Local Government Engineering Department
People's Republic of Bangladesh

The Project for Developing Inclusive City Governance for City Corporation

Final Report

Environmental Impact Assessment (EIA)

March 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

PADECO Co., Ltd.

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ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

REPORT FOR

OVERPASS AT SAGORIKA-ALANKAR JUNCTION

CHITTAGONG CITY CORPORATION

March 2014

Development Design Consultants Ltd. (DDC)

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ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway Transportation Officials
ACC	Accident Costs
ACV	Aggregate Crushing Value
ADB	Asian Development Bank
ADT	Average Daily Traffic
AIV	Aggregate Impact Value
ANSI	American National Standard Institute
ASTM	American Society for Testing & Materials
AWS	American Welding Society
BCL	Bangladesh Consultants Limited.
BCR	Benefit-Cost Ratio
BDS	Bangladesh Standard
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BOQ	Bill of Quantity
BR	Bangladesh Railway
BRT	Bus Rapid Transit
BRTA	Bangladesh Road Transport Authority
BS	British Standard / Bangladesh Survey
BTE	Bureau of Transport Economics
BTTB	Bangladesh Telegraph and Telephone Board
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAAB	Civil Aviation Authority of Bangladesh
CBA	Cost-Benefit Analysis
CBR	California Bearing Ratio
CCC	Chittagong City Corporation
CDA	Chittagong Development Authority
CNG	Compressed Natural Gas
DC	Deputy Commissioner
DCC	Dhaka City Corporation
DD	Directional Distribution
DDC	Development Design Consultants Ltd.
DESA	Dhaka Electric Supply Authority
DESCO	Dhaka Electric Supply Company Ltd.
DHV	Design Hourly Volume
DMDP	Dhaka Metropolitan Development Plan
DMP	Dhaka Metropolitan Police
DOE	Department of Environment
DOHS	Defense Officers Housing Society
DSMA	Dhaka Statistical Metropolitan Area
DTCB	Dhaka Transport Coordination Board
DUTP	Dhaka Urban Transport Project
DV	Design Vehicle
DWASA	Dhaka Water Supply and Sewerage Authority
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environment Conservation Rules

EGL	Existing Ground Level
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPZ	Export Processing Zone
EQS	Environmental Quality Standards
ESOs	Environmental Safety Officers
FHWA	Federal Highway Administration
FIRR	Financial Internal Rate of Return
FM	Fineness Modulus
FY	Fiscal Year
GDP	Gross Domestic Product
GIS	Geographic Information System
GM	General Manager
GoB	Government of Bangladesh
GVW	Gross Vehicular Weight
HCM	Highway Capacity Manual
HFL	Highest Flood Level
HRD	Higher Discount Rate
HTS	High Tensile Steel
IABSE	International Association of Bridge and Structural Engineers
ICD	Inland Container Depot
JV	Join Venture
IEE	Initial Environmental Examination
IERR	Internal Economic Rate of Return
IFRR	Internal Financial Rate of Return
IGAs	Income Generating Activities
IRC	Indian Road Congress
IRI	International Roughness Index
IRR	Internal Rate of Return
ITE	Institute of Traffic Engineers
IWM	Institute of Water Modeling
KPa	Kilo Pascal
LAAV	Los Angeles Abrasion Value
LBI	The Louis Berger Group, Inc
LOS	Level of Service
LRD	Lower Discount Rate
LRT	Light Rail Transit
MC	Maintenance Cost
MCA	Multi-criteria Analysis
MCDA	Multi-criteria Decision Analysis
MD	Modal Demand
MOEF	Ministry of Environment and Forestry
MPa	Mega Pascal
MRT	Mass Rapid Transit
MS	Mild Steel
MSL	Mean Sea Level
MT	Motorized Transport
NMV	Non Motorized Vehicle
NPV	Net Present Value

O&M	Operation and Maintenance
O-D	Origin & Destination
PA	Project Area
PAPs	Project Affected Persons
PCU	Passenger Car Unit
PDB	Power Development Board
PDO	Property Damage Only
PGCB	Power Grid Company of Bangladesh
PM	Particulate Matter
PPE	Personal Protective Equipment
PPVs	Peak Particle Velocities
PSD	Passing Sight Distance
PTC	Passenger Time Cost
PTTS	Passenger Travel Time Saving
PWD	Public Works Department
R/A	Residential Area
RAJUK	Rajdhani Unnayan Kartripakkha
RAP	Resettlement Action Plan
RHD	Roads & Highways Department
ROW	Right of Way
RUC	Road User Costs
SPT	Standard Penetration Tests
SSD	Stopping Sight Distance
STP	Strategic Transport Plan
T&T	Telegraph and Telephone
TCH	The Consulting House
TRRL	Transport and Road Research Laboratory
TTC	Travel Time Costs
UTCB	Urban Transport Coordination Board
VC Ratio	Volume-Capacity Ratio
VIP	Very Important Person
VOC	Vehicle operating Cost / Volatile Organic Compounds
VOT	Value of Travel Time/Value Time Cost
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Author

Chapter 1. INTRODUCTION

1.1 Study Background

The port city of Chittagong is threshold of export & import and is the second largest city in Bangladesh. It is growing fast as the commercial hub of Bangladesh. The second International airport of Bangladesh is situated in this city.

Historically, the port city has a hinterland ranging up to the whole of Eastern Indian Subcontinent. Chittagong city is surrounded by important primary and secondary road network.

The total population of the city is around 4.0 million and every year around 0.1 million is added to the total population of the city. Due to the population growth, the demand for services has grown up in all sectors including transport. Traffic congestion is aggravating day by day because of rapid urbanization and increase in commercial activities.

As assistance to the Government of Bangladesh, JICA sent PADECO team to Chittagong for infrastructure development study under the purview of Chittagong City Corporation (ChCC). Based on the study, ChCC selected six major roads to build overpasses on it. Among them Sagorika- Alankar Crossing Overpass has been earmarked to be given major priority.

The project aims to relieve traffic congestion at Sagorika- Alankar crossing and consequently reduce transport cost for business and commoners, social and economic well-being of the city dwellers and the nation as a whole, also to improve the environment and quality of life in the city.

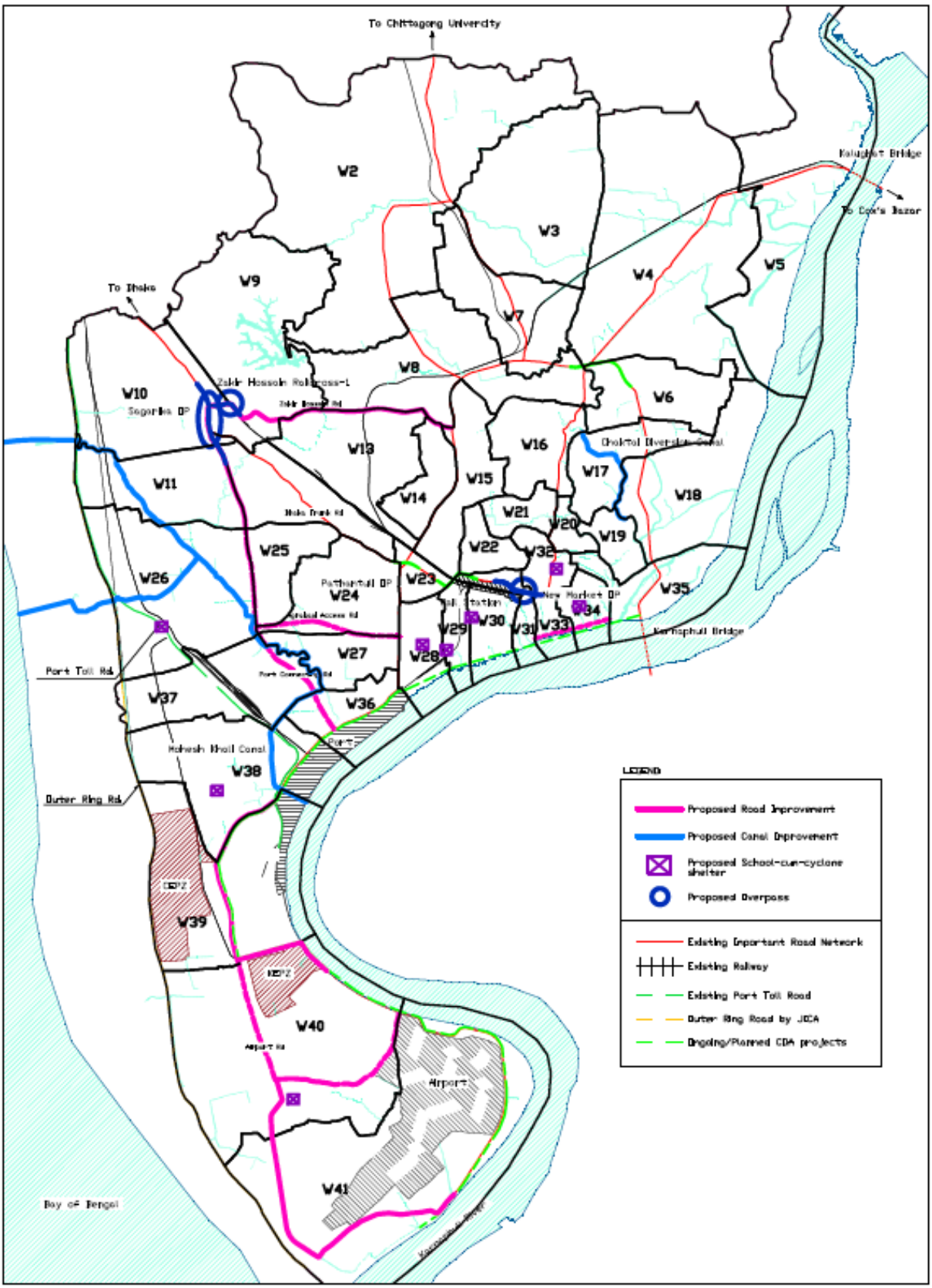


Figure 1-1: Chittagong City Map

Source: Chittagong City Corporation

Existing Transport Network Map of Chittagong City showing proposed Overpass Location at Sagorika Road (Extracted from Satellite Image)

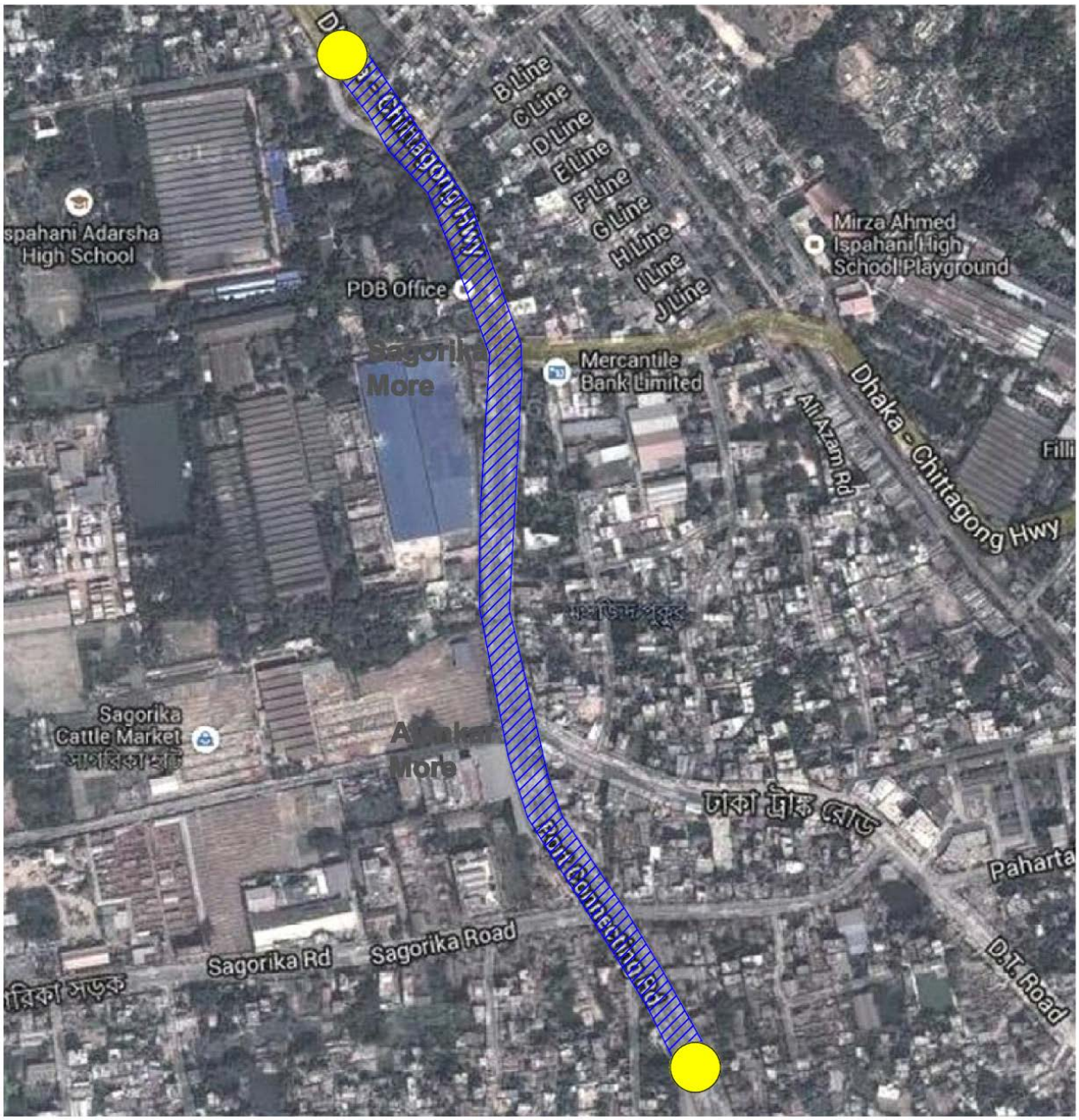


Figure 1-2 : Location of Proposed Overpass

1.2 Objective of the Preliminary Environmental Impact Assessment Study

The main objective of the study is to identify and assess potential impacts on social/natural environment and pollution caused by the intervention of the projects. Under this study, in order to avoid or minimize environmental, social and pollution impacts Environmental Management & Monitoring Plan (EMP & EMoP) will be prepared to take actions to the potential environmental impacts as well as to proposed mitigation measures. The study has been carried out based on the guidelines for Environmental Assessment of both JICA and Bangladesh Government.

1.3 Scope and Approach of the Study

The scope of the EIA study is based upon the requirements of the environmental guidelines of JICA and GoB. The scopes of works include:

- To prepare the initial Environmental Impact Assessment (EIA) report to be followed as per existing DOE requirements of the Government of Bangladesh.
- To identify the potential key environmental impacts associated with the project by critical study of the project activities;
- To collect the baseline information on physio-chemical, ecological and social impacts of the project through use of field survey and secondary data.
- Project description from environmental aspect
- Environmental quality survey on water (surface & ground);
- Conducting field survey for Flora and Fauna;
- Identification of mitigation measures;
- Preparation of Preliminary EMP to reduce or eliminate significant environmental impacts; and
- Preparation of approx. environmental cost.

1.3 Approach of EIA

Study approach can be summarized as follows:

- The Project component is described from environmental aspect,
- Review of EIA relevant to the projects,
- Detail methodology is set up.
- Environmental base line is described from both primary and secondary data,
- Impact is assessed,
- Mitigation measure is proposed,
- Impact evaluation is made considering the mitigation measures,
- Preliminary EMP is proposed with approximate cost estimates
- Recommendations are made for further studies, if required.

Chapter 2. LEGAL REQUIREMENT

2.1 Environmental Laws and Guidelines of Bangladesh

Development projects are governed by some legal and/or institutional requirements. So understanding of relevant policy, strategy and regulatory issues are very important for any project proponent before they actually execute a program or plan. The relevant national legislative, regulatory and policy requirements are reviewed in the following sections. The key pieces of policy and legislation which apply to such project execution programs are described in the following sections.

2.1.1 National Environment Management Action Plan (NEMAP), 1995-2005

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 through which various decisions, plans, legislative measures, rules and regulations toward safeguarding the environment and natural resources including those of biological diversities 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 four 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.

2.1.2 The Environment Conservation Act, 1995 (subsequent amendments in 2000, 2002 and 2010)

The ECA is currently the main legislation relating to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement.

The main objectives of ECA are:

- Conservation and improvement of the environment; and

- Control and mitigation of pollution of the environment.

The main focuses of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/ initiated in the ecologically critical areas (ECA);
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines

Before any new project can go ahead, as stipulated under the ECA, the project promoter must obtain Environmental Clearance from the Director General (DG), Department of Environment (DOE), Govt. of Bangladesh. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 5 years imprisonment or a maximum fine of Tk.100,000 or both. The DOE executes the Act under the leadership of the DG. The Project will be undertaken in line with the aims and objectives of the Act by conserving the environment and controlling and mitigating potential impacts throughout the drilling program.

Environmental Conservation Act (Amendment 2000)

The Bangladesh *Environment Conservation Act* Amendment 2000 focuses on ascertaining responsibility for compensation in cases of damage to ecosystems, increased provision of punitive measures both for fines and imprisonment and the authority to take cognizance of offences.

Environmental Conservation Act (Amendment 2002)

- The 2002 Amendment of the ECA elaborates on the following parts of the Act:
- Restrictions on polluting automobiles;
- Restrictions on the sale, production of environmentally harmful items like polythene bags;
- Assistance from law enforcement agencies for environmental actions;
- Break up of punitive measures; and
- Authority to try environmental cases.

Environmental Conservation Act (Amendment 2010)

This amendment of the act introduces new rules & restriction on:

- No individual or institution (Gov. or Semi Gov, / Non Gov. / Self Governing) can cut any Hill and Hillock. In case of national interest; it can be done after getting clearance from respective department
- Owner of the ship breaking yard will be bound to ensure proper management of their hazardous wastes to prevent environmental pollution and Health Risk
- No water body can be filled up/changed; in case of national interest, it can be done after getting clearance from the respective department; and

- Emitter of any activities/incident will be bound to control emission of environmental pollutants that exceeds the existing emission standards.

2.1.3 Environment Conservation Rules (ECR), 1997 and Amendments

These are a set of rules, promulgated under the ECA (1995) and its amendments. The Environment Conservation Rules provide categorization of industries and projects and identify types of environmental assessment required against respective categories of industries or projects. The Rules set:

- The National Environmental Quality Standards (NEQS) for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.;
- The requirement for and procedures to obtain environmental clearance; and
- The requirement for IEE and EIA according to categories of industrial and other development interventions.

The Environment Conservation Rules, 1997 were issued by the GOB to exercise the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas;
- Classification of industries and projects into 4 categories;
- Procedures for issuing the Environmental Clearance Certificate (ECC); and
- Determination of environmental standards.

Rule 3 defines the factors to be considered in declaring an "ecologically critical area" as per Section 5 of the ECA (1995). It empowers the Government to declare the area as the Ecologically Critical Areas (ECA), if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which operations or processes may be carried out or may not be initiated in the ecologically critical area. Under this mandate, the Ministry of Environment and Forest (MOEF) has declared Sunderban, Cox's Bazar-Tekhnaf Sea Shore, Saint Martin Island, Sonadia Island, Hakaluki Haor, Tanguar Haor, Marzat Baor and Gulshan-Baridhara Lake as ecologically critical areas and prohibited certain activities in those areas. Rule 7 of the 1997 ECR provides a classification of industrial units and projects into four categories, depending on environmental impact and location. These categories are:

- **Green;**
- **Orange A;**
- **Orange B;** and
- **Red.**

The categorization of a project determines the procedure for issuance of an Environmental Clearance Certificate (ECC). All proposed industrial units and projects that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the "Orange-A", "Orange-B" and "Red" Categories, firstly a site clearance certificate (SCC) and thereafter an environmental clearance certificate (ECC) will be required. A detailed description of those four categories of industry/project is in Schedule-1 of ECR (1997). The Rules were

essentially developed for industrial developments, but under Schedule 1 of the Guidelines (Clauses 63 and 64) the following falls into the Orange B Category.

All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange-A, Orange- B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be required to be issued. A detailed description of those four categories of industries has been given in Schedule-1 of ECR (1997). Apart from general requirement, for every Red category proposed industrial unit or project, the application must be accompanied with Feasibility Report on Initial Environmental Examination, Environmental Impact Assessment based on approved TOR by DOE, Environmental Management Plan (EMP) etc.

The ECR (1997) also contains the procedures for obtaining Environmental Clearance Certificates from the Department of Environment for different types of proposed units or projects. Any person or organization wishing to establish an industrial unit or project must obtain ECC from the Director General. The application for such certificate must be in the prescribed form together with the prescribed fees laid down in Schedule 13, through the deposit of a Treasury Chalan in favor of the Director General. Rule 8 prescribes the duration of validity of such certificate (3 years for Green category and 1 year for other categories) and compulsory requirement renewal of certificate at least 30 days before expiry of its validity.

2.1.4 Environmental Clearance Certificate (ECC)

The ECC is issued by the Department of Environment (DOE), the technical arm of the Ministry of Environment and Forests (MOEF). The procedures of obtaining ECC are shown in Figure 2-1.

2.1.5 JICA Guidelines

JICA requires that projects funded by it be environmentally and socially sustainable. To ensure it JICA has formulated specific social and environmental guidelines entitled "JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS 2010" (available at JICA website) for application in their funded projects. As per JICA's environmental and social compliance requirements, the implementing (or recipient) country of the JICA funded project will confirm that JICA's environmental requirements are fully satisfied in line with its environmental and social guidelines.

For review purpose JICA classifies all of its to-be-funded projects into four categories in the order of environmental impacts in terms of their complicity, extent and intensity: Category-A, B, C and FI. Category-A is the project, which may cause significant adverse environmental and social impacts and Category-B is the project, of which potential adverse impacts on the environment and society are less adverse than those of Category A project. Category-C is the project likely to have minimal or little adverse impact on the environment and society. Projects having several sub-projects with potential environmental impacts are classified under Category-FI when the sub-projects are specified by the lender after the funding approval of JICA; these sub-projects cannot be specified prior to the approval.

Under the environmental categorization criteria of JICA, the present project falls within the Environmental Category B because of the following reasons:

- The project has less adverse environmental impacts than a Category-A project;
- The adverse impacts are site-specific, simple and can be mitigated easily with available ready-made mitigation measures.

Source: Department of Environment Guideline

Figure 2-1: Procedure for obtaining Environment Clearance Certificate

Chapter 3. APPROACH AND METHODOLOGY

The EIA is conducted if the project is likely to have minor or limited impacts, which can easily be predicted and evaluated and for which mitigation measures are prescribed easily. EIA can prescribe any necessary environmental management plan (EMP) and monetary programs to make the project environmentally sound.

Critical study of the important environmental components has been done by a quick assessment during the field survey, review of relevant available reports, and secondary information from Bangladesh Bureau of Statistics and the Consultant's experience of similar studies. Overall assessment has been carried out on the basis of Environmental Conservation Act, 1995 and Environmental Conservation Rules, 1997 and other relevant regulations of DOE, Bangladesh.

3.1 Collection of Primary Data

Information regarding existing natural and social environment of the study area needed to be collected by conducting appropriate surveys and from secondary sources.

The primary data was collected by conducting field and reconnaissance surveys through structured checklists about physical features, ecological aspects, and socioeconomic status of the people in the study area. Observations and interviews with different levels of officials were also recorded.

Information of the existing roads (crest width, carriageway, footpath, etc.) in the study area was collected and an inventory of the entire stretch of affected infrastructure within the Right of Way (ROW) of the project site was prepared. A detailed topographic survey was conducted for this purpose.

- Two major objectives were fulfilled by this survey: The land use pattern on both sides of the roadways was ascertained; and the indicators for baseline survey for physio-chemical and ecological environment, socioeconomic status for construction of flyover were selected.

A checklist was prepared for the collection of information on general land use and settlement pattern, trees and vegetation, utilities including all structures (both commercial and non-commercial), mosques/ temples, educational institutions, etc. within the project impacted zone on both sides of the roads of the study area. The impacted zones were considered up to 50 meter distance from the centre of the road on both sides which extended inside the built up area.

Existing noise level and air quality at the project location is being measured to have baseline noise and air quality data that can be considered in design and evaluated during and after construction as well as in operational period.

Opinion survey of the road users, local people and other stakeholders has been carried out. Different categories of respondents has been considered for interviewing such as, car, taxi and truck drivers, rickshaw pullers, CNG baby taxi drivers, van puller, street beggars, street vendors, passengers, local residents, businessmen, shopkeepers and slum people, etc.

The environmental survey is being supplemented by a socioeconomic survey conducted for the project. Approximately 5 – 10% of total households in the project area were surveyed during the socioeconomic survey. These households have taken from the entire influence area using two-stage stratified sampling methods. Socioeconomic survey sample areas has identified in two major groups:

- Commercial areas; and

- Residential areas.

All the project affected persons (PAPs) including household, shops, business centres, street vendors, etc. had been taken into consideration.

Socioeconomic survey will gather information from those who are the representative of all types of settlements, with different types of land use patterns.

The socioeconomic survey also includes those locations in the area, where shops and other residences tend to be semi-pucca rather than pucca as well as multi-storied buildings.

The survey team tried their best to achieve maximum representation of all types of land uses encountered on existing roadways and give a balanced sample of all kinds of land use found in the project area within their 5 – 10% sampling.

3.2 Collection of Secondary Data

Secondary data were collected from the relevant IEE, EIA reports, meteorological department, Bureau of Statistics, relevant websites, Statistical Yearbook of Bangladesh, etc. The consultant team members also held discussions with the concerned officials of the relevant govt. departments and ChCC with a view to getting better and clearer picture of the socioeconomic aspects.

3.3 Processing and Analysis of Data

Appropriate computer software was used to analyze the data collected from field level. Initial screening of the environmental impact analysis on the basis of field and secondary data has been completed. Detailed environmental and socioeconomic data analyses will be subsequently performed to prepare the EIA report.

Chapter 4. PROJECT DESCRIPTION AND EXISTING CONDITION

4.1 Project Location

The Environmental Impact Assessment for Sagorika-Alankar Crossing is needed for making overpass on this road. Sagorika-Alankar Crossing is situated on Dhaka-Chittagong Highway. Also it is connecting the Port Connecting Road. It has connection to Dhaka Trunk Road and Zakir Hossain Road from right handed side.

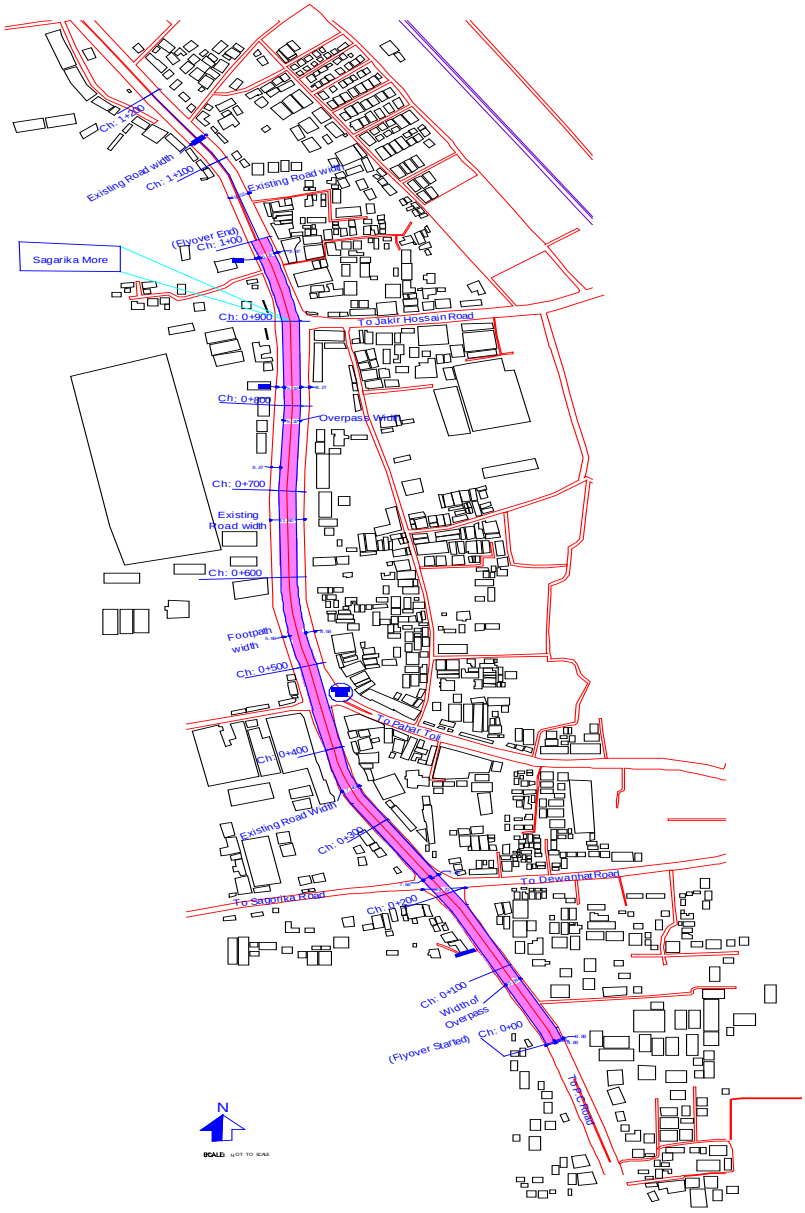


Figure 4-1: Project Location map

4.2 Description of Sagorika- Alankar More Overpass

The location of the proposed Sagorika-Alankar More overpass is selected along Dhaka road through Alankar more via Signboard to Port-Connecting road. Proposed length of this overpass is about 1.2km and it is expected to be a 4-lane overpass to be built by Chittagong City Corporation. There will be two 200m ramps on the both sides of the overpass and the length of the main overpass portion will be 800m. Width of this overpass will be 15.32 m. Existing average road width of the location is about 15.32 m. There exists 2-2.3 m drain and drain cum footpath also along the both sides of the road. From Signboard to Alankar more 4-5.5 m hard shoulder is found beside the both sides of the main road. There are several multi-storied hotels, markets, CNG and fuel stations, textile mills, banks, bus counters and so many tin shade markets found beside the road in the overpass location.

4.3 Existing Road Infrastructures

To connect the National Port with the Capital, Dhaka and other parts of the country, the main communication routes on land – both the railway and the highway pass through the heart of the city creating continuous road blocking and traffic jam in all directions. The present road facilities of Chittagong City may be described in relation to the end points of the roads, average width and lanes, sidewalk and drainage facility with the roads (Table 4-1). Road Pavement of most of the roads is fair to poor. Average vehicular speed is less than 10 km/hr in busy hours and around it.

Table 4-1 : Road Connectivity and Facilities

Sl No	Road Name and length within City	Abbreviat-ed Symbols	Road Connected Towards		Road Width & Lanes		Sidewalk & Drainage	
			North/East	South/West	Width (m)	Lane (Nos.)	Sidewalk (Y/N)	Drainage (Y/N)
1	Dhaka Chittagong Highway	DCH	Chittagong	Dhaka	-----	4	No	No
2	Dhaka Trunk Road	DTR	DCH	STR/ASR	18.5	2 (6)	No	No
3	CDA Avenue	CDA	CAR	DTR	38.3	6	Yes	Yes
4	Cox'x Bazar Road	CBR	AGR	SAB	20.3	2	No	No
5	Hathazari Rangamati Road	HRR	Hathazari	CDA	12.4	2	No	No
6	Chittagong Kaptai Road	CKR	Kaptai	CAR	9.7	2	No	No
7	Arakan Road	CAR	KGB	CDA	23.1	2 (4)	No	No
8	Bayezid Bostami Road	BBR	HRR	CDA	23.6	2	No	Yes
9	Zakir Hossain Road	ZHR	DCH	CDA	17.4	4	No	Yes
10	Railway Road	RLR	ZHR	CDA	13.2	2	No	No
11	P.G. Road	PGR	CDA	DTR	27.9	4	Yes	Yes
12	Tiger Pass Road	TPR	CDA	CDA	20.4	4	Yes	Yes
13	Jublee Road	JUR	NAR	COR	29.7	6	Yes	Yes
14	Port Connecting Road	PCR	DCH	DMR	36.6	2	No	Yes
15	Agrabad Access Road	AAR	SMR	PCR	34.0	2 (4)	No	Yes
16	Patenga Road	PTR	NHR	Embk.	23.3	2 (4)	No	No
17	M.A. Aziz Road	MAR	DMR	NHR	32.7	4	No	No
18	Double Mooring Road	DMR	PCR	SMR	26.3	4	Yes	Yes
19	Sk. Mujib Road	SMR	DTR	DMR	30.1	4	Yes	Yes
20	Air Port Road	APR	NHR	PTR	11.3	2	No	No
21	Sea-port Road	SPR	MAR	NHR	18.2	2	No	No
22	Strand Road	STR	DMR	JUR	11.3	2	No	Yes
23	Batali Hill Road	BHR	----	----	10.1	2	Yes	Yes
24	Nur Ahmed Road	NAR	CSR	JUR	22.0	4	Yes	Yes
25	Court Road	COR	ASR	JUR	17.5	4	Yes	Yes
26	Momin DC Hill Road	MDR	----	-----	13.3	2	Yes	Yes
27	A Sattar Road	ASR	CSR	COR	9.3	2	No	Yes
28	Nowab Sirajuddowla Road	NSR	KGR	COR	10.1	2	No	Yes

Sl No	Road Name and length within City	Abbreviat-ed Symbols	Road Connected Towards		Road Width & Lanes		Sidewalk & Drainage	
			North/East	South/West	Width (m)	Lane (Nos.)	Sidewalk (Y/N)	Drainage (Y/N)
29	Halishahar College Road	HCR	----	----	9.0	2	No	Yes
30	Chatteswari Road	CSR	NAR	KGR	14.0	2	No	Yes
31	O. R. Nizam Road	ONR	----	----	17.1	2	No	Yes
32	Kathal Ganj Road	KGR	----	----	11.4	2	No	Yes
33	K. B. Aman Ali Road	KAR	KGR	AGR	6.9	2	No	Yes
34	Kapash Gola Road	KGR	CDA	CSR	12.1	2	No	Yes
35	Abdul Gafur Road	AGR	CDA	CBR	33.2	2	No	No
36	Shah Amanat Bridge	SAB	CBR	Shikalbaha	7.1	2	Yes	----
37	Kalurghat Bridge	KGB	CAR	Bandarban	3.3	1	No	----
38	Port Access Road	PAR	DCH	Ctg. Port	12.1	2	No	No

4.4 Traffic Count at Sagorika-Alankar More

Traffic Count Survey for 16 hours (6.00 a.m. to 10 p.m.) was done on 3 Nov., 2013 for Sagorika-Alankar More. Are view of the survey is given below.

Table 4-2 : Traffic Count at Sagorika Alanker More

From Baropul to Alankar more:				
Truck	Bus	Car	CNG / Auto Rickshaw	Bicycle / Rickshaw / Van / Push Cart / Animal Cart
6031	3697	4963	10541	10368
From Alankar to Cornelhat road:				
9146	6722	13246	30507	20015

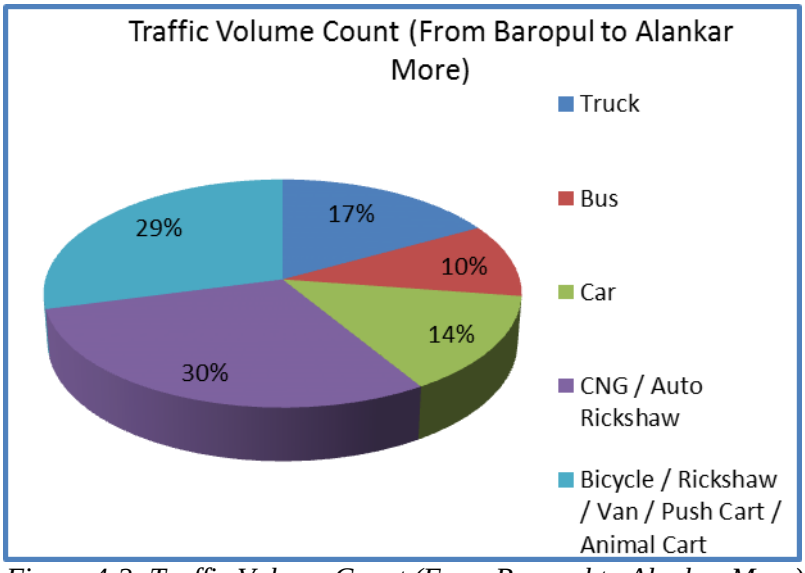


Figure 4-2: Traffic Volume Count (From Baropul to Alankar More)

Around 6031 Trucks, 3697 buses, 4963Cars, 10541 Auto Rickshaws and 10368 non-motorized vehicles run through Baropul to Alankar more daily from 6.00 am to 10.00 pm. From the pie chart above it is revealed that about 17% trucks, 10% buses, 14% cars, 30% auto rickshaws and 29% other non motorized vehicles pass the road daily. Being a public transport, CNG auto rickshaw covers the maximum percentage (about 30%) among others.

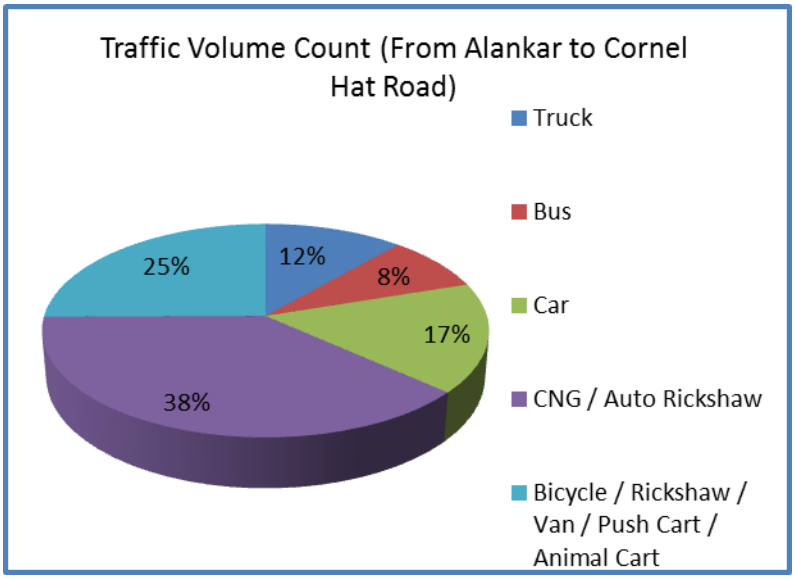


Figure 4-3: Traffic Volume Count (From Alankar to Cornel Hat Road)

Around 9146 Trucks, 6722 Buses, 13246 Cars, 30507 Auto Rickshaws and 20015 non-motorized vehicles move through Baropul to Alankar more daily from 6.00 am to 10.00 pm. From the pie chart above it is found that about 12% trucks, 8% buses, 17% cars, 38% auto rickshaws and 25% other non motorized vehicles pass the road daily. Here also CNG auto rickshaw occupies the maximum percentage (about 38%) of the road among all other types of vehicles.

Chapter 5. DESCRIPTION OF THE ENVIRONMENT

5.1 Physical Environment

5.1.1 Atmosphere/Climate

Typically Chittagong City experiences tropical weather with hot and humid climate. It is characterized by high temperature and heavy rainfall with excessive humidity in the summer season. There are three distinct seasons: pre-monsoon (hot and dry), monsoon (rainy and humid) and post-monsoon (mild winter / cold). The pre-monsoon season starts from March onward up to May. The monsoon begins in June and withdraws in October. It is followed by post-monsoon with characteristic cool and dry weather extending up to February. The monthly mean Sea Level Pressure (SLP) of Chittagong is high in the winter and low in the monsoon season. Chittagong City is vulnerable to a wide range of natural hazards including flashfloods, tropical cyclones, wind-induced storm surges, nor-wasters which originate under intense hot and humid condition during pre-monsoon (March-June)

5.1.2 Temperature

The city experiences variations in minimum and maximum temperature in different seasons as well. The **Table 5-1** indicates six years monthly- annual maximum and minimum temperature since 2000. It reveals that the annual average minimum temperature is 22°C, with lowest minimum in January (15.7°C) and highest minimum in August (26.7°C). The monthly highest and lowest minimum & maximum temperature records for the same periods are given in the same Table. The table reflects that the annual average maximum temperature is 50.9°C with a variation ranging from 50.5°C to 51.4°C. The highest maximum temperature in these six years is 54.4°C and lowest minimum temperature is 11.2 °C.

Table 5-1: Monthly-Yearly Average Maximum & Minimum with Annual Max & Min Temperature (°C) in Chittagong

Name of Months	2000		2001		2002		2005		2004		2005		Average	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	27.8	11.4	27.7	12.7	28.1	15.5	25.8	15.6	26.2	14.8	27.5	14.5	27.2	15.7
February	28.5	16.1	50.4	17.0	51.4	16.5	50.7	17.5	29.4	16.2	50.6	18.4	50.2	16.9
March	50.9	21.4	54.1	22.8	55.2	20.4	51.0	19.6	51.5	21.9	50.9	22.2	51.9	21.4
April	52.1	25.4	55.8	24.8	51.5	25.2	52.7	24.4	51.4	25.9	55.4	24.8	52.5	24.1
May	51.5	24.5	51.5	24.4	51.5	24.1	52.8	24.6	55.6	25.8	55.5	24.7	52.5	24.6
June	51.1	25.2	50.2	25.2	51.5	25.5	29.9	24.9	51.7	25.4	52.9	26.9	51.2	25.5
July	50.5	25.2	50.7	25.1	50.2	25.5	52.1	25.8	50.5	25.5	51.5	25.6	50.8	25.4
August	51.0	25.1	51.9	25.7	51.0	25.1	51.9	25.7	51.7	25.5	50.6	52.9	51.4	26.7
September	51.8	25.1	52.0	25.5	52.4	25.5	51.9	25.5	51.1	25.1	52.6	25.5	51.9	25.5
October	51.6	24.5	52.1	24.7	52.6	25.8	52.9	24.8	52.0	25.6	55.0	24.7	52.5	24.4
November	51.5	19.7	50.4	21.5	50.4	20.9	51.2	18.7	50.8	18.5	50.8	19.5	50.8	19.8
December	28.6	15.0	28.9	15.5	28.0	16.1	28.5	16.2	28.9	16.5	29.0	17.2	28.6	16.0
Annual Average	50.5	21.6	51.1	21.9	51.0	21.8	50.9	21.8	50.7	21.8	51.4	25.1	50.9	22.0
Annual Highest & Lowest	52.6	11.2	55.9	11.6	55.5	15.2	55.0	15.6	55.6	14.0	54.4	15.2	54.4	11.2

Source: Bangladesh Meteorological Department (October, 2005)

The Chittagong city is situated to the southeastern Bangladesh on the northeast bank of Bay of Bengal. The thermal regime of the area is characterized by mild winter with lowest

mean minimum temperature of 14°C and highest maximum temperature of 52.4°C in the month of May **(Table-5-2).** The annual distribution minimum and maximum temperature has been shown in **Figure-5-1**. According to the figure, varying temperature indicates two peaks one in May and the other in September. The high temperature between 50.9 to 52.4°C is maintained from March to October. The high minimum temperature is maintained from 24.8-25.5°C. Amplitude of diurnal variation is low in summer (6-7°C) and high in winter (around 12°C).

Table 5-2: Monthly distribution of Minimum and Maximum Temperature (°C) of Chittagong (lat 22°16' N, long 91°49' E)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmin	14.0	16.4	20.5	25.7	24.8	25.5	25.2	25.2	25.2	24.1	20.5	15.7
Tmax	26.5	28.5	50.9	52.0	52.4	51.5	50.9	51.2	51.7	51.6	29.9	27.1

Source: Bangladesh Meteorological Department; BMD

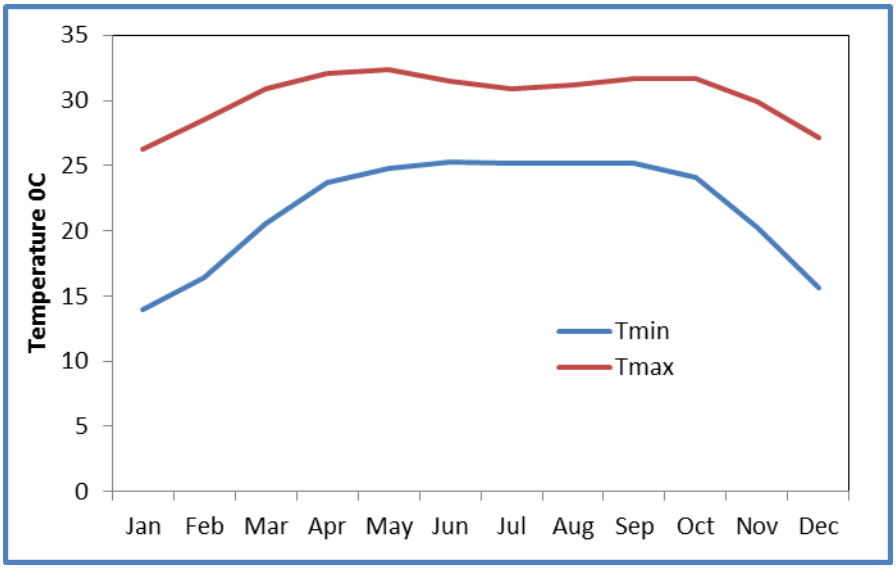


Figure 5-1: Annual distribution of maximum and minimum temperature of Chittagong

Source: Bangladesh Meteorological Department; BMD

5.1.3 Rainfall

Annual rainfall in the city ranges from 2100 mm to 5800 mm in the past 16 years since 1990. Average annual rainfall is 2612 mm. Distribution of monthly rainfall is uneven, heavily skewed towards wet season. More then 80 percent of the total rainfall occurs between June and September. Monthly average rainfall is given in **Table 5-3**. As evident from the **Table 5-3**, monthly average rainfall is very little during cold and dry post-monsoon, ranging from 6 mm to 84 mm. Contrary to that, in the hot and humid monsoon season, rainfall is abundant, ranging from 124 mm to 705 mm per month on the average.

Table 5-3: Monthly-Yearly Total Rainfall (mm) in Chittagong for the Period from January 1990 to December 2004

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1990	0	59	55	250	205	668	1058	115	141	255	74	56	2852
1991	19	0	45	-	-	774	818	557	560	211	99	15	2694
1992	0	119	0	1	127	571	412	280	291	455	4	54	2274
1995	17	71	225	100	667	791	457	658	275	129	14	0	5560
1994	7	8	194	264	208	581	580	597	100	101	20	0	2260
1995	0	12	18	51	268	559	685	546	150	55	5	1	2126
1996	0	106	91	254	251	472	465	584	540	545	5	1	2890
1997	0	52	118	40	270	425	1055	585	550	154	49	0	5014
1998	57	105	97	184	587	151	1291	1216	195	124	95	0	5856
1999	0	0	4	0	465	908	492	862	212	189	24	107	5261
2000	50	0	46	119	577	622	708	559	159	462	15	0	5277
2001	0	7	8	40	455	622	585	258	224	242	81	0	2502
2002	2	0	54	64	516	599	757	456	117	115	154	0	2268
2005	0	0	150	47	171	1179	286	255	209	228	0	66	2591
2004	0	0	5	145	250	595	902	170	548	206	0	0	2819
2005	5	0	57	128	148	287	555	682	416	75	22	0	2575

Source: Bangladesh Meteorological Department (October, 2006)

Figure- 5-2 shows the annual distribution of monthly rainfall for Chittagong city. The highest rainfall of 727 mm occurs in the month of July. The monsoon rainfall begins with the onset of monsoon in the first week of June. The average June rainfall is around 600 mm and that for July is 511 mm. The rainfall of the month of May and September is around 500 mm. The winter months are dry.

The city being situated by the sea to its west receives high annual rainfall (2907 mm) with its highest contribution of 2119 mm (75% of the annual rainfall) in the monsoon season during the months from June-September **(Table-5-4).** Most of the rainfall comes from the activities of southwest monsoon i.e. from the monsoon depressions and cumulus convections which is enhanced by hill topography of the area. Quite occasionally heavy shower causes flash floods and landslides with mud floods over hill areas of the city. The landslides cause high casualties to properties and lives.

The pre-monsoon season (March-May) receives 476 mm of rainfall which is 16.4% of the annual. The post-monsoon rainfall constitutes 275 mm which is 9.5% of the annual. The winter is very dry over the city. The annual distribution of monthly rainfall has been shown based on the meteorological data of Bangladesh.

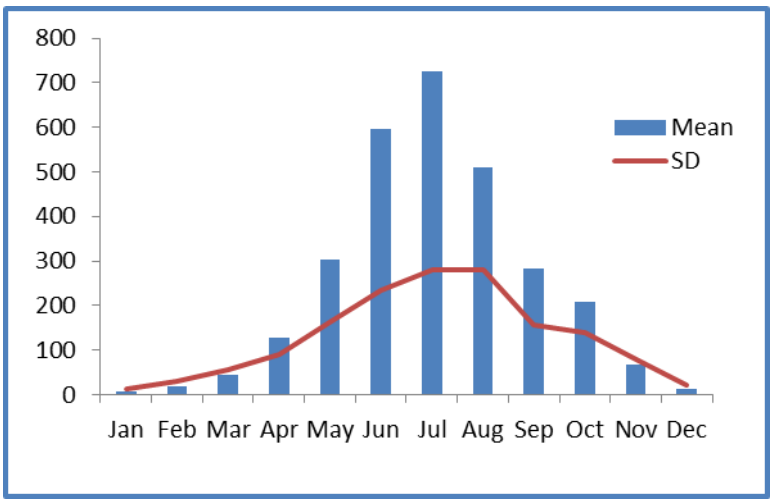


Figure 5-2: Annual distribution of monthly rainfall (mm) of Chittagong City

Source: Bangladesh Meteorological Department; BMD

Table 5-4: Seasonal distribution of rainfall (mm) of Chittagong (lat 22°16' N, long 91°49' E)

	Winter	Pre-monsoon	Monsoon	Post-monsoon	Annual
Rainfall	56.7	476.2	2118.7	275	2907.0
% of Annual	1.5	16.4	72.9	9.5	100.0

Source: Bangladesh Meteorological Department; BMD

5.1.4 Humidity

The monthly average humidity of past six years (2000-2005) of Chittagong city has also been shown in **Table-5-5.** The monthly mean humidity of Chittagong city has been shown in **Table-5-6** with graphical presentation in **Figure-5-3**. It is seen that from May onwards, hot and humid condition creeps in and throughout the wet season, the humidity remains well above 75% until November coinciding with the retreat of monsoon. The high average humidity between 80-86.7 % is observed during the month of May-October. The month January-March show relatively lower humidity (70-74%).

Table 5-5: Monthly-Yearly Average Relative Humidity in % in Chittagong

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	70	62	69	78	84	86	86	87	85	86	78	72	79
2001	65	66	61	75	85	87	87	84	85	85	82	77	78
2002	70	67	64	70	75	77	82	80	75	75	74	69	75
2005	75	66	69	70	72	82	77	76	75	75	62	65	72
2004	71	58	68	72	75	79	85	81	81	75	65	62	72
2005	64	64	74	69	71	78	82	85	80	78	71	72	74
Average	69	64	68	72	76	82	85	82	80	78	72	69	74.6

Source: Bangladesh Meteorological Department (October, 2005)

Table 5-6: Mean monthly humidity (%) at Chittagong

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
72.9	70.6	74.2	78.4	80.5	84.7	86.7	85.9	84.5	82.5	78.8	75.7

Source: Bangladesh Meteorological Department; BMD

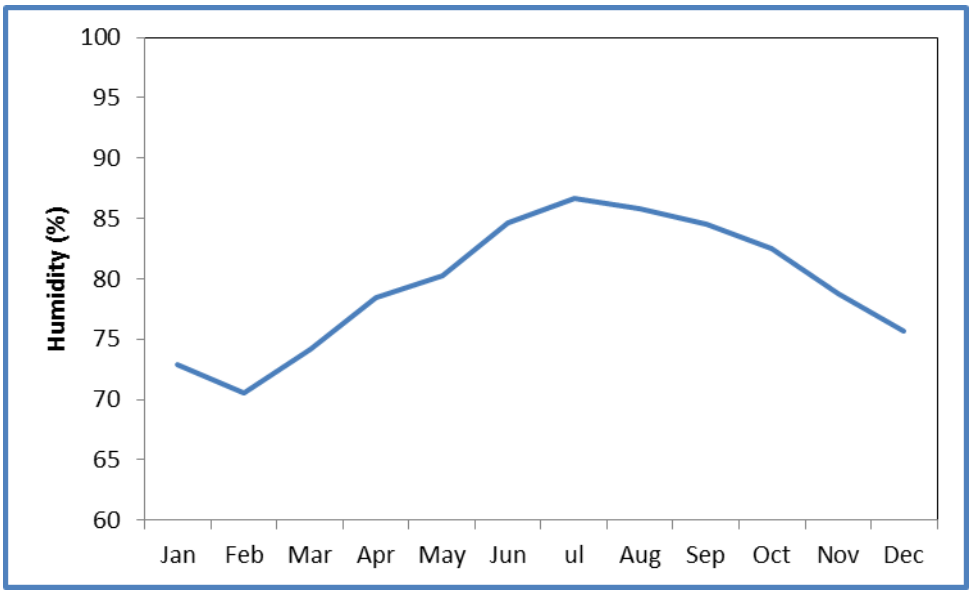


Figure 5-3: Monthly mean humidity at Chittagong

Source: Bangladesh Meteorological Department; BMD

5.1.5 Sea Level Pressure

Table 5-7 shows the monthly and yearly average sea level pressure of previous five years (2000-2004). It shows that from the month November to February the sea level pressure remains higher (1012.9hPa- 1015.4hPa) than any other time of the year.

Table 5-7: Monthly-Yearly Average Sea Level Pressure (hPa) In Chittagong

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	1014.7	1015.5	1011.0	1008.2	1005.7	1004.0	1005.0	1004.5	1007.1	1009.0	1015.5	1014.7	1009.0
2001	1014.2	1012.5	1011.5	1009.8	1005.5	1002.7	1005.1	1005.9	1007.6	1010.6	1014.5	1017.0	1009.4
2002	1015.8	1015.9	1011.9	1010.1	1005.5	1004.2	1005.0	1004.2	1008.1	1007.5	1012.0	1015.5	1009.5
2005	1016.9	1014.7	1012.5	1009.8	1006.5	1005.0	1004.8	1004.8	1007.1	1011.4	1014.4	1016.0	1010.1
2004	1015.6	1014.2	1011.4	1009.5	1005.5	1004.5	1004.5	1005.5	1008.2	1008.9	1010.5	1015.5	1009.5
Average	1015.4	1014.2	1011.6	1009.5	1005.7	1005.6	1005.7	1004.1	1007.6	1009.5	1012.9	1015.7	1009.4

Source: Bangladesh Meteorological Department (October, 2005)

The **Figure-5-4** demonstrates the monthly mean Sea Level Pressure (SLP) of Chittagong which exhibits high pressure in the winter and low pressure in the monsoon season with the lowest in June and July with mean SLP of around 1002 hPa). The monsoon low pressure is associated with semi-permanent monsoon trough. The monsoon depressions are formed in the head of the Bay of Bengal with central pressure of around 995 hPa. The heavy rainfall occurs in Chittagong areas in the situation of depression and strong convection.

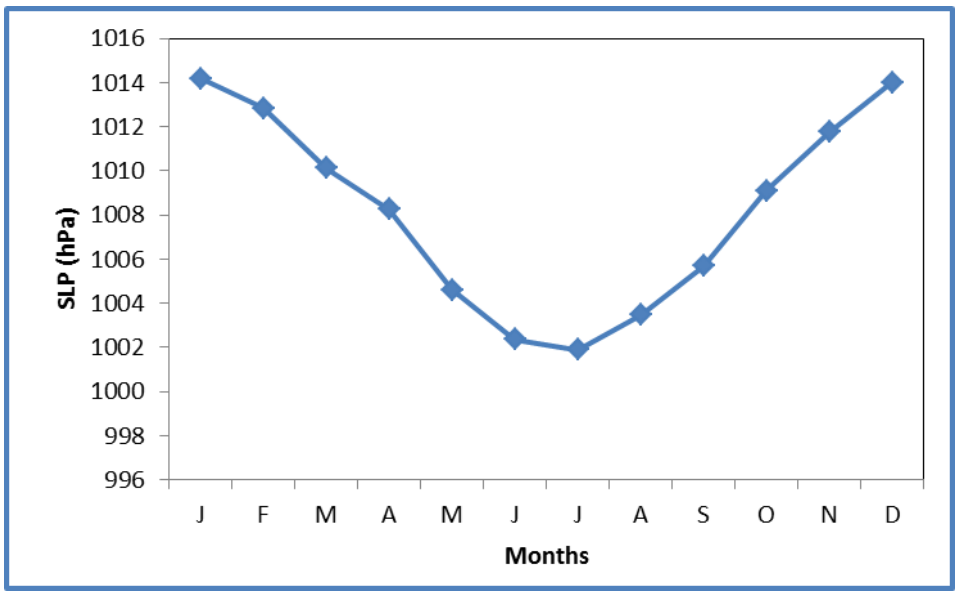


Figure 5-4: Sea Level Pressure of Chittagong

Source: Bangladesh Meteorological Department; BMD

5.1.6 Wind Speed and Direction

The monthly maximum and monthly average wind speed (Knots/Hour) of the years 2000-2004 are given in the **Table 5-8 and Table 5-9** respectively. The wind speed varies between 4.2 knots to 12.6 knots, November registering the lowest and May the highest (**Table 5-8**). The cool and dry season from November to February keeps wind speed low and from March onward with rising temperature, causes wind speed to gain momentum. Throughout the winter season (Nov-Feb), prevailing wind direction remains northward, March being the transition period, wind direction becomes erratic followed by relatively stable southward wind direction from April to September (**Table 5-9**).

Table 5-8: Monthly Maximum Wind Speed in Knots/Hour and Direction in Degrees

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	Dir
2000	7	270	6	050	14	180	12	210	14	150	10	180	16	160	12	180	8	160	15	180	6	560	6	560
2001	6	560	11	180	6	210	12	180	15	510	8	140	8	180	8	180	6	210	5	180	5	560	5	540
2002	8	560	7	520	12	180	12	560	15	180	10	190	9	180	10	180	6	150	4	290	4	150	10	050
2005	4	510	4	560	14	520	8	180	12	180	12	180	10	170	8	180	7	190	6	180	2	560	4	180
2004	5	560	5	560	8	180	15	180	9	180	8	180	8	180	6	180	6	180	6	050	4	150	5	560
Average	5.6		6.6		10.8		11.8		12.6		9.6		10.2		8.8		6.6		7.2		4.2		5.6	

spd-speed(knots/h),dir-direction

Source: Bangladesh Meteorological Department (October, 2005)

Table 5-9 : Monthly Average Wind Speed in Knots/Hour and Direction in Alphabetically

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	Spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	dir	spd	Dir
2000	2.5	N	2.7	N	4.4	S	5.1	S	5.5	S	5.9	S	4.4	SSE	5.5	S	2.8	S	4.4	S	2.5	N	2.2	N
2001	2.6	N	2.8	N	2.5	N	4.6	S	2.9	S	5.0	S	5.1	S	2.8	S	2.6	S	2.2	N	2.4	N	1.7	N
2002	2.7	N	2.6	N	4.8	S	5.5	S	4.1	S	2.9	S	2.5	S	2.7	S	2.5	S	2.5	S	1.9	N	1.8	N
2005	1.7	N	1.9	N	2.7	W	5.2	S	5.9	S	2.8	S	5.0	S	5.0	S	2.5	S	1.8	NW	1.4	N	1.9	N
2004	1.9	N	2.4	N	5.8	S	5.6	S	2.9	S	2.8	S	5.1	S	2.5	S	2.6	S	2.9	S	2.5	NW	2.9	SW
Average	2.5		2.5		5.6		4.4		5.5		5.1		5.2		2.9		2.6		2.7		2.1		2.1	

spd- speed(knots/h), dir- direction

Source: Bangladesh Meteorological Department (October, 2005)

The mean monthly wind speed and mean monthly maximum wind speed have been shown in **Table-5-10** with prevailing wind direction. It is seen that mean monthly wind speed

varies from 4.0 km/hr in December to 10.4 km/hour in June. The mean monthly maximum wind speed varies 8.5 km/hour in December to 19.1 km/hour in May. For most of the period, the direction of the wind is S/SE/SW except for the winter when the wind direction is N/NE/NW. It is well that the Chittagong area is highly vulnerable to deadly tropical cyclones. The wind speed of tropical cyclones of super cyclonic intensity may range from 210 and above. The 1991 April 29, 1991 cyclone attained the wind speed of around 250 km/hr.

Table 5-10: Mean monthly wind speed and mean monthly maximum wind speed at Chittagong (Unit: km/hour)

Wind speed and Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Mean Wind Speed	4.7	6.1	8.8	10.4	8.9	10.4	10.0	8.5	7.5	6.0	4.2	4.0
Mean Monthly Maximum Wind Speed	9.7	15.2	15.1	16.6	19.1	18.5	17.5	15.9	14.4	15.5	12.0	8.5
Prevailing Wind Direction	NW	NE	S/SW	S/SW	S/SE/SW	S/SE	S/SE	SE	SE	SE	N/NE	N/NE

Source: Bangladesh Meteorological Department; BMD

5.1.7 Tropical cyclone and storm surges

The Chittagong city is vulnerable to the impacts of tropical cyclones and associated storm surges. The tropical cyclones of the Bay of Bengal attain wind speed as high as 250 km/hour. The statistical analysis of the land-falling cyclones to Bangladesh shows that 15 cyclones hit the Noakhali-Chittagong coast 1961-2010 which affected the Chittagong city and the surrounding areas. This comprised 26% of the total cyclones numbering 57 that hit Bangladesh coast during this period. The April 29, 1991 cyclone was one the severest cyclones that hit Chittagong, the storm surge of which was as high as 8 m or more. The tropical cyclone of May 29, 1991 was also a super cyclone with wind speed of 210 km/hour, but the storm surge was relatively low (4.6 m). The reason why the storm surge was low is that the cyclone hit the coast at low water condition of astronomical tide.

Catastrophic events like the cyclones and storm surges of 1970 and 1991 were rare events, other hazards occur in the city almost every year. The major Cyclonic Storms and Tidal Surges affecting project area between 1985 and 1988 are presented in the **Table 5-11**.

Coastal erosion is a localized problem of the city along its southwestern coast. Protective measures like concrete-blocks and RC embankment were constructed at some selected sites like Patenga Coast and Chittagong Port along both banks of the Karnaphuli River.

Table 5-11: Major Cyclonic Storms & Tidal Surges Affecting Project Area between 1985 and 1998

Date	Landfall	Max. Wind Speed in km/hr	Storm Surge height in feet	Affected Area
14-15/10/85	Near estuary of Feni River	95	-	Chittagong, Noakhali & off-shore islands
5-9/11/85	Cox's Bazar	156	5	Chittagong, Cox's Bazar, Noakhali, Patuakhali, & Barisal
24-25/05/85	Near estuary of Feni River	155	15	Cox's Bazar, Chittagong, Noakhali & off-shore islands
25-29/04/91	Cox's Bazar	225	22	Cox's Bazar, Chittagong,

Date	Landfall	Max. Wind Speed in km/hr	Storm Surge height in feet	Affected Area
				Noakhali, Patuakhali & Barisal
51/05/91	Near Meghna estuary	110	6	Barisal, Patuakhali, Noakhali, Chittagong & off-shore islands
17-19/05/92	Cox's Bazar	90	-	Cox's Bazar, Chittagong & off-shore islands
16-19/05/97	Sitakunda	220	10	Bhola, Noakhali, Chittagong, Cox's Bazar & off-shore islands
25-27/09/97	Sitakunda	150	10	Bhola, Noakhali, Chittagong, Cox's Bazar & off-shore islands
16-20/05/98	Sitakunda	120	8	Noakhali, Chittagong, Cox's Bazar & off-shore islands

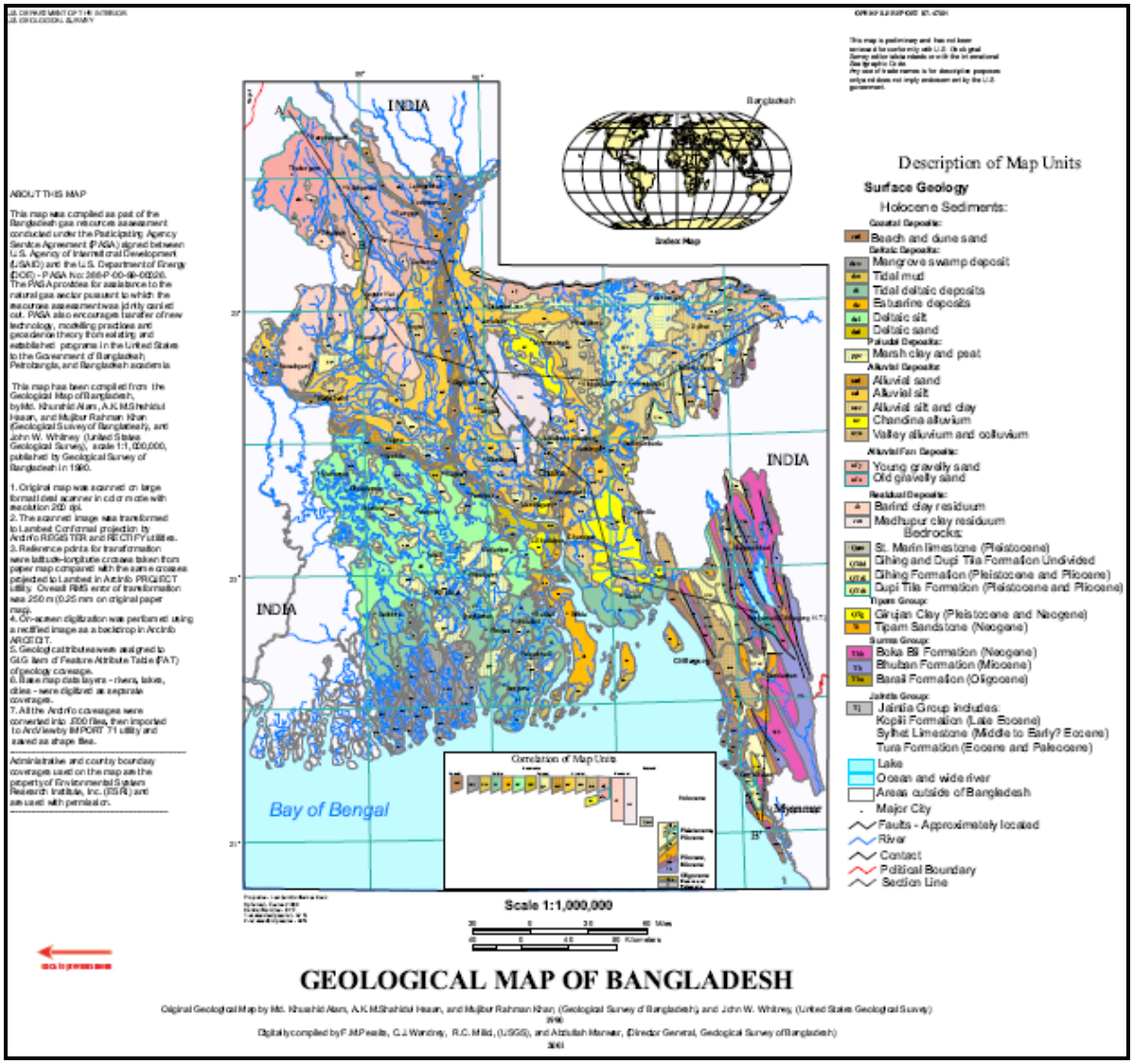
Source: Bangladesh Meteorology Department

5.2 Geology

5.2.1 Topography

The physical landscape of the Chittagong City is influenced by its hilly topography. It is bordered by the Karnaphuli River in the South and the Bay of Bengal in the west, hills in the north and flood and coastal plain in the middle part of the city extending in north-south direction. The coastal plain occupying the Southern and Southeastern part is about 2-4 meters above sea level and is susceptible to cyclonic storm surges.

Unlike cyclones, seasonal flooding is a problem along the eastern and southeastern part of the city. Flash floods during April-May and sometimes, in July-August cause damage to agriculture and sub-urban areas along the city peripheries. However, floodwater does not stay for more than a week. Besides flash floods, surface run-off generated by excessive rainfall during wet seasons, submerges a number of sites in the city with stagnant water.



Source: Geological survey of Bangladesh (GSB)
Figure 5-5: Geological Map of Bangladesh,

5.2.2 Tectonic Framework of Bangladesh

Tectonic Framework refers to the basic structural frame on which Bangladesh stands. It is essential to have a clear conception about the tectonic framework of Bangladesh in order to evaluate the geological formations of the area.

Bangladesh is divided into two major tectonic units: i) Stable Pre-Cambrian Platform in the northwest, and ii) Geosynclinals basin in the southeast. A third unit, a narrow northeast-southwest trending zone called the hinge zone separates the above two units almost through the middle of the country. This hinge zone is currently known as *palaeo continental slope*.

Geosynclinal Basin in the southeast is characterized by the huge thickness (maximum of about 20 km near the basin centre) of clastic sedimentary rocks, mostly sandstone and shale of Tertiary age. It occupies the greater Dhaka-Faridpur-Noakhali-Sylhet [Silet]-Comilla [Kumilla]-Chittagong areas. The huge thickness of sediments in the basin is a

result of tectonic mobility or instability of the areas causing rapid subsidence and sedimentation in a relatively short span of geologic time. The geosynclinal basin is subdivided into two parts i.e. fold belt in the east and a foredeep to the west.

Folded Belt represents the most prominent tectonic element of Bengal Foredeep with general sub-meridional trending hills parallel to the Arakan Yoma Folded System. Folded belt extends within Bangladesh for 450 km (N-S) and about 150 km wide covering an area of 55,000 sq km of on-shore area. A large number of narrow, elongated N-S trending folds of the eastern part of Bangladesh (Sylhet and Chittagong Divisions), Tripura, southern part of Assam, Mizoram and Myanmar territory adjacent to S-E of the Chittagong Hill Tracts occupy the Folded Belt west of the Arakan Yoma Folded System. The folds are characterized by ridge forming, box-like in cross section, high amplitude with variable width and lie en-echelon with the adjacent structures. The elevation of these elongated anticlinal folds in Bangladesh ranges from 100 -1,000m. Some of the structures are faulted and thrusted and the intensity of folding increases gradually from west to east. Consequently, the structures of the eastern part are tightly folded, faulted and thrusted with narrower synclines between them.

5.2.3 Seismic Vulnerability of Chittagong

The country's biggest dam and hydropower plant in Kapti is located not very far away from the city. But due to its geographical location, Chittagong city is located in a very disaster prone area. People of this area face different kinds of disasters like floods, cyclone and tornadoes at regular intervals. People are used to these kinds of hazards; Earthquake in Chittagong, even in Bangladesh has not yet been recognized as a serious natural disaster. So, people are not at all aware of it and also they are not prepared to face this hazard. Recent repeated earthquakes in greater Chittagong area (Ansary et. Al., 2001; Ansary and Sadek, 2006; Karim, 2005, Khan, 2005) have generated a potential threat and raised a great concern among the people of the country, especially among those around Chittagong region.

Tectonically Chittagong occupies a part of western margin of Tripura-Chittagng Folded Belt (Alam et al, 1990). The trend of this folded belt is in the NNW-SSE direction, and fold are frequently dislocated or faulted (Matin et. El. 1985) longitudinally or transversely to the strike Chittagong city is located in the plunging zone of the Sitakunda asymmetrical anticline (Muminullah, 1978). This anticline is stretched up to the Feni River from the city area. The axis of the fold is to the NW-SSE direction, parallel to the general trend of regional strike, along the Chittagong-Dhaka Trunk Road.

The asymmetrical plunging anticline has steeper western flank and gently dipping eastern flank. The western flank merges abruptly into alluvium due to a major fault parallel to the axis. The folded sediments are highly twisted and distorted in the plunge area around the city (Muminullah, 1978). There are major faults having evidence of vertical movements, and the minor faults having no evidence of vertical movement, but can be inferred from the lineament and orientation of the valleys. A regional fault in the west runs in the NNW-SSE direction, parallel to the strike fold and the Chittagong-Dhaka Trunk road. This fault (Sitakunda fault) extends further south and cuts the hills around Marine Academy on the south-em bank Karnaphuli River. Another fault, which runs parallel to Pass Road, is named as Tiger Pass fault. The Mio-Plioceene hills are elevated form the adjacent plains of fluviotidal complex due to this faulting. The trend of this fault is in the NW-SE direction and it cuts the regional fault in the west at an angle of 55°. The other major fault named as

Karnaphuli fault runs in the NW-Se direction, this fault has elevated the Marine Academy Hills from the adjacent Karnaphuli flood plains. The Karnaphuli River flows through a graben, restricted by the Tiger Pass fault and the Karnaphuli fault. Numerous lineaments and fractures have been developed across or parallel to the bedding plane during the development of the main faults.

The fluviotidal complex of the study area is formed of very recent non-cohesive, homogenous, saturated clays silt and equi-granular line sand deposited on Tertiary-Neocene bedrock. The engineering properties of the alluvial sequence indicate that the soil stratum has a very low unconfined compressive strength and moderately high liquid limit, a wide range of plasticity index and the ground water level is near the surface. The seismic properties of the vertical sedimentary sequence in the fluviotidal complex indicate that the soft alluvium may amplify some components of seismic energy.

5.2.4 Seismicity Records of Chittagong

The study area is located in the Tripura-Chittagong Fold Belt (Alam et.al. 1990), where a thick sedimentary sequence deposited through Tertiary to Pleistocene age, which have been folded during the Himalayan organic movements (Krishnan, 1982). During this long geological time the area has experienced a varied environment due to the transgression and regression of sea. The area occupies most of the plunge area of Sitakunda Anticline and the plunge area is cut by Sitakunda fault, Tiger Pass fault and Karnaphuli fault. It is also observed that the older sediments are severely joined and fractured indicating dissipation of accumulated energy. According to the Bangladesh national Building Code (1995), Chittagong City is located in Zone-2 with peak ground acceleration (PGA) value of 0.15g.

Chittagong has a long history of earthquakes. There are hundreds of evidence of earthquakes that jolted Chittagong and its surrounding areas. One of the largest earthquake in history occurred in 1762 at Arakan in the southern part of Chittagong division. Although the magnitude could not be recorded at that time but it caused heavy damages. It also triggered the earliest documented tsunami in the Bay of Bengal. Another big earthquake occurred in 1869 with a surface-wave magnitude of 7.5 at Cachar, Asam. This was also strongly felt in the whole Chittagong division. The 1912 Mandalay earthquake with a surface-wave magnitude of 7.9 was strong felt in Chittagong. The 1950 Assam earthquake with a magnitude of 8.6 was also strong felt in the city and its surrounding areas.

If we look at the recent time we find that since 1996 till to date, the Chittagong region, close to Myanmar border, has experienced more than 200 light and moderate earthquakes (Karmakar, 2005). The 1997 Jaintapur earthquake in the border of India and Bangladesh occurred with a magnitude of 5.6. It was felt mainly in Chittagong and also in Rangpur, Sylhet and Meghalya. In 21st November 1997, a magnitude 5.7 earthquake which occurred in the border of India and Bangladesh shook Chittagong city. This quake was felt throughout the country. But Chittagong had the most destructive effect. One five storied RCC building collapsed in this incident and 25 people were killed. On 22nd July, 1999 another earthquake of magnitude 5.2 took place in Moheshkhali Island of Chittagong division. This quake was followed by few aftershocks and caused widespread damage in which at least six people were killed and more than five hundred were injured. Cracks were developed in the concrete structures of cyclone shelters and there was considerable damage of mud houses.

The recent earthquake that jolted Chittagong city and the adjoining hill districts occurred on 27th July, 2005. The magnitude of this earthquake was 5.6 (surface-wave magnitude). Its epicenter was at Kalabunia village of Barkal upazila of Rangamati district.

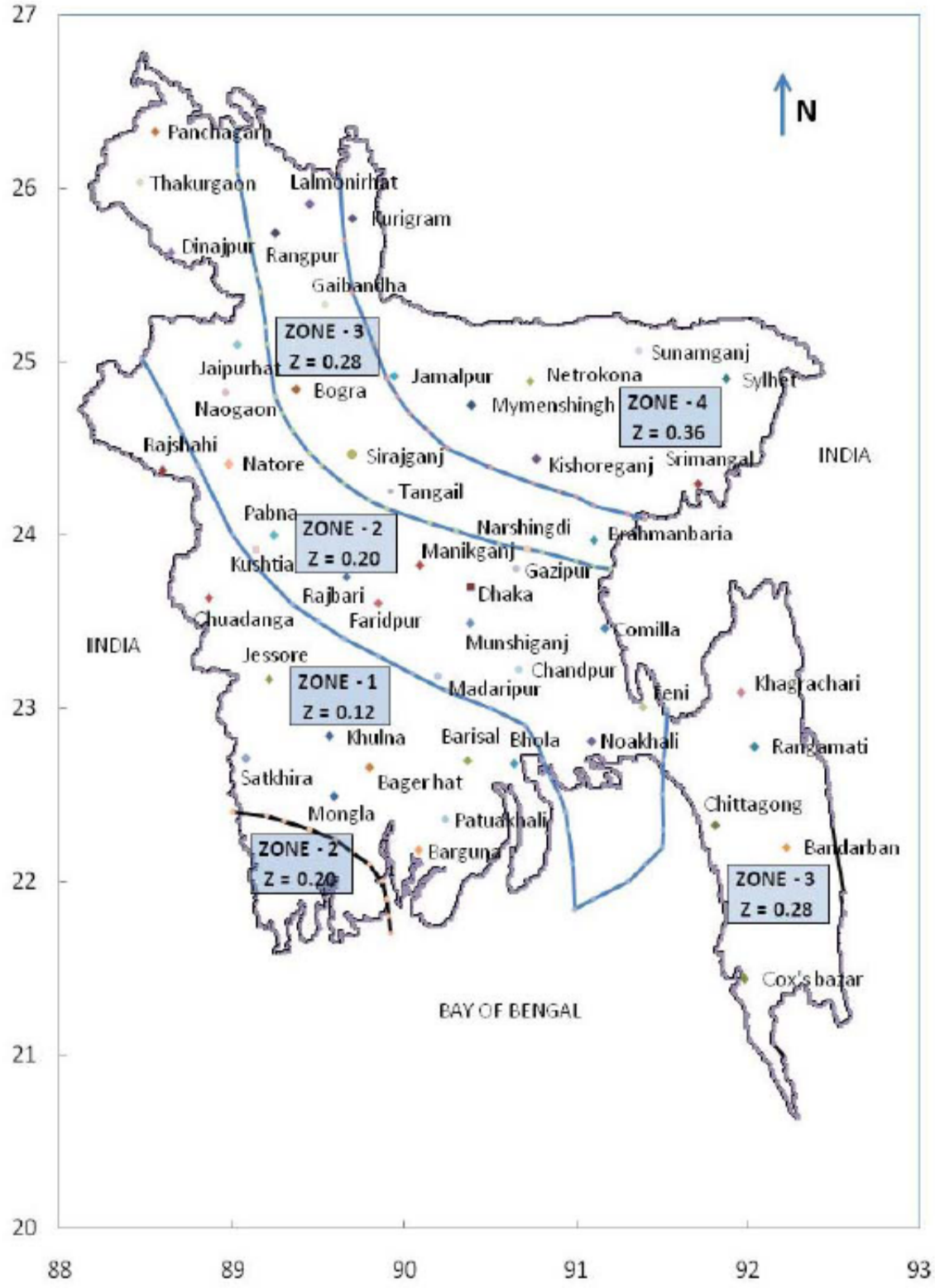
5.2.5 Seismic Zones

Seismic Zoning Map of BNBC 1993 has divided Bangladesh into three seismic zones based on the vulnerability to earthquakes and possible severity of damage. According to this map, Chittagong and its surroundings are located in Seismic Zone 2, the moderate risk hazards zone. Geotectonic movement in and around the city has been reportedly wide. The boundaries of the tract to the west, south and east are characterized by step faulting. Chittagong city area does not show any surface folding. Large numbers of faults and lineaments have N–S, E–W, NE–SW, NW–SE trends recognized from air photo interpretation and the nature of the steam courses. All four sides of the city are bounded by major faults.

Source : Bangladesh National Building Code, 1993

Figure 5-6: Seismic Zoning Map of Bangladesh as in 1993

BNBC has been revised in 2013. In the map of seismic zones of Bangladesh, Bangladesh has been divided into four parts. Chittagong city falls under zone 5 with Z value of 0.28.



Source: BNBC Revised 2013 **Fig. 2.5.1: Seismic Zoning Map of Bangladesh**

Figure 5-7: Seismic Zoning Map of Bangladesh as in 2013

5.2.6 Soil

Soil can be described in many different ways. One can define soil by its physical composition. That is presented in **Table 5-12** to show how varied it is around the project area. Soil classification used in the table is largely relevant to the farmers. For road and embankment construction, the soils utilized are available in dunes of Chittagong coast and in the estuarine Channel near Karnaphuli River.

Table 5-12: Soil Type and their Distribution

General Soil Type	**Features**	**Prominent exposure over Chittagong City**
Brown Hill soils	Brown sandy loams to clay loam slightly to strongly acid	Worth Eastern Part of Chittagong
Piedmont Soil		
Grey Piedmont Soil	Structured Grey sandy loams to clays, strongly acid, developed in piedmont outwash in the piedmont aprons and valleys in areas adjoining or within the North Eastern hilly region.	Valleys of Chittagong North Eastern hills
Brown Piedmont Soil	Sandy and clay loam, strongly acidic, constituting upper part of valleys	Upper part of valleys of Chittagong hills
Calcareous Flood Plain Soils		
Calcareous Grey Flood Plan Soil	Structured Grey silt loams to silty clays, calcareous from the surface or at shallow depths, turns saline in dry seasons in coastal tracts	Coastal area of Chittagong partly linked with riverine flood plain
Calcareous Alluvium	Lose sandy and silty stratified, massive in the older sections of flood plain, slow presence of calcites neutral to alkaline in coastal area	Coastal area of Chittagong partly linked with riverine flood plain.
Non-Calcareous Alluvium	Lose sandy & silt, stratified massive in the older flood plains, neutral to alkaline	Inner part in between hills and coasts of Chittagong

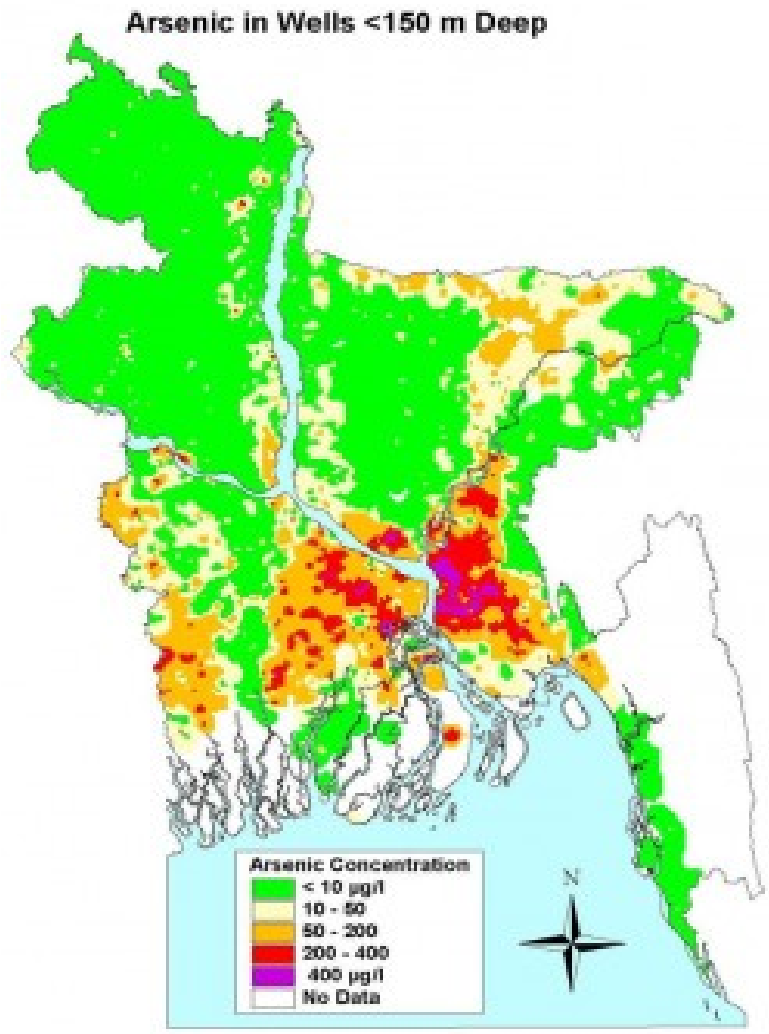
Source: Soil Resource Development Institute (SRDU), Ministry of Agricultures, Dhaka

The soils of Chittagong sub-region resemble Grey Floodplain soils, but are medium to strongly acid throughout, and are more prominently mixed with soils of redder colour in the sub soil.

5.2.7 Surface and Groundwater Quality

Surface water of the city and its surroundings is being polluted by indiscriminate disposal of untreated municipal and industrial wastes in swamps and natural channels in and around the city.

Groundwater withdrawal has increased more than 900% over the last 50 years resulting in lowering of the water table by 20 meter. Recent studies show that the level of ground water has been decreasing by an alarming rate of 2 – 5 meters per year. Though arsenic contamination are critical in some areas in Bangladesh, fortunately arsenic contamination in groundwater of Chittagong city has not been identified yet (Figure 5-8).



Source: Bangladesh Maps & Satellite Images, Harvard University

Figure 5-8: Arsenic Contamination in Wells in Bangladesh

5.2.8 Quality of Air

The main pollutants emitted from the vehicle exhausts (particulate matters, hydrocarbon, carbon monoxide, carbon dioxide, oxides of nitrogen, etc.) disperse widely into the atmosphere and their concentration reduces rapidly with distance from the road. The highest concentrations of CO, CO_2 and HC are encountered in congested slow moving traffic; whilst the highest emissions of NO_X are encountered whilst driving at high speed. It is obvious that Chittagong city is likely to have serious air pollutants in its more congested areas, especially at New Market, Bahaddarhat, Dewanhat, Sagarika locations. However, the pollution level will be little lower in the overpass study area. In fact no instrumented monitoring results are found for the project area under study.

5.2.9 Noise and Vibration

Noise and vibration generation in the project area is mainly due to the traffic movements on the road connecting the point of intersection. Noises are generated by the engine, exhaust system and transmission, and are the dominant noise source when traffic is not

flowing freely, particularly from heavy vehicles. The factors which influence a basic traffic noise level are traffic flow, speed and mode of transports, road gradient and road surface characteristics. The noise level at a particular reception point will also be affected by other factors among which are distance from the noise source, the nature of the intervening ground surface and the presence of obstructions. Therefore, noise level will vary dependent on vehicle speed and condition of road surface and other sources.

Existing noise level data within the study area is not available. The monitored data will be used in the EIA report for formulation of mitigation measures for attenuation of noise at the sensitive sites of the project area.

Similarly, data on vibration due to traffic movement is also not available. Traffic vibration is a low frequency disturbance producing physical movement in buildings and their occupants. Generally vibration transmits through the air or through ground. Measurement of vibration is in terms of Peak Particle Velocities (PPVs), which is equal to the maximum speed of movement of a point in the ground during the passage of a vibration. It is noted that the traffic vibration of a level of 0.2 mm/s PPV measured on the floor in a vertical direction is generally imperceptible. At about 0.5 mm/s, the vibration is perceptible and may become disturbing or annoying at higher levels. Therefore, construction of the overpass may cause vibration impact to nearby high rise buildings along side the overpass during the construction as well as in the operational stage.

5.3 Biological Environment

5.3.1 Trees and Vegetation in the project site

Trees and vegetation in Bangladesh represent an important natural resource and provide people with fuel, timber, food, fodder and shade. In the project area, no natural forest and significant vegetation including trees are found. Only a few numbers of roadside trees and vegetation are present within the proposed alignment of the overpass. There are some big trees of different types planted in the project impacted zone outside the right of way of the roadways which will be affected by the project if additional land acquisition is required.

Various types of trees of all sizes from large mature trees to saplings are found outside the proposed of the overpass. A few numbers of garden trees such as patabahar (*Codiaeum variegatum)*, bokul (*Mimusops elengi)* as well as debdaru (*Polyalthia longifolia)*, shishu (*Dalbergia sissoo)*, mahogany (*Swietenia macrophylla)*, etc. are found in the road median strip. Detailed survey of the trees and vegetation falling within the right of way of the proposed flyover will be performed in the design phase and will be included in the EIA report.

Very few trees and vegetation are found due to rapid urbanization in the surrounding area. Some timber trees like Babla (*Acacia nilotica*), Shishu (*Dalbergia sissoo)*, Mahogany (*Swietenia macrophylla)*, etc. and fruit trees like Mango (*Mangifera indica)*, Jackfruit (*Artocarpus heterophyllus*), Litchi (*Litchi chinensis)*, etc. are found within the impacted zone.

5.3.2 Natural and Domesticated Flora in Chittagong city

There is hardly any forest land that is outside the control of the Government. But all habitations are clothed with many varieties of domesticated vegetation other than agricultural crops.

Varieties of trees are found in the social afforestation that exists in both sides of the embankment. Nearly every Mahallah is clothed by trees. Apart from shade these provide to

keep the ambience cooler, these cut down the impacts of fierce cyclonic storms and offer many useful material. The vegetative resources also come from water covered areas. One need not consider the water bodies, seasonal or annual, as hindrance to well being. Floating nacrophytes like Kachuripana (*Echihornia crassipes*) Topapana (*Pista stratiotes*), and Khudipana (*Lemna perpusilla*) are extensively converted into mulching materials to improve soil structure. Some parts of the harvested microphytes are used as fodder. Shapla (*Nymphaea nouchali*), Paclma (*Nelmbo nucifera*) rare in Chittagong, Kalmi (*Ipoemia aquatica*), Helencha (*Enhydra fluctutanus*), etc.

The range of cultivated vegetation is also large on account of topographic variations. The Department of Environment (DoE) of the Government of Bangladesh has defined the land levels in relation of flooding as noted in **Table 5-15**.

Table 5-13: Land Levels in Relation to Flooding

Land Level	Characteristics	Flood Water Level (FWL)
High land (H)	Land which is above normal flood level	FWL <900 mm
Medium High land (MH)	Land which is normally flooded about 900 mm during the flood season	FWL = 900 mm
Medium Low land (ML)	Land which is normally flooded between 900 mm to 1800 mm deep during the flood season	900 mm <FWL <1800 mm
Low land (L)	Land which is normally flooded between 1800 mm to 5000 mm deep during the flood season	1800 mm <FWL <5000 mm
Very Low land (VL)	Land which is normally flooded deeper the 5000 mm during flood season.	FWL >5000 mm

Source: Bangladesh Meteorological Department, BMD

The DoE has noted the following relationship between crops and local hydrology & topography:

On High land : Suitable for perennial dry land crops in permeable soils- Aug and Aman paddy can be cultivated in bunds are made to retain rein water on fields. Ward 41, 57 and 26 have such high lands.

On Medium High land: Suitable for crops which can withstand and grow under shallow flooding. Species such as Aus paddy, Jute and aman paddy can be cultivated under this condition- Early kharif dry land crops which mature before the onset of flooding can be cultivated on permeable soils, and late Kharif and early rabi dry and crops on soils which drain in September-October. Similar condition is found in some portion of ward 41, 57 and 26.

On Medium Low land: Mixed broadcast aus & deep water aman can be cropped. This type of land & cultivation is absent in the project area except in some borrow pit near the coastal embankment.

On Low land: Deep water aman can be cultivated. This type of land is also absent in the project area for cultivation.

On Very Low land: Generally suitable for cultivation of irrigated boro paddy. This type of land in absent in the project area for cultivation.

5.3.3 Natural & Domesticated Fauna in Chittagong city

Mainly due to advancing human habitat, a large variety of natural animals has become extinct. Many other are endangered. These have been listed by the Ministry of Environment and Forest, none of which are found near the project site. The coastal low lands in sea side and swamps found in the region where sometimes some migratory birds come in winter season.

Domestication of animals and birds was a source of income in the project area which will now really be in danger due to anticipated scarcity of fodder and natural feeds due to project implementation.

5.3.4 Wildlife and Endangered Species

No wildlife habitats are available in the project site as these areas are already under stress from human habitations. Declining forest cover coupled with unplanned hill cutting and fragmentation of habitat through infrastructure development initiatives, both public and private, caused the very rapid transformation of local habitats of these species. Species like, mayna (*Acridotheres ginginianus*), tia, crow are still common.

Rapid urbanization has transformed the otherwise dark night into day, thereby threatening the existence of nocturnal species like bats, owls (*Bubo nipalensis*), foxes, and jackals.
Aside from the above, it is noted that there are records of observations of three migratory waterfowl species that are cited as critically endangered species. Those are reported to come at Patenga Beach or some where else on chars along the coast of the Bay of Bengal and stay in winter season (September through March).

The ecological resources of the project area comprise of different environmental entities, like trees and vegetation, fisheries, wetland and aquatic biology, and sensitive areas.

5.3.5 Wetland and Aquatic Wildlife

There is no wetland in the project site. As the wetlands falling within the project area are not defined, the aquatic biology of the area is not so important from conservation point of view.

5.3.6 Environmentally Sensitive and Protected Area

There is no declared environmentally sensitive and protected area in the proposed implementation site of the flyover.

5.4 Social Environment

5.4.1 Population and Community

The population of Chittagong City stood at 4,009,425 in 2011. A look at population growth rates shows that growth was small in built-up areas, as might be expected owing to the already high concentration of people in the areas. This trend is expected to become increasingly stronger hereafter, with population in areas adjacent to the built-up area continuing to rise at the same time that population also expands in areas outside the city perimeter, thereby resulting in the outward spread of population.

Table 5-14: Population in Chittagong City Corporation

Administrative Unit *Residence* Community	Area in Acres	Total Households	Population			Population density [sq. km]
			Total	In Households	Floating	
1	2	5	4	5	6	7
Kotwali Thana Total	1898	65671	519972	518008	1964	41660
Ward No-15 Total		10672	51605	51455	170	
Ward No-16 (Part) Total		9505	49065	49065	0	
Ward No-20 Total		6958	52655	52650	5	
Ward No-21 Total		7975	40014	40014	0	
Ward No-22 Total		7864	55454	55454	0	
Ward No-51 Total		5485	17857	16208	1649	
Ward No-52 Total		4284	24425	24417	6	
Ward No-55 Total		5774	26620	26620	0	
Ward No-54 Total		7457	54855	54699	156	
Ward No-55 (Part) Total		1901	7468	7468	0	
Pahartali Thana Total	5289	42024	190657	190504	155	14524
Pahartali Thana		42024	190657	190504	155	
Ward No-10 Total		9147	41685	41559	126	
Ward No-11 (Part) Total		17090	75516	75516	0	
Ward No-12 Total		15787	75656	75629	7	
Panchlaish Thana Total	2051	44771	219152	219120	12	26405
Panchlaish Thana		44771	219152	219120	12	
Ward No-07 Total		24997	125517	125517	0	
Ward No-08(Part) Total		18921	89471	89459	12	
Ward No-16 (Part) Total		855	4144	4144	0	
Chandgaon Thana Total	6257	54949	256411	256575	56	10127
Chandgaon Thana		54949	256411	256575	56	
Ward No-04 Total		25555	107807	107774	55	
Ward No-05 Total		17901	86491	86488	5	
Ward No-06 Total		15715	62115	62115	0	
Double Mooring Thana Total	2006	77815	561154	560590	564	44491
Double Mooring Thana		77815	561154	560590	564	
Ward No-25 Total		6669	51175	51175	0	
Ward No-24 (Part) Total		16692	78609	78600	9	
Ward No-27 Total		14695	66755	66712	45	
Ward No-28 Total		10878	50410	49898	512	
Ward No-29 Total		9524	44548	44548	0	
Ward No-50 Total		9651	45928	45928	0	
Ward No-56 Total		9904	45929	45929	0	
Bakalia Thana Total	2997	56756	262705	262691	12	21661
Bakalia Thana		56756	262705	262691	12	
Ward No-17 Total		20774	97145	97158	7	
Ward No-18 Total		15665	65869	65868	1	
Ward No-19 Total		16894	76502	76502	0	
Ward No-55 (Part) Total		5405	25587	25585	4	
Bayejid Bostami Thana Total	4544	46701	211555	211549	6	12025
Bayejid Bostami Thana		46701	211555	211549	6	
Ward No-01 Total		6101	29209	29209	0	
Ward No-02 Total		24705	105514	105514	0	
Ward No-05 Total		14251	68794	68788	6	
Khulshi Thana Total	5242	60800	278625	278614	9	21258
Khulshi Thana		60800	278625	278614	9	
Ward No-08(Part) Total		9657	44585	44585	0	
Ward No-09 Total		17955	78515	78512	1	
Ward No-15 Total		16441	80590	80590	0	
Ward No-14 Total		16789	75555	75527	8	

Administrative Unit *Residence* Community	Area in Acres	Total Households	Population			Population density [sq. km]
			Total	In Households	Floating	
1	2	5	4	5	6	7
Patenga Thana Total	8069	50125	152677	152677	0	4065
Betagi Union Total		50125	152677	152677	0	
Ward No-40 Total		21559	88595	88595	0	
Ward No-41 Total		8586	44084	44084	0	
Halishahar Thana Total	2582	51291	151515	151488	27	15719
Halishahar Thana		51291	151515	151488	27	
Ward No-11 (Part) Total		5725	18246	18219	27	
Ward No-24(Part) Total		6220	29904	29904	0	
Ward No-25 Total		10972	50566	50566	0	
Ward No-26 Total		10576	52999	52999	0	
*Bandar		1872	9550	9550	0	

Source: BBS (Bangladesh Bureau of Statistics, 2011)

In respect of community, Chittagong City is dominated by Muslims like in other cities in Bangladesh. Hindus, Christians and tribal people are scattered all over the city. However, there are two areas with clear concentration of Hindus and Christians. For instance, Ward Number 20, Dewanbazar is Hindu-dominated and the Patharghata ward (no. 54) is dominated by Christians.

Source: Chittagong Development Authority, CDA

Figure 5-9: Chittagong City Corporation under 41 Municipal Wards

5.4.2 Physical or Cultural Heritage

The port city, Chittagong City and its surrounding hills are blessed with many places attracting tourists. The famous beach town, Cox's Bazar is within 5 hours motor drive and hill town Rangamati on the Kaptai Lake is only 2 hours drive from the city. In addition, Chittagong has many charming places like the tomb of Muslim Saint Sultan Bayazid Bostami, on the hillocks located in the city centre. The World War II Cemetery is another important tourist attraction of the city. Its quiet and serene environment in a picturesque location makes this spot a very special attraction in the city. The shrine of Hazrat Shah Amanat lying in the outskirt of the city is another destination for the Muslim devotees. Similarly, Hindu pilgrims also regularly converge in the Sitakunda Hill-top based Chandranath Temple located in the northwestern outskirt of the city.

5.4.3 Structure or Sites of Historical, Archaeological, Paleontotogical or Architectural Significance

The Court Building Museum situated at Fairy Hill has a panoramic view of the city skyline. In terms of open spaces, two prominent sea beaches, Patenga and Fouzdarhat are tourist attractions both for city goers and outsiders. A large number of crowds gather in the two beaches every day, particularly during the rain-free winter seasons. At Agrabad, there is an ethnological museum, which preserves the artifacts and documents of cultural heritage of the tribal community of the country. Both the general public including academicians and tourists find it an interesting treasure house.

Foy's lake is another natural scenic attraction within the city; though man-made, it's hilly location, quiet environment and clean water and presence of charming migratory birds is worth visiting. It is about 8 km away from the city centre towards east of Pahartali Railway Station and west of Khulshi, a high-class residential area. The area to the immediate north and east of the lake is designated as a Botanical and Zoological Garden.

Battali Hill and adjoining hillocks are vantage points for appreciating the attractive city skyline. However, part of these landscapes is encroached by squatters.

5.4.4 Land use and Urbanization

Other than the sections along the Dhaka Trunk Road and the south bank of the Karnaphuli River, nearly all the area falls within the city perimeter. Chittagong city, however, still has room for development in certain sections where urbanization has not progressed. In particular, considerable room for development is available in Chandgaon, located along the west bank of the Karnaphuli River; in Bayazid Bostami in the northern part of the city; and the west side of Hathazari Rangamati Road. These sections are expected to be urbanized in the near future.

The west bank of the Karnaphuli River is close to the central district and has high potential for development. The area has not been developed to any great extent, however, apparently due to the fact that it has suffered frequently from cyclone damage and has inferior bank protection.

The urbanized area of Chittagong City has spread outwards in response to pressure from population growth. A key issue concerning land use in the city is how to ensure systematic development in line with long-term visions for the city such as the Chittagong Master Plan, rather than allowing urbanization to progress in a disorderly fashion.

Issues concerning land use in Chittagong include the following:

- Outward spread of the built-up area due to overcrowding in the city center
- Illegal development of residential land and the construction of high-rises that violate the Construction Standards Law
- Illegal hill cutting and the resultant environmental deterioration such as slope collapses, debris flows and sediment deposition in khals
- Flooding of areas located along the Bay of Bengal and the Karnaphuli River
- Insufficient number of open spaces and recreational facilities

5.4.5 Water Supply and Sanitation

Other than potable drinking water, Chittagong City dwellers utilize ponds water for cooking, bathing and outdoor and indoor washing purposes. Karnaphuli River originates from the eastern hilly areas outside the country and empties in the Bay of Bengal marking the southern boundary of the city. It is the major river basin in the south-eastern region of the country and the principal water supply source for Chittagong city in addition to city ground water Deep Tube Wells sources. The river has total length of about 50 km in main channel from the point of Kapti Lake. Kapti Lake is the largest man-made lake providing water to the Karnaphuli and is the only source of hydroelectric power of the country.

There is no sewer in the city but domestic sewage are disposed by septic tank with soak well and / or detention water disposed to the city drains including hospital sullage and liquid wastes.

5.4.6 Industries and Employment

There are six major industrial areas in Chittagong city at present, one of which is the Chittagong Export Processing Zone. The Bangladesh Industrial Standard Classification Code classifies industrial land into five types ranging from A1 to A5. Four types, A1 to A4, are represented in Chittagong by the six major industrial areas. The Chittagong EPZ, which houses many high-tech firms, is a combination of A2 and high-tech A-1. The Karnaphuli EPZ, an extension of the Chittagong EPZ, lies within the Patenga Industrial Area.

5.4.7 Trading and Transportation

Exports from and imports into Bangladesh are both expanding steadily. Exports registered an average annual growth of 5.7% over the past five years, while imports showed a rise of 5.4%. The two sectors grew at about the same pace, with exports performing slightly better.

The main export items are garments and knitted textile products, which together account for an overwhelming 75% of the nation’s total export value. The heavy reliance on a single export category, namely textile products, makes Bangladesh’s export sector highly vulnerable to any depression in the global market. Efforts to develop additional products for export are desired.

Export processing zones account for a solid share (15.5 %) of the total value of exports from Bangladesh. They constitute important industrial centers for the earning of foreign currency.

Bangladesh imports more than it exports. Imports into the country run at about 145% of exports out of the country in terms of value. Major import items except for capital goods are raw materials, such as textiles, petroleum products and raw cotton.

For good export import of Goods, the Chittagong Port is utilized transportation system as maximum as possible for communication. Transportation of goods is becoming more common through roads specially through the Port Access (toll) Road by Container Trucks. Train is also used for container transportation purposes.

5.4.8 Fisheries and Wild Fish Catch

Chittagong City fish markets are replenished by sweet water fish of Kaptai Lake, Karnaphuli River, Halda River and various Khals linked with esturian channel, Sangue River etc. Fifty percent of fish market is occupied by sea fish. Most of the fishermen remain in Chittagong city and its suburb area specially the offshore islands like Sandwip, Hatia, Moheshkhali, Kutubdia, etc.

5.5 Air Pollution

The city suffers from air pollution, originated from different sources including nearby brickfields, dusty open spaces, bad smell from industrial effluents, smokes from industries and motorized transport vehicles including road, river and marine vessels. Being located in the hill margins, inversion of temperature helps to generate fog and smoggy environment in the city sky, particularly during the dry seasons thereby creating health hazards for the city inhabitants. The Department of Environment (DoE) regularly monitors important air pollutants like NOx, SOx, CO_2 , CO, SPM, CH_4 and Pb at several locations in the city.

In both industrial and commercial areas, SPM value has also crossed the standard value, which means that the state of SPM concentration is at an alarming level in the city. High concentration of SPM value is attributed to the large scale on-going construction work during dry season, dusty unpaved road sides, poor vegetation cover and unregulated vehicular movement within the city.

Unlike SPM, the overall concentration of SOx and NOx in the city air appears to be in better condition. None of the pollutants crosses over the allowable standard limit as prescribed by the DoE for different areas.

5.6 Noise

The city also suffers from noise pollution during both day and night-time. At present, strict enforcement of using hydraulic horns of vehicular transport are not followed. Heavy duty lorries and trucks loaded with containers plying at the night cause serious noise pollution. The DoE monitors noise and vibration levels at selected road intersections occasionally.

Table 5-15: Total Area Affected By Aircraft Noise Of Chittagong Airport

Year	Area (ha) More than WECPNL 70	More than WECPNL 75
1995	1,518	758
2005	1,290	749
2015	1,505	754

Source: Department of Environment, DOEBD

1) The Aircraft noise contours are calculated for the year 1995, 2005 (Phase I) and 2015 (Phase II), WECPNL = Weight Equivalent Continuous Noise Level.

2) In the area where WECPNL is more than 70, appropriate measure are generally required for land use. In the year 2005 and 2015 those areas are estimated to be smaller than those in the year 1995 since the utilization of runway 25 for takeoff which generate more noise than landing will increase incompension with Runway 05, and a large area of the affected area is projected in the sea.

5.7 Water Pollution

Chittagong City has limited sources of fresh water supply. At present, water extracted underground and treated surface water from Haldha and Karnaphuli Rivers are supplied to the city population. Both of the rivers are increasingly at the risk of getting polluted by industrial effluents, household wastes, medical wastes, and agricultural waste and marine vessels wastes. The DoE has been monitoring water quality of the rivers and ground water of the city on a regular basis since 1995. There are 10 sample stations from where DoE takes water samples and analyze the water quality. Moreover, DoE collects and analyzes water samples of Chittagong City hotels and industrial liquid wastes on a selective basis.

Previous studies on Chittagong coastal water pollution indicated that the dissolved concentrations of metallic and non-metallic elements in water are higher towards the sea. Conversely, the metallic and non-metallic concentrations in the sediments are higher towards land. This has been attributed to land-based activities and untreated effluents from urban centers. In the lower Kumira, and Upper and Lower Karnaphuli, the lead concentration was found to be above the acceptable level (0.2 ppm, Chowdhury et. al., 1994). A survey conducted by DoE reported that more than 50 ship breaking industries operate in the Chittagong coast and over 60 big ships are dismantled (ship breaking activities) every year. During ship breaking, effluents are released in the Swandip Channel causing localized marine pollution problem. It has been observed that dissolved oxygen (DO) concentration varies from 5.6 to 5.8 mg/l and Biochemical Oxygen Demand (BOD) concentration ranges from 2.2 to 2.5 mg/l (DoE, 1997).

5.8 Garbage Disposal

The city generates more than 5000 metric tons of wastes each day, however, the city corporation collects only one-third of the wastes for disposal. It has no designated disposal sites at the moment and it dumps on two dumping sites. One of the estimations indicates that about 750 tons of household wastes are dumped in 2,000 designated dumping points while rest are dumped on the streets, canals, drains, khals, sea and rivers directly. The primary sources of wastes are households, Markets, Road Sweepings, Drain Cleanings, Construction Waste, Industrial Waste, Garments (Zhut), Leather Goods and Medical Waste. There are two major dumping sites-1. Roufabad and 2. Halishahar. The dumping site in Roufabad is a private land located at West Sholoshahar (Ward No. 7) behind Amin Jute Mills with an area of 5 acres. The dumping site in Halishahar is owned by City Corporation and is located at North Middle Halishahar under Ward No. 57. It has an area of about 5 acres. The city corporation owns 60 Motor vans and involves about 1,900 people in collection, transportation and dumping of garbage. Dumped garbage create some leachets that sometimes pollute ground water in the area.

5.9 Oil Spillage and Chemical Disposal

The Port and EPZ area are the main source of oil spillage from trucks and industries was lead by rain water through road connecting drains. EPZ is also responsible for polluting khals and drains by chemical wastes. Clinic and Hospital wastes also include some chemicals which get way to water body through drains and khals.

Chapter 6. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.1 Key Consideration

In this section of the IEE, potential impacts of the overpass project and their recommended mitigation measures will be described. Potential impacts have been identified by screening methodology recommended by the GOB and JICA Guidelines.

The screening procedure follows the same sequence and enumeration pattern as the previous chapter, thereby facilitating references between the potential impacts and the existing conditions and locations to which they relate. Many environmental parameters/ indicators have shown impact values significantly high which need to be addressed. The purpose of identification of key issues is to focus on those environmental impacts that need careful attention for ensuring sustainable and environment friendly development of the commercial capital city as well the country in the long run. Identification of the significant environmental indicators/ parameters, rationale for selection, source of impact and nature of impact for the project is carried out based on the existing environment and is presented in Table 8. The impacts fall under the categories related to:

- Physical environment,
- Ecological environment, and
- Social environment

The anticipated adverse impacts on the environment, which may occur during the following three key phases of the implementation of the project are briefly described below.

- Preconstruction phase/ project design phase,
- Construction phase, and
- Operational phase.

6.2 Impacts Related to Physical Environment

6.2.1 Preconstruction Phase of the Project

Adequate consideration of relevant specifications and proper design of the overpass will be ensured to avoid a number of potential adverse impacts on physical environment due to drastic landscape changes of the project area and its surroundings. The following impacts need to be addressed.

6.2.2 Road Safety Aspects

Properly designed geometrical alignment is a major factor for road safety of the overpass. Improper geometrical design of the overpass will cause accidents, loss of lives and damage to properties. Adverse impacts of the overpass from road safety point of view may have their root in design stage due to decisions taken in regard of engineering details such as sight distances, turning radii, intersection configuration, etc.

Potential Impacts/ Issues: Increased road safety concerns.

Mitigation Measures: Ensure appropriate design for the geometrical and spatial characteristics of the flyover.

6.2.3 Identification of Important Environmental Components (IECs)

Considering the types of the interventions expected in the proposed projects, the following environmental parameters are selected for the screening purpose. Considering the scale and type of the projects a total of 18 Important Environmental Components (IECs) were selected after consulting with several projects in same kind of scale and appropriateness. The IECs were classified in four categories such as Natural Environment, Ecological Parameters, Environmental Pollution and Social Environment. Table 6-1 presents the type of IECs and their rationale for proposed projects.

Table 6-1: Rational to Select Environmental Parameters

Environmental Parameters/Important Environmental Components (IECs)		**Rationale**
Natural Environment		
1.	Topography	Due to construction of the overpass topography of the project site might change.
2.	Soil Erosion and Siltation	Implantation of the projects might cause soil erosion and siltation.
3.	Regional Hydrology (Flooding, Drainage Conges and Water Logging)	Road construction may affect on drainage congestion and water logging.
4.	Ground Water Table	If the projects cause water stagnation, then ground water may affect.
5.	Landscape and Land use	The interventions particularly overpass construction may affect on existing landscape and land use pattern.
Ecological Parameters		
6.	Forest / Tree / Crop	Construction/reconstruction and widening of road and overpass might have some negative impacts on road side trees.
7.	Environmentally Protected and Sensitive Areas.	Environmental study should confirm the existence of environmentally protected and sensitive areas.
Environmental Pollution		
8.	Air Pollution	Air pollution may occur through the use of vehicles and equipments, cleaning of materials, coating of construction materials, dust from stone/brick crushing etc.
9.	Ground & Surface Water Pollution	Accidental spillage of toxic chemicals such as fuel, lubricants, and solvents may pollute water.
10.	Noise and Vibration	This can occur during construction activities and vehicular movement.
11.	Soil Contamination	Soil can get polluted due to construction activities.
12.	Waste Disposal	This can be an issue during construction period.
Social Environment		
13.	Employment	Employment will create at construction stage.
14.	Historical and Cultural Loss	Additional projects implementation may damage mosque, graveyards etc. The influx of non-local labors may also result social disruption.
15.	Worker's Health and Safety	Health risk is related to handling of construction equipments, various chemical materials during construction phase.
16.	Accident	During the construction and reconstruction activities, operation of heavy vehicles and machineries may cause traffic accidents in and around the proposed project sites. Also, accidents may occur to the workers during the construction.

The following table demonstrates the importance of Air, Noise and Economic involvement with the impact parameters of a highways/overpass projects

Table 6-2: Identification of Significant Environmental Indicators/Parameters, Rationale for Selection, Sources and Natures of Impact for the Overpass Project

Impacts		Mitigation Measures			
Road Safety Aspects of the Overpass		Ensure Proper Geometric Design of the Proposed Overpass			
Serial Number	Items	Performance Measure (*Service Measure)	Appropriate for Use		
			Air	Noise	Economic
1	Urban streets	Travel speed*	•	•	•
		Running time	•		•
		Intersection control delay	•		•
2	Signalized Intersections	Control delay*	•		•
		V/C ratio	•		•
3	Intersections without signals	Control delay*	•		•
		Queue length	•	•	•
		V/C ratio	•		•
4	Pedestrians	Space*			
		Pedestrian delay*			
		Speed			•
		V/C ratio			•
5	Bicycles	Hindrance*			
		Control delay*			•
		Travel speed			•
6	Two-lane Highways	Percent time-spent-following*			
		Speed*	•	•	•
7	Multilane Highways	Density*			
		Speed	•	•	•
		V/C ratio	•		•
8	Freeway Facilities	Density*			
		Vehicle delay			•
		Speed	•	•	•
		Travel time			•
9	Basic Freeway Segments	Density*			
		Speed	•	•	•
		V/C ratio	•		•
10	Freeway Weaving	Density*			
		Weaving speed	•	•	•
		Non-weaving speed	•	•	•
11	Ramps and Ramp Junctions	Density*			
		Speed	•	•	•
12	Interchange Ramp Terminal	Control delay*	•		•
13	Transit	Service frequency*	•	•	•
		Hours of service*	•	•	•
		Passenger loading*	•	•	•
		Reliability*	•	•	•

Source: ***Highway Capacity Manual 2000***

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6.2.4 Ambient Air Quality and Noise

It is likely that due to implementation of the project, the vehicular movement will be gradually high and create air pollution in the atmosphere and high noise level to the nearby settlement. Due consideration may be made to minimize the impacts to the environment.

6.2.5 Water Pollution

It is not expected that a high level of water pollution will occur due to the overpass implementation. The leakage of the oils and accidental spillage may be managed by the construction of road side drains with interceptors at some interval.

6.3 Impacts Caused by Project Implementation

While the project overpass would certainly produce beneficial effects, the chances of causing adverse impacts are not lean. For convenience of understanding, the potential adverse impacts and their mitigation measures have been identified in the context of:

1. Impacts from project design;
2. Impacts during construction of the designed infrastructure; and
3. Impacts during operation (use) of the constructed infrastructure.

Identification of the nature of the adverse impacts and their mitigation measures had emerged largely from field visits and partly from examination of secondary sources and discussions with stakeholders along the corridor of impact.

6.3.1 Impacts Related to Design Consideration

It is necessary to mention that the construction of an overpass with a peak height to 8.5 meter above existing ground level is designed to be placed on the existing roadways. Whatever impacts that the designed overpass will cause will be part of the ambient environment. But the experience already gathered about it would suggest how carefully one should proceed with the overpass and its ramps. The construction of a four-lane overpass road over the recommended alignment is entirely new. On account of a different nature of road over an existing road, special consideration would be required while designing.

In this section, the major issues have been pointedly mentioned with suggestions on design.

In Table 6-3, the issues have been listed with observations on mitigation of adverse impacts.

Table 6-3: Potential Negative Impacts in the Context of Design & Mitigation Measures

Sl. No.	Potential Adverse Impacts	Mitigation Measures
A	Overpass for cattle, loaded fisherman and beach goers.	Special signal system should be arranged to avoid accident.
B	Seepage of any water under the pavement avoided.	Special roadside drain & full embankment consolidation is needed to avoid seepage and rain-cuts.
C	The overpass will pass under a few	At Feeder Road-2, the power

Sl. No.	Potential Adverse Impacts	Mitigation Measures
	electric transmission lines.	transmission line comes proximity of the proposed alignment. Elevated wiring with guard net will be necessary.
D	A number of trees would be felled to lay the Project Road.	Care for minimizing the loss and replanting after construction of the overpass complete.

6.3.2 Adverse Impacts in the Context of Construction & their Mitigation

Many types of adverse impacts happen during construction. Most of these are temporary in nature. These are presented in Table 6-4 along with suggested mitigation measures. In this chapter, particular attention to be made specifically while handling construction works and setting of labor camps. It is also necessary to monitor the emerging quality of air and water as also of the noise level during construction phase.

Table 6-4: Negative Impacts & their Mitigation during Construction

Causes and Expressions of Adverse Impacts	**Mitigation Measure**	**Residual Effects**
Potential Adverse Impacts on Land Resources		
Land requisition for Construction Camp & Site storage	Reinstatement after use	Negligible
Removal of soil & habitat disturbance during earthworks	Back filling, landscaping and regeneration of vegetation	Negotiate for owner's consent on minor landscape change
Noise & dust created at Stone crushing at licensed sites	Use screens & sprinkle water	Locating stone crusher at site may be advantageous as the fine dusts can be used as fill
Contamination of soil at Asphalt plant site	Set the plant on impervious base and use controlled waste disposal method	Reinstate; but minor degradation of soil is unavoidable
Exploitation of fill material for embankment	Study the feasibility of reusing dredged sand from the navigation Channel of the Chittagong Port.	Contaminated fill materials may remain as the body of embankment.
Potential Adverse Impacts on Water Resources		
Contamination of soil and water by Spillage of oil and chemicals	Careful management of storage & washing of tools	Negligible
Pollution risk & general environmental degradation avoided though toilet facilities & canteens for workers	Observe good practices including safe collection & disposal of wastes	Obtain support from the nearby conservancy service
Risk of pollution of nearby water courses by spillage due to accident	Install emergency response plan	May vary with the nature of the accident

Causes and Expressions of Adverse Impacts	Mitigation Measure	Residual Effects
Potential Adverse Impacts on Air Quality & Noise Level		
Decrease of air quality and increase of ambient noise level due to dust & noise from plant and equipment	Use dust & noise control devises; enforce reasonable working hours	Avoid locating construction machineries & plants within 500m of habitation
Decrease of air quality due to emission from Hot-mix plant and equipment	Use emission control devices. Avoid locating construction machineries & plants within 500m of habitation	Slight discomfort during construction period.
Potential Adverse Impacts on Biological Resources		
Depletion of trees & loss of habitat due to impact on flora	Prevention of unnecessary tree felling; develop plantations to compensate for loss of trees	Depends on the quality of implementation of the mitigation measures
Potential Adverse Social Impacts on Human Resources		
Medical Treatment of injuries and other affectations in Labour Camp	Ready availability of First Aid Boxes and regular visits by physicians supported by proper Medicare	Spread of infectious diseases Might occur if the mitigation measure is not properly taken.
Increased risk of sexually transmitted diseases in Labour gangs	Regular check-up	This problem may not arise with the project in hand as no labor camp is needed
Potential Adverse Impacts on Cultural Heritage		
Damage from negligent practices due to impacts on cultural sites	Vigilance to apply measures of protection	This problem is not likely to arise.

6.3.3 Adverse Impacts & their Mitigation in the Context of Operation

A being constructed road through use will generally have positive impacts on the environment. But some adverse impacts can still be negative in nature. Regular monitoring is necessary to detect early signs of negative impacts. These adverse impacts may cause degradation of the quality of water and air, increase of noise level, and threat to safety of human resources. The contexts of monitoring and mitigation measures are noted in Table-6-5

Table 6-5: Adverse Impacts & their Mitigation during Operation

Potentials of Adverse Impact	Mitigation Measure
On Water Resources	
Under normal circumstances, vehicular emission and spillage get deposited on the road surface. During rains, these are carried into the local water courses and pollute those.	Roads should he drains with sumps as interceptors. Monitoring the interceptors in the roadside drains would suggest when to clear the deposits. If properly implemented, the expected permanent impact would be very low and would always be site specific.
Severe impacts may arise from spillage of	What is needed is emergency response system.

Potentials of Adverse Impact	Mitigation Measure
hazardous materials in the event of road accident. Depending on the spilled material, the nature of impact varies. Contamination of watercourses by toxic substances would need spillage removal operations. Spillage of inflammable materials can cause fire hazards.	Installation of telephone facilities at some points by the roadside would help in quickly activating the existing emergency response system of Bangladesh.
On Air Quality	
Negative impacts come from emission.	The mitigation measures are of many types, such as enforcing the owners of vehicles to obtain every six-month a certificate on the emission level; Adoption of a national policy against use of sulpher contaminated diesel or lead contaminated petrol is necessary.
On Noise Level	
Negative impacts arise from increased speed of vehicles, volume of traffic and use of noisy gears.	The mitigation measures are (a) Carrying out periodic monitoring of ambient noise level on the road to identify the places of severe affectation; (b) Raise vegetative screens to impede transmission of noise at places of severe affectation; (c) Enforce speed reduction near habitations; (d) Impose penalty upon the owners for use of noisy gears.
On Biological Resource	
Negative impacts come from careless garbage disposal on roadside, illegal felling of trees, poaching of animals, etc.	Many of these processes are not likely to operate in the project area. The appropriate regulatory authority should be alerted as and when necessary and requested to follow safe practice.
On Human Resources	
Negative impacts arise from increased speed of vehicular traffic leading to decreased safety to the pedestrians. Mitigation measures are many indeed.	Where habitations exist on the edge of the ROW, it is necessary to look into: (a)necessity of service road for slower and local traffic, (b) planting on the slope, (c) lighting on road at night; (d) Placing proper road signs to direct vehicular traffic and assist pedestrian crossing; (e) Monitoring of accidents to discover the need for site specific stricter controls; and (f) Implementation of all these cannot eliminate risk to safety altogether. Hence the objective should be reduction of frequency of accidents.

6.3.4 Enhancement of the Quality of Environment

There is limited opportunity to improve the given quality of environment. However, some of the probable mitigation measures on physical environment, on ecological environment and on human and economic development are presented in this chapter.

6.4 Mitigation of Adverse Impacts

6.4.1 Mitigation of Adverse Impacts on Physical Environment

a) Air Quality and Noise Level

Enforcement of speed reduction near habitations and / or imposing of penalty upon the owners for use of noisy gears may drastically reduce the air and noise pollution. Adoption of national policy against use of Sulphur contaminated diesel or lead contaminated petrol is necessary.

b) Surface and Ground Water Protection

Serve impacts may arise from spillage of hazardous materials in the event of road accident. Contamination of water courses by toxic substances of the spilled substances would need spillage removal operation in addition to emergency response system development installing telephone facilities at some points by the roadside.

6.4.2 Mitigation of Adverse Social Impacts on the Human and Economic Development

a) Road Transport Development

Feeder road, link road and village roads should be improved but the public bus route should be avoided to make the overpass crowd free.

b) Waste Water and Drainage System

All drains should be maintained clean and the natural khals and canals should be properly excavated. No garbage disposal to any khal or drains should allow. Fishery development by intake of saline water through sluice gate or other way should be stopped to maintain the terrestrial eco-system safeguarding mangrove forest.

c) Livelihood and Quality of Life

During construction, local labour and women force should be utilized. The illegal squatter may be voluntarily resettled. In case involuntary resettlement is unavoidable, detailed design should address alternatives and prepare JICA Guideline required resettlement plans such as Abbreviated Resettlement Action Plan.

6.5 Impact Bounding

During preparation of the IEE of the flyover project, the spatial boundaries were considered to extend to the edge of the proposed Right of Way. In case of topographical study, ecological features and hydrological assessment of the project site were examined in

terms of its local and regional context. For noise pollution, the extent of the study was also limited to the Right of Way of the project.

6.6 Environmental Risk Assessment

Environmental Risk Assessment of a project is an integral part of the Environmental Impact Assessment (EIA). The EIA assessed and identified the impact of the project to the surrounding population and the natural ecosystem. In fact, Environmental Risk Assessment is expected to investigate these identified concerns where significant consequences and uncertainties exist. The major safety hazard in the flyover project is Occupational and Public Health and Safety, but the actual risk depends on how and when hazards would occur and what would be their duration, magnitude and severity.

6.7 Evaluation of Impact

Initial Environmental screening has been done and environmental parameters or indicators were identified. These parameters are screened and assessed with respect to their potential by using EIA checklist in Table 6-6 Rating of negative impacts based on probability and severity of relevant parameters for the project were carried out.

Potential impacts have been classified into 3 categories:

- Positive impact;
- Negative impact; and
- No impact.

The negative impacts have been assigned ratings of 'Probability' and 'Severity' in accordance with the following:

Table 6-6: Rating of negative impacts based on probability and severity

Probability (p)	**Severity (s)**
1. Negligible 2. Slight 3. Possible 4. Likely 5. Very likely 6. Inevitable 7. No damage 8. Minor damage/ hazard to single receptor 9. Minor damage/ hazard to multiple receptor 10. Significant damage/ hazard to single receptor 11. Significant damage/ hazard to multiple receptor 12. Destruction of single/ multiple receptor	1. No damage 2. Minor damage/ hazard to single receptor 3. Minor damage/ hazard to multiple receptor 4. Significant damage/ hazard to single receptor 5. Significant damage/ hazard to multiple receptor 6. Destruction of single/ multiple receptor 7. Negligible 8. Slight 9. Possible 10. Likely 11. Very likely 12. Inevitable

The Impact Value is calculated as the product of 'probability' and 'severity', thus

Impact value = p x s

The recommendation for alleviation of negative impact is as follows:

Impact Value	**Assessment**	**Recommended Action**
1 – 12	Low Impact	May be acceptable
13 – 24	Medium Impact	Reduce/ Eliminate
25 – 36	High Impact	Reduce

The followings are the assessed potentially adverse impacts:

1. Dust and suspended solids
2. Gases like CO_x, NO_x, SO_x, Pb, SMP
3. Local rainfall flooding
4. Surface water pollution (mud, chemo, bio, fecal)
5. Sedimentation
6. Groundwater pollution (bio, chemo)
7. Disposal of Bentonite slurry on the lands
8. Land type changes
9. Soil chemistry (Toxicity)
10. Water logging
11. Earthquakes (constraint)
12. Social disruption
13. Loss of livelihood
14. Changes in settlement pattern
15. Political and institutional administration
16. Demography
17. Gender issues
18. Inequality
19. Education and literacy
20. Archaeological sites
21. Quality of human life
22. Economic and political instability
23. Employment opportunity
24. Economic development
25. Roads
26. Traffic congestion
27. Traveling time
28. Traveling cost
29. Railways
30. Disruption of commercial and industrial business
31. Power supply
32. Telecommunication
33. Water supply
34. Sewerage and storm water drainage
35. Waterborne disease
36. Noise and air pollution
37. Disruption of commercial and industrial business
38. Disease
39. Social instability/ conflict
40. Rehabilitation/ resettlement
41. Health and safety
42. Labour management
43. Direct construction impact management

EIA checklist in Table 6-7 indicates that among the 40 negative impacts, the highest impact value is 30 in the case of direct construction impact management and health and safety issues under social environment. This is followed by physio-chemical environment, such as air, noise, and water and soil pollution – the rating ranging between 16 and 20. All other impacts are found within low and medium impact rating categories.

Table 6-7: Initial Environmental Examination Checklist for Construction of the Flyover

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
NATURAL ENVIRONMENT							
Physico-chemical Environment							
Atmosphere:							
Air Pollution							
Dust and suspended solids			•	5	5	25	Dust generation during earthworks, excavation and casting of foundation of flyover and dismantling of the existing physical infrastructures
Gases like CO_x, NO_x, SO_x, Pb, SMP			•	3	4	12	Pollution will be created due to emission from construction vehicle traffic and operation of the construction equipment
Climate:							
Rainfall		•					Project construction site is subject to climatic constraints
Cyclones		•					Same as above
Water Resources:							
Surface Water Quantity							
Local rainfall flooding			•	4	4	16	Due to water logging at construction site during flood and severe rainfall in monsoon period
Main river flooding		•					Project site is not directly connected to the man river
Surface Water Quality							
Pollution (mud, chemo, bio, fecal)			•	4	4	16	Disposal of construction wastewater and sanitary wastage, spillage of waste oil

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
							and lubricants, etc. into nearby surface water
Domestic water supply		•					No concern
Irrigation		•					Same as above
Sedimentation			•	4	4	16	Wash out of construction waste liquid will cause sedimentation load in the surface water of surrounding water bodies during the monsoon season
Groundwater Availability							
Domestic water supply		•					No concern
Groundwater Water Quality							
Pollution (bio, chemo)			•	4	3	12	Spillage of lubricants, fuel, etc. during construction from vehicles and construction equipment at site
Contamination (Arsenic)		•					Arsenic contamination of ground water is of less concern in Chittagong city. (Ref. to Map in Section 5.1 Natural Environment)
Disposal of Bentonite slurry on the lands			•	5	4	20	During piling works for construction of piers
Land Resources:							
Topography		•					Project site is not subject to topographic constraints
Land (soil)type			•	5	5	25	Significant degradation will occur on

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
							landscape. Appropriate mitigation measures will be recommended as further study is made.
Soil Quality:							
Chemistry (salinity)		•					No concern
Chemistry (Toxicity)			•	4	4	16	Spillage of oil, fuel, lubricants, etc. from construction traffic and equipment and disposal of Bentonite slurry
Water logging			•	4	4	16	Inadequate drainage facilities
Seismic characteristics:							
Earthquakes (constraint)			•	5	4	20	Significant concern on design
Natural Biological Environment							Not applicable at this stage
Livelihood							
Social Environment							
Social disruption			•	4	5	20	Due to disturbance during construction phase
Loss of livelihood			•	4	5	20	All business on the encroachment will be closed temporally. *The detailed design should examine the alternatives to minimize the closure of business as much as possible*
Settlement pattern			•	3	4	12	The change of landscape cannot be determined at this stage
Political and institutional administration		•					No major concern
Demography		•					No concern

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
Gender issues		•					No concern
Inequality		•					No concern
Education and literacy		•					No concern
Archaeological sites		•					No concern
Quality of human life	•						After implementation of project
Common Resource Rights:							
Power supply			•	4	4	16	Disruption due to removal and shifting *(detailed design will consider the mitigation measures)*
Telecommunication			•	4	4	16	Disruption due to removal and shifting *(detailed design will consider the mitigation measures)*
Water supply			•	4	4	16	Disruption due to removal and shifting *(detailed design will consider the mitigation measures)*
Sewerage and storm water drainage			•	5	5	25	Disruption due to removal and shifting *(detailed design will consider the mitigation measures)*
Human Health							
Waterborne disease			•	3	3	9	May occur from contaminated drinking water at the site *(detailed design will consider the mitigation measures)*
Noise and air pollution			•	4	3	12	Operation of construction equipment such as excavator, roller, hot mix plant,

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
							etc. *(detailed design will consider the mitigation measures)*
Human nutrition	•						After implementation of project
Economic Environment							
Economic Livelihood							
Disruption of commercial and industrial business			•	5	4	20	During construction works and would be recovered after construction *(detailed design will consider the mitigation measures)*
Employment opportunity	•						Job opportunities will increase during construction period
Economic development	•						New business centers will be developed after implementation of the project
Infrastructure and Communications:							
Roads	•						Improvement after completion of the project
Traffic congestion	•						Reduction after completion of project
Traveling time	•						Will be reduced after completion of the project
Traveling cost	•						Reduction after completion of project
Railways	•						After completion of project
Social Risks and Hazards							
Disease			•	4	4	16	May occur from transmission of diseases from the laborers at the site *(detailed design will consider the*

Aspects	Impacts (•)			Negative Impact Value			Comments on existing components/ concerns, causes of pollution and other relevant issues)
	Positive	No Impact	Negative	Probability (p)	Severity (s)	Impact Value (p x s)	
							mitigation measures)
Social instability/ conflict			•	2	3	6	Conflict may occur between the local laborers and the outsiders *(detailed design will consider the mitigation measures)*
Economic and political instability		•					No concern
DIRECT CONSTRUCTION IMPACTS							
Rehabilitation/ resettlement			•	5	4	20	Vulnerable businessmen on the encroachment will need rehabilitation/ resettlement *(detailed design will consider the mitigation measures)*
Health and safety			•	6	5	30	Occupational and public health and safety issues at the construction site *(detailed design will consider the mitigation measures)*
Labor management			•	5	4	20	Labor conflict may occur at the site *(detailed design will consider the mitigation measures)*
Direct construction impact management			•	5	6	30	Important management and environmental issues to be considered *(detailed design will consider the mitigation measures)*
Total Impacts	9	18	33				

Chapter 7. ENVIRONMENTAL MONITORING PLAN

7.1 Environmental Monitoring

Most of the negative impacts arise from construction activities. Monitoring during construction can play a key role to off-set the negative impacts or to keep the negative impacts to a minimum. Environmental Monitoring (EM) for proposed development are as follows:

- Measure the extent of expected or poorly quantified impacts;
- Ensure incorporation of Environmental Mitigation Measure (EMM) during implementation of the proposed projects;
- Observe effectiveness of EMM;
- Ensure early detection of unexpected impacts and adoption of appropriate protection measures;
- Provide periodic reviews to observe adherence to Environmental Quality Standards (EQS) and adjust EMM, if required; and
- Detect unacceptable level of impacts and adopt corrective measures.

Environmental monitoring requires a set of indicators that could be conveniently measured, assessed and evaluated periodically to establish trends of impacts. Monitoring of construction related environmental impact should take place throughout the period of implementation of the project. Some of important monitoring issues are described here.

- Surface water of the downstream of the proposed projects will be tested routinely for important water quality parameters to monitor that the construction activities are not deteriorating downstream water body's water quality.
- Prior to approving the ground water for drinking, contractor shall submit the test results of the groundwater to the consultant.
- Agricultural lands surrounding the project area will be monitored to check if there is any crop damage by the construction activities.
- Periodic check on workers' health will be carried out by the contractor and to isolate any cases of infectious diseases.

7.2 Environmental Monitoring Schedule

Table 7-1 gives the implementation timing and responsible agency for all EMP items.

Table 7-1: Summary of Environmental Monitoring Schedule

Environmental Impacts		Possible Mitigation Measures	Residual Impacts	Monitoring Parameters	Frequency of Monitoring	Implementation and Monitoring Agency
PRE-CONSTRUCTION STAGE						
1	Topography	▪ Select existing borrow pits ▪ Avoid unnecessary digging activities on the topography ▪ A proper construction guidelines can be prepared and followed	▪ Little Impact of existing Topography	As proposed in mitigation measures	Throughout the construction period	Consultant and Contractors
2	Forest / Tree / Crop loss	▪ Notice for removal of trees ▪ Provide adequate, quick and fair compensation to the owners	▪ Some ecological impact	As proposed in mitigation measures	Regularly during the project phases till compensation is fully made.	LGED, Consultant, Contractors and PAPs
CONSTRUCTION STAGE						
3	Wildlife	• Minimize disturbances to habitat condition	▪ Little Impact	As proposed in mitigation measures	Throughout the construction period	Consultant and Contractor

Environmental Impacts		Possible Mitigation Measures	Residual Impacts	Monitoring Parameters	Frequency of Monitoring	Implementation and Monitoring Agency
4	Air Pollution	▪ Spray water on dry surfaces regularly to reduce dust generation. ▪ Maintain optimum moisture content during transportation, compaction and handling of soils.	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	DoE, Consultant & Contractor, LGED
5	Contamination of surface and ground water	▪ Prevent discharge of organic, inorganic, and toxic materials ▪ Provide retention pond to ensure natural treatment for the wastes before discharging into the receiving water. ▪ Reduce turbidity deposition at the downstream of adjacent water bodies.	▪ Minimal Impact	pH, DO, COD, SS, AS, EC, NO_3, NO_2, FC, TC and others usual parameters if required.	3 times in 3 locations throughout the construction period	DoE, Consultant & Contractor, LGED, DPHE
6	Noise and Vibration	▪ Regulate the construction process ▪ Install barrier, if required.	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	DoE, Consultant & Contractor, LGED, DPHE
7	Soil Contamination	▪ Implement strict handling and storage practices to prevent accidental spillage ▪ Provide proper waste management plan and implement accordingly	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	DoE, Consultant & Contractor.
8	Waste Disposal	▪ A waste management plan should be prepared and followed.	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	Consultant & Contractor

Environmental Impacts		Possible Mitigation Measures	Residual Impacts	Monitoring Parameters	Frequency of Monitoring	Implementation and Monitoring Agency
9	Worker's Health and Safety	▪ Provide regular health inspection and vaccination among workers and establish clinic in project camps, if possible ▪ Provide hygienic toilets in project camps ▪ Ensure security of construction area by providing proper fencing, lighting and security force ▪ Ensure supply of quality water ▪ Make the workers aware of chemical materials and proper handling methods ▪ Setup warning signs, signals and provide personnel ▪ protective equipment (PPE) for all workers	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	Consultant & Contractor
10	Accidents	▪ BRTA rules and regulations will need to be strictly followed to minimize the risk of traffic accidents during construction activities	▪ Minimal Impact	As proposed in mitigation measures	Throughout the construction period	Consultant, and Contractor

7.3 RULES OF SAFE PRACTICE

It is necessary that the construction engineer implements the mitigation measures properly. He may know how wisely this can be achieved if he knows what safe practice can be adopted for protection of environment. To enlighten in this regard, the rules of safe practice are noted in this chapter. It would be advantageous if these rules are made conditions in the Bid Document while appointing the contractors, namely, materials contractor, construction contractor and construction Supervisory Engineer.

7.3.1 General

The contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on-site and off-site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in this document.

The contractor shall take all necessary measures and precautions to avoid any nuisance or disturbance arising from the execution of the works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated. The provisions of this sub-clause shall, however, be disregarded in respect of emergency work required for saving life or property or safety of the works.

In the event of any spoil or debris or silts from the sites being deposited on any adjacent land, the contractor shall immediately remove all such spoils, debris or silt and restore the affected area to the original state to the satisfaction of the Supervising Engineer.

Surplus excavation materials and topsoil shall, wherever possible, be used to reinstate quarries or borrow pits or other areas as may be approved by the Supervising Engineer. Such materials should be spread in such a manner as to limit subsequent erosion and shall be re-vegetated as the existing ground conditions dictates.

7.3.2 Fuel & Chemical Storage

All fuel and chemical storage shall be sited on an impervious base within an embanked area and secured by fencing. The storage area shall be located away from any watercourse or wetland. The base and walls of the embankment shall be impermeable and of sufficient capacity to contain 110% of the volume of tanks. Filling and refuelling shall be strictly controlled and subjected to formal procedures.

All valves and trigger guns shall be resistant to unauthorized interference and vandalism and be turned off and securely locked when not in use.

The contents of any tank or drum shall be clearly marked on the body of the container.

Measures shall be taken to ensure that no contamination happens or discharges enter any drain or watercourses.

7.3.3 Water Quality

One sample for testing water quality should be taken at each site of labour camp and construction project office. Standards of permissible water quality set by the Department of Environment, Government of Bangladesh..

The contractor shall prevent any instance of water supply originated from abstraction from polluted water sources (including underground percolating water) as a result of execution of the works.

Areas where water is regularly or repetitively used for dust suppression purposes (including, without limitation, stockpiles for making concrete-batches and asphalt plants) shall be laid to fall to specifically constructed settlement tanks to permit sedimentation of particulate matter. After resettlement the water may be re-used for dust suppression.

All water and liquid waste products arriving at the sites shall be collected and disposed off at locations on-site or off-site and in a manner that shall not cause either nuisance or pollution.

The contractor shall not discharge or deposit any matter arising from the execution of the works into any place except with the permission of the Supervising Engineer and the regulatory authorities concerned.

The contractor shall at all time ensure that all existing stream courses and drains within and adjacent to the site are kept safe and free from any debris and any materials arising from the works.

The contractor shall protect all water courses, waterways, ditches, canals, drains, lakes and the like from pollution, silting, flooding, or erosion as a result of the execution of the works.

The contractor shall submit the details of his temporary drainage work system (including all surface channels, sediment traps, washing basins and discharge pits) to the Supervising Engineer for approval prior to commencing work on its construction.

7.3.4 Air Quality

Air quality should be tested at construction sites. Standards of permissible air quality set by the Department of Environment, Government of Bangladesh.

The contractor shall devise and arrange methods of working to minimize dust, gaseous or other air borne emissions and carry out the works in such a manner as to minimize adverse impacts on air quality.

The contractor shall utilize effective water sprays during the delivery and handling of materials when dust is to be created and to dampen stored materials during dry weather.

Stockpiles of materials should be sited in sheltered areas or within hoarding away from sensitive areas. Stockpiles of inflammable materials shall be covered with clean tarpaulins with application of sprayed water during dry and windy weather. Stockpiles of debris shall be dampened prior to their movement, except where this is contrary to the specifications.

Any vehicle with an open load-carrying area used for transport of potentially dust - producing materials shall have properly fitted side and tailboards. Materials having potential to produce dust shall not be loaded to level higher than the side and tail boards and shall be covered with clean tarpaulin in good condition. The tarpaulin should be properly secured and extend at least 300mm over the edges of the sideboard and tailboard. During high wind, no dust generating operations shall be permitted within 200m of residential areas having regard to the prevailing direction of the wind.

Construction vehicle and machinery shall be kept in good working order and engines turned off when not in use. Appropriate measures shall be taken to limit exhaust emissions from construction vehicles, machinery and plant and the contractor shall include details of such proposed measures in the mitigation and monitoring plan to be submitted to the Supervising Engineer.

In residential areas or other sensitive areas, such as nurseries, schools, hospitals, etc., advance warning shall be given to potentially affected persons so that some measures can be taken by them before commencement of the works.

7.3.5 Noise

The contractor shall consider noise as an environmental concern in his planning and while execution of works. Noise level should be tested at construction sites.

Standards of permissible noise level set by the Department of Environment, Government of Bangladesh.

The contractor shall use plant and equipment conforming to international standards and directives on noise. Use of machineries causing vibrations and emissions shall strictly follow guidelines which will include details of measures for abating noise at source in the mitigation and monitoring plan to be submitted to the Supervising Engineer.

The contractor shall take all necessary measures to ensure that operations of all mechanical equipment and construction processes on and off the site shall not cause any unnecessary or excessive noise taking into account applicable environmental requirements. The contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimize the noise emissions during construction works.

When operating close to sensitive areas such as residential, nursery, school or medical facilities, the contractor’s hours of working shall be limited with 0800 to 1800 hours.

7.3.6 Transmission of Diseases

The contractor shall take all necessary measures to prevent transmission of diseases between the local inhabitants and the labourers engaged for the works. The contractor shall install the necessary medical facilities for this purpose.

If construction labour camps are set up, then the contractor shall verify that that weekly check up for detecting the occurrence of sexually transmitted diseases amongst the

labourers engaged for the works are actually being carried out and submit a certificate to that effect to the Supervising Engineer.

7.3.7 Preservation of Antiquities

The contractor shall take all necessary measures to protect any antiquities or archaeological finds as required by law.

Where antiquities if shown on the drawings or otherwise identified during the course of the works, these shall be protected by means of suitable fencing and barriers to the satisfaction of the Supervising Engineer.

Environment Enhancement

On completion of the works, the contractor shall reinstate all areas with natural vegetation to the satisfaction of the Supervising Engineer.

The contractor shall remove all old tires and internal tubes from within the limits of site and, subject to the agreement of the adjacent landowners, form an additional area of 75m on either side of the road centre line. The contractor shall dispose off all materials in a manner approved by the Supervising Engineer.

Where directed by the Supervising Engineer, the contractor shall improve and reinstate the land on which informal road-side service areas have been established by removing all debris and contaminated soils, re-grading to natural ground levels and re-establishing the natural vegetation where appropriate. All debris and contaminated materials shall be disposed off site as approved by the Supervising Engineer.

Chapter 8. CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

8.1.1 Natural Environment

In physical environment category, the EIA study found that the most critical Important Environmental Components (IECs) are dust and suspended solids, Land (soil) type as well as Sewerage and storm water drainage. However, impact on it is nominal and fully mitigable if the EMP is sincerely implemented.

8.1.2 Ecological Environment

No endangered species is impacted by the interventions. No major negative impact on wildlife and vegetation are expected. There is no ecologically sensitive area in the project sites. There is no critically endangered species found in the project area.

8.1.3 Social Environment

No land acquisition and resettlement is required for implementing the projects. Impacts on other social parameters such as Worker's Health and Safety and Accidents are minimum and controllable if the mitigation measures mentioned in the EMP are properly established.

8.1.4 Environmental Pollution

The significant environmental pollution IEC is air pollution. Huge amount of dust and suspended solids will produce during construction. Moderate noise and vibration pollution will also be occurred in the neighborhood during construction. Appropriate specification of construction equipments based on ambient pollution level should be prepared and followed in order to reduce the level of pollution. Proper maintenance of the construction equipments is recommended.

8.1.5 Direct Construction Impacts

During construction occupational and public health and safety as well as direct construction impact management is an important issue. Detailed design will consider the mitigation measures.

8.2 Recommendations

Based on the findings of this study, following recommendations are made for both the detailed design and construction phases of the Project:

The Important Environmental Components identified can be avoided or mitigated. It is recommended to include appropriate specific environmental provisions and mitigation measures in contract documents and institutional strengthening for environmental management.

Within the EIA process, potential impacts to environmentally sensitive areas have duly been assessed following the guidelines of EIA and the context of a fully defined project description. It must be noted that extent of potential impacts can vary according to detailed design of the proposed overpass ramps, widths, etc. Although the examination in the EIA is based on the worst case scenario as it is currently perceived, detailed design determining widths, potential bypass locations and other important project characteristics could alter the situation.

Therefore, according to the detailed design of the proposed overpass, extent of the environmental and social impacts identified in EIA should be monitored and mitigation measures for them should be reexamined to make implementation of the proposed overpass project environmentally sound and sustainable.