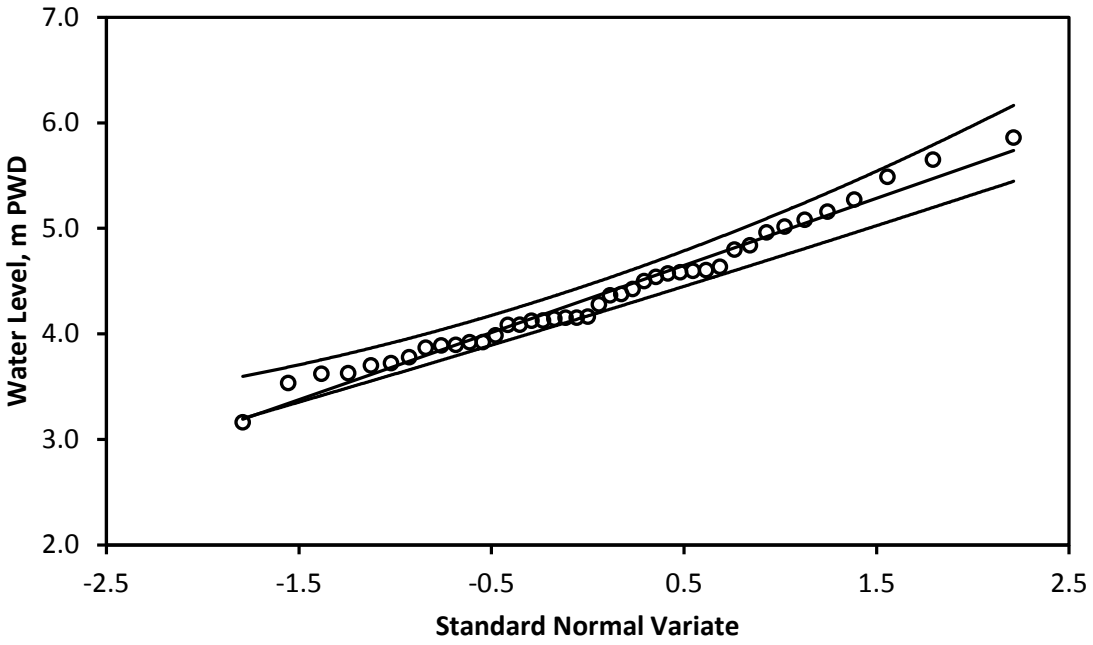


Figure 5.17: Probability plot alongwith 90% confidence interval of the fitted LN3 distribution to the annual peak water level data of the Betna-Kholpetua river at Kalaroa.

Table 5.11: Fitted PDFs and the corresponding values of PPCC for annual peak water level data of the Betna-Kholpetua river at Kalaroa.

PDF	Return period					PPCC	Rank
	2.33	5	20	50	100		
LN2	4.42	4.83	5.39	5.70	5.91	0.99	4
LN3	**4.38**	**4.83**	**5.48**	**5.86**	**6.13**	1.00	1
P3	4.40	4.84	5.43	5.76	5.99	0.99	3
LP3	4.40	4.82	5.44	5.80	6.06	1.00	2
EV1	4.34	4.78	5.50	5.95	6.29	0.99	5

Table 5.12: Estimated water level of the Betna-Kholpetua river at Navaron.

PDF	Return period					PPCC	Rank
	2.33	5	20	50	100		
LN2	4.72	5.13	5.69	6.00	6.21	0.99468	4
LN3	**4.68**	**5.13**	**5.78**	**6.16**	**6.43**	0.99507	1
P3	4.70	5.14	5.73	6.06	6.29	0.99483	3
LP3	4.70	5.12	5.74	6.10	6.36	0.99501	2
EV1	4.64	5.08	5.80	6.25	6.59	0.99084	5

5.7 Impact of Climate Change on Water Level

In the backdrop of climate change, it is important to assess whether the anticipated climate change will have any impacts on design water level and discharge. This stems from the present common understanding that the effect of climate change would be to increase the sea level rise and monsoon rainfall which in turn are likely to have an impact on design water level and discharge, respectively. The proposed bridge site is located in a tidal area and therefore the location is considered to be influenced by the impact of climate change in terms of both sea level rise and monsoon rainfall.

According to the Fourth Assessment Report (AR4), IPCC (2007), the average rate of sea level rise was 0.18 ± 0.005 m/yr from 1961 to 2003. Figure 5.17 shows sea level rise based on 23 tidal gauge records around the world from 1880 to 2000 and satellite altimetry data from 1990 to 2000.

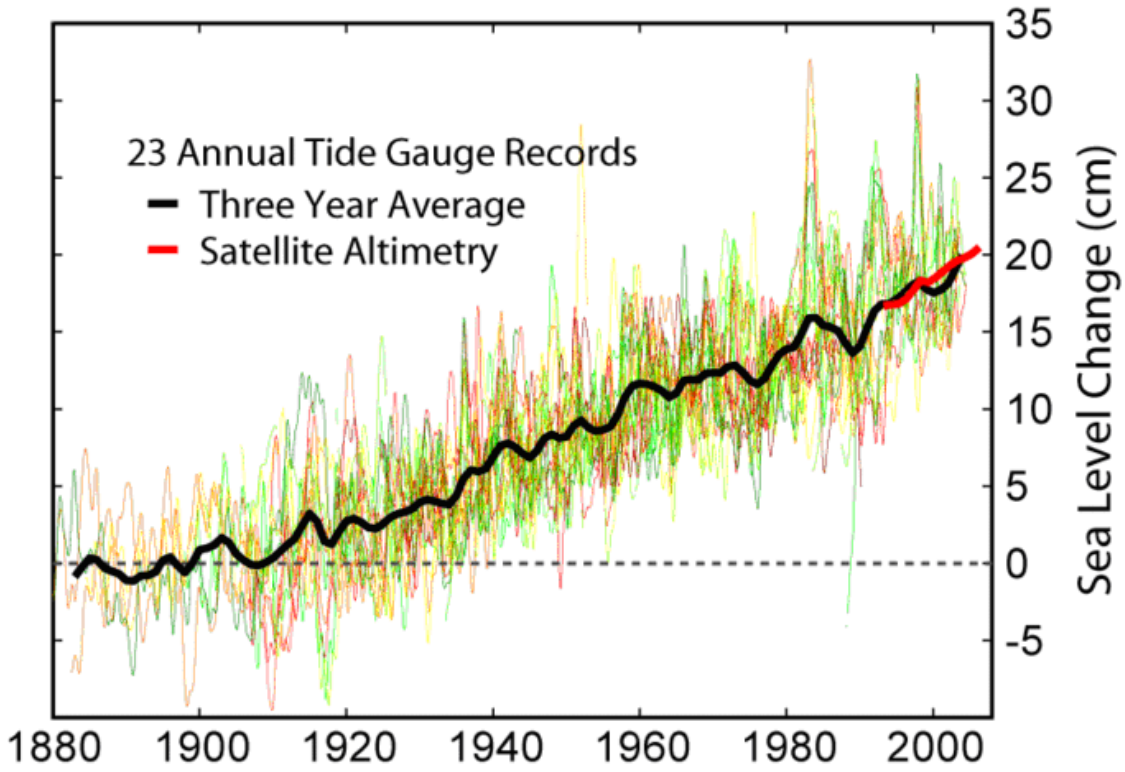


Figure 5.18: Rise of sea level based on 23 tidal gauge records and satellite altimetry. The thick dark line is a three-year moving average of the instrumental records. The recent annually averaged satellite altimetry data are shown in red (Douglas, 1997).

Trends of rise of sea level at three coastal stations of Bangladesh have been presented in Table 5.13. Using last 22 years historical tidal data, trends of rise of sea level are 4.0 mm/year at Hiron

Point, 6.0 mm/year at Char Changa and 7.0 mm/year at Cox's Bazar. Hence the mean sea level rise over the Bangladesh coast is around 4mm/year or 0.4m/100 years.

Table 5.13: Trend of tidal in three coastal stations (MoEF, 2005).

Tidal Station	Region	Latitude (N)	Longitude (E)	Datum (m)	Trend (mm/year)
Hiron Point	Western	21°48'	89°28'	3.784	4
Char Changa	Central	22°08'	91°06'	4.996	6
Cox's Bazar	Eastern	21°26'	91°59'	4.836	7.8

Based on the predictions of various global climate models data, sea level has been projected for different climate change emission scenarios known as SRES scenarios. According to AR4 report, sea level is projected to rise between the present (1980–1999) and the end of this century (2090–2099) under the SRES B1 scenario by 0.18 to 0.38 m, B2 by 0.20 to 0.43 m, A1B by 0.21 to 0.48 m, A1T by 0.20 to 0.45 m, A2 by 0.23 to 0.51 m, and A1FI by 0.26 to 0.59 m. Figure 5.18 shows projected sea level for various SRES scenarios. In all scenarios, the average rate of rise during the 21st century very likely exceeds the 1961 to 2003 average rate (0.18 ± 0.005 m/yr). During 2090 to 2099 under A1B, the central estimate of the rate of rise is 0.38 m/yr. For an average model, the scenario spread in sea level rise is only 0.02m by the middle of the century, and by the end of the century it is 0.15m.

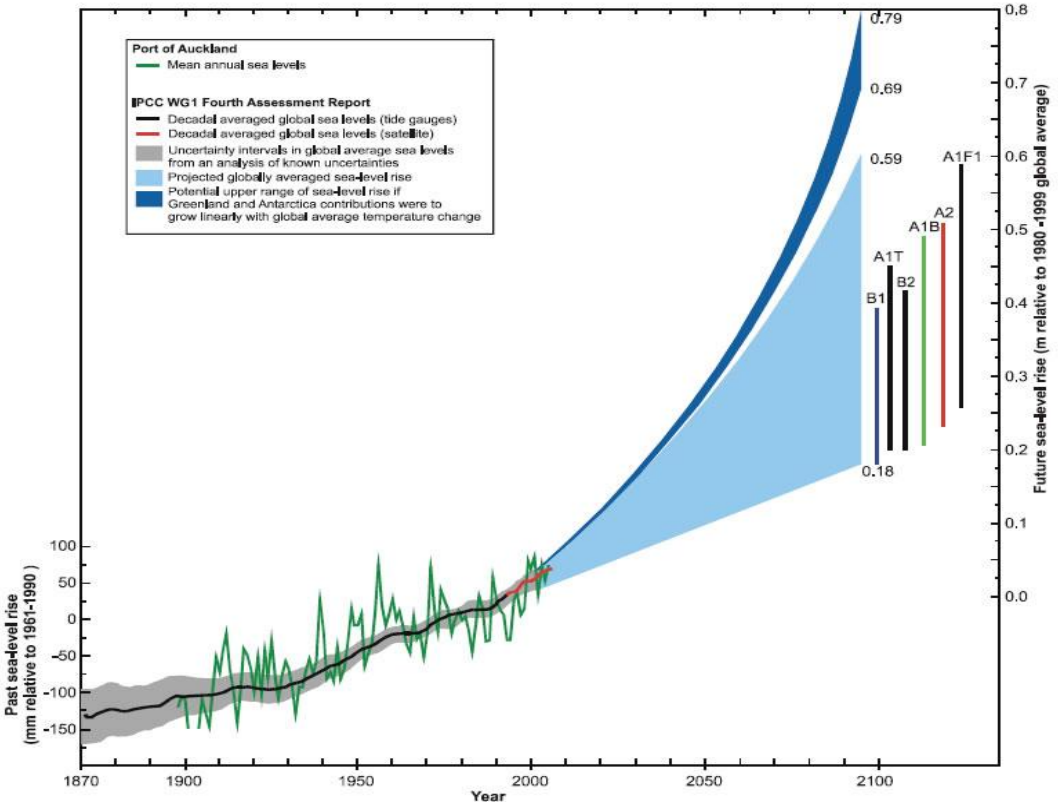


Figure 5.19: Predicted Sea Level rise (IPCC, 2001).

According to the IPCC, mean rise of sea level based on the SRES A1B scenarios will be 0.35m (range 0.21m-0.48m) at 2090-2099 relative to baseline years 1980-1999. Hence, mean change of seal level in the next 20 years will be 0.07m. Given the uncertainties in the projection of the sea level rise and the fact that the proposed corridor location is far away from the coast line, the effect of sea level rise due to climate change on design water level is not considered in subsequent analysis.

CHAPTER SIX
HYDROLOGICAL HAZARDS ASSESSMENT

(***Working Paper 2: Hydrological Hazard assessment)***

6.1 Introduction

The dominant hydrological hazards usually in an area are river flood and drainage congestion due to internal heavy rainfall. The study area is a corridor. So, here hazard would generate mainly from river flood. The drainage congestion might be assessed from rainfall-runoff analysis on catchment basis. For that purpose, catchment wise drainage data for the entire corridor is needed. If drainage data are available and supplied by UDD, then drainage hazards map also could be presented.

6.2 Water Level Gages on the Corridor

There are two water level gage stations – one at Jhikargacha (Station: SW 162) over the Kobadak and another one at Navaron (SW 22) over the Betna-Kholpetua and maintained by the Bangladesh Water Development Board. These two gage stations together with the rivers and corridor are shown in Google Earth Map in Figure 5.1. The map of high resolution Digital Elevation Model (DEM) of the Jessore-Benapole Highway Corridor under study is also shown in Figure 5.2.

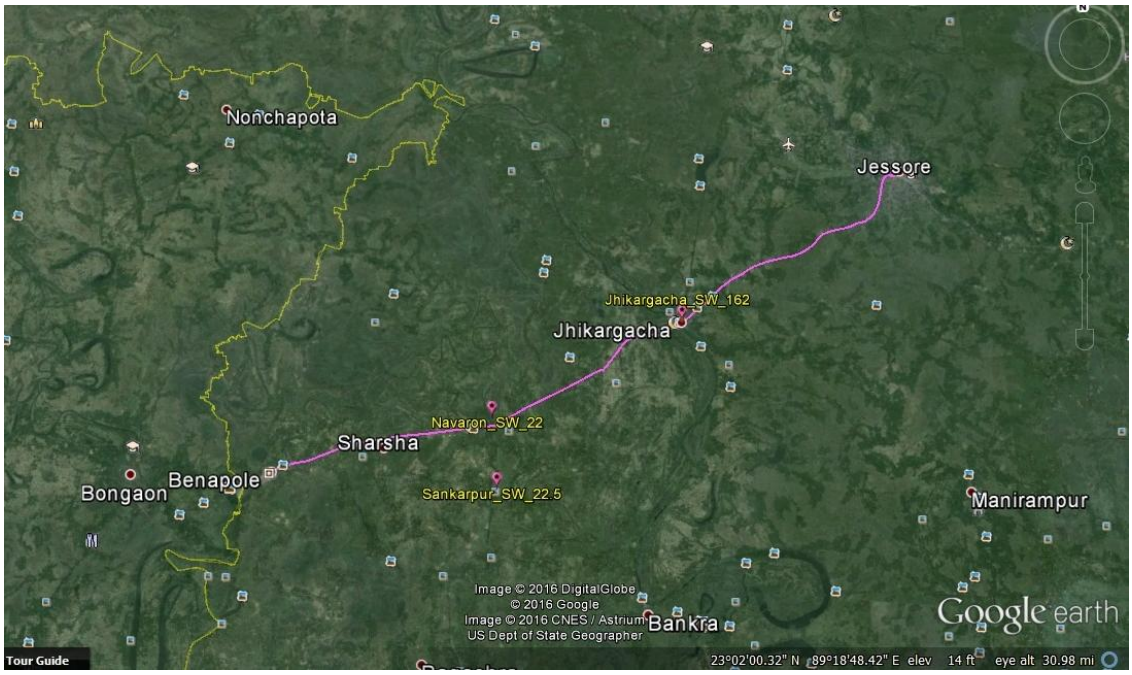


Figure 6.1: Two gage stations and the Jessore-Benapole corridor.

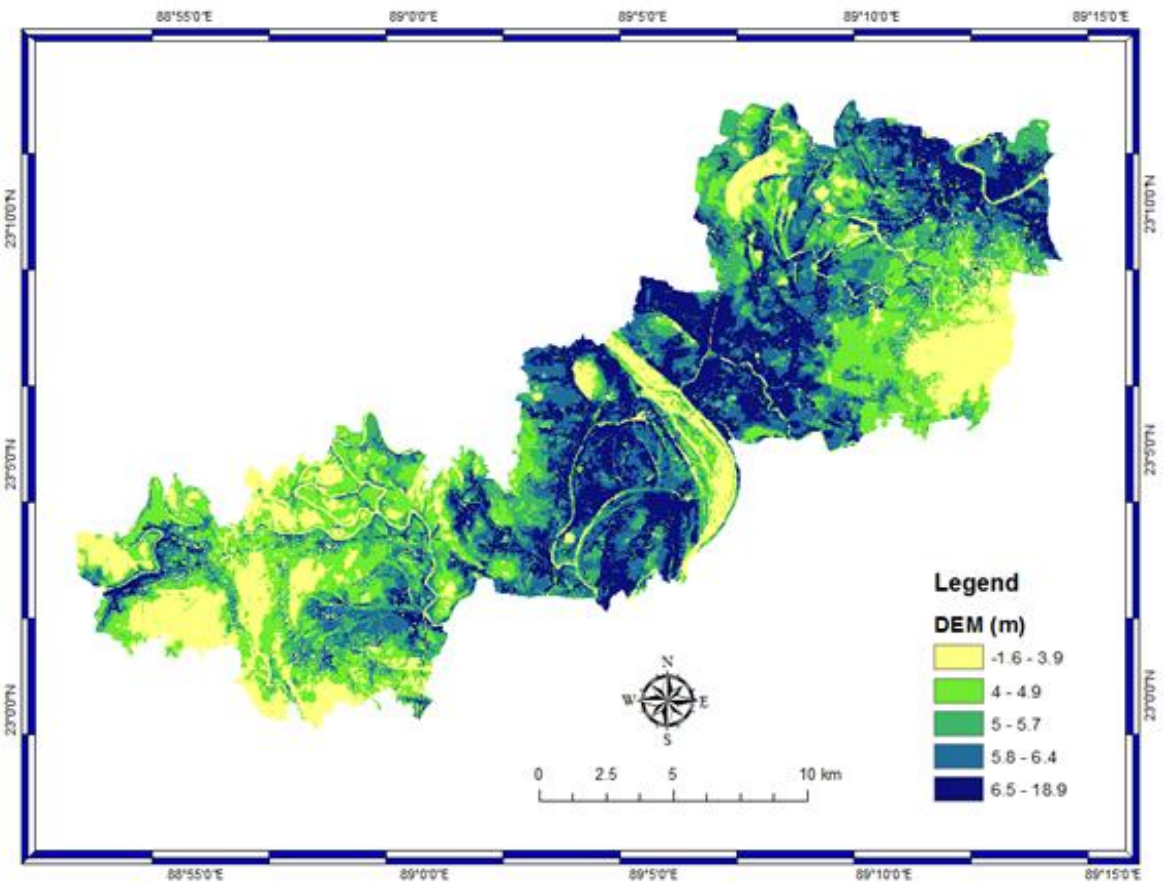


Figure 6.2: High resolution Digital Elevation Model (DEM) of the study area.

6.3 Estimation of Flood Inundation Maps

Two rivers, namely the Kobadak and the Betna-Kholpetua cross the Jessore-Benapole Highway Corridor and are responsible for flood hazards over the corridor as well as the adjacent areas. Estimation of different water levels on the Jessore-Benapole Highway Corridor has been discussed in the Chapter Four.

The flood hazard has been assessed from the design flood magnitude as determined from flood frequency analysis with the help of open source GIS software and DEM. The flood frequency analysis were carried out to estimate design high water levels based on the best fitted Probable Distribution Fitted curves, corresponding to 2.33-, 5-, 20-, 50- and 100-year return period floods. Flood inundation maps were generated accordingly for the 2.33-, 5-, 20-, 50- and 100-year return period floods over the Jessore-Benapole Highway Corridor.

Flood analysis results of the Jessore-Benapole Highway Corridor showing return period in yr, water level in m PWD and inundated area in m^2 and % are shown in Table 6.1. Flood inundation map showing all the return periods (2.33-, 5-, 20-, 50- and 100-year) in one map is shown Figure

6.3, while in Figures 5.4 to 5.8 they are shown individually for each flood corresponding to each return period respectively. They show that existing development areas, settlements, infrastructures, the total corridor etc. are supposed to be under floodwater creating many kinds of hazards which need to be taken into consideration for planning and development purposes.

Table 6.1: Flood analysis of the Jessore-Benapole Highway Corridor showing return period in yr, water level in m PWD and inundated area in m^2 and %.

Return period (year)	2.33	5	20	50	100
Water Level (m PWD) at Jhikargacha	4.77	5.25	5.91	6.27	6.53
Area (m^2)	12194	16259	21771	24977	27066
(%) of the study area	41.65	55.54	74.36	85.31	92.45

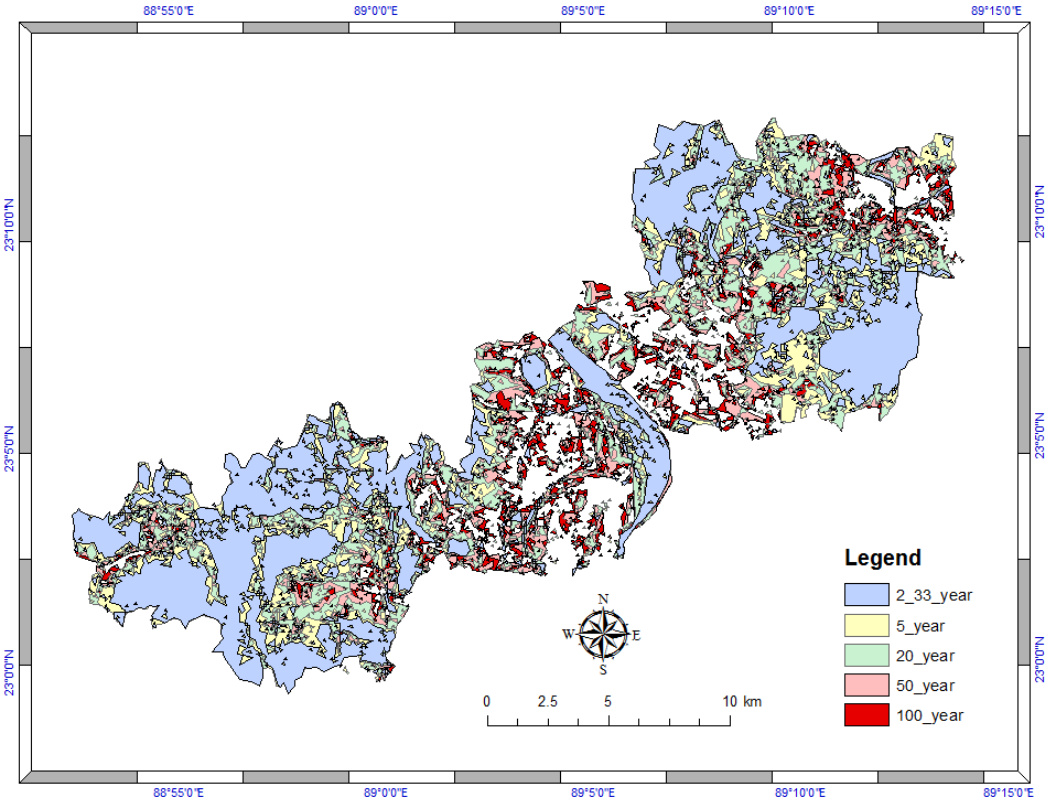


Figure 6.3: Inundation map of the Jessore-Benapole Highway Corridor considering all return periods up to 100 year.

2.33-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 2.33-year is shown in Figure 6.4. 2.33-year return period flood is considered as very

usual flood for Bangladesh and the Table 5.1 shows that for a normal flood of 2.33-year return period, about 41.65% of the study area under the Jessore-Benapole Highway Corridor will be inundated.

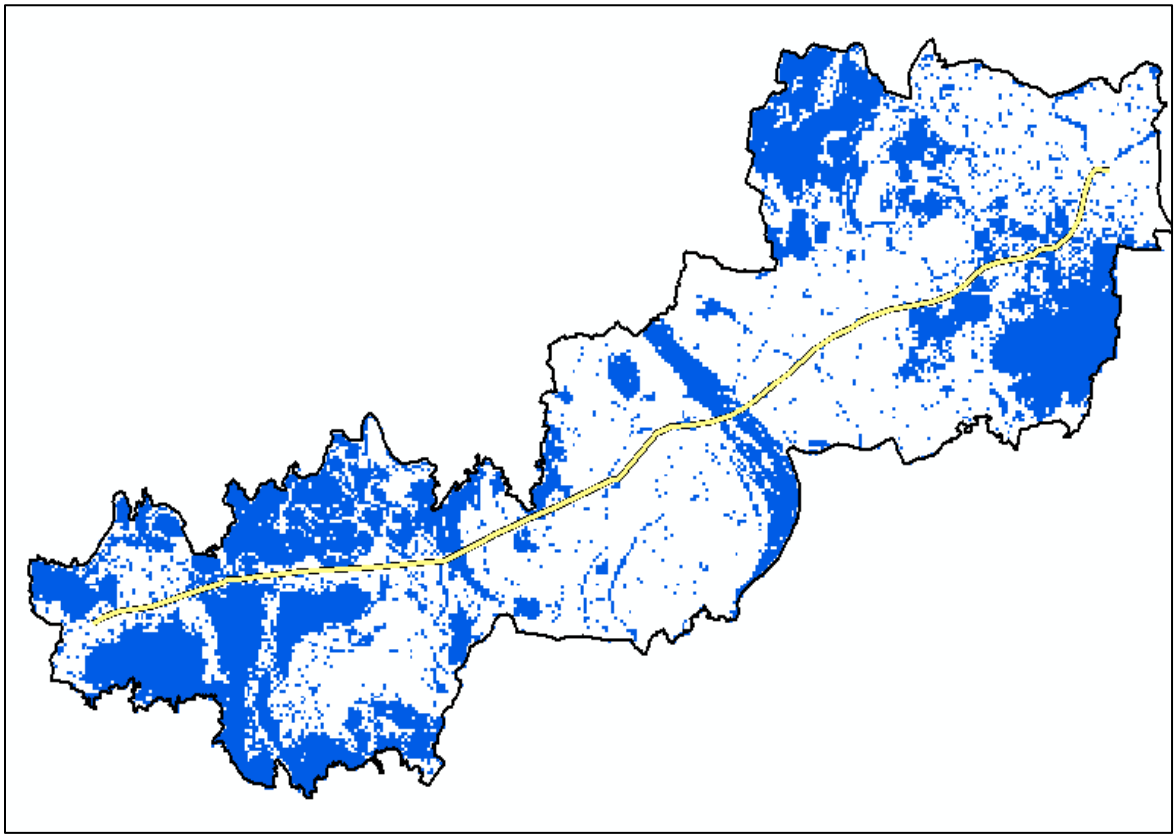


Figure 6.4: Inundation map of mean annual flood (2.33 year return period) over the Jessore-Benapole Highway Corridor.

5-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 5-year is shown in Figure 6.5. For a flood of 5 yr return period, about 55.54 % of the study area under Jessore-Benapole Highway Corridor will be inundated, which means that additional 13.89% of land will be inundated in comparison to 2.33-year return period.

20-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 20-year is shown in Figure 6.6. For a flood of 20-year return period, 74.36 % of the study area under Jessore-Benapole Highway Corridor will be inundated, which means that additional 18.82% of land will be inundated in comparison to 5 yr return period.

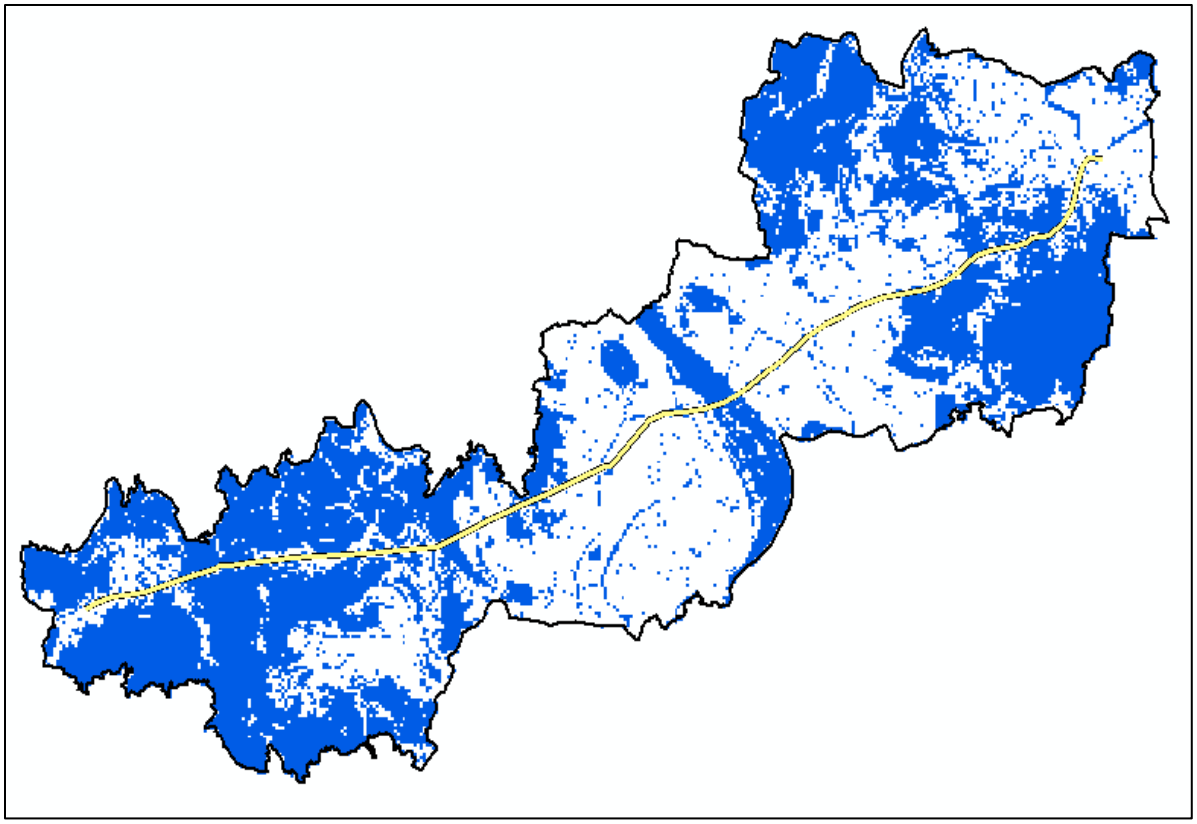


Figure 6.5: Inundation map mean annual flood (5 year return period) over the Jessore-Benapole Highway Corridor.

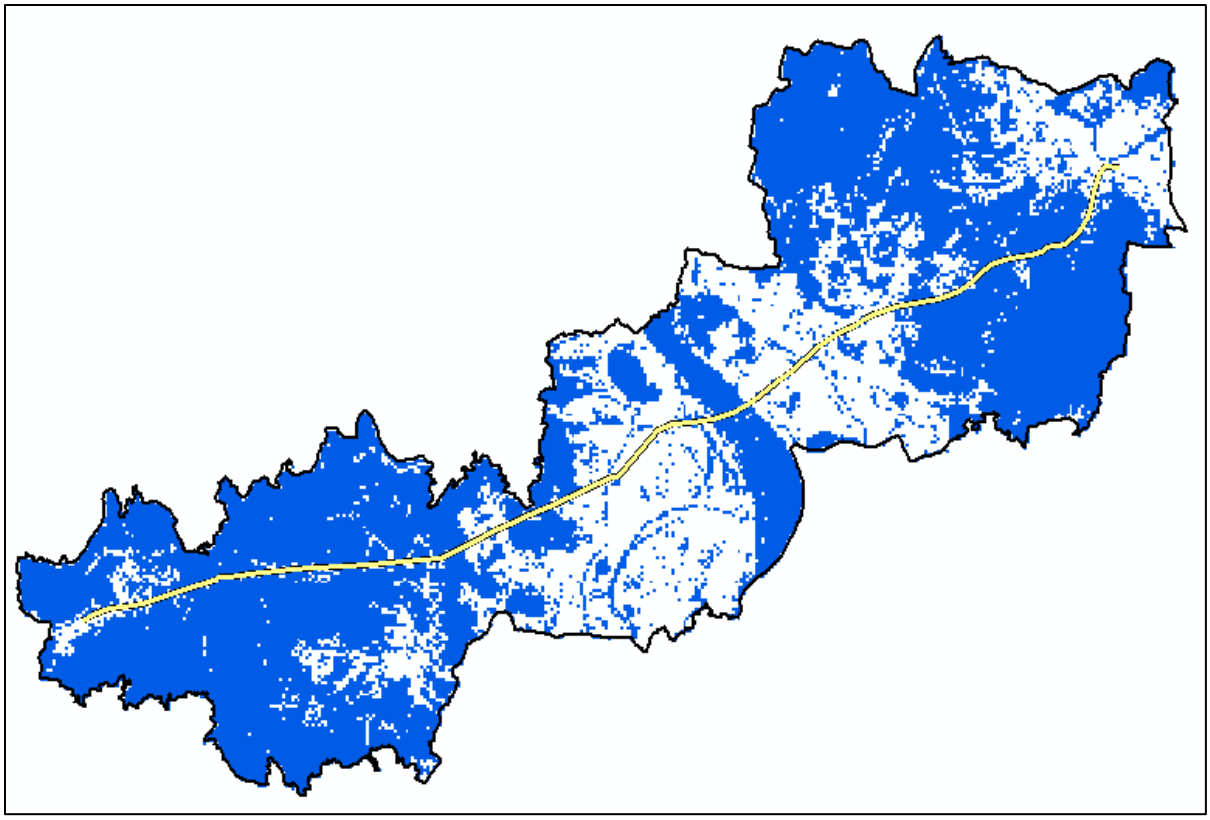


Figure 6.6: Inundation map mean annual flood (20-year return period) over the Jessore-Benapole Highway Corridor.

50-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 50-year is shown in Figure 6.7. For a flood of 50-year return period, 85.31 % of the study area under Jessore-Benapole Highway Corridor will be inundated, which means that additional 10.95 % of land will be inundated in comparison to 20-year return period.

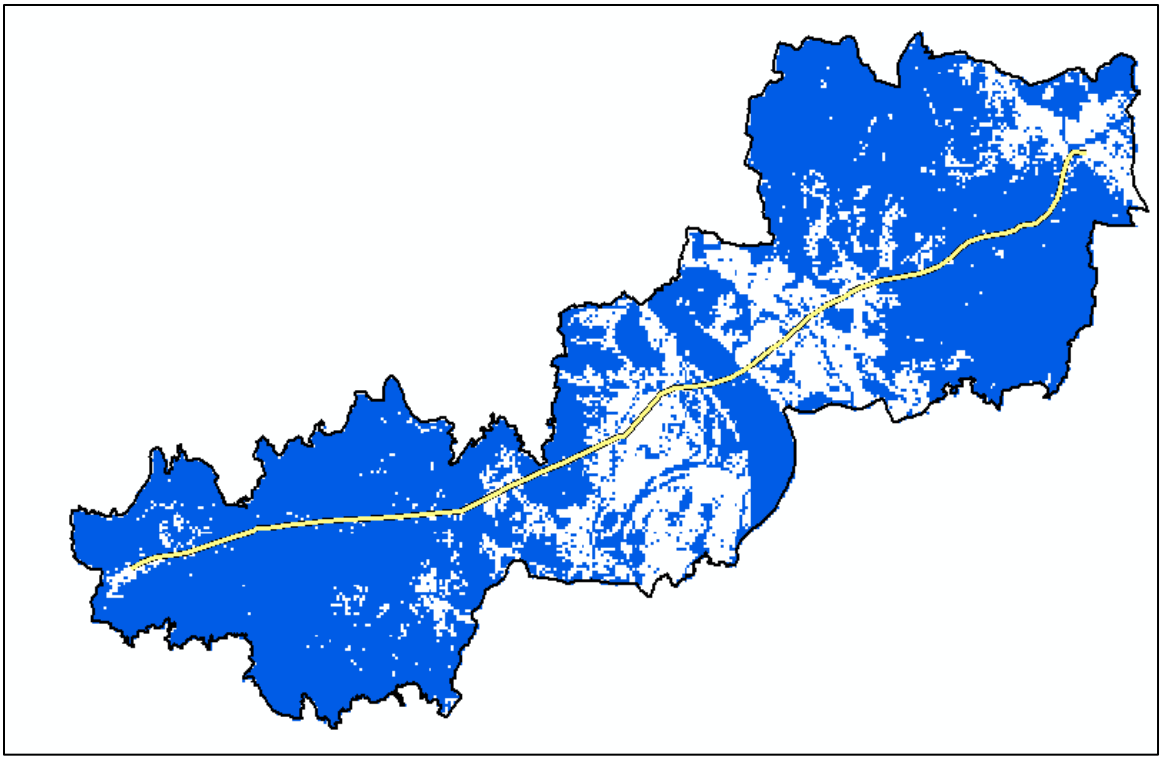


Figure 6.7: Inundation map mean annual flood (50-year return period) over the Jessore-Benapole Highway Corridor.

100-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 100-year is shown in Figure 6.8. For a flood of 100-year return period, 92.45 % of the study area under Jessore-Benapole Highway Corridor will be inundated, which means that an additional of 7.14 % of land will be inundated in comparison to 50 yr return period.

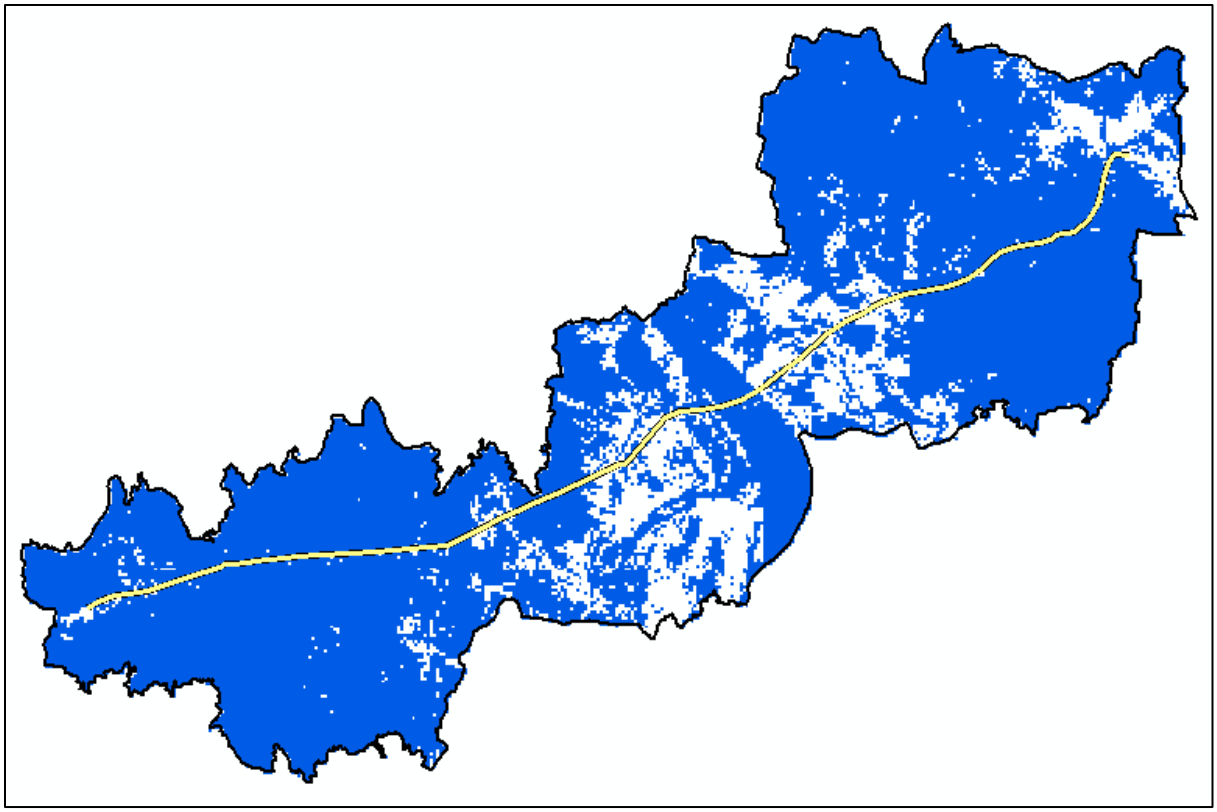


Figure 6.8: Inundation map mean annual flood (100-year return period) over the Jessore-Benapole Highway Corridor.

CHAPTER SEVEN
POLICY GUIDELINES

(***Working Paper 3: Policy Guidelines for Land Use Planning and Hazard Mitigation)***

7.1 Introduction

Bangladesh is uniquely placed in the southeast region and bears high possibility to become a regional hub. It needs intervention for exploring opportunity through the development of each and every sector like road, rail, waterway together with rural and urban hub related with regional connectivity. The Jessore-Benapole Highway Corridor Development is a venture of such type to modernize our traffic movement and consequently turn into an establishment fit for connectivity with the Asian Highway and Railway. For this Bangladesh, at the end, will be converted into the transport hub of land routes, connecting Yunnan Province of China (South East Asia) with South Asia where transit traffic between west Bengal and North East India across Bangladesh could be viewed as a part of such programme of improved regional connectivity encouraging and involving Nepal and Bhutan.

The Development Plan for Jessore-Benapole Corridor is to be done considering the Benapole Municipality and Land Port area; Sharsha Upazila Town; Jhikargachha Upazila Town and Jessore Municipality, where preparation of land use planning and hazard mitigation guidelines considering hydrological situation of the project area, was a part of the corridor development plan.

These Policy Guidelines are suggestive centering on water related issues by nature for the effective development of the Jessore-Benapole Highway Corridor. So, land use zone is restricted to the development of the corridor under the Jessore-Benapole Highway and includes the following categories like flood and land zoning, agriculture, urban area, industrial area, highway corridor, industrial area, infrastructure, traffic and transport, integrated logistic hub for highway, airport and protection zone – water bodies and forest etc.

The policy guidelines under various ministries denoting specific uses of land and water and permissible for different uses for planning were reviewed and quoted in Appendix - A. Other guidelines are suggestive in nature and put forward as a holistic approach for the development of Jessore-Benapole Corridor.

7.2 Flood and Land Zoning

Flood analysis of the Jessore-Benapole Highway Corridor using existing water level data at Kobadak at Jhikargacha and Betna at Navaron for return period of 2.33 yr, 5.0 yr, 20 yr, 50 yr

and 100 yr has been carried out and inundations for those floods of return periods are estimated. They show that existing development areas, settlements, infrastructures, the total corridor etc. are supposed to be under floodwater creating many kinds of hazards which need to be taken into consideration for planning and development purposes. The flood analysis results shown in previous chapter show the extent and severity of inundation of the corridor and it might be apprehended very well.

2.33-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 2.33-year shows about 42 % of the corridor comprises common wetlands including boro cultivation, fish habitats, fish sanctuary, water bodies, haor-baor-beel, river, khal, flood flow channels etc. This area should come under conservation area and not to be intervened for ensuring food security, nutrition and ecological and environmental balance.

5-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 5-year is shows that additional 13.89% of land will be inundated in comparison to 2.33-year return period and includes wetlands, water bodies, and flood plain for cultivation of aus and aman and other agricultural crops which should not be intervened except irrigation and agricultural activities. Developmental works are essential for us but to be carried out ensuring its flood regimes to retain the vast ecological and environmental setting.

20-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 20-year shows that additional 18.82% of land will be inundated in comparison to 5 yr return period and includes additional area comprising rural settlements, homesteads, rural growth centres, rural infrastructures like rural roads connecting growth centres, union parishad head quarters, college, high schools, hospitals, rural farm lands, cultivation of rabi crops, homestead forests, etc. The land under this category should not be urbanized.

50-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 50-year shows that for a flood of 50-year return period an additional area of 10.95 % of land will be inundated in comparison to 20-year return period. This additional area includes urban settlements, homesteads, rural growth centres, rural infrastructures like rural roads connecting growth centres and urban settlements, commerce and industry, upazila and municipalities, college, high schools, hospitals, urban vegetations, parks and open spaces and to be kept intact.

100-year Flood Inundation Map of the Jessore-Benapole Highway Corridor considering return period of 100-year return period shows that additional 7.14 % of land will be inundated in comparison to 50 yr return period of flood. This additional area comprises urban centres, flood shelters, National Highway, railway, power plants and stations, relief and rehabilitation activities, grave yards, etc. and should not come under any intervention.

Remarks: It is to be noted that the Jessore–Benapole National Highway was inundated during unprecedented flood of 2000. It was a rare event for the corridor and equivalent to 100 yr return period having magnitude of about 6.53 m PWD at Jhikargacha. It was revealed during field visit and public discussion that the road elevation and existing openings provided for the structures on it seemed inadequate during the flood of 2000. So, existing national highway should be upgraded i.e. present road elevation as well as bridge, culvert openings should be increased where it is possible up to 6.53 m PWD starting from Jhikargacha, where freeboard should be also included. It is also to be noted that after 1998 flood, the National Highway of Dhaka-Chittagong, Dhaka-Sylhet and Dhaka-Aricha were upgraded vertically and horizontally so that they can tolerate the high magnitude of flood like 1988 and 1998 and function smoothly.

7.3 Multi Purpose Uses of Corridor

As the Jessore-Benapole Highway Corridor Development would be ultimately turned into a life line of the country, so its development should encompass various types integrated development approaches for achieving the optimal uses. Main possible uses are enumerated below:

Agricultural Uses - The prime fertile agricultural land, existing plantations and aquaculture areas provide the major services for food security. These existing agricultural/rural land use activities to be kept intact, and urbanization will not be allowed. The permissible major uses are like: i) agriculture, horticulture, orchards and nurseries dairy and poultry, farm housing, fish farming, slaughter house, cottage industry not involving the use of any machinery driven power which do not create noise, vibration, smoke or dust; ii) small scale agro-based industries, bricks industry, feed mixing plant etc.; iii) brick kilns and lime kilns, power plant; iv) public utility establishments such as sub-station, receiving station, sewage disposal, gas installation, water supply installations including treatment plants; v) brick, tile or pottery manufacture; vi) hospital treating contagious dieses for disabled patients; vii) petrol filling stations with garages; viii) weigh bridges, service and repair of farm machinery; ix) godowns for storage of agriculture produce, fertilizers, cooking gas cylinders etc. and x) many others.

Urban Uses - The existing and proposed urbanized areas are apprehended to be vigorously developed and modernized as post corridor development foresee. So, existing and proposed urbanized areas shall prevail and to be followed as per perspective master plans of the Bangladesh govt.

Industrial Uses - Permissible uses for industrial purposes and land use categories are classified in several groups by govt. of Bangladesh. Accordingly permissions may be given for industries as per the prevailing rules and regulations in Bangladesh. An economic activity is primarily assigned for each second order city in the perspective plan of the country and might be looked in to for approval of the uses for the development.

Highway Corridor - Permissible activities for highway corridor might be of various types like higher order commercial establishments, area specific non-polluting green industrial establishments, all uses specified in mixed uses/multiple uses in the concerned master plans, infrastructure projects, and logistics based activities etc. They are all allowable being in the context of permissible rules.

Traffic and Transportation - Under traffic and transportation rules multi dimensional activities might be permissible such as 75 meter wide inner ring road, 150 meter wide outer ring road, railway line - single line and double line, sub urban rail, dedicated flight corridor, high speed rail, water ways, National Highway, State Highway, District roads and all other category of roads may be taken. The alignment of the entire above transportation network will be, as per, the detailed master plan or the actual alignment on ground.

Multi Model integrated Logistic Hub - The Jessore-Benapole Highway Corridor Development would center around four nodal municipalities and cities. So, in perspective plan, the corridor is supposed to have interchange of goods from one mode of transport to another mode of transport especially through these nodal portals. The corridor would act as a transit hub among different modes of transport. Loading, unloading and elated main and ancillary activities are to be in these uses. Moreover, logistic hub related activities are also to be permitted in these areas. The details of the same may be given in the detailed area development plan/Project Plan.

Airport Area - All Airports related activities shall be permitted for this corridor with the prior approval of airport authority.

Protection Zone - Water bodies are our life providers. So, all existing water courses, rivers, lakes, tanks as indicated in the topographical sheets published by the Survey of Bangladesh /Revenue records, satellite imagery, irrigation department or other competent authorities, should be protected. The boundary of water bodies and inundation might be ascertained as per flood analysis mentioned in the section Flood and Land Zoning and relate to high tide level or high flood level. No construction is permitted in waterbodies' premises and the water spreads. The provision of buffer belt could be a good option as per government orders enforce.

The fishing activities, boating and the picnics along the river banks, recreational activities are considered as only exceptions. Platforms for fishing and rain shelters, sky jetties for boating are considered as friendly structures.

Forests - declared as Reserved Forests and notified by the Forest Department, come under protection zone. No activity other than forest and greenery is permitted in this zone unless expressly allowed by the Forest Department. Forest boundaries shall be as per Forest Department records.

CHAPTER EIGHT
INITIAL ENVIRONMENTAL EXAMINATION

8.1 Introduction

This chapter presents the results of Initial Environmental Examination (IEE) of the proposed for the development of the Jessore- Benapole National HighwayCorridor.Development Management Plan for Jessore–Benapole Highway Corridor includes 12 Union Parishads of Arabpur, Diara, Paurahsava, Upashahar, Jhikargachha, Chanchra, Godkhali, Panisars, Sharsha, Nabharan, Benapole, Ulashi and would guide need of future land use and infrastructure within the next 20 years. The total project area is around 324 sq. km connecting Benapole Land Port to Jessore District Town, where the areas of urban and rural parts are 130 sq. km and 194 sq. km respectively.

Development of this Corridor along with other facilities involves a considerable amount of construction activities which have both negative and positive impacts on environment. To mitigate the negative environmental impacts and enhance the positive environmental impacts due to development of this Corridor, IEE is requireds

8.2 Objective

The main objective of the IEE of the proposed Jessore- Benapole National Highway Corridoris to conduct an environmental assessment, identify potential negative impacts, provide recommendations to minimize or mitigate negative impacts and enhance positive impacts.

8.3 Scope

The scope of works of the IEE for the proposed project is as follows:

- Review of the relevant existing information/data and documents;
- Provide a description of the existing environment (such as baseline data on physical, biological and socioeconomic characteristics of the proposed project sites along with areaof influence);
- Consult with the stakeholders and relevant others of the proposed project;
- Identify all relevant GOB applicable policies, laws and requirements that need to be complied with,
- Assess project-related impacts and recommend possible mitigation measures for the negative impacts and enhancement for the positive impacts; and
- Formulate an Environmental Management Plan to implement and monitoring the mitigationmeasures.

8.4 Methodology

The IEE has been carried out for the proposed project following the steps as givenbelow:

- Review of relevant documents;
- Review environmental requirements of GOB;
- Collection and analysis of baseline information on environment;
- Identification/screening of potential environmental impacts;
- Impact Assessment.

8.5 Policy, Legal and Administrative Framework

Regulatory requirements toward protection and conservation of environment and variousenvironmental resources and toward protection of social environment from adverse impact ofprojects and activities associated with them have been enunciated by the GOB pertinentamong these requirements are given below.

- National Environmental Policy, 1992;
- National Environment Management Action Plan, 1995;
- Environment Conservation Act, 1995;
- Environment Conservation Rules, 1997;
- Environment Court Act, 2000 and subsequent amendments in 2002;
- The National Water Policy, 1999;
- The Brick Burning (Control) Act, 1989;
- The Brick Burning (Control) Amendment Act, 1992 and 2001;
- Water Supply and Sanitation Act, 1996;
- Bangladesh Labour Law, 2006;
- National Forest Policy ad Forest Sector Review (1994, 2005);
- Bangladesh Climate Change Strategy and Action Plan (2008);

Relevant international treaties are given below:

- On protection of birds (Paris);
- Occupational hazards due to air pollution, noise and vibration (Geneva);
- Occupational safety and health in working environment (Geneva);
- Occupational health services (Geneva); and
- International convention on climate changes (Kyoto Protocol)
- Paris Agreement on climate change (2015)

A detailed review of the national policy, legal, and regulatory framework relevant to the environmental and social aspects of this project has been provided in Appendix-B

.

8.6 Categories of Projects

Under the Environmental Conservation Rules (1997) a classification system was established for development projects and industries on basis of the location, the size and the severity of potential pollution. There are four categories of projects: green, orange A, orange B and red with respectively no, minor, medium and severe environmental impacts. For the Orange B category of projects, an IEE is required.

The RHD multistoried office building project falls under the Orange B category of projects. The IEE should include the prediction, evaluation and mitigation of environmental impacts and an Environmental Management Plan (EMP). Environmental Clearance Certificate (ECC) is not required for RHD. Only site clearance is required.

8.7. Description of the project

Detail description of the study area has been provided in the Chapter 2 of this report. Figure 2.1 shows a Map of the proposed Jessore-Benapole Highway Corridor.

8.8 Description of the environment (baseline data)

A review and assessment the environmental baseline condition of the physical, biological and socio-economic environment of the proposed project has been provided in Chapter 2. The assessment is divided into two broad categories:

- Physical Environment –climate, hydrology, drainage, environmental pollutions, geology and soil;
- Socio-economic Environment –demographics, land use, infrastructure, job opportunities, health and safety (H&S).

8.9 Initial Environmental Examination

The potential impact on existing physico-chemical setting (either positive or negative) was evaluated with the output from the hydrology, hydraulics and morphology working teams. Impact on water quality was evaluated by the IEE team considering baseline observations during the field visit, scale of project activities and expected changes in the natural settings considering usual experiences during construction. The socio-economic changes were evaluated based on project documents, and public consultation during field reconnaissance. Detail public consultation as is done for a full-scale EIA was not conducted since it was beyond the scope of analysis.

A checklist of the IECs with qualitative scores (positive or negative) is provided in this chapter which would provide a guideline for detail evaluation during a full-scale EIA. The structure of an Environmental Management Plan (EMP), which is to be the final output for detail EIA, is provided at the end of this chapter.

8.9.1 Initial Environmental Examination of IECs

Table 8.1 presents the IECs considered for IEE of the project with qualitative assessment of impacts. A conservative approach was taken while evaluating the negative impacts. It appears that the project has several positive impacts while there are some negative impacts on the physical environment and ecosystem components. The full-scale EIA to be conducted, which would weigh out individual impacts as well as use several weighted decision factors for the IECs, would decide on whether the negative impacts outweigh the positive impacts.

Table 8.1: Checklist for Initial Environmental Examination of the proposed project.

Environmental Parameters	Initial Environmental Examination				
	Positive Impact	No impact	Adverse Impact		
			Low	Moderate	Severe
• Physical Impact					
Regional Hydrology and Flooding				√	
Erosion and Siltation				√	
Drainage congestion/Water Logging				√	
Water Pollution			√		
Air Quality			√		
Noise Pollution			√		
• Ecological Impact					
Fish Habitat				√	
Trees and Vegetation			√		
• Human Interest					
Loss of Lands (Type)			√		
Employment Opportunities	√				
Industrial Activities	√				
Transportation and Road Communication	√				
Navigation and Boat Communication		√			
• Quality of Life Values					
Travel Safety			√		
Service Accessibility to Health	√				
Education/Literacy	√				
Cultural and Heritage Values	√				

8.10. Identification of Potential Environmental Impacts and Environmental Management Plan (EMP)

This section discusses the potential environmental impacts due to the proposed project along with possible mitigation measures to minimize the impacts in the design (preconstruction), construction, and operational stages.An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done based on baseline data collected from secondary and primary sources. Identification of potential impacts due to the project site development has been done using the Checklist as presented in the Table 8.1. In the checklist, activities, which may affect the environment due to various stages of the project actions, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms "no Impact", "low", "moderate" and "severe" are used in the Checklist to classify the magnitude of SEIs. The potential impacts have also been identified based on experts' opinions and inputs received from public consultation events. The environmental impacts can be broadly classified as those taking place during preconstruction, construction and operation stages. Activities involved affecting environmental resources at different stages of the proposed project implementation as well as potential /significant environmental impacts are identified.

The Environmental Management Plan (EMP) is prepared to facilitate effective implementation of recommended mitigations measures with defined roles and responsibility, regulatory compliance requirements, stages of implementation with time frame and costs. The mitigation measures are proposed to eliminate or minimize the identified impacts associated with pre-construction, construction and operation stages of the project, to acceptable level by adopting the most feasible options.

The EMP consists of a set of mitigations, monitoring and implementation arrangements to be taken during preconstruction, construction and operation stages of the project. The EMP also includes the actions needed for implementation of these measures. The major components of the EMP are:

- Mitigation Plan;
- Monitoring Plan

8.10.1 During Pre-Construction Stage

1. Removal of Dismantled Concrete, Damaged Vehicles and Equipment

Impact: Existing infrastructure within the project area of RHD, need to be dismantled and removed. Anticipated impacts from these damaged concretes, vehicles and equipment will be the pollution of soils, air and ground water as well as creation of mosquito.

Mitigation: Prior to start construction, the existing infrastructure should be dismantled, broken into chips and stored in the designated area of RHD by skilled technicians/labors properly. RHD can use these concrete chips for the temporary approaches of the bridges over the diversion roads. Any hazardous materials or wastes such as lead acid batteries and old printers and toners

must be disposed of carefully either by selling to waste recycling agents or disposed only in designed locations.

2. Removal of Utilities

Impact: The electric lines, gas pipe lines telephone lines, water supply and sewage pipelines that pass over the project area need to be shifted prior to commence construction. These lines will be hazardous to workers‟ health and safety during construction phase.

Mitigation: Prior to start construction, electric lines along with poles should be shifted without long time disruption of electricity supply with the consultation of the JCC.The gas pipe lines should be relocated without long time disruption of gas supply with the consultation of TITAS Company. The telephone lines should be shifted without long time disruption of telephone communication. The water supply and sewerage pipelines that cross under the ground elevation of the project area, need to be shifted prior to start construction. Proper health and safety (H&S) measures (use of PPE such as hand gloves, belt for working at height, safety shoes and helmet as well as install H&S signboard) for the workers should be taken during shifting of the electric lines to avoid any accidents.

3. Removal of Trees

Impact: As per field assessment, the pre-construction stage will require cut and removal of large, medium and small trees of different species within the project boundary. Carrying of these trees especially during day time may create traffic congestion especially 9:00 to 11:00 and 17:00 to 21:00 and road accident.

Mitigation: To compensate the loss caused due to felling of trees, RHD in its own land will plant trees in the operation stage as per the prescription of Forest Department (FD). Just after cutting the trees, all these trees are carried properly by trucks during nighttime for storing at the designated area of the RHD from where the RHD is sold by offering quotation.

8.10.2 During Construction Stage

1. Drainage Congestion

Impact: Construction of the proposed project area will significantly impact upon the existing drainage pattern through impedance to natural flow conditions. Temporary drainage congestion will occur especially during monsoon period due to excavation of earth from the foundation trench of the proposed project area. In addition, drainage congestion resulting in to stagnant water or local flooding also may be occurred in the places such as construction yard and labor’s camp. The drainage system on the surrounding of the proposed project area will be affected by construction activities.

Mitigation: Temporary storm water drainage congestion in the proposed projectarea due to rainwater should be removed by pumping of rain water from the foundation trench by pump. Drainage congestion at the labor camp and construction yard should be removed by temporary earth or brick drain. Alternative temporary drain close to inside the boundary should be provided up to the outfall in case of existing drain is closed/dismantled. Storm water, rainwater, waste water etc. will be drained out by the sewerage pipelines.

2. Ground Water/Drinking Water

Impact: The proposed project location can affect the ground water resources due to uncontrolled extraction of groundwater for construction purpose. Once the required quantity of water for the construction purpose (only for mixing of concrete, curing and washing of stone chips) will not be high, impact on quantity of GW will be insignificant. Drinking and domestic water requirement for worker's camp will be the arranged by the contractor. Contamination of groundwater is not envisaged since construction camp will have septic tanks or mobile toilets depending on the number of workers in the camp. However accidental spillage of hazardous liquid on the construction yard may contaminated the GW/SW.

Mitigation: The contractor will make arrangement for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected. It means that due to construction works the nearby communities will not be affected by water scarcity. If GW scarcity in the locality is occurred in that case the contractor should use quality surface water (SW) from nearby sources. Prior to use such SW, quality of SW should be ensured by testing. Handling and storage of the potential contaminants (such as hazardous chemicals, fuels, lubricants, acids, paints etc) must be organized under strict condition to avoid water pollution during construction of the proposed project. SW/GW quality monitoring should be carried out quarterly during construction. If monitored parameters as mentioned in water quality are not within the DOE standard limit, the contractor should provide potable water for all workers at construction site. Handling of hazardous liquid should be done carefully by the experienced labors.

3. Air Pollution

Impact: Air quality may be affected for short duration in and around the construction site due to various construction activities and construction vehicular movement. The pollutants of primary concern include Sox and SPM. The construction equipment/vehicles, using fuel and diesel and movement of vehicles will also contribute to air pollution releasing hazardous air emissions such as NOX, SO2, etc. This will impact the air quality affecting the immediate vicinity (especially residential areas) of the working area.

Another possible source of air pollution will be dust due to handling of sand, cement, breaking of bricks/boulders, mixing of concrete ingredients and burning of bitumen for internal roads. However, due to the openness of construction sites and wind conditions, the dust and engine emissions are expected to have limited effects on the existing air quality. The anticipated air quality problem will be short lived, localized and minor lasting mainly during the construction.

Mitigation: To keep the pollution level within acceptable limit, construction related emissions should be regulated. Regular water spray on dusty surfaces during dry season to reduce dust generation must be practiced. The rules and regulations of the building specification guideline as mentioned in BNBC should be followed especially by the contractors. Loading and unloading of construction materials likely to generate fugitive emission, shall be done in covered area or provisions of water fogging arrangement may be made around these areas. Regular maintenance of machinery and equipment and vehicular pollution check shall be made mandatory. Ambient

air quality monitoring should be carried out quarterly during construction. If monitored parameters are above the DOE standard, suitable control measures must be taken by the contractor.

4. Noise and Vibration

Impact: A significant increase in noise is expected during construction. Noise levels in and around the construction sites could further increase because of operating construction vehicles/equipment and during unloading and loading of construction materials. Several vehicles and equipment will be required for the construction of the proposed project and will depend upon the construction methodology for various types of works. However, the equipment will broadly consist of mixture machine, concrete vibrator, brick/boulder breaking machine, crane etc. and construction vehicles will consist of dump trucks, transport vehicles, etc. which will cause noise pollution. Most of these will use diesel engines that generate noise and exhaust emissions. The main source of existing noise pollution is passing vehicles using hydraulic horns.

Mitigation: Strict measures for noise pollution control need to be undertaken during construction activities. The Contractor should be asked for consideration of this aspect; and should apply optimum site activities and site layout so as not to exacerbate existing noise levels at sensitive receptor sites (e.g. residential areas). Temporary noise barrier (such as wooden screen, heavy jute screen, heavy plastic screen etc.) should be constructed to protect the nearby residential areas from noise pollution. If temporary noise barrier is not feasible then regulate construction activities and timing (from 7:00 to 20:00) so as the impact intensity is minimized. Undesirable noise should be avoided by confining the source of noise. Brick breaking machine should be confined within a temporary shed so that noise pollution could be kept minimum. In no case, such machine should be allowed to operate at night. Protection devices (ear plugs or ear muffs) shall be provided to the workers operating near high noise generating machines during construction. Construction equipment and vehicles shall be fitted with silencers and maintained properly.

5. Waste Pollution

Impact: The construction process will take about 2 years and as a result, the worker camp will take a semi-permanent appearance. Most waste generated will include construction wastes (solid wastes: piece of rods, woods, bricks, stones, containers etc. liquid waste: paint, bitumen, oil etc.) and general wastes (solid wastes: papers, plastic containers, residues of food, fruits etc. and Liquid waste: from kitchen and bathroom etc.). These wastes will be generated due to construction camp, construction activities and materials used for construction. If inadequate arrangements exist for the disposal of above mentioned wastes, there will be negative impact on the soil, aesthetic beauty of area and workers' health and safety. Possibilities of bitumen and oil leaks spread of contaminants brought through material transport also may be occurred.

Mitigation: Solid wastes collection system will be essential, which should include separation and collection of solid wastes in the dustbins/ waste containers throughout the work site, construction yard/labor camp. The wastes such as piece of rods and woods, newspapers, containers etc. can be sold to the venders and rest wastes can be dumped into the nearby road side waste containers of

the JCC from where JCC will send these wastes to Waste Dumping Site regularly by their own arrangement. A log of the disposal of toxic and other waste materials is to be kept by the Contractor. Waste water from the labor camp should be disposed through sewerage pipeline. Prior to transport, container of all liquid materials such as bitumen, oil etc. should be checked by experienced persons properly.

6. Sewerage Pollution/Sanitation Hazards

Impact: During construction stage, the proposed project area shall be occupied by the construction workers. Inadequate and unhygienic sanitation facility can pollute the surrounding area as well as various diseases might be spread out among the workers. Sewerage waste also might be the source of odor pollution to the local environment.

Mitigation: Sewage disposal should follow accepted practice (through sewerage pipe) and avoid ground water contamination.

7. Road and Traffic

Impact: The heavy construction vehicles would be required during construction for carrying of various construction materials and equipment. The existing 6m wide bituminous paved road which connects the proposed project area. Almost all types of vehicles such as buses, minibuses, microbuses, Jeeps, cars, rickshaws, motor cycles, rickshaw vans, students and workers use this road. The construction vehicles will add more traffics and as a result, traffic congestions will be increased. In addition, road accidents may be increased due to movement of construction vehicles with construction materials and equipment.

Mitigation: Proper Traffic Management Plan (TMP) should be prepared during detailed design stage and act accordingly during construction stage of the project. In this TMP, the road safety measures such as speed breakers, warning signs/lights, road safety signs, zebra crossing, flagman etc. should be included to ensure uninterrupted traffic movement during construction. Traffic congestions should be minimized by adopting proper planning. Timing schedule for arrival of construction materials can be adjusted so that interruption with the public utilities will be minimal. The public must also be informed about the timing of the movement of the construction vehicles inorder to minimize inconveniences. In addition, Bangladesh Road Transport Authority (BRTA) rules and regulations should be strictly followed.

8. Construction Materials

Impact: Improper selection of construction materials may threat the environment. For example, traditional brick making process involve burning of trees, emission of Sulphur through coal burning, emission of dust etc. which are detrimental to health and environment.

Mitigation: Hollow cement bricks as partition materials against bricks may be used. Steel shuttering and steel props can be used instead of wood and bamboo.

9. Landscape

Impact: Construction activities especially excavation of foundation trench, stock piling of construction materials, placing of construction equipment, parking of construction vehicles etc. will change the local landscape temporarily.

Mitigation: Stockpiling of construction materials, placing of equipment, parking of vehicles etc. should be done in systematic way to enhance the aesthetics of the site. Duration of stockpiling of construction materials should be minimized as much as possible.

10. Job Opportunities

Impact: At the peak of construction phase, it is likely to provide employment in various positions. The contractor will be responsible for creating these employment opportunities. Priority will need to be given to the local community for unskilled labor. This may result in an increase on household income. At the time of construction, business opportunity in this area will also be increased.

Recommendation: Based on the nature of job, adequate salary with other social benefits should be ensured for the men and women workers in time. In addition to adequate salary, equal pay for same type of work between men and women should also be provided. The demand may create short-fall for the people in the area, as well as people can enhance their businesses in supplying daily needed commodities, over-the-counter medicines, fast/dry foods and training accessories. The local inhabitants can also boost up their business through laundry and washing facilities during construction. Job opportunities should be arranged.

11. Community Health and Safety

Impact: Improper health and safety (H&S) policy maintained at the site may lead to outbreak of different diseases to the surrounding communities through the sick construction workers. From the traffic survey, it is known that all types of motorized transports such as jeeps, pick up, cars, taxi-cabs, auto rickshaws, tempo and motor cycles move on the road.

Mitigation: Proper TMP and health and safety should be prepared during design and act accordingly during construction to avoid road accidents and health hazards of the surrounding project community. In addition, mitigation measures, such as health screening tests for the workers and proper designation and signage of restricted areas for public to avoid accidents and injuries.

12. Occupational Health and Safety

Impact: Construction workers may face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable for such sites, malfunctioning equipment, careless use of equipment and vehicles, etc. At the construction site, camp will be constructed for temporary accommodation for workers. Poorly designed temporary camp and sanitation facilities may pose a health threat and nuisance to the workers. Uncontrolled vending of food and drinking water on the work site may also pose a risk with respect to the transmission of contagious diseases like Typhoid, Diarrhea, Malaria, Dengue, etc. Construction workers will be required to handle hazardous materials such as cement, bitumen, paints, chemicals, fuels etc., therefore increasing health risks of workers. In addition, construction workers will be affected if adequate mitigation measures are not taken surrounding the buildings.

Mitigation: A proper Occupational Health and Safety (H&S) Plan should be prepared and follow it to avoid health hazard of the workers. First Aid Box and Personnel Protective Equipment (PPE) such as ear plugs, helmets, hand gloves, safety shoes, goggles, raincoats (during rains) etc.

are provided for the workers on construction site. The safety belts and harnesses must be worn by the workers, working at heights always and safe anchorage points provided. Plastic net should be provided surrounding the buildings. In case of major accident, transport should be made available to take the patient to the nearest hospital. Health and Safety Manager (H&SM) should be engaged for the construction period of the project. Workers operating the equipment and drivers driving the construction vehicles at construction site should be skilled. Proper H&S signboards and appropriate information to the local people about the construction activities should be provided.

8.10.3 During Construction Operation Stage

Operational impacts continue during the life of the project after the completion of construction stage and these impacts are long lasting and in some cases permanent. Following sub-sections provide the following potential impacts along with mitigation measures.

1. Drainage Congestion

Impact: Drainage congestion may occur during operation period in surrounding the proposed project area if all the drains are not adequate in size and are not covered with provision of several adequate round holes.

Mitigation: The adequate sizes of drains with holes should be provided and connected with the natural drain and maintained regularly so that solid wastes such as papers, tree leafs, food grains etc. cannot enter the drain and create blockage.

2. Noise Pollution

Impact: Noise levels will vary dependent on vehicle speed, the road surface (whether the surface is wet or dry). Additional traffic noise will be generated through the persistent use of horns.

Mitigation: Existing noise level within the proposed project area has been exceeded the DOE standard value. Therefore, measures for noise pollution control need to be undertaken during operation stage. Dense tree plantation around the project area must be carried out especially at the residential areas to protect from noise pollution. The BRTA rules and regulations must be followed to reduce noise pollution. Restriction should be imposed on the movement of the old vehicles, installation of generators openly and appointment of unskilled drivers as well as use of hydraulic horn in the complex area. Regular noise monitoring by observation should be carried out during office time.

3. Air Pollution

Impact: It is expected that air pollution will be increased during operation stage mainly due to movement of vehicles in the project area and on the entry road.

Mitigation: The BRTA rules and regulations must be followed to reduce air pollution. Restriction should be imposed on the movement of the old vehicles, installation of generators openly and appointment of unskilled drivers in the complex area. Air monitoring by observation should be carried out during office time regularly.

4. Waste Pollution

Impact: The office staff will be staying during day time within the project. The wastes (solid wastes: organic waste such as waste foods, fruits etc. and inorganic waste such as waste papers, damaged electronic goods, containers etc. and liquid waste: waste water, oil, paint etc.) will be generated mainly from the cafeterias, office rooms, IT section, conference room etc. during the operation stage, which need to be collected and disposed effectively and timely manner. Improper management of solid wastes may lead to soil and ground water contamination through the generation of leachate. Bad odor due to non-removal of waste regularly will also cause unhealthy conditions in the project and surrounding area including attracting nuisance animals such as flies and mosquitoes. Wastes will also cause human health diseases. Overall, negative impacts are predicted due to wastes during the operation stage if Handling and disposal of solid wastes will not be carried out in accordance with a proper waste management plan (WMP).

Mitigation: Appropriate waste collection and disposal system must be developed for the proposed project. Setting up of separate covered system waste collectors (one for organic and other for inorganic wastes) in each office room and corridor, IT section, conference room, cafeterias, parking area, both sides of the gate etc. The inorganic wastes (reusable) should be sold. The organic wastes should be disposed in the covered drums placed at designated area of the project area from where the JCC will collect by their truck for final dumping at central waste dumping site. These collectors should be cleaned and replaced by the designated persons regularly.

Alternatively, RHD can think of making collaboration with company such as Waste Concern who are producing organic fertilizer from organic waste by composting method. This will be a very good sustainable way of waste management which would at the same time reduce pressure on the burdened disposal system of JCC as well as increase the fertility of agriculture soils and as result, crop production will be increased.

5. Tree Plantation

Impact: Trees will be removed due to construction of the proposed project area and as a result ecosystem of this area will be disrupted.

141. Mitigation: To compensate the loss caused due to felling of trees, RHD will replant trees in the areas as mentioned below according to the prescription of Forest Department (FD) e.g., minimum two tree seedlings to be planted for each tree felled during monsoon period (June to August). The tree re-plantation in the project area will not only function as landscape features resulting in harmonizing and amalgamating the physical structures of proposed complex with surrounding environment but will also acts as pollution sink/noise barrier. Adequate steps therefore shall be taken to ensure survival of these trees. The NGOs will be responsible for planting, monitoring and maintaining (about for 2 years) of trees. From the third year, RHD will be responsible for maintaining of trees.

6. Landscape

Impact: Aesthetic beauty plays an important role in improving the working environment of the project area. The construction of the beautiful arch structural views of the proposed project will

improve the aesthetics view of the project area. In addition, replantation of various tree species within the proposed project area will enhance the aesthetic beauty of that region.

Mitigation: A proper Maintenance and Operation (O&M) Plan should be prepared during detailed design and act accordingly during operation stage of the project.

7. Community Health and Safety

Impact: Accidents may be occurred due to movement of vehicles if proper safety measures are not taken. It was published in the daily newspapers that road accident occurs in the national highways almost every day.

Mitigation: Proper Traffic Management Plan (TMP) should be prepared during detailed design stage and act accordingly during construction stage of the project. In this TMP, the road safety measures such as signalization, limited speed of vehicles, speed breakers, warning signs/lights, road safety signs, zebra crossing, flagman etc. should be included to ensure public H&S especially at these two points. In addition, only skilled drivers should be engaged for driving of vehicles. Bangladesh Road Transport Authority (BRTA) rules and regulations should be strictly followed.

8.11 Monitoring Plan

Environmental Monitoring is a very important aspect of environmental management to safeguard the environment. In accordance with the EMP, an Environmental Monitoring Plan (EMOP) has been developed and presented in Table 8.2. The contract documents will contain a listing of all required monitoring measures and a time frame for the compliance monitoring of these activities. The monitoring will comprise surveillance to check whether the contractor is meeting the provisions of the contract during construction and operation of the project including the responsible agencies for supervision. The RHD through PIC will be responsible to supervise monitoring activities of all contractors procured under the Project.

Table 8.2: Environmental Monitoring Program during Pre-Construction, Construction and Operation Stages.

Environmental Aspect	**Monitoring Parameter**	**Means of Monitoring**	**Frequency**	**Location**	**Responsible Agency**	
					Implemented By	**Supervised By**
Pre-Construction Stage:						
Removal of electricity line, gas connection, connection, and water supply connection telephone	Monitoring all prescribed mitigation measures in EMP	Visual inspection to ensure the shifting of all utilities	During site clearance	Proposed project area	JCC, DPHC, BTCL	RHD, JCC
Removal of existing RHD structures	Monitoring all prescribed mitigation measures in EMP	Visual inspection to ensure the removal of structures	During site clearance	Proposed RHD area	RHD	JCC
Tree cutting	Monitoring all prescribed mitigation measures in EMP	Visual inspection to ensure the removal of trees in time	During site clearance	Proposed RHD area	RHD	JCC

Environmental Aspect	Monitoring Parameter	Means of Monitoring	Frequency	Location	Responsible Agency	
Construction and Operational Stage						
Supply drinking water	pH, Manganese (Mn), Arsenic(As), Iron(Fe), Chlioride, and Fecal Coliform(FC)	Laboratory analysis against the baseline need to be established	During construction and operational stage	Inside the boundary of RHD	Contractor through a nationally recognized laboratory	RHD, JCC
Air Quality	SPM, PM_{10}, SO_x, NOx, CO and CO_2,	Laboratory analysis against the baseline will be needed	During construction and operational stage (1 in 6 months)	At the construction site	Contractor through a nationally recognized laboratory	RHD, JCC
Noise Level	Measurement of noise dB(A)	Visual inspection to ensure good standard equipment are in use	During day and night time and whenever any complains are received about disturbance due to construction noise. (1 in 3 months)	Near residential area, construction yard and site.	Contractor through a nationally recognized laboratory	RHD, JCC
Wastes	Check collection and	Inspection	Daily	RHD and	RHD	RHD

Environmental Aspect	Monitoring Parameter	Means of Monitoring	Frequency	Location	Responsible Agency	
Community H&S	Monitoring road safety measures	Inspection	Daily	At entrance gate and meeting point	RHD	RHD
Environmental Risks	Monitoring the mitigation measures	Inspection	Daily	RHD	RHD	RHD

CHAPTER NINE
CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

i. It is evident from hydrologic analysis that inundation of the Jessore-Benapole Highway Corridor for different return periods of floods (2.33, 5, 20, 50 and 100 year) should be of major concern in its development plan especially land use planning and protection.

ii. Field visits findings indicated that historical flood of 2000 has had great impact upon the corridor. Vertical as well as horizontal clearances on the corridor for different existing hydraulic structures were inadequate and should be upgraded inclusive.

iii. Field visits as well as secondary data analysis clearly demonstrate that huge numbers of cross dams are built over the water bodies including prominent rivers for fish cultures at both left and right end of the corridor.

iv. Multipurpose uses of the corridor should be ensured and integrated approaches should be the philosophy of the development plan of the corridor.

v. Protective land zone approaches should be followed as per government policies, rules and laws.

9.2 Recommendations

i. The development plan of the Jessore-Benapole Highway Corridor especially land use planning and protection should be as per inundation of the corridor for different periods of flood events.

ii. The Jessore-Benapole Highway Corridor should be upgraded considering increase of free boards and opening lengths of existing flood management infrastructures.

iii. Integrated approaches should be considered for the development plan of the corridor.

iv. The development plan of the Jessore-Benapole Highway Corridor should include conservation of water body, biodiversity and other aquatic life. Provision of eco-bio pass could be considered for some locations on the corridor.

v. For effective water and land management along the corridor local knowledge and public participation of the corridor should be encouraged.

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APPENDIX - A: Policy guidelines as quoted in different policies of Bangladesh Government.

A. National Land use Policy (MoL, 2001)

2. e. Land is very much congenial to natural environment of the surroundings and it must be ensured.

g. The natural forestry should be preserved, river erosion should be arrested, and landslide should be stopped.

3.4 Due to geographical locations, the especial lands, and other lands like forestry, tiller types, water bodies, or especial garden type lands, cannot be physically changed without the approval of the concerned authority.

5.5 Irrigated land should be totally prohibited for acquisition. Fertile lands being used two times or more and potential for cultivation of such crops should not be used for any non-agricultural purpose at any cost.

17.15 Existing water bodies would be kept open and not subject to any kind of filling. For this purpose, small pond holders will decide operation and maintenance of their ponds, while large water bodies like rivers, canals, haor, baor, beel would be maintained by the public users and the GoB. To achieve the goal, regular maintenance and excavation and re-excavation would be carried out.

17.16 As far as possible, flood control embankments would be used as streets/roads;

17.17 Afforestation would be carried out on built embankments;

17.18 Excavated ditches/trenches would be used as water bodies for cultivation of fisheries and duck rearing. It is recommended to re-excavate the existing filled up water bodies for soil spoil to construct flood control embankment without digging new ditches.

17.19 It must be ensured that no new water logging is created as a result of construction of flood control embankment.

B. Bangladesh Water Act (2013)

a. That it is an urgent necessity to conserve the water of a dighi, pond or any other similar water source as a source of potable water due to severe scarcity of such potable water for any natural or other reason, or

b. That it is an urgent necessity to conserve a haor, baor or any other similar water source for seasonal birds to stay or to move safely and to keep their sanctuary safe.

C. National Water Policy (1999)

a. Develop flood-proofing system to manage natural disasters

b. Provide desired level of protection in designated flood risks zones

c. Implement river training and erosion control works for preservation of scarce land and prevention of landlessness and pauperization

D. National Environment Policy (1992)

a. The policy seeks to identify and regulate activities that pollute and degrade environment to ensure environmentally sound development in all sectors.

E. National Forest Policy (1994)

b. The policy proposed that approximately 20% of the area of Bangladesh will be afforested by 2015. Special emphasis is placed on programmes for new charlands, denuded state of forest, the Barrind Tract, the fallow land in general, and on the sides of land of road, rail, and flood embankments.

F. National Fisheries Policy (1998)

The policy highlights the need to conserve fish habitats, especially in the development of water management infrastructures. It clearly points to a determination to prevent further drainage of standing water bodies for agricultural development, and to promote fisheries development in all water bodies.

a. Fisheries and wildlife will receive due emphasis in water resource planning in areas where their social impact is high.
b. Measures will be taken to minimise disruption to the natural aquatic environment in streams and water channels.
c. Drainage schemes, to the extent possible, will avoid state-owned swamps and marshes that have primary value for waterfowl or other wildlife.
d. Water bodies like baors, haors, beels, roadside borrow pits, etc. will, as far as possible, be reserved for fish production and development. Perennial links of these water bodies with the rivers will also be properly maintained.
e. Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.
f. Brackish aquaculture will be confined to specific zones designated by the Government for this purpose.

Appendix-B: Review of the national policy, legal and regulatory framework

B.1 National Environmental Laws

The key national policies, strategies, and plans relevant to environmental management are briefly discussed below.

B.1.1 The Environment Conservation Act, 1995 (subsequent amendments in 2000 and 2002)

The provisions of the Act authorize the Director General (DG) of Department of Environment to undertake any activity he deems fit and necessary to conserve and enhance the quality of environment and to control, prevent and mitigate pollution. The main highlights of the act are:

- Declaration of Ecologically Critical Areas;
- Obtaining Environmental Clearance Certificate;
- Regulation with respect to vehicles emitting smoke harmful for the environment;
- Regulation of development activities from environmental perspective;
- Promulgation of standards for quality of air, water, noise, and soils for different areas and for different purposes;
- Promulgation of acceptable limits for discharging and emitting waste;
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation and improvement of environment

B.1.2 Bangladesh Environment Conservation Act (ECA), (Amendments) 2010

The ECA 1995 was amended in 2010, which provided clarification of defining wetlands as well as Ecologically Critical Areas and included many important environmental concerns such as conservation of wetlands, hill cutting, ship breaking, and hazardous waste disposal. This amendment empowered the government to enforce more penalties than before. Moreover, affected persons were given provision for putting objections or taking legal actions against the polluters or any entity creating nuisance to affected person

B.1.3 Environment Conservation Rules, 1997 (subsequent amendments in 2002 and 2003)

The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter alia, the following:

- The national Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities based on actual (for existing industries/development projects/activities) and anticipated (for proposed

industries/development projects/activities) pollution load;

- Procedure for obtaining environmental clearance;
- Requirement for undertaking IEE and EIA as well as formulating EMP according to categories of industries/development projects/activities;
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

Depending upon location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories: Green, Orange A, Orange B and Red respectively, to nil, minor, medium and severe impacts on important environmental components (IECs).

B.1.4 The EIA Guidelines for Industry, 1997

The EIA Guidelines is a handbook for procedures for preparing the EIAs and for reviewing them for the benefit of the development partners, EIA Consultants, reviewers, and academicians. While preparing these guidelines, the present environmental status as well as the need for rapid economic development of Bangladesh has been kept in view. These considerations have essentially resulted in simpler procedures to be followed for preparing the EIAs and their review.

B.1.5 Bangladesh Environment Court Act, 2010

Bangladesh Environment Court Act, 2010 has been enacted to resolve the disputes and establishing justice over environmental and social damage raised due to any development activities. This act allows government to take necessary legal action against any parties who creates environmental hazards/ damage to environmentally sensitive areas as well as human society. According to this act, government can take legal actions if any environmental problem occurs due to project interventions.

B.2 Relevant National Polices, Strategies and Plans

B.2.1 National Environmental Policy, 1992

The Bangladesh National Environmental Policy, approved in May 1992, sets out the basic framework for environmental action together with a set of broad sectoral action guidelines. Key elements of the Policy are:

- Maintaining ecological balance and ensuring sustainable development of the country through protection and conservation of the environment
- Protecting the country from natural disasters
- Identifying and regulating all activities that pollute and destroy the environment
- Ensuring environment-friendly development in all sectors

- Ensuring sustainable and environmentally sound management of the natural resources
- Maintaining active association, as far as possible, with all international initiatives related to environment *The Environmental Policy of 1992*, which amongst other policies, seeks to ensure that transport systems, including roads and inland waterways, do not pollute the environment or degrade resources. The Policy states that Environmental Impact Assessments (EIA) should be conducted before projects are undertaken.

B.2.2 National Environment Management Action Plan (NEMAP), 1995

The National Environmental Management Action Plan (NEMAP) is a wide-ranging and multi-faceted plan, which builds on and extends the statements, set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005, and set out of the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP was developed based on the following broad objectives:

- Identification of key environmental issues affecting Bangladesh
- Identification of actions necessary to halt or reduce the rate of environmental degradation.
- Improvement of the natural environment
- Conservation of habitats and bio-diversity
- Promotion of sustainable development
- Improvement of the quality of life of the people

To this end, it has grouped all the relevant necessary actions under heads: institutional, sectoral, location-specific and long-term issues. The *institutional* aspects reflect the need of inter-sectoral cooperation to tackle environmental problems those need new and appropriate institutional mechanisms at national and local levels. The *sectoral* aspects reflect the way the Ministries and agencies are organized and make it easier to identify the agency to carry out the recommended actions. The *location-specific* aspect focuses on particularly acute environmental problems at local levels that need to be addressed on a priority basis. The *long-term* issues include environmental degradation of such degree that it might become more serious and threatening than they seem to be if their cognizance is not immediately taken.

B.2.3 National Water Policy, 1999

Endorsed by the GoB in 1999, the National Water Policy (NWP) aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. According to the policy, all agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks.

B.2.4 National Livestock Development Policy, 2007

The National Livestock Development Policy (NLDP) has been prepared to address the key challenges and opportunity for a comprehensive sustainable development of the livestock sub-sector by creating an enabling policy framework. As livestock is one of the key assets in livelihoods of the program area, and protection of livestock from floods should be emphasized along with security of human life. The proposed project interventions will contribute to the safety of livestock and thus increase livestock productivity in the program area.

B.2.5 Private Forest Policy 1994

The policy suggested for extended effort to bring about 20% of the country's land under the afforestation programs of the government and private sector by year 2015 by accelerating the pace of the program through the coordinated efforts of the government and NGOs and active participation of the people in order to achieve self-reliance in forest products and maintenance of ecological balance. The policy viewed equitable distribution of benefits among the people, especially those whose livelihood depend on trees and forests; and people's participation in afforestation programs and incorporation of people's opinions and suggestions in the planning and decision-making process. The people- centered objectives of the policy are: creation of rural employment opportunities and expansion of forest-based rural development sectors; and prevention of illegal occupation of forest lands and other forest offences through people's participation. The policy statements envisage: massive afforestation on marginal public lands through partnerships with local people and NGOs; afforestation of denuded/encroached reserved forests with an agro forestry model through participation of people and NGOs; giving ownership of a certain amount of land to the tribal people through forest settlement processes; strengthening of the Forest Department; strengthening of educational, training and research facilities; and amendment of laws, rules and regulations relating to the forestry sector and if necessary, promulgation of new laws and rules. Thus, over time the policy has shifted somewhat from total state control to a management regime involving local communities in specific categories of forests.

Because of limited amount of forestland, the policy underscores for effective measures for afforestation in rural areas, in the newly accreted chars, and in the denuded Unclassed State Forest areas of Chittagong Hill Tract and northern zone of the country including the Barind tract. The policy also encourages the private sector participation in afforestation.

B.2.6 National Policy for Safe Water Supply and Sanitation(1998)

The National Drinking Water Supply and Sanitation Policy (1998) goal is accessibility to all of water and sanitation services within the shortest possible time at a price that is affordable to all. The Policy will be achieved through strategies formulated at various levels in consultation with the Ministry of Planning. Policy objectives are (i) to improve the standard of public health and (ii) to ensure an improved environment. Policies for rural and urban areas are presented

separately as they differ in institutional aspects, content, and magnitude.

B.2.7 National Policy for Arsenic Mitigation (2004)

The National Policy for Arsenic Mitigation (2004) provides a guideline for mitigating the effect of arsenic on people and environment in a realistic and sustainable way. It supplements the National Water Policy (1998) and the National Policy for Safe Water Supply and Sanitation (1998) in fulfilling national goals related to poverty alleviation, public health, and food security.

The Policy states that access to safe water for drinking and cooking shall be ensured through implementation of alternative water supply options in all arsenic-affected areas. Arsenic mitigation activities under the Policy will focus on public awareness, alternative arsenic safe water supply, diagnoses and management of patients and capacity building. The national arsenic program is to encourage and promote research and development on the impact of arsenic on water supplies, health, food, and agriculture.12

B.2.8 National Adaptation Programme of Action (NAPA)

In 2005, the Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh has prepared the National Adaptation Program of Action (NAPA) for Bangladesh, as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized the necessity of addressing climate change and environmental issue and natural resource management. The NAPA is the beginning of a long journey to address adverse impacts of climate change including variability and extreme events and to promote sustainable development of the country. There are 15 adaptation strategies suggested to address adverse effects of climate change. Among the 15 adaptation strategies the following strategies are relevant for reducing climate change induced vulnerability:

- Construction of flood shelters, and information and assistance center to cope with enhanced recurrent floods in major floodplains
- Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.

This project broadly contributes toward achieving the aims and objectives of the climate change adaptation strategies.

B.2.8 Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009

The Government of Bangladesh has prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009. The BCCSAP is built on six pillars:

i. Food security, social protection and health to ensure that the poorest and most vulnerable in

society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.

ii. Comprehensive disaster management to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.

iii. Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructures (cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.

iv. Research and Knowledge management to predict that the likely scale and timing of climate change impacts on different sectors of economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.

v. Mitigation and low carbon development to evolve low carbon development options and implement these as the country's economy grows over the coming decades.

vi. Capacity building and Institutional strengthening to enhance the capacity government ministries, civil society and private sector to meet the challenge of climate change.

This project will contribute towards achieving the objective of pillars such as (i), (ii), (iii), (iv), and (vi).

B.3 Other Relevant Acts, Laws and Rules

B.3.1 Bangladesh Wildlife (Protection and Safety)Act, 2012

The Act protects 1,307 species of plants and animals, including 32 species of amphibian, 154 species of reptile, 113 species of mammal, 52 species of fish, 32 species of coral, 137 species of mollusk, 22 species of crustacean, 24 species of insect, six species of rodent, 41 species of plant and 13 species of orchid. Of these, eight amphibians, 58 reptiles, 41 bird, and 40 mammal species are listed as endangered in the IUCN Red Data Book (2000). The Act mandates:

- one to three years imprisonment, a fine of BDT 50,000 to 200,000, or both, for wildlife poaching, capturing, trapping, and trading, and for the purchase of wild animals, parts of wild animals, trophies, meat or other products without license.

The Act mandates two to seven years imprisonment and BDT 100,000 to 1 million fine or both, for killing an elephant or tiger; and 12 years plus BDT 1.5 million for repeat offenders.

- five years imprisonment and BDT 200,000 fine for killing a cheetah, clouded cheetah, gibbon, sambar deer, crocodile, gavial, whale, and dolphin.

- two years imprisonment and BDT 200,000 fine for killing a wild bird or migratory bird.
- empowers the Government to create an eco-park, safari park, botanical garden, or breeding ground on any state-owned forest land, land or water-body.
- two years imprisonment for farming, woodcutting, burning, and construction on such reserves.

B.3.2 Bangladesh Wild life(Preservation)Order(1973) and Act(1974)

The Bangladesh Wildlife Preservation (Amendment) 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 and provides the following legal definitions:

- Game reserve is defined as an area declared by Government wherein the capture of wild animals is unlawful, to protect wildlife and increase the population of important species;
- National park is defined as an area declared by Government comprising a comparatively large area of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora, and fauna in their natural state, to which access for public recreation and education, and for scientific research, may be allowed;
- Wildlife sanctuary is defined as an area declared by Government that is closed to hunting, shooting, or trapping of wild animals as an undisturbed breeding ground, primarily for the purpose of protecting all natural resources, including wildlife vegetation, soil, and water.

The Act allows Government to relax any or all specified prohibitions for scientific purposes, for aesthetic enjoyment, or betterment of scenery.

B.3.3 Protection and Conservation of Fish Act (1950)

This Act 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.

B.3.4 East-Bengal Protection and Fish Conservation Act (1950) and Amendments

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. These instruments define a relatively non-specific framework that simply provides a means for Government to introduce rules to protect inland waters not in private ownership. Among other things, they sanction rule- making regarding destruction of, or any attempt to destroy, fish by poisoning of water or depletion of fisheries by pollution, industrial effluent, or otherwise.

B.3.5 Protection and Conservation of Fish Rules (1985)

These Rules are in line with the overall objectives of the Fisheries Act and its amendments. Section 5 of the Rules states that, "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 states, "No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters."

B.3.6 Forestry Acts

Systematic management of forests started in the 1860s after the establishment of a Forest Department in the Province of Bengal. To regulate activities within forests, rules and regulations have been formulated, amended, modified and improved upon over the years. These rules and regulations are formulated based on long-existing acts and policies.

Forest legislation in Bangladesh dates to 1865, when the first Indian Forest Act was enacted. It provided for protection of tree, prevention of fires, prohibition of cultivation, and grazing in forest areas. Until a comprehensive Indian Forest Act was formulated in 1927, several acts and amendments covering forest administration in British India were enacted and were as follows: (a) Government Forest Act, 1865; (b) Forest Act, 1890; (c) Amending Act, 1891; (d) Indian Forest (Amendment) Act, 1901; (e) Indian Forest (Amendment) Act, 1911; (f) Repealing and Amending Act, 1914; (g) Indian Forest Amendment Act, 1918; and (h) Devolution Act, 1920.

The Forest Act of 1927, as amended with its related rules and regulations, is still the basic law governing forests in Bangladesh. The emphasis of the Act is on the protection of reserved forest. Some important features of the Act are: (i) Under the purview of the Forest Act, all rights or claims over forestlands have been settled at the time of the reservation. The Act prohibits the grant of any new rights of any kind to individuals or communities; (ii) Any activity within the forest reserves is prohibited, unless permitted by the Forest Department; (iii) Most of the violations may result in court cases where the minimum fine is Taka 2,000 and/or two month's rigorous imprisonment; and (iv) The Act empowers the Forest Department to regulate the use of water-courses within Reserve Forests.

B.3.7 Forest Act1927 (Amendment 2000)

The Forest Act of 1927 as amended in 1989 has its roots in Indian Forest Act, 1878. The Forest Act 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".

Forest department is the main agency to implement the provisions of the Forest Act. The Act, however, does not specify any sort of institutional structure for the forest or other land holding agencies. It also does not set out any specific policy direction for managing the forests.

Most of the forest lands under the management of forest department are areas declared to be reserved and protected forests under this act. The act empowers the government to regulate the felling, extraction, and transport of forest produce in the country.

B.3.8 Private Forest Act (PFA),1959

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. The Private Forest Ordinance was originally enacted in 1945, as the Bengal Private Forest Act, and was re-enacted by the Bangladesh (then East Pakistan) in 1949 before being issued as an Act in 1959. These government managed lands under this act are called "vested forests". The Forest Department manages approximately 8,500 hectares in the country as "vested forests". This area is relatively small, but the area historically affected by this law is much larger.

PFA, 1959 empowers the government to require management plans for private forests and to assume control of private forests as vested forests. Government has broad powers to write rules regarding use and protection of vested forests, and apply rules to "controlled forests," which include all private forests subject to any requirement of the Act.

B.3.9 Embankment and Drainage Act,1952

The East Bengal Act No. 1, 1953 has been adapted by the People Republic of Bangladesh, by the Bangladesh Order (adaptation of Existing Laws), 1972 (President's Order No. 48 of 1972). The Act consolidates 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 specific Sections and Articles relevant to this project are mentioned below.

- Section 4 (1) of the Act states that the embankment, water-course, and tow-path, earth, pathways, gates, berms and hedges of the embankments shall vest in the Government of the Authority (BWDB).
- Section 56 (1) states that, person will be subject to penalty (500 taka or imprisonment... if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course.

- Section 15 allows for the engineer (engineer in charge of Divisional level BWDB) for constructing new embankment or enlarging, lengthening or repairing existing embankments.
- The other sections of the Act give powers and access to the Government or Authority or Engineers to commence necessary Project activities, for land acquisition (through the Deputy Commissioner), and site clearing activities including removal of trees or houses (if necessary).

B.3.10 Bangladesh WaterAct,2013

The recently published 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. In general, if one takes a critical look at the Act, the new law has provided the right framework for better management of water resources in the country.As per this Act, all forms of water (e.g., surface water, ground water, sea water, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. The private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act. A worthwhile initiative is the requirement for permits/licenses for large scale water withdrawal by individuals and organizations beyond domestic use. Without prior permission issued by the Executive Committee, no individuals or organizations will be allowed to extract, distribute, use, develop, protect, and conserve water resources, nor they will be allowed to build any structure that impede the natural flow of rivers and creeks. However, the maximum amount of surface water or groundwater that can be withdrawn by individuals or organizations is not mentioned in the Act. Setting up a priority order for water usage in an area where the water resources is in critical condition is also a significant step.

B.3.11 Bangladesh LaborAct,2006

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. Some of the relevant Sections are:

- Section 150. Employer's Liability for Compensation: (1) If personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer shall be liable to pay compensation in accordance with the provisions of this Act; and (2) Provided that the employer shall not be so liable - (a) in respect of any injury which does not result in the total or partial disablement of the workman for a period exceeding three days; (b) in respect of any injury, not resulting in death or permanent total disablement, caused by an accident which is directly attributable to - (i) the workman having been at the time thereof under the influence of drink or drugs, or (ii) the willful disobedience of the workman to an order expressly given, or to a rule expressly framed, for the purpose of securing the safety of workmen, or (iii) the willful removal or disregard by the

workman of any safety guard or other device which he knew to have been provided for the purpose of securing the safety of workmen.

- Section 151. (1) Amount of Compensation: Subject to the provisions of this Act, the amount of compensation shall be as follows, namely :- (a) where death results from the injury, an amount equal to fifty cent of the monthly wages of the deceased workman multiplied by the relevant factor; or an amount of fifty thousand taka, whichever is more; (b) where permanent disablement results from the injury an amount equal to sixty per cent of the monthly wages of the injured workman multiplied by the relevant factor.

B.3.12 Bangladesh NationalBuilding Code,2006

The Bangladesh National Building Code (BNBC) clearly sets out the constructional responsibilities according to which the relevant authority of a construction site shall adopt some precautionary measures to ensure the safety of the workmen. According to Section 1.2.1 of Chapter 1 of Part 7, "In a construction or demolition work, the terms of contract between the owner and the contractor and between a consultant and the owner shall be clearly defined and put in writing". These however will not absolve the owner.

from any of his responsibilities under the various provisions of this Code and other applicable regulations and bye-laws. The terms of contract between the owner and the contractor will determine the responsibilities and liabilities of either party in the concerned matters, within the provisions of the relevant Acts and Codes (e.g.) the Employers' Liability Act, 1938, the Factories Act 1965, the Fatal Accident Act, 1955 and Workmen's Compensation Act 1923". (After the introduction of the Bangladesh Labor Act, 2006, these Acts have been repealed.)

The BNBC also stipulates the general duties of the employer to the public as well as workers. According to this section, "All equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run way, barricade, chute, lift shall be substantially constructed and erected so as not to create any unsafe situation for the workmen using them or the workmen and public passing under, on or near them".

The Code also clarifies the issue of safety of workmen during construction and with relation to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the site during construction and at the same time specifies the specific measures to be taken to prevent such health hazards. According to this chapter, exhaust ventilation, use of protective devices, medical checkups etc. are the measures to be taken by the employer to ensure a healthy workplace for the workers.

To prevent workers falling from heights, the Code sets out the detailed requirements on the formation and use of scaffolding. According to Section 3.9.2 of the same chapter, "every temporary floor openings shall either have railing of at least 900 mm height or shall be constantly attended". Every floor hole shall be guarded by either a railing with toe board or a

hinged cover. Alternatively, the hole may be constantly attended or protected by a removable railing. Every stairway floor opening shall be guarded by railing at least 900 mm high on the exposed sides except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board except at entrance to opening. Every open sided floor or platform 1.2 meters or more above adjacent ground level shall be guarded by a railing on all open sides except where there is entrance to ramp, stairway or fixed ladder, the above precautions shall also be taken near the open edges of the floors and the roofs".

B.4 Other Laws

There are several other laws and regulations applicable which are relevant for this project. These are presented in the Table A.1 below.

Table A.1: Laws and Acts.

Act/Law/Ordinance	Brief description	**Responsible Agency**
The Vehicle Act (1927) and the Motor Vehicles Ordinance (1983)	Provides rules for exhaust emission, air and noise pollution and road and traffic safety	Road Authority
Rules for Removal of Wrecks and Obstructions in inland Navigable Water Ways (1973)	Rules for removal of wrecks and obstructions	IBWTA
The Water Supply and Sanitation Act (1996)	Regulates the management and control of water supply and sanitation in urban areas.	MoLG, RD&C
The Ground Water Management Ordinance (1985)	Describes the management of ground water resources and licensing of tube wells	UpazilaParishad
The Private Forests Ordinance (1959)	Deals with the conservation of private forests and afforestation of wastelands.	MoEF
The Antiquities Act (1968)	Describes the preservation of cultural heritage, historic monuments and protected sites	

B.5 International Treaties Signed by GoB

Bangladesh has signed most international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation, the Kyoto protocol and Paris Agreement on climate change. An overview of the relevant international treaties signed by GoB is shown in Table A.2.

Table A.2: Treaty or Convention and Responsible Agency.

Treaty	Year	Brief Description	Relevant Department
Protection of birds (Paris)	1950	Protection of birds in wild state	DoE/DoF
Ramsar Convention	1971	Protection of wetlands	DoE/DoF
Protocol Waterfowl Habitat	1982	Amendment of Ramsar Convention to protect specific habitats for waterfowl	DoE/DoF
World Cultural and Natural Heritage (Paris)	1972	Protection of major cultural and natural monuments	DoArch
CITES convention	1973	Ban and restrictions on international trade in endangered species of wild fauna and flora	DoE/DoF
Bonn Convention	1979	Conservation of migratory species of wild animals	DoE/DoF
Prevention and Control of Occupational hazards	1974	Protect workers against occupational exposure to carcinogenic substances and agents	MoH
Occupational hazards due to air pollution, noise & vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment	MoH
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MoH
Occupational Health services	1985	To promote a safe and healthy working environment	MoH

Treaty	Year	Brief Description	Relevant Department
Convention on oil pollution damage (Brussels)	1969	Civil liability on oil pollution damage from ships	DoE/MoS
Civil liability on transport of dangerous goods (Geneva)	1989	Safe methods for transport of dangerous goods by road, railway and inland vessels	MoC
Safety in use of chemicals during work	1990	Occupational safety of use of chemicals in the work place	DoE
Convention on oil pollution	1990	Legal framework and preparedness for control of oil pollution	DoE/MoS
Vienna convention	1985	Protection of ozone layer	DoE
London Protocol	1990	Control of global emissions that deplete ozone layer	DoE
UN framework convention on climate change (Rio de Janeiro)	1992	Regulation of greenhouse gases emissions	DoE
Convention on Biological Diversity (Rio de Janeiro)	1992	Conservation of bio-diversity, sustainable use of its components and access to genetic resources	DoE
International Convention on Climate Changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases	DoE
Protocol on biological safety (Cartagena protocol)	2000	Biological safety in transport and use of genetically modified organisms	DoE
Paris Agreement	2016	International Agreement in climate change and greenhouse gases	DoE

Appendix - C: Description of Services of Water Resource Management Expert

Description of the Services

The **Water Resources Management Expert** will report to the PD. S/he will work closely with other members of the team with the following

Duties and Responsibilities: (i) To study sub regional water resource system; (ii) To study the efficiency of existing drainage system; (iii) To prepare land use planning guidelines considering hydrological situation of the project area; (iv) To make study over hydrological hazards of the area and prepare guidelines for hazard mitigation; (v) to prepare flood prediction model of long, medium and short term (100, 50, 20 and 5-year period) for Project area (vi) To prepare IEE (Initial Environmental Evaluation) for the area.

Table 1 Consultant's Reporting Obligations

Sl. No.	Reports	Contents of Reports	Persons to Receive them	Date of Submission
1	Inception Report	• Readjustment of the work plan on weekly schedule for WRM related surveys and studies • List of Working Papers with tentative content required for Interim report • Content and sources of secondary data required for the working papers • Content and sources of primary data required for the working papers • Methodology of WRM database preparation	PD	end of first month
2	Interim Progress Report (a) First Status Report (b) Second Status Report	• Preparation of working papers for the Plan package form Primary data and Secondary database. • Coordination among the Survey and Planning professionals in WRM related activities; • sub regional water resource system; • study the efficiency of existing drainage system; • prepare land use planning guidelines considering hydrological situation of the project area; • study over hydrological hazards of the area and prepare guidelines for hazard mitigation; • to prepare flood prediction model of long, medium and short term (100, 50, 20 and 5-year period) for Project area • Prepare IEE (Initial Environmental Evaluation) for the area.	PD	i. 4th week of 3rd month ii. 4th week of 4th month
3	Draft Report	• Tentative location alignment of Water related Infrastructures with tentative land use plan and other infrastructures	PD	4th week of 6th month